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The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

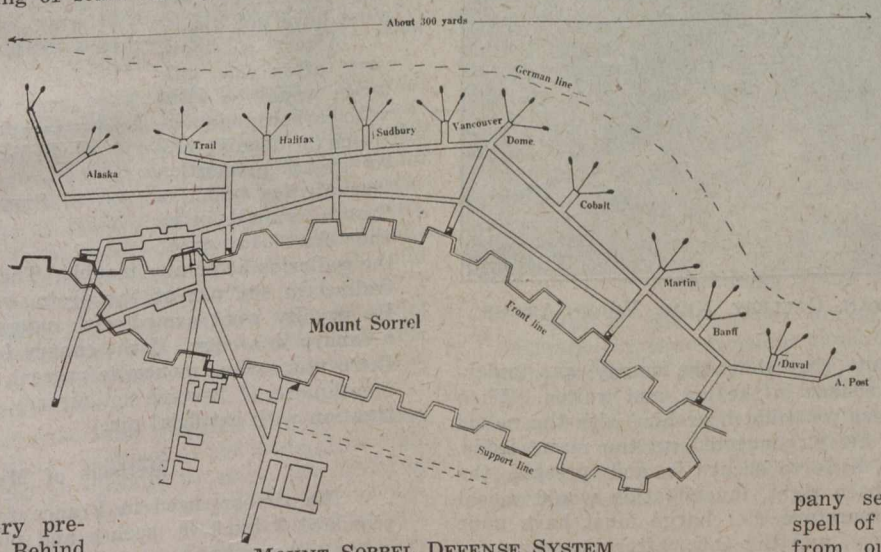
Mining Methods and Tunnelling at the Front

Underground Adventures with Second Canadian Tunnelling Company—Defense of Mount Sorrel—Construction of Galleries and Dugouts—Surveying Under Difficulties—Experiences at Listening Posts—Light Charges in Bore Holes Rout Enemy Listeners

By CAPT. JAS. A. KNIGHT, M.C.

Formerly with the Second Canadian Tunnelling Company.

THE Second Canadian Tunnelling Company arrived in France in March, 1916, all the personnel being drawn from the Canadian mining camps. My personal knowledge of the company dates from July 1st, 1916, when I joined it on transfer from the cyclists. On June 2nd, 1916, when the Germans launched an attack on Sanctuary Wood, this company was mining in the front line and had about 50% of its personnel rendered casualties. It was then withdrawn and reorganized, and several of us were taken on as probationers for commission, as the supply of mining officers was very low. I was first given one stripe and a gang of fourteen men, working at the reclaiming of some old saps which had been captured by Heinie and later retaken by our Second Division. As soon as we had living quarters arranged, we commenced to drive towards the German line, as we wanted to get a protecting gallery around the high ground known as Mount Sorrel, about 1½ miles south-east of Ypres and only 200 yds. to the left of Hill Sixty.



MOUNT SORREL DEFENSE SYSTEM

Our infantry had such a precarious hold on the edge of Mount Sorrel that every precaution was necessary. Behind us was nothing but low swamp through which it was quite impossible to make trenches. The natural thing for Fritzie to do was to try to blow us off the edge, and figuring that he would do the natural thing, we were ordered to put in a protective gallery to keep him back. Finding that our progress was too slow, the O.C. ordered us to start an incline from the front line, and we had no sooner reached the desired level (25 ft.) and commenced to drive horizontally than we ran into one of Fritzie's surprises, and he blew us, killing five men and wrecking our stair. This was very serious, as it showed us that he was already almost under our trench, and also was suspicious of us.

We then went about thirty yards to the right and left and started two inclines. Great care was taken to keep these saps secret, and strict quietness enforced. These were both driven down to the level required and galleries were driven out about 30 yds. We were then ordered to cross cut and connect. As these cross-cuts were expected to cut his gallery, our job was not very inviting, as we expected that he was patiently waiting for us to get near again to repeat his former kick. The officers in charge of this work adopted a very novel scheme which, although daring, worked all right. Work in each face would be stopped while a small bore hole was teased ahead about 25 ft., angling slightly outwards, then a very light charge would be placed in this hole and blown. Figuring that any listeners in the enemy galleries would have been chased away by the sound of the blow, our men would work like fiends for a couple of hours, when the ruse would be repeated.

In due course we cut his gallery and connected up our two stairs without losing another man. In this case our officers simply gambled on the probable effect of the blows on the Huns' actions and we won. It was considered quite a feat. After this the belt was continued with varying success till all the high ground was protected, about fifteen small mines being blown by each side. Sometimes Heinie caught some of our men, but we finally got the system finished as shown on plan. After this the company settled down to a long spell of fighting the Hun back from our line till June 7th, 1917, when, at the battle of Messines Ridge, every large mine on our front was successfully blown and tunnelling was ancient history.

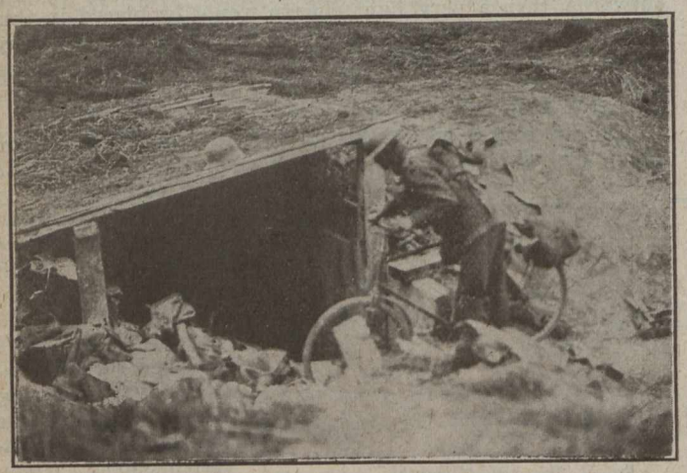
While work was proceeding in offensive mining, the greatest thing necessary was to hear the enemy and not to let him hear us; therefore quietness was essential. This need of silence was the main reason why no mechanical devices were used. No one was permitted to wear boots in the galleries, the men mostly using sandbag slippers which they made themselves. The tunics were left off for fear the buttons would rattle on the timber, and all tools, timber, etc., which were carried through were swathed in sandbags to deaden any sound. No talking above a whisper was allowed.

Every 50 ft. along the main gallery, small listening pockets were driven off and bore holes radiated from the end. At the end of each bore hole there was placed a sealed torpedo containing 100 lbs. of ammanol, with an electric detonator and leads, and main leads were stretched down the main gallery from the office. Also each pocket had an electric

push-button connected to the office. Listeners lay in each pocket continuously, working in shifts of six hours on and twelve off. Each man had a geophone, which was a round wooden box, 3 ins. in diameter and 1 in. thick, containing a mass of mercury between two mica diaphragms, with ear connections like a doctor's stethoscope.

These geophones were very sensitive, and a good listener could pick up sounds of careless working through 16 or 20 ft. of sand, depending on its density. Practically the limit of hearing with the naked ear was 3 or 4 ft. Of course, in clay these distances were often much greater.

The leads from the torpedoes were carried out in gas-pipe tubes for protection, and if the geophone was placed in touch with the metal, the sounds were carried much better, so that when a listener heard a sound, he tried each pipe in turn, thus getting some idea of the direction of the sound. He then rang the bell, and either the officer on shift or the listening patrol would join him and confirm the sounds. Then the pockets on each side would be carefully tested and the source of the sound estimated. It was then necessary to determine whether the sound came from below or from above ground. This generally meant a few hours at night spent crawling around among the wire, etc., of No Man's Land to make sure the sounds did not come from wiring parties, or trench digging, or any other of the numerous noises of the night between the lines.

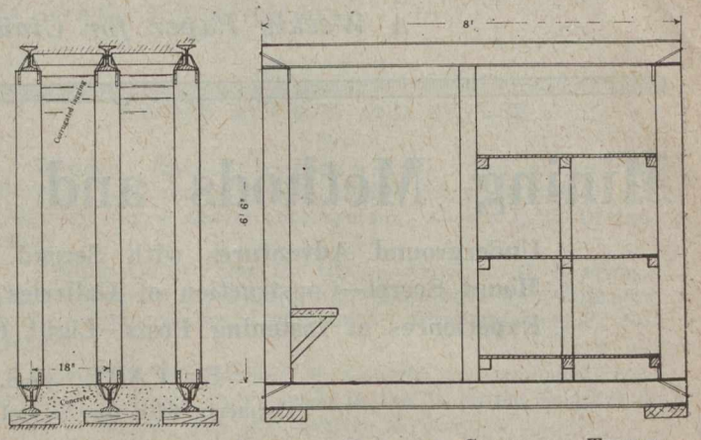


ENTRANCE TO GERMAN GALLERY NEAR VIS-EN-ARTOIS

When we were quite sure that the enemy was underground, we noted the sounds in the log and waited. When he got close enough that we could hear him with the naked ear, we quietly stole away, connected up the main leads, tamped the gallery a little to secure it, and pressed the exploder. If we had been right, investigation would reveal our gallery all O.K., therefore the charge must have gone into the enemy's gallery, and the O.C., after investigation, patted us on the back and told us what fine fellows we were. On the other hand, if we found our own gallery smashed, it showed that we had had our "wind up" and blown a mouse or some other harmless noise, and the O.C. would say, "Hum! I guess Redan needs a new man. You ought to be retired in disgrace to a job where Fritzie couldn't reach you underground and given opportunity to think of your past failures."

My greatest scare came from a mouse which had got down a bore hole; the rattle of its claws on the pipe exactly resembled the muffled scrape of a shovel. I had been called down by the listener and had lain in the dark for about two hours waiting for time to blow, the arrangement being that I would connect the leads, press the bell and the office would give me one minute to get back to safety before they would touch her off. However, when I had the leads all bared ready to connect (and I must admit that my hair was standing on end and I was sweating profusely, as I was quite sure Heinie was only three feet away), much to my relief I saw a small pink nose and two sharp ears appear at the mouth of the hole.

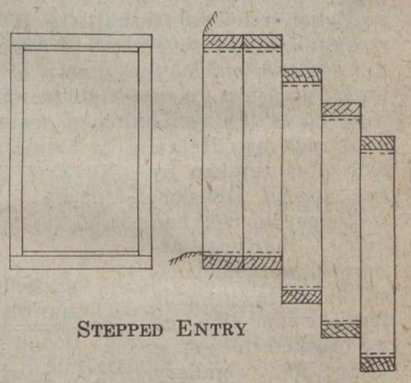
The desire to let the enemy get as close as possible, matched against the necessity of not letting him get in, to-



TYPE OF LIVING GALLERY BUILT BY CANADIAN TROOPS

gether with the intense quiet and darkness, made the work extremely nerve-racking, and many men could not stand it for over three months. One night one of our men was too cautious about blowing, and Fritzie actually stole one of our torpedoes. Why he did not blow us we never knew, but he never got the chance again, as our flanking torpedoes were immediately blown, and as our gallery was untouched, we must have got him.

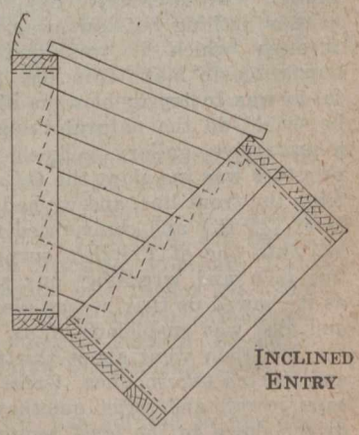
After a blow, very often the galleries would be filled with carbon monoxide, which is deadly, and so great precaution was always taken, a "proto man" being the first to enter the galleries after any trouble. The "proto man" was a man trained in the use of the proto, or mine-rescue apparatus. He usually went armed with oxygen tank on his back and a canary in a cage. If the canary fell off the perch, he knew there was carbon monoxide present, so he would strap on his mouthpiece, if it were not already on, and finish his investigation with artificial air.



STEPPED ENTRY

Methods of Mining

The timber used in France for mining purposes was standard 3 by 9 in. spruce and pine, with some local elm when the supply ran short. Standard sets were made up in the yards, the inside dimensions being 2 ft. 3 ins. by 4 ft., 2 ft. 6 ins. by 5 ft., 2 ft. 6 ins. by 5 ft. 6 ins., 3 ft. by 6 ft., and 6 ft. 6 ins. by 6 ft. Most mine galleries were 2 ft. 3 ins. by 4 ft., and connecting galleries, 2 ft. 6 ins. by 5 ft. or 5 ft. 6 ins. Main galleries for passage of troops were generally 3 ft. by 6 ft., and living dugouts, 6 ft. 6 ins. by 6 ft.



INCLINED ENTRY

In shallow work, that is, with less than 30 ft. of head cover, sinking and rising was carried out by the use of stairways and not shafts, 2 ft. 6 ins. by 5 ft. 6 ins. or 3 ft. by

6 ft. timber being used if the sets were stepped down, and 2 ft. 6 ins. by 5 ft. if the timber were set in the incline and steps placed later. This latter method was used by our company near the end of our work, as we found it the quicker method and also easier for keeping line and elevations. The sets of timber were made up of two legs and two caps or sills.

The caps and sills were supplied with spreaders nailed to the 3 in. by 9 in. timber against which the legs set, and so no nails were necessary to set the timber. The ground excavated was just a neat fit, except over the cap, which was one inch slack to allow for setting.

The Germans used a mortised end on their caps and legs, consisting of a ⅓ tongue, but this required a larger cut, and also was more noisy to handle, as they secured them with wedges, although this was not really necessary. We never made a practice of bracing the galleries, but in the dugouts, which were generally 6 ft. 6 ins. by 14 ft. long, we placed a centre support of two 3 in. by 9 in. timbers on edge, with 6 in. by 9 in. posts at centre and each end. Later, we placed a system of spreaders on top and bottom in order to resist the rebound or bump caused by the explosion of shells right overhead. The failure of many galleries and dugouts was due to the legs jumping the spreaders after a blow.

Construction of Galleries

When the ground was satisfactory, sets consisting of 8 ft. I-beams supported on pit props and secured to them by means of cast-iron chairs or hairpin clips (which were best, as they resisted bumping, which the cast-iron chairs did not), were placed at about 18-in. centres and then "lagged" with corrugated iron. This made a very roomy gallery, which we bunked with lumber and wire, three tiers of bunks, two-man wide, accommodating six men every 6 ft. 6 ins. of gallery. Some of these were concreted, and by driving air shafts to the surface about every 40 ft., we got very good ventilation.

When deep shafts were being sunk through quicksand, 4 ft. or 6 ft. steel tubing was used, the flanges being inside. This tubing was supplied in three segments. When the ground was good, these were sunk by digging out below and jacking down by the use of screw-jacks, the successive tiers of steel being bolted on at the top. The lower set was supplied with a flanged cutting edge. When quicksand was encountered, the whole thing was jacked down until solid ground was reached. As I never worked in a deep shaft, I cannot give a very accurate description of the difficulties met with in this work, although line was very hard to keep, due to a slight movement which sometimes existed in the sand, especially near the canal south of Ypres.

After the shaft had been sunk well into the clay or hard sand at the level desired, one segment of the lower tiers could be dropped out, leaving an opening to start the drift, or drive. Line was kept by the use of cross levels on the top, and also checked with a plumb-bob. The difficulties encountered in driving level and using timber sets were mainly due to quicksand just below the sills, and also to broken or shaken ground above the caps leading to a lost roof or cave-in.

Fore-Poling and False Sets

When the roof was allowed to drop, a method known as fore-poling was necessary in order to recover a solid roof. This consisted of driving stakes into the solid face in front, at an elevation above the top of the caps, and catching them on the top of the last set placed. Then the cavity was filled up with spoil in bags and packed until the roof was reached. The gallery would then be continued, the sets being placed under the poles which steadied the roof. If the cavity was not packed tightly, the roof would continue to shell off as fast as the face was removed. At times the ground at the face would not be strong enough to carry the fore-poling, in which case what was known as false sets would be used. They were sets placed inside the last set of the gallery, and sufficiently small to allow about 1½ ins. clearance, top and sides. Long lagging would then be driven through between these sets, angling outwards. After this timber had been driven sufficiently far into the ground ahead, wedges were driven between the inside ends of the lagging and the gallery timber. Thus the ground in front was held in place by the cantilever action of the lagging. The trouble with this method of procedure was that the gallery was very irregular in section, because the sets placed directly in front of the false set would be slightly smaller than the original section.

Pilot Galleries

Very often it was found very hard to drive a large face, although a small one would hold quite well. In ground of this nature a small gallery known as a pilot was used. This method consisted of driving a small gallery about the centre of the main face, and afterwards returning and enlarging it to full size, using the pilot timbers to steady the ground in front. In one case I found it necessary to use a second pilot, and as the gallery in question was being driven through a graveyard, the rum jar was a very necessary friend. A shot of rum every half hour barely sufficed to deaden the stench.

Working conditions seldom allowed one to pick his sight. In one connection made by our company it was found necessary to use false sets and to fore-pole the floor as well as the top and sides, the ground being semi-quicksand. Working in this ground was very unsatisfactory.

Vertical wooden shafts were sometimes used in good ground, the sets being placed at the bottom and hung by strapping to a collar set placed on the ground at the top.

So far I have only mentioned the difficulties met with due to the ground. It must be remembered that all the time the Hun was watching as closely as possible, and the moment he saw a bit of timber or fresh ground or blue clay, he turned all kinds of noisy messengers on to the locality. It was generally necessary to start work at night, and until every man was well below ground no work could be carried on in daylight, and all material would have to be carefully covered with sacking and sand before day broke. After sufficient cover was obtained, the spoil from the day shifts would be piled in the gallery in sandbags, and an extra party of men put on at night to clear it away and dump it, taking care to cover the fresh sand with surface sand before leaving.

Very often a face which seemed to be quite hard and firm would suddenly fall in, due to the shake of a big shell falling near, a condition never met with in civilian mining.

Surveying Under Difficulties

Most of the time our surveying was done with 4-in. prismatic compasses, and as some of the galleries were lined with corrugated iron, and dud shells were likely to be on any side of one, it can be seen that connections were very often made largely by guess. After our second year, however, we managed to get an excuse for a transit and a very good dumpy level, so we were able to make a few decent-looking connections.

The Dominion Iron & Steel Co., Ltd., announces that it has received an order from Rumania for 7,500 tons of specially shaped rails. Work on the order will commence in January.

The Asphalt Association, which has had temporary offices at 56 Church St., Toronto, for the past few months, has obtained permanent quarters in the Tyrrell Bldg., 95 King St. E., Toronto. The temporary telephone numbers are Main 4288 and 4289. The office is in charge of Bruce Aldrich, district engineer for the association.

The following officers were chosen by the Town Planning Association of Southwestern Ontario to serve for the ensuing year:—President, Ald. John Bridge, Windsor; first vice-president, W. A. Childs, Hamilton; second vice-president, S. Baker, city clerk, London; hon. secretary, Gordon Philips, London; hon. treasurer, John Cottam, London; executive committee, F. Maclure Sclanders (Border Cities), J. McAdam (Sarnia), W. B. Burgoyne (St. Catharines), J. M. Shuttleworth (Brantford), and W. H. Breithaupt (Kitchener).

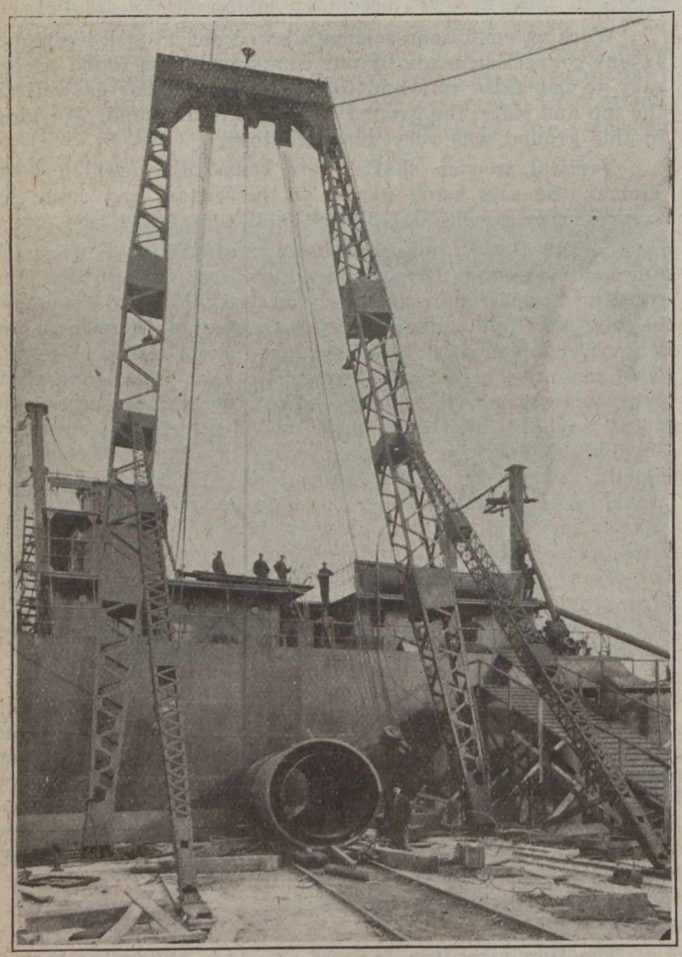
LARGE SHEAR-LEGS BUILT AT TORONTO

SHEAR-LEGS 80 ft. high, 35 ft. wide at the base, 10 ft. wide at the top, and with carrying capacity of 100 tons distributed equally between two blocks, were recently erected at the yards of the Dominion Shipbuilding Co., Toronto.

The two blocks allow both symmetrically and eccentrically loaded machinery to be carried horizontally with equal facility. The top girder also carries an auxiliary fall, of 10 tons' capacity, to take lighter weights.

The main legs are hinged at the bottom and allow the shear legs to tilt forward to a maximum, when loaded to capacity, of 50 ft. overhang from the base. When carrying 50% of the full load, the overhang may be increased to 60 ft. The 50-ft. overhang is sufficient to allow machinery to be placed in the centre of a boat or on the side away from the shear-legs.

In order to obtain strength without excessive cost, latticed steel construction was decided upon for both main



SHEAR-LEGS BUILT FOR DOMINION SHIPBUILDING CO.

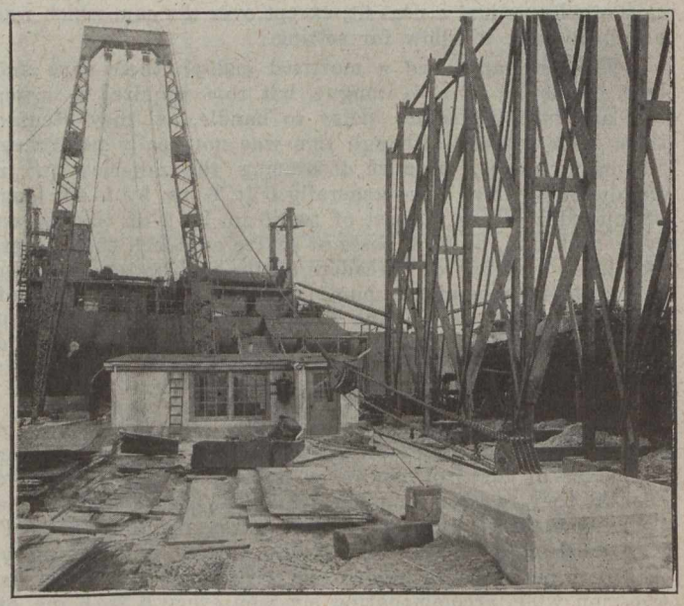
and back legs. The top girder is of steel plate. The main legs have a maximum dimension of 4 ft. square at the middle, tapering to 18 ins. square at the ends. All the legs are strengthened by diaphragms.

The shoes and hinges are of cast steel and are embedded in concrete. The back guys are 2-in. plough steel cables, which are each attached to a quadruple luffing tackle which is anchored to a 4-in. steel pin buried 10 feet deep in concrete.

The steel hoisting blocks are 15 ins. in diameter. Each of the four 50-ton blocks have six sheaves, carrying ¾-in. plough steel cable. These cables are connected to the hoisting machinery by way of underground ducts.

The hoisting speed of the 50-ton blocks is 6 ft. per min., and they are operated by a four-drum electric hoist, equipped with a 60-h.p. motor. This hoist also operates the luffing tackle. Two drums of the hoist are in series and two in multiple. There is a special single-drum electric hoist, with a 60 h.p. motor, for operating the 10-ton block with speeds up to 50 ft. per min. These hoists have automatic brakes and band brakes on the drums. Cut steel gears were used throughout, with the exception of the main gears on the drums, which are of cast-iron.

The shear-legs were fabricated by W. D. Beath & Sons, Ltd., and McGregor & McIntyre, Ltd., both of Toronto and were supplied to the Dominion Shipbuilding Co. through



VIEW SHOWING HOIST HOUSE AND LUFFING TACKLE

F. H. Hopkins & Co. The design was suggested by the engineering staff of the Dominion Shipbuilding Co. and was detailed and elaborated by C. V. Osborn, Toronto manager of F. H. Hopkins & Co., and by Harry Brass, engineer for W. D. Beath & Sons, Ltd.

At the annual meeting of the Border Cities branch of the Engineering Institute of Canada, the following officers were elected: Chairman, H. B. R. Craig; secretary-treasurer, J. E. Porter; executive, J. J. Newman, H. Thorne and Ed. Brain.

J. M. Leamy, provincial electrical engineer of Manitoba, states that construction on the first lignite briquetting plant in Western Canada will commence early in the spring. The plant will be located six miles southeast of Bienfait, Sask., on a spur of the C.P.R. All the buildings will be of steel construction.

With the object of promoting a highway from Fort William to Winnipeg, a new organization, to be known as the Central Canada Colonization and Highway Association, has been formed. Out of a total mileage of 423 miles, 60% will have to be brought up to a "good roads" standard and connected to sections already constructed. The suggested road would open about 50,000,000 acres of land that are at present undeveloped.

In Alberta and Saskatchewan, about 54,000,000 acres of land require irrigation, says the superintendent of the Dominion reclamation service. A further area of 19,000,000 acres, lying between the North and South Saskatchewan and the Battle and Deer rivers, is declared by engineers to be irrigable. At the present time about 1,500,000 acres are irrigated, and the Dominion government has promised immediate surveys of another 500,000 acres which will be irrigated at an estimated cost of $20,000,000. The Canadian Pacific railway has developed in Southern Alberta the largest individual project on the American continent, with an irrigable area of 600,000 acres, and canals and ditches having a total length of over 3,000 miles.

$6,000,000 SEWERAGE SCHEME RECOMMENDED FOR WESTERN PART OF YORK TOWNSHIP, ONT.

COMPLEMENTARY to the report on the sewerage scheme for the eastern division of York Township, Ont., which was published in last week's issue of *The Canadian Engineer*, is the report which has just been submitted by the township engineer, Frank Barber, and his associate, R. O. Wynne-Roberts, planning a sewerage scheme for the western division of the township at an estimated expenditure of about six million dollars. The following information is abstracted from the report:—

The topography of the western division, which includes that part of the township from Oriole parkway on the east to the Humber river on the west, but excludes the subdivisions which are located north of St. Clair avenue, Toronto, near Jane street, is such as to render it impossible to design a scheme similar to that proposed for the eastern division, where the engineers recommend one large sewerage system capable of being divided into sections which could be constructed as required. The general inclination of about half of the western division is south and southeast towards the city of Toronto, the other half tending to fall southeast towards Black creek.

It would be impossible to drain the sewage and roof water from most of this division towards Black creek, but when storm water has also to be disposed of, then the dimensions, and therefore the cost, of the sewers become prohibitive. Consequently, it has been considered advisable to split the division into ten sections, of which all but one will have a combined system of sewers for sewage and storm water.

The proposed sections, which are localized by their names, are as follows: (1) Bathurst, (2) Cedarvale, (3) Oakwood, (4) Silverthorne, (5) Eglinton, (6) Roselawn, (7) Bedford Park, (8) Upper Black Creek, (9) Lower Black Creek, and (10) Mount Dennis.

1. The Bathurst section, which is described as the district lying east of Forest Hill road and Bathurst street, from the vicinity of Upper Canada College to Wilson street, has an area of 1,030 acres, and drains naturally towards the city of Toronto by streams flowing southeast to the Don river.

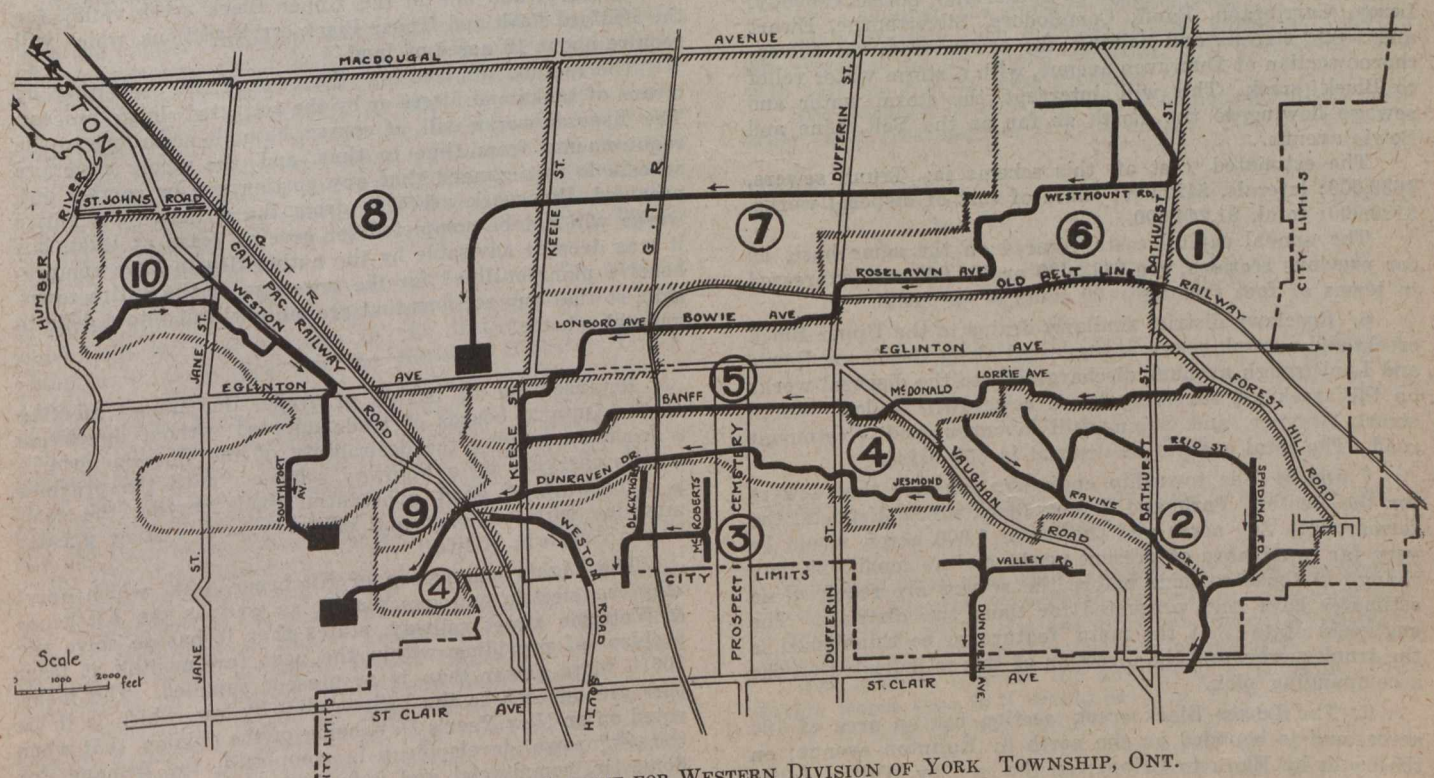
The watersheds of these streams have a total area of 3,544 acres, and are tributary to the natural water-courses passing through North Toronto. As provision was made for the drainage of the natural run-off from these watersheds into the proposed trunk sewers for the North Toronto drainage system, the engineers recommend that the Bathurst section should be sewered into the city system.

The estimated cost of sewers is $920,000 for trunk sewers and $616,000 for laterals, which, based upon 30-year 6% debentures for trunk sewers and 10-year 6% debentures for laterals, would indicate an annual capital cost of $149,000, or $112,000 if based upon 30-year 6% debentures for the whole work. On a frontage basis, this amounts to 48 cents and 37 cents per foot respectively, and adding the city's present charge of 23 cents per foot for outlet rental and maintenance, the amount is 71 cents per foot per annum.

2. It is proposed that the Cedarvale section shall extend from Forest Hill road on the east to Vaughan road and Oakwood avenue on the west, and from the Toronto city limits on the south to Dearborne and Lorrie avenues on the north; this comprises about 530 acres. The natural outlet for the sewage and storm water is to Rosedale creek, and the works commissioner of Toronto stated in 1915 that a portion of the section could be drained into the Rosedale creek sewer.

The total area of the watershed of Rosedale creek is 2,100 acres, with a runoff towards the city of Toronto. The city authorities are bound to accept the natural flow, but they contend that they are not responsible for the disposal of sewage or streams when houses are built and streets are graded and paved. The York Township engineers consider that the city of Toronto should provide outlet facilities for the sewage and storm-water from the Cedarvale section, with the understanding that three trunk sewers shall be constructed across the watershed when required in the future, namely, on Dearborne and Lorrie avenues for the Eglinton section, on Roselawn for the Roselawn section, and on Park road for the Bedford Park section, these trunk sewers to act as interceptors and to divert the storm-water to Black creek, thus limiting the discharge into the city of Toronto to that from the Cedarvale section solely.

The cost of sewers in the Cedarvale district is estimated at $422,000 for trunk sewers and $342,000 for laterals, with an annual capital cost of $77,000 or $56,000 (equivalent to 50 cents or 37 cents a foot), depending upon whether 30-year 6% debentures are considered for trunk sewers only or for the whole system. The addition of the annual charge of 23



PROPOSED SEWERAGE SCHEME FOR WESTERN DIVISION OF YORK TOWNSHIP, ONT.

cents, which may be increased, brings the estimated cost of construction of these sewers to 73 cents per foot frontage per annum.

3. The Oakwood section comprises the area lying between Vaughan road, Wilmington, Hanson, Donald, Eversfield, Hatherly, Summit and Aileen avenues on the north, Bathurst street on the east, the Toronto city limits on the south, and the railway on the west.

It is stated that nineteen avenues have sewers for part or the whole of their lengths, and as it is considered inadvisable to make any change which would complicate the system, a recommendation is made that the sewers required for the remainder of the streets in Oakwood section should connect with the city sewerage system. About 520 acres in this district must be sewered at a cost of about $520,000, or an annual capital cost of 44 cents per foot frontage on a basis of 10-year 6% debentures. The total charge, including the rental, amounts to 67 cents per foot per annum.

The points of connection can be arranged to suit the city sewerage system, but the tentative location of these connections are shown in the accompanying plan. The works commissioner of Toronto has stated that the city can accommodate the combined flow from about 204 acres, but it would be necessary for the township authorities to construct a storm sewer paralleling St. Clair avenue from Ossington avenue to the Rosedale creek sewer.

4. The Silverthorne section, with an area of 360 acres, must be drained into Black creek, and for that purpose a trunk sewer is proposed, to be built along Wilmington, Jesmond, Harris, Westmount, Martin, Holmesdale, Chudleigh and Harvey streets, thence to Dunraven, Keele, Elora and Northland streets, with a storm sewer relief to Black creek which will intercept another storm sewer flowing from the north.

The cost of this scheme will be approximately as follows: Trunk sewers, $364,000; laterals, $219,000; share of cost of disposal works, $110,000; total, $693,000.

The annual capital cost is estimated at $64,000, or 59½ cents per foot when based on 30-year 6% debentures for trunk sewers and 10-year 6% debentures for lateral sewers, and $51,000, or 47 cents a foot when calculated upon a basis of 30-year 6% debentures for both.

5. The proposal for the Eglinton district, including 620 acres, includes a trunk sewer (with an outlet at Black creek) flowing along Dearborne, Pellatt, Sutherland, Lorrie, Clovelly, Leroy, Carrington, Banff, Commodore, Silverthorne, Ewart and Keele streets, and joining the sewer from the Silverthorne section at Dunraven avenue, with a storm water relief to Black creek. This will intercept the storm water and sewage flowing to the north as far as the Belt Line and Bowie avenue.

The estimated cost of this scheme is: Trunk sewers, $632,000; laterals, $422,000; share of cost of disposal works, $190,000; total, $1,244,000.

The annual capital costs, figured on the same basis as for previous sections, are $112,000 or $91,000, or (expressed in terms of foot frontage) 60 cents or 49 cents.

6. Roselawn district similarly drains to the Upper Black creek, and a trunk sewer is suggested along Roselawn, Bowie and Lonborough avenues, discharging into the disposal works on the creek. A subsiding trunk sewer will follow Fourth street, Stayner and Summerhill avenues and Westmount road. The total area to be drained is 630 acres.

7 and 8. The township engineers consider that sewers for the Bedford Park and Upper Black creek districts, the former with 860 acres and the latter 1,000 acres, would be very far in advance of present needs, and as conditions may change in those sections before the sewers are required, no estimates have been presented for those two districts. The engineers state that the main feature to be established is the trunk sewer, and the direction of this is indicated on the accompanying plan.

9. The Lower Black creek section has an area of 100 acres, and is bounded on the north by Eglinton avenue; on the south by Elora to Cripps; on the east by Walter, Juliet and Bicknell avenues; and on the west by the railway tracks to Jasper and Symes avenues.

The section is too low-lying to permit the sewage being discharged by gravity into the trunk sewers which pass in the vicinity, and pumping will be required at the disposal works. The estimated cost of this scheme is about $145,000, as follows: Trunk sewer, $20,000; lateral sewers, $60,000; pumps and wells, $5,000; share of cost of disposal works, $30,000; storm sewers, $30,000; total, $145,000.

Estimating the annual fixed charge on a basis of 30-year 6% debentures for trunk sewers, disposal works and storm-water system, and 10-year 6% debentures for laterals, pumps and wells, with a maintenance, power and repair charge of $2,200, it amounts to $16,661, or $13,043 if on a basis of 30-year 6% debentures for all works. The estimated cost per foot frontage is 55 cents in the former case and 44 cents in the latter.

10. The Mount Dennis district includes all the territory west of the railway tracks, south of Weston limits, east of Humber river and north of Black creek, and has an area of 440 acres exclusive of low-lying gardens. It is proposed to drain this area to a disposal plant situated in the Black creek valley, to the north of the creek and east of Southport avenue. The estimated cost of the scheme is $836,000, and the annual capital cost would be about 59 cents per foot of assessable frontage, or 45 cents per foot if the laterals be based upon 30-year debentures.

When the flow of sewage exceeds three to six times the average flow, the surplus will, where possible, be discharged into relief sewers, but the cost of these are not included in the foregoing schemes, because the sewers already designed are ample for a long time.

The surplus over six times the normal flow will be discharged into the stream, which will at that time be in flood, and consequently no harm can then be done. Consideration was given to every means for enabling all the sections to have one joint sewage disposal works, but this had to be abandoned owing to the difficulties of arranging for the trunk sewers to cross the different valleys at satisfactory grades and on account of the cost of such trunk sewers.

Consequently, at present it seems necessary to have two disposal plants for the western division, one in the Lower Black creek valley for the Silverthorne, Eglinton, Roselawn and Mount Dennis sections, for which 20 acres of land will be necessary, and one in the Upper Black creek valley for the Bedford Park and Upper Black creek sections, which will require about 18 acres of land.

The method of treating the sewage will be either by means of tanks and filters or by the activated sludge process. The disposal works will, of course, be built according to the requirements from time to time, and the whole sewerage scheme is so arranged that any portion can be carried out, provided the work proceeds from the outlets. The entire works will not be completed for several years at least, but it was deemed advisable by the authorities to have comprehensive plans outlined for the sewerage of the entire township, so that any sections that are built will fit into a definite general scheme.

Representing 53 boards of trade, the annual meeting of the Ontario boards of trade adopted without opposition a resolution urging the desirability of the Ontario government's carrying on a highway scheme "until the province is a network of good, substantial roads serving the communities with economy and efficiency, and adding greatly to the comforts of life."

The Light Commission of Kitchener, Ont., which operates the electric and gas plants, as well as the Kitchener & Waterloo street railway, states that it has to solve the problem of providing within the next few months at least 100% more power than is at present supplied. The members are opposed to the hydro-radial by-law, which is to be voted on on New Year's Day, being of the opinion, that when the Chippawa development is completed, the demand for domestic, commercial and industrial power will utilize the 450,000 h.p. that will be developed, without radial railways.

G. B. GREENE HEADS OTTAWA BRANCH, C. B. & C. I.

At the annual meeting of the Ottawa branch of the Association of Canadian Building and Construction Industries held December 10th, G. B. Greene, general manager of the General Supply Co. of Canada, Ltd., Ottawa, Ont., was elected president.

Other executive officers chosen for the ensuing year were: Vice-president, H. Graham (general contractor), J. L. Douglas (trade contractor) and R. Hooper (supply man); honorary treasurer, E. M. Barrett; and honorary secretary, G. A. Crain.

In addition to many prominent contractors, there were present several members of the Board of Trade, including the secretary, Cecil Bethune, and E. R. Bremner, both of whom addressed the meeting. F. B. Belfry spoke on behalf of the Ottawa Housing Commission, urging greater interest on the part of contractors in the work of that body.

TORONTO HARBOR COMMISSION'S WORK

Between the years 1912 and 1918 the Toronto Harbor Commission accomplished works amounting to $9,764,800. From the Dominion government 257.5 acres of water lots were acquired by patent; the commission also acquired 4,700 ft. of frontage or riparian or water rights between Bathurst and York streets. Business and industrial properties and parks required the handling of 16,000,000 cu. yds. of material in reclaiming 1,057 acres of water lots and marsh lands.

Approximately 2½ miles of commercial dock walls were constructed, which, with the exception of the Don retention walls, are in the inner harbor.

At the eastern harbor terminal, the work done includes 11,630 ft. of sidewalks, 9,350 ft. of concrete pavements of various widths, 9,500 ft. of storm sewers from 12 ins. to 42 ins. in diameter, and 4,500 ft. of overflow sewers (sizes 6 by 18 ft., 6 by 16 ft., and 6 by 8 ft.).

NATIONAL HIGHWAY TRAFFIC ASSOCIATION

At the annual convention of the National Highway Traffic Association, which is to be held January 29th, 1920, in Chicago, the morning session will be devoted to the reading of reports of committees on highway transport franchises; interrelationship of highway, railway and waterway transport; traffic limitation strips on roadway surfaces; and sign posting for detours and through routes to municipalities; and an address by George W. Tillson, consulting engineer, La Grange, Ill., on "The Effect of Car Tracks on Traffic Capacity of Roadways."

"Highways and Motor Transport" will be the general theme of discussion at the afternoon and evening sessions, which will be joint sessions of the National Automobile Chamber of Commerce and the National Highway Traffic Association. The addresses to be delivered include: "Taking an Interest in Motor Truck Legislation," by Harry Meixwell, Jr., secretary, Automobile Industries Legislative Commission, New York; "Value of Highway Transport Surveys," by F. Van Z. Lane, transportation engineer, Packard Motor Car Co.; and "Interrelationship between Highway Transport and the Back-to-the-Farm Movement," by L. C. Hargreaves, of the Goodrich Rubber Co.

Arthur H. Blanchard, of the University of Michigan, who is president of the association, will speak on the "Relation of Highways to Motor Truck Operating Cost," and William G. Edens, president, Illinois Highway Improvement Association, on "Progress in Highway Improvement."

"Constructing Roads for Motor Truck Traffic," is the title of a paper by Prof. T. R. Agg, Iowa State College. Raymond Beck, chief of the Goodrich National Touring Bureau, will discuss the "Status of Legislation Relative to Snow Removal from Interstate and Intrastate Highways."

COMPUTING CROSS-SECTION AREAS BY THE METHOD OF CO-ORDINATES

By J. A. McDonald
Provincial Land Surveyor, Hermanville, P.E.I.

In spite of its simplicity, the computation of areas by the method of co-ordinates is not often practised by engineers and surveyors. In the following article a formula is obtained for a given area in terms of its co-ordinates, and a general formula derived which is applicable to a cross-section area of any shape.

Referring to Fig. 1, the area of the figure 1234 is equal to the trapezoids $(a12b)+(b23c)-(a14d)-(d43c)$.

Expressed as an equation in terms of the co-ordinates:—

$$\text{Area } 1234 = (y_1-y_2)(x_1+x_2)/2+(y_2-y_3)(x_2+x_3)/2-(y_1-y_4)(x_1+x_4)/2-(y_4-y_3)(x_4+x_3)/2$$

$$= \tfrac{1}{2}[y_1(x_2-x_4)+y_2(x_3-x_1)+y_3(x_4-x_2)+y_4(x_1-x_3)].$$

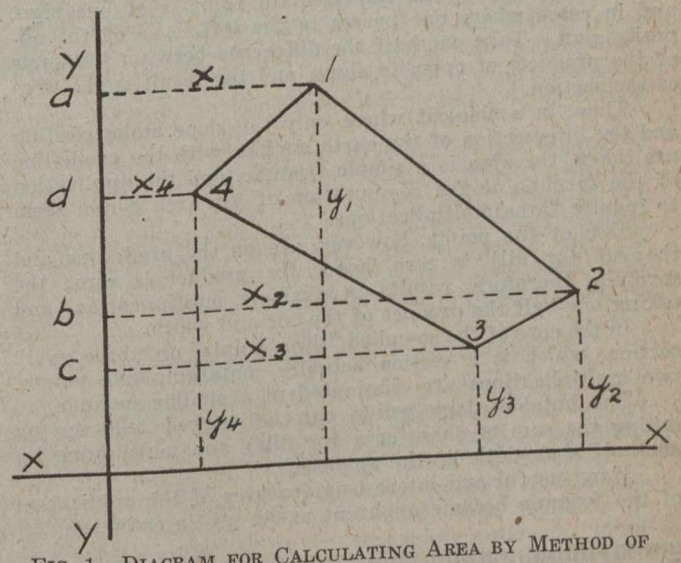


Fig. 1—Diagram for Calculating Area by Method of Co-ordinates

From this equation is derived the following rules for obtaining the area when the co-ordinates are given:—

(1) Number the corners consecutively.

(2) Multiply each ordinate by the difference between the abscissae of the points preceding and succeeding, and take half the sum of these products.

The adoption of this method in computing railway and other earth cross-sections is quite simple. The cross-section

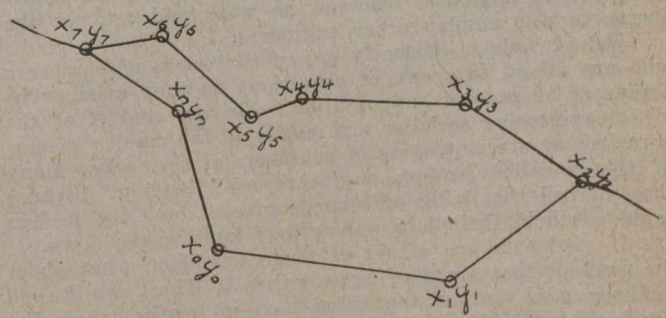


Fig. 2—Diagram Showing General Application of Formula

is considered as an area all of whose co-ordinates are known; the cuts or fills are represented as ordinates and expressed in terms of y, whilst the distances out from the centre become abscissae, and are expressed in terms of x.

The general formula for any possible shape of cross-section whose area is A would be (Fig. 2):—

$$A = \tfrac{1}{2}[y_0(x_1-x_n)+y_1(x_2-x_0)+y_2(x_3-x_1)+y_3(x_4-x_2)+y_4(x_5-x_3)+y_5(x_6-x_4)+y_6(x_7-x_5)+y_7(x_n-x_6)+y_n(x_0-x_7)].$$

The application of this formula is by no means so difficult as the formidable appearance of the above algebraic statement would indicate.

When making use of this formula, it may be advisable in figuring the first few sections, to draw rough sketches of the sections in order to ensure taking the points in correct order; a very little practice will enable an engineer to compute the areas directly from his cross-section notes.

The formula is not an approximation, as are the slope and other formulæ, but is mathematically exact and applicable to every kind of section.

The following directions should be followed:—

"Begin at any point on the section and proceed in either direction (clockwise or counter clockwise), multiplying each cut (or fill) in its order by its horizontal distance between the point just preceding and the point just succeeding. In cases where one passes to the right in measuring the horizontal distance from the preceding to the succeeding point, the product obtained by multiplying this distance by the cut (or fill) at the intermediate point is of one sign, and in cases where one passes to the left, it is of the opposite sign. Take one-half the difference between the sums of the products of opposite signs, and the result is the area of the section."

Thus, in a side-cut where only the slope stake reading and the intersection of the earth surface with the grade-line are taken, the area is a simple triangle, and the application of the formula to the computation of the area would seem to require three multiplications.

Two of the points, however, are on the grade-line and the cut (or fill) is zero, hence the product is zero; the formula, therefore, results in a single multiplication and taking one-half the product of the cut and width.

In the case of the so-called "three points" or "three level" section, which is a section actually containing five points, two multiplications are eliminated in a similar manner.

The outside slope points can be worked together by taking the sum of these cuts (or fills) and multiplying by one-half the width of the roadbed.

Many useful and interesting features of the application of the formula become apparent as its use is extended.

Letter to the Editor

TRADE UNIONISM AND ENGINEERS

Sir,—I have read, with much interest, the letter on "Tradé Unionism and Engineers," by Fred Christie, in your issue of December 18th, and I think he voices the sentiments of all engineers who do the work and are not the engineers who employ other engineers.

Mr. Christie is evidently not of that class of engineers who are afraid to speak of conditions as they exist. The engineers at present supposed to be in the control of the large engineering societies are mostly in the employ of corporations or are employers of engineers of their own. Many of the so-called leading engineers are "leading" because they control the living of other engineers, and the leaders could not hold their jobs unless they kept wages down.

If engineers are afraid of trade unionism, what about the methods that are used against them? These are the old methods used against the union men in former years, but which the employers no longer dare use. For instance, thirty of the leading engineers wanted to have a committee meet their employer and discuss pay. Would he receive the committee? Not so that you would notice it. He received the paid representative of the men who cleaned out his premises, but not the committee of his engineers.

The pay of the engineers has been raised less than 20%, while the scavenger has been raised 150% or more, and in some cases is getting nearly as much as the engineers. Force must be met with force, and the individual engineer negotiating with the employer is a joke. The engineer has no business education, is usually in debt for his schooling, and has a family, but in general has to assume the attitude of a supplicant instead of a freeman.

Some engineers are now in charge of $2,000,000 worth of various work in a year, and get less than $3,000. I paid an armature winder $66 for last week's work and hope to pay him more next week; the more he makes, the more I make. But the machine he wound was designed by me on a $23-a-week salary and an education that cost me $10,000 and seven years' time! That was some years ago, but the engineers in the same place are really getting less than that now, so far as the purchasing power of their money goes.

Dignity is all right, but when you have to hold off the grocery man, dignity is no good. How can a man with a college education be dignified with from $1,500 to $3,000 these days?

A salary of less than $5,000 a year is no good for dignity, and few engineers are getting that or ever will get it until they belong to some organization with "sand."

The sooner the engineers join a union, the better for all,—employers of engineers included. A man cannot work when he is only one jump ahead of the sheriff.

Another thing is this: The employer, while he will not pay the experienced engineer a decent salary, will pay a set of dubs three times as much to do the same work; that is, he gets six men at a low pay to do one man's work, and pays them in the aggregate three times as much as he would have to pay the one man. This has happened and is happening many times.

Some big companies have engineers by the dozen doing work that anyone with even less than a high-school education could do. Of course, it is a good idea to have a lot of technical men doing clerical work; they know what the words mean; but clerical work gets clerical pay, no matter who does it, and until engineers doing clerical work catch onto themselves, so long will they get clerks' pay.

The remedy for this is to exclude clerks from engineering societies; they are doing menial work, and not engineering work. The idea is that they are in line for promotion, but for 95 out of 100 there are no good jobs.

In the average large engineering establishment there are not over three good paying jobs and they are held for 40 years or so by the same men. What chance is there of promotion?

Many engineers now make a specialty of marrying rich girls or daughters of their employers, and in this connection I have never known of an engineer who married the daughter of his employer who failed to have the best job in the place. I suppose the business acumen he displayed in getting the girl is what got him the job, but I doubt it.

Never have I known an engineer, a hired one I mean, to get a good job without some influence other than his ability. The members outside of the influential circle can get into one by some kind of an organization doing its business with a paid representative, and by no other way. The ordinary engineer negotiating with his employer on the salary question is a joke.

N. C. MILLS,
Vice-President and Managing Director,
Montreal Armature Works, Ltd.

Montreal, Que., December 20th, 1919.

During the fiscal year 1918-1919, work was done in the province of Quebec on 904 miles of road, which included 282 miles of completed roads and 292 miles of winter roads. An aggregate of 16,580 ft. of bridges and culverts were also built by the highways department. The total amount expended during the year was $530,935.

In order to provide water and electric power for Palestine, Albert Hjorth, a Norwegian engineer, suggests a tunnel 37 miles long, from the Mediterranean to the Dead Sea, passing under Jerusalem, with power plant on the shores of the Dead Sea, and a pumping station on the Sea of Galilee. The initial cost would be $40,000,000. The surface of the Dead Sea is 1,300 ft. below sea level, and that of the Sea of Galilee, 650 ft.

Economic Values in Sewage and Sewage Sludge

Grease in Dried Sludge, or Tankage, Makes Its Assimilation by Soil Very Difficult—Sludge Must Be Acidulated with Mineral Acid and Percolated—Adaptation of Cobwell Process—Address to American Society for Municipal Improvements

By RAYMOND WELLS
Chemist and Technologist, Homer, N.Y.

WHAT is sewage sludge? Is it just a plain nuisance—something to be sunk, burned or buried—or is it just a very unattractive mass of low-grade raw material offering slight potentialities in economic values, provided of course that they can be liberated?

Much sleep has been lost by enthusiasts in both directions. It is unnecessary to say that for many years the fertile brains of inventors, engineers and chemists have been directed toward methods of restoring to the economic cycle all or any portion of the values contained in sewage or sewage sludge. Unquestionably vast quantities of valuable materials are present in sewage, but so great is the dilution in the carrying medium, and so dangerous to the public health is any delay in rendering it innocuous, that methods of recovery so readily applied in other waste reclamation are not applicable to sewage or sewage sludge.

The net result of all labor and thought along this line seems to have been the accumulation of a great deal of knowledge of what cannot be done, and as yet there is no method in actual operation on a large scale for recovering anything of value, or indeed offering any reasonable disposition of the sludge problem.

The apparently most patent and logical disposal of sludge would be the direct recovery of manurial values by direct application to the land. Water, however, is an expensive thing to transport in wagon bodies, and a grease-soaked fertilizer is difficult of assimilation by the soil, and constant application of such material invariably destroys soil texture.

Partial elimination of moisture by bed drainage and drying, followed by incineration, has offered a more or less practical and expensive disposition of the sludge, with of course no values recovered.

Colloidal Character of Precipitate

Partial elimination of moisture by filterpressing or centrifuging, followed by drying, would seem to be the simplest method of putting sludge into a valuable form. But unfortunately the almost colloidal character of the precipitate and the amount of grease and metallic soaps contained render pressing and centrifuging below 75% to 80% of moisture a difficult task. The subsequent evaporation of so great an amount of water in any type of drier is most expensive and the odors given off are extremely disagreeable. Furthermore, in direct heat driers, the volume of gases of combustion, together with the moisture-saturated air, is so great as to preclude any thought of condensing or scrubbing out the odors. For this reason alone, aside from the difficulties encountered in drying such a material, it is difficult to see any hope of solution in this direction.

Furthermore the dried residue or tankage obtained by this method, while having considerable manurial value, is in a most undesirable condition for use as fertilizer or fertilizer base-goods. This is due to the grease contained, which, when it exceeds 8% in any tankage, renders its assimilation by the soil extremely difficult.

To really complete the cycle of operation, the dried sludge should be percolated, grease removed and the percolated tankage redried. Since, however, a large percentage of the grease present is in combination with alkaline earth and metals in the form of metallic soaps, it renders solution by simple percolation impossible. For this reason it is necessary to acidulate the sludge, prior to percolation, with some mineral acid, so that the fatty acids combined with metals as soaps will be liberated and put in such condition that they will be soluble in the usual solvents employed in percolation.

This acidulation would have to take place prior to the drying operation, in suitable lead-lined digesting apparatus, and no matter how carefully this operation were carried out, the wear and tear on the drying apparatus and the percolator, due to acid action, would render the operation very expensive and troublesome. Not only would the apparatus employed be very short-lived, but the action taking place between the liberated fatty acids and the grease in immediate contact with even a trace of mineral acid at high temperature, would crack the fatty materials so badly as to render them valueless.

This was very evident in attempts by the writer to handle samples of sludge made by the acid, or Miles, process, by direct drying. At a certain point where most of the moisture was eliminated, charring took place, with copious evolution of sulphur dioxide and acrolein vapors, and the grease obtained by subsequent extraction and distillation gave an extraordinary amount of tar and unsaponifiable matter.

Percolation and Redrying Unsuccessful

Not only does this reaction take place in the drying operation, but the solvent carrying the grease also carries with it small traces of mineral acid which must be carefully washed and settled out before distillation for recovery of solvent. If this is not done upon approaching a certain concentration in the still, violent foaming, with evolution of sulphur dioxide and fatty decomposition products, takes place and again the grease is damaged. It may be well to note that the mineral acid referred to is, of course, sulphuric acid, no other acid being available, on account of price, for use on such low-grade raw material.

For the above reasons, the operation of drying, percolating, redrying, etc., so readily applied to other materials, seems not to be very successful when used on sewage sludge.

Destructive distillation of the dried or semi-dried sludge has been attempted, with the usual methods of recovery of the ammoniacal liquors and oils. Here again the problem of moisture elimination is intruded, and the recoveries made are not such as warrant the hope of even paying for the operation, much less of showing any profitable return. In the case of distillation both of dried sludge and of garbage tankage, the experiments of the writer have in all cases failed to show a greater recovery of nitrogen in the ammoniacal liquors than 35 to 40% of that present in the original samples. As a rule, an additional 30% remains in the retort charcoal, with the residue passing off as nitrogen in the combustible gases. The oils passing over are of little value except as fuel. This appeals to the writer as being a very expensive way of producing fuel oil.

Acidulation of semi-dried sludge from filter-presses or centrifuges, followed by drying in retorts, with subsequent distillation in current of superheated steam to carry over the fatty acids liberated by acid, has been tried but found unsatisfactory for many reasons.

Methods have been described and tested out on a large scale, attempting the direct extraction of greases from wet sludge by volatile solvents. In these processes, which are difficult and expensive to carry out, a partial solution of the free grease results, together with a portion of the waxes and soaps existent in sewage. The result is the formation of extremely resistant emulsions which seem to defy any recovery treatment by distillation. After such an emulsified mass has reached a certain concentration in the solvent

recovery stills, the whole charge expands into a foamy mass of which, seemingly, a gallon will fill a large tank.

An endless number of methods and schemes have been tried, first and last, but apparently none had sufficient merit to survive the first attempts. Possibly many failed under market conditions which do not exist at the present time; or, what is more likely, at their beginning they promised so much that mere partial success gave nothing but discouragement.

Leaving the recovery method aside for the moment, are there any—and if so what are—the inherent values of sewage sludge? What type and condition of the sludge offers the greatest possibilities?

Grease and Nitrogen Content

Setting aside for the present the moisture content, the value of the sludge will be governed by its grease and nitrogen content. While all sludges contain small percentages of bone phosphate and potash, from a practical standpoint they may be neglected. Consider the following analyses (dry basis):—

	Ammonia	Grease
Baltimore sludge, acid process, fresh, ..	3.26%	27.23%
Boston sludge, acid process, fresh, ...	3.91%	29.30%
Chicago Sanitary District, activated sludge, fresh, ...	5.10%	14.70%
Pleasantville, N.Y., settling basins' sludge, one month in basins, ...	4.14%	27.40%
Syracuse settling basin's sludge, fresh, ..	4.02%	9.60%
Syracuse activated sludge, fresh, ...	5.06%	17.70%

All of those analyses are from samples of sludge produced from comparatively fresh sewage and are representative of sludge rapidly deposited and not allowed to rest in th tnks for any great length of time. For that reason little bacterial action had taken place and the ammonia and grease content are at their maximum for the different types of sludge. Compare with those, these analyses of samples of sludge from so-called septic tanks or sludge which has been exposed for a great length of time on drying beds:—

	Ammonia	Grease
Baltimore sludge (from tanks) on bed approximately 6 months, ...	2.34%	1.50%
Chicago, activated sludge, 9 months old, ...	4.40%	5.00%
Akron, O., sludge, 3 months in tank, 6 months on bed, ...	1.00%	6.00%

All other things being equal, the value of a sludge for by-product recovery purposes depends upon the shortest possible period of tanking and shortest elapsed time between tank and ultimate utilization. In other words, bacterial action and weather erosion must be restricted to a minimum. This is directly contrary to usual sewage practice and is one of the rocks on which the disposal proposition has stumbled.

Minimum Value Worth Recovering

Below a certain minimum of recoverable values, there is no use attempting recovery. This minimum seems to be, for low-grade ammoniates such as garbage tankage and sewage sludge, approximately 3% ammonia. Below this the expense of handling and freight cost put it out of all hope of competition with other and more concentrated materials. From an economic and business standpoint, any goods falling below this rating had better be forgotten and no time wasted on developing methods of handling.

Moisture content of sludge leaving tanks is the next most vital consideration. In order to come within economic range of any method of artificial drying of any material containing 3 to 3.3% ammonia and 10 to 15% grease on dry basis, moisture must not exceed 75 to 80%. All sludges as they come from tanks or basins are far above this, and activated sludge way beyond. Sludge from ordinary sedimentation basins can be drained and air-dried within several weeks to 77 to 80% moisture, and by centrifuging to about the same amount. It would appear, however, that the simplest and most inexpensive method is that of depositing sludge, after removal from tanks, on drainage beds exposed to atmospheric drying conditions. In any case, without the presence of water dumping facilities, the sludge must be partially dewatered before final disposition.

With sludge containing 75% moisture, the ultimate disposition with by-product recovery is not impossible, though difficult and presenting many curious conditions.

To accomplish the disposal with production of a marketable tankage and grease, the elimination of all of the moisture with subsequent extraction of the grease by volatile solvents, a system of drying, extraction and recovery in one operation is suggested. Such a combined and complete operation is carried out at the present time only by the Cobwell process.

This process, as is doubtless well known, is applied to the handling of municipal garbage, dead animals, slaughterhouse offal and other wet organic waste materials. At the request of several engineers and municipal officials, a number of small-scale and several large-scale experiments have been undertaken and carried out on sewage sludge, with results which seem to warrant some hope of solution of the problem.

Adaptation of Cobwell Process

It is unnecessary to go into any detail in description of a process with which most engineers are familiar. But some variations are required in applying it to handling of sewage sludge.

In this method of dehydration with simultaneous degreasing, the principle employed is that of desiccation in a hot bath of an immiscible solvent which shall serve not only as a dehydrating medium but shall also, during the period of drying, continually dissolve the grease contained in the material to be dried.

Such a solvent preferably employed in the handling of sewage sludge, is a high boiling petroleum naphtha, distilling within the range 360 to 420 degs. F., which corresponds to the first 60 to 70% over in the fractionation of "standard waterwhite kerosene." This material serves not only as the most economical heating medium, but owing to the high temperature maintained in the desiccating mass, serves to remove or dissolve the metallic soaps as well as the free grease.

Cold, or merely warm, solvents of a less oily nature have little solvent action on such soaps, but high boiling oils, particularly when carrying small quantities of grease, are able to dissolve them without difficulty. Upon cooling they are apt to be deposited as jelly-like masses or to cause the gelatinization of the whole solvent solution, and for that reason the solution must be treated, before entering recovery stills, in such a manner that the soaps are decomposed and a solution of clean fatty acids result. This treatment will be taken up in order.

Description of Apparatus

The following is a brief description of apparatus and the method of carrying out the operation:—

The principal apparatus consists essentially of a closed tank, circular in shape and of a diameter three times the height. Jackets are provided on the bottom and well up the sides, so that as much available heating surface is obtained as is possible. Through the bottom, oblong screened openings are provided for the withdrawal of solvent and grease, and for the pumping in of solvent during the cooking or desiccating operation.

Within the tank proper is a central shaft, provided with two sweeps set very close to the bottom in such a manner that they shall slide under the mass to be treated, imparting an undulatory motion, without cutting through the mass itself. For this reason very little power is required. The tanks are of shallow form in order that the amount of heating surface in proportion to the mass to be treated may be as great as possible. Greater height and capacity could only be obtained at the expense of operating time and greater consumption of power. The top of the tank is provided with charging manhole and outlet pipe to condenser for vapors.

After the tank is loaded with sludge, the charging manhole is securely closed by the swing cover, solvent is admitted through the bottom screens, sufficient to immerse totally the mass of sludge, and steam turned on jackets.

Combined vapors of solvent and water vapor pass out through vapor line to surface condensers of suitable capacity, and in these the mixture of solvent and water vapor is condensed to liquid, which, leaving the tail pipe of the condenser, passes to separating tank, where by virtue of the lighter gravity of the solvent, separation of solvent and water is effected. The solvent flows to storage for re-use. Owing to rapid evaporation, the solvent level is lowered in the tank and a further quantity is pumped in.

Four to five hours are required for the evaporation of all of the water, and at this time, through the sight glasses, the dried fibre, etc., can be observed floating on the top of the solvent. At this point the agitator is stopped, the steam turned off, the drain valves opened, and the grease-laden solvent pumped out through a solvent out-pump line. Several washes with fresh solvent complete the degreasing of the mass, which is then heated, agitated and (with the help of live steam) freed from the absorbed solvent left in the mass after draining.

Preliminary Treatment

Solvent carrying with it the extracted grease, soaps, etc., must receive preliminary treatment before passing to the solvent-recovery and grease-finishing stills. This treatment is carried out in a lead-lined tank provided with an agitator. To the solvent is added a sufficient quantity of sulphuric or muriatic acid and water to completely decompose the metallic soaps present. The acid water is well churned up with the solvent, allowed to settle and drained off; fresh water is added and mixed, allowed to settle and the clear grease-solvent solution run to the recovery stills.

By this treatment, foaming and other difficulties are avoided in the distillation, and the grease recovered does not form the difficultly separated emulsions it is disposed to do. Such grease can be cleaned up and settled free from mechanical impurities and moisture without undue trouble.

The entire cycle of operations takes place in a closed circuit, and the only vent for non-condensable gases for the whole system of tanks (or reducers), condensers, separating tanks, washers, stills and storage tanks, is on the final solvent storage tank or tanks. This vent in turn exhausts through an oil scrubber to recover traces of naphtha carried over by carburetting. During no period of the operation is the sludge exposed to the air or manhandled in any way, until it is finally discharged from the side-door of the tank in a dried, degreased condition. The only places where odors or noxious effluent is exposed to the air and liable to cause an unsanitary and nuisance condition, are at the gas vents on the storage tanks and at the effluent overflow on the separating tank.

This effluent is, of course, distilled water from the sludge, and carries with it the odor of the sludge, which in the case of fresh sludge and that preferably handled, is very offensive. The quantity of this water is of course equal to that contained in the sludge prior to desiccation and the condensed steam from the steaming out of the solvent from the drained sludge prior to dumping from machine. This approximates a ton of effluent for every ton of sludge handled.

Deodorizing Effluent by Chlorination

The only way found by the writer to effect deodorization of this effluent and to render it harmless is by the addition of chlorinated lime or chlorine water. The greatest amount necessary for deodorizing very foul water is one part of 35% available chlorine bleaching powder to 3,000 parts effluent. The non-condensable gases leaving the storage tank vents must be scrubbed with chlorinated lime solution before being allowed to pass to atmosphere.

With these precautions, it is safe to say that the entire operation of desiccation and degreasing, or the whole recovery operation, can be carried out with no offense to public welfare and sanitation.

In handling sewage sludge by this method, no difficulties have arisen, other than those usually met with in handling wet organic materials of other sorts, and since in sludge the moisture is present in free condition, mechanically combined, the period required for desiccation is much shorter than that met with in the treatment of garbage and animal refuse, in which the majority of the water is more or less chemically combined. For this reason only four or five hours are required in drying a given amount of sludge, compared with at least twice that for same amount of garbage.

Capacity and Cost

Experiments and trial runs indicate the capacity of each tank as 8 tons in 24 hrs., and in a plant handling the sludge from a town of 200,000 inhabitants (approximately 40 tons daily, 75% moisture basis) the cost for handling, including overhead and fixed charges, will approach $6 to $6.50 per ton on green sludge.

This cost will not be greatly changed in handling sludge containing 65% or 50% moisture, but since the gross tonnage to be handled would be greatly reduced, the plant investment would be greatly reduced, and the by-product returns per green ton much greater. If by any method of dewatering on beds or other inexpensive method, the moisture can be reduced below 75%, by just so much will the success of a recovery plant pass from just self-maintenance to a possible profit.

After carrying out such an operation, what possible yield of by-products may be expected, and what is their character and what their value? This depends entirely on the nature of the sewage handled. It has been presupposed that any sludge running less than 3% of ammonia on a dry tankage basis is not worth handling, unless indeed the grease content is very high, in which case it is possible that the grease alone might pay for recovery.

From an average of a number of analyses, however, it would seem as if a sludge low in ammonia is also low in grease, so that a 3% ammonia tankage would indicate a 15 to 25% grease content on a dry basis. For these reasons, in handling a 75% moisture sludge, a yield of 420 lbs. of tankage and 75 lbs. of grease may be expected.

Market "Value" of Grease

What is the nature of this grease and tankage? Have they any market value? What use is it to rescue this material if it cannot be sold or used? This is not a matter to be dismissed offhand. At the present time, if either or both of these products were thrown on the market, emphatically they would not find a purchaser, or certainly the price would be absurdly low. Consider the nature of these by-products as indicated by their analyses:—

ANALYSES OF GREASES FROM DIFFERENT TYPES OF SLUDGE

	Free fatty acid.	Unsaponifiable.	Neutral.	Dirt and moisture.
Baltimore (acidulated),	77.48%	11.78%	.....	10.74%
Chicago (activated), ..	48.80%	24.40%	19.10%	7.70%
Syracuse (sedimentation),	51.50%	19.30%	18.70%	10.50%
Pleasantville, N.Y. (sedimentation), ...	75.70%	19.80%	4.50%	.....
Boston, Moon island (sedimentation):—				
Free fatty acid (as oleic), ...				48.40%
Free fatty acid (by weight), ...				40.19%
Rosin acids (in fatty acid), ...				14.36%
Fatty acids (by difference), ...				25.83%
Unsaponifiable, ...				21.09%
Neutral grease (by weight), (molecular weight of neutral fatty acids, 272), ...				20.00%
Metallic soaps and solid impurities, ...				3.30%

The first four analyses are of grease recovered in the process outlined, and it will be noticed that in the first three, large quantities of solid impurities and moisture are recorded. All grease of sewage sludge origin on leaving stills contains large amounts of such impurities, since due to the emulsifying action of the waxes present in the so-called unsaponifiable, it is very difficult to obtain clean greases without subsequent washing with acid and settling. The fourth analysis is of a grease after such treatment.

These analyses are of several different types of sludge and sewage treatment, yet all present the following general characteristics:—

The saponifiable matter in each case consists for the most part of free fatty acids and a very small portion of neutral grease or combined glycerines. This is, of course, anticipated by the fact that the greater part of the grease present in sewage sludge comes from hydrolyzed soap solutions, or through the action of bacteria and ferments, neutral grease has been broken down into fatty acids and glycerine. In any event, the neutral grease present gives no hope of glycerine recovery, so at once the so-called grease falls into the grade of poor-class fatty acid stock. Of the total fatty acids present in a number of analyses, from 1 to 15% of the total consist of rosin acids. These again are from the soap solutions.

The unsaponifiable matter varies from 10 to 30%, but a majority of samples analysed show an average of 20%. As may be supposed, the lowest percentages are found in strictly domestic sewages, where they are traceable to body waxes and products of physiological action. In mixed sewage from manufacturing towns, the unsaponifiable is highest, as it is made up of mineral oils thrown out from different factories, wells, etc.

A small percentage of metallic soaps of calcium, iron, aluminum and magnesium are present, but upon proper treatment are broken down into fatty acids and mineral salts, washed out as sulphates or chlorides (depending upon the sort of acid used for refining).

Very Low-Grade Material

From these premises it is necessary to conclude that sewage grease can be regarded only as a very low-grade fatty acid stock containing 70 to 75% of fatty acids and 25 to 30% of unsaponifiable. These fatty acids, depending on the sewage from which they are extracted, will vary in color from a dark ruby red to a black, tarry-looking mass. In consistency the variation is between a soft, buttery mass and a hard, solid cake. This is quite readily explained; the former is very high in fluid mineral and industrial refuse oils, the latter from domestic sewage in which the high-melting-point fatty acids have been hydrolyzed and precipitated from the soap liquors, whereas the oleic-acid soaps or oleic acid present in mixed soaps, remain in solution and pass off with the effluent.

Fatty acids of this type have no legitimate market at this time. Such materials are only valuable as they are refined and made into marketable products. A purchaser of sewage grease would have to expect by his own efforts to give it all of the value it might ultimately have, and having created something out of nothing, he would care to pay little for the raw material. That sewage grease in refined or manufactured form has value is not to be questioned. Such a grease as that indicated by the analyses of Pleasantville sludge grease, upon distillation in the manner usually employed for fatty acids, gave the following yields:—

Light colored distillate,	85%
Still returns,	6%
Stearine pitch,	6%
Loss,	3%

The distillate was orange yellow in color and of high titre, and upon pressing gave 50% of good colored stearic acid of titre 53.3C., and 50% of red oil containing 38.25% unsaponifiable. Upon pressing, all unsaponifiable matter passes out of seeded or crystalline cake in the red oil, leaving good stearic acid behind. This red oil is marketable for grease-compounding and as wool oil. In other words, sewage grease must be manufactured to have value. Once its value is established, a market will be automatically created for the raw grease.

Shall Municipalities Combine Efforts?

Upon whom shall the burden of carrying out these operations fall? Shall each sewage plant carry out the whole work from sewage to finished product? Shall a number of sewage plants pool their sludge, or their raw grease and tankage, and finish at a central plant, or shall a number of plants interest directly a corporation or individual able to carry out the refining operation? At this point sewage sludge ceases to be a problem for the scientist and becomes a purely business proposition.

Returning to the question of disposition of the tankage, it would require considerable propaganda to place upon the fertilizer-goods market a low-grade 3% ammoniate, cursed with the name sewage sludge, though in the old days of poudrette it had an enhanced value in the public mind far greater than its chemical value indicated. The great diluent of sewage tankage is insoluble ash or mineral matter, running from 40 to 70%, with 60% as an average. It is not impossible to concentrate this, though methods are not yet complete for doing so. A number of experiments conducted by the University of California indicate that for percentage of nitrogen contained, degreased sludge has higher plant-food value than that in dried blood or high-grade tankage.

Even with reasonable markets for the tankage and grease, it is a question whether it is possible to recover enough materials to defray the cost of the operation. In the opinion of the writer, and from experience in the garbage-reduction business, it does not seem impossible, though there would be little margin of profit left. But the sludge would be disposed of, its disposition paid for and a large amount of needed materials returned to active use, assisting in helping out the world's supply of chemicals and greases. The individual city would receive no monetary return, probably, but virtually to create actual concrete products of economic value, to pay for the creation and at the same time solve a troublesome disposition problem, is something well worthy of consideration.

With ordinary sedimentation of suspended solids, it is not at all unreasonable to expect from the sewage of a town of 150,000 people, daily recoveries of 5 tons of tankage and 1 ton of grease. There are many towns of this size. Any city of this class which can return to a useful cycle $50,000 worth of needed materials annually should consider well the disposition of its sludge pile.

Solving the problem of sludge disposition is not impossible, but it is difficult. No chemist, engineer, business man or politician can solve it alone. That co-operation which has not existed must first be accomplished before there may be any hope of solution.

Approximately 100 miles of road have been resurfaced this year in Elgin County, Ont., and eight culverts and two bridges have been built. The total expenditure on construction, maintenance and overhead has amounted to about $140,000.

Four by-laws have been passed in Calgary, voting $350,000 for a sewage disposal plant; $278,316 for extensions to the waterworks system; $155,978 to be added to a sum previously voted for building a concrete bridge to replace the Louis bridge over the Bow river; and $155,000 for a fireproof addition to the hospital.

Hon. Peter J. Veniot, minister of public works in the New Brunswick government, speaking at St. John, N.B., stated that New Brupnswick, of all provinces in Canada, is the only one that constructs and maintains its roads entirely from provincial funds. In the past three years, the sum of $2,125,000 has been spent on public roads, and it is hoped that during the next ten or fifteen years it will be possible to repair and maintain in good condition all the 17,000 miles of main trunk roads in the province.

With the intention of supplying Halifax with 7,800 h.p. at an estimated cost of $1,200,000, the Nova Scotia Power Commission has been authorized to proceed with the development of the water powers at St. Margaret's bay. The preliminary plans call for the establishment of storage dams at various points on the Northeast and Indian rivers. The water of the Northeast river will be collected by a head dam at Coon pond, and thence directed by a flume to a power-house at the head of Mill lake, where a head of 160 ft. will be obtained. The water of the Indian river, collected at a head dam at the foot of Sandy lake, will be directed to the same power-house, giving a head of 100 ft. A third flume will conduct the water from this power-house to a second power-house, which is to be established at tidewater, where the head is 90 ft. The power will be transmitted to Halifax on a wooden pole transmission line, 20 miles long.

ESSEX BORDER WATER WORKS

DESIRING to consolidate the existing water systems within the district, the Essex Border Utilities Commission has adopted a report which has been presented by Morris Knowles, Ltd., consulting engineers, Windsor, Ont., and will soon ask the people of the Border Cities to vote upon the scheme.

In the engineers' report, provision is made for five years' development of the water supply systems of the border municipalities, whereby the present generally unsatisfactory conditions of supply in the district will be relieved, and new territory which is not now supplied with water will be made available.

An approximate valuation of the Windsor water works, the Walkerville Water Co.'s distribution system and existing pipe lines in Ford City, Sandwich, Sandwich East and Sandwich West, totals $950,000, and an approximate fair compensation to Hiram Walker's Sons, Ltd., for pumping equipment is estimated by the engineers at $30,000. It is recommended that these systems be consolidated under the commission's direction by assuming the indebtedness now carried by the various systems and by issuing debentures to the various corporations for the remaining value.

The first year's program of improvement to the existing system includes the extension of a pipe line from Windsor to and through Sandwich to form a complete loop, at a cost of $95,000, and the arrangement of a site for consolidated supply and purification works, at a cost of $200,000.

During the second year it is proposed to start the construction of the consolidated works and filter plant, at an estimated expenditure of $250,000, and to connect with the Windsor distribution system by means of a 36-in. main, at a cost of $185,000. This would give a much better distribution system, and as soon as the pumps are ready to operate, would provide, by means of the extensions recommended for the first year, a much improved domestic and fire service for Ford City, Walkerville, Windsor and Sandwich.

Further extension of the distribution system in Windsor and Walkerville is contemplated for the third year, and is estimated to cost $105,000. The construction of the pumping station and filter plant would also be completed at a further cost of $225,000.

For the purpose of reinforcing the distribution system in Windsor, and giving much needed fire protection in the business area, several 12-in. mains would be laid during the fourth and fifth years. The distribution system would be extended from Sandwich to Sandwich West and Ojibway, further reinforcing mains in Sandwich bringing the total expenditure for these years to $220,000, and making a grand total, for the five-years' development, of $1,130,000.

By acquiring the Windsor pumping station and taking over the pumping equipment of Hiram Walker's Sons, Ltd., it would be possible to utilize in the consolidated pumping station the pumps which have been recently purchased by the Windsor Water Commission and also the newer steam pupms in both the Windsor and Hiram Walker stations.

The Bureau of Municipal Research has issued a bulletin on "Forms of City Government," which says:—"To overcome some of the drawbacks of the mayor-council-board-of-control plan, the formation of an administrative board, made up of the heads of the various civic departments, with one of their number as chairman, has been suggested. This could be tried by any city, without change from the present system, simply by directing the heads of departments to meet once a week for discussion of administrative policies and the taking of joint action wherever possible without special legislative enactment. A mayor, council and board of control could be elected on the plan at present in use, council retaining its legislative and policy-deciding functions. Later, if the working of the board was successful, provisional legislation could be obtained to enable it to undertake the work now done by the board of control. The city council could then keep in touch with the departmental administration through a small executive committee appointed from their number to act with the administrative board."

REGULATIONS UNDER CANADA HIGHWAYS ACT

Order-in-Council States Method of Making Application for Federal Aid and Gives Information Regarding the Proposed Administration of the Act

SECTION five of the Canada Highways Act, which was passed last July by the Dominion parliament and which will be administered by A. W. Campbell, commissioner of highways, states that the governor in council may make such regulations as are deemed advisable for giving effect to the objects and purposes of the Act, which appropriates $20,000,000 to encourage the provinces in the construction or improvement of highways. In the December 13th issue of the "Canada Gazette," the official medium for notices of government rulings, notice is given of the adoption by order-in-council of the following regulations under the above-mentioned Act:—

"Sec. 5—The governor in council may make such regulations to be published in the 'Canada Gazette' as are deemed advisable for giving effect to the objects and purposes of this Act."

Work to be Aided

1. The highways to be aided under the Act shall comprise such main and market roads as have been designated by the province as hereinafter provided with a view to encouraging production and stimulating trade and commerce, and as shall be approved by the minster.

To Supplement Customary Expenditure

2. It is understood that the expenditures called for under the Canada Highways Act are intended to supplement the usual amounts granted and devoted to the construction and improvement of its highways by the province itself.

Method of Making Application

3. Before an agreement is made with respect to any road or roads, there shall be furnished to the minister by the provincial government a statement setting forth a programme for construction or improvement of a system of highways in the province, from which projects shall be selected. Such statement shall be accompanied by a general map of the proposed program, bearing the approval of the provincial government and the endorsement of the highways department thereof. Each provincial program shall include, first, roads having greatest local agricultural and commerical importance; and second, roads having both local and general importance, and these programmes shall be so adjusted and arranged that the whole shall be correlated and form, as far as possible, a general system of interprovincial highways. This program and amendments thereto shall be satisfactory to the minister, and applications relating to the construction of specific portions thereof shall be made from time to time as provided for in the following section:—

Plans, Specifications, Estimates, etc.

4. Each application for aid shall be embodied in a project statement, on forms which may be had on application to the commissioner of highways of the department of railways and canals, which shall contain the following information and exhibits:—

(*a*) The purposes the undertaking will serve, and why it is in the public interest;

(*b*) The character and extent of traffic, present and prospective, on the road;

(*c*) How the undertaking relates to the provincial program;

(*d*) A statement of the type of construction or improvement it is proposed to make, together with a report of the engineer of the provincial highways department endorsing the adoption of the proposed type and the design thereof as being the most economical and practicable in the public interest, his reasons therefor, and a full explanation of any special or unusual features thereof;

(*e*) The administrative control of and responsibility for the undertaking;

(*f*) The source and method of procuring the necessary money for the underaking and the extent to which interested municipalities contribute thereto;

(*g*) Plans in standard form to be prescribed by the minister and in detail following accepted engineering practice, together with a sketch map showing the position of the proposed project on the general program map of the province;

(*h*) Specifications in standard form to be prescribed by the minister setting forth the proposed type and method of construction, materials to be used, and other essentials, in such detail as to afford complete knowledge of all steps to be taken in carrying out the project;

(*i*) Copies of the form of contract to be used, together with all documents referred to therein or made a part thereof; and

(*j*) Estimated cost of the project, giving a schedule of quantities and the estimated cost of each item in detail.

All project statements, plans, specifications, estimates and other papers required in connection with any application of a province for aid under the Act shall be forwarded to the commissioner.

The Agreement

5. When a project statement has been approved by the minister an agreement, as provided for in the Act, between the province and the minister shall be executed in triplicate by the province on a form furnished by the commissioner.

No payment under the Act shall be made until such agreement has been executed by the minister, nor shall payment be made for work done prior to such execution unless with the express approval of the governor in council, which approval shall not be given in connection with work done prior to the coming into force of the Canada Highways Act or not done in accordance with these regulations.

Tenders and Contracts

6. All expenditures shall be made pursuant to tender and contract, except as provided by the Act, and shall be on the basis of unit prices. Tenders shall be called for at least three weeks before the work is to be let, and notice of the calling for tenders shall appear in a contractors' or engineering journal as well as in such local newspapers as the province deems necessary.

Payments

7. In determining the actual necessary and reasonable cost of any highway for the purpose of fixing the amount to be paid under the Act, the cost of the following shall not be considered as a part thereof:—

The cost of right-of-way and incidental damages, bridges, viaducts, subways, exceptional grade separation, provincial overhead and administrative expenses, the making of surveys, plans, specifications and estimates, or any engineering expenses incident to the project prior to the beginning of actual construction. The cost of culverts having a clear width of opening of not more than twenty feet may be included.

Certified vouchers showing the amounts expended on each section of completed road, also showing the amount, if any, expended on any uncompleted section up to sub-grade at the termination of each fiscal year during the five-year period commencing April 1st, 1919, shall be submitted to the commissioner; and when he has certified that the terms and conditions of the agreement, in respect of the plans and specifications annexed thereto have been carried out as far as relates to such sections, forty per cent. of the cost thereof as defined by these regulations, and expressly subject to section five thereof, will, upon authority of the minister, be paid to the provincial treasurer, or other person named in the agreement to receive the same.

Records

8. Such records of the tenders submitted of the cost of the work, of the inspections made and tests of materials shall be kept by the province as shall enable the commissioner at any time to determine the cost to the province and the status of the construction work done on any project. These accounts and records, together with all supporting documents, shall be open at all times to the inspection of the commissioner or his representative, and certified copies thereof shall be furnished at his request.

Inspection

9. The supervision of each project by the provincial highway department shall include adequate inspection of work and material by competent engineers throughout the course of construction. To this end, any recommendation of the minister to the provincial government with respect to the necessary technical qualifications and experience of the members of the highway organization will be enforced by such government.

Maintenance

10. Each province shall agree that when the roads or highways constructed or improved with Federal aid shall have been accepted as completed, the province shall maintain, or cause the same to be maintained, with all necessary repairs and renewals, so as to preserve the standard of construction of each particular class of completed road or highway.

CONFERENCE ON CONCRETE HOUSES

FROM February 17th to 19th there will be held at the Auditorium Hotel, Chicago, a National Conference on Concrete House Construction. The purpose of the conference is two-fold: (1) To consider the housing problem in the United States and Canada; and (2) to present, crystallize and make available, information regarding the most modern practice in the construction of concrete houses.

The following committees are now being organized: Architecture and design, community planning, financing permanent homes, fire prevention and insurance rates, building codes, monolithic concrete houses, special unit houses, concrete block houses and concrete and cement roofing.

Among the organizations co-operating in this conference are the American Concrete Institute, the Associated General Contractors of America, the Concrete Products Association, the Portland Cement Association, the Illinois Society of Architects, the Illinois Chapter of the American Institute of Architects, and the U.S. League of Building and Loan Associations.

During the week of the conference on house construction, there will also meet at the Auditorium Hotel the American Concrete Institute, the Concrete Products Association, the Concrete Block Machinery Association and the American Concrete Pipe Association.

Work has been completed on the installation of the hydro-electric power plant at Squamish, B.C., the tidewater terminus of the Pacific Great Eastern Railway, and the plant wiil be "turned over" this month. The project involved the construction of a dam in the Stuwamus river. The cost of the development was about $90,000.

Premier Drury, of Ontario, outlining the road policy of his administration, said that it is the people of the little towns and rural districts who need good roads the most, and that there is great need for market roads throughout the province. It had been argued, he said, that the revenue from motor cars should be expended on main highways. He held that part, at least, of this revenue should be used on roads serving the greater body of people. His highway policy would include these three things, he said: (1) The abandonment of the construction of expensive trunk highways, retaining the roads already built and probably improving them and making them all into "decent-running roads;" (2) spreading out the provincial roads where they will do the "greatest good to the greatest number," spending the money available on the whole road system and giving aid to country roads; and (3) giving assistance to township roads.

WHY QUEBEC MUNICIPALITIES SHOULD HAVE CLEARING HOUSE FOR INFORMATION*

By Charles A. Mullen
Director of Paving Dept., Milton Hersey Co., Montreal

THE broad objects of the Union of Quebec Municipalities, briefly stated, are to secure voluntary co-operation among the member cities, for the support and collective municipal ownership of a public organization to act as a clearing house for information and as a central bureau through which two or more cities, when they so desire, can combine for the purpose of securing from the province legislation which in is their interest, and for any other matter wherein it is thought two or more cities, acting together, can get better results than if they acted separately.

A service that could be organized quickly, and which would at once begin to pay dividends in savings effected by the several municipalities, is a central bureau which could be used for purchasing many items of supplies. This service would not abolish any separate municipal purchasing bureaus now in existence, but would be rather a super-bureau, requiring a well-organized system of purchases in each member city, for its proper working.

Central Purchasing Bureau

Why have the purchasing officials of many cities getting data and prices on general equipment they all use, when it can all be done by one man; and why not buy collectively whenever it is possible to do better that way? The organization of proper purchasing systems for its member cities would in itself be a suitable field of activity for this Union, and one good man, who would by study and experience become particularly proficient, could be handed around from city to city.

Through a central organization, each municipality will be better able to look its latest "gift horse" in the mouth, for the collective transactions of all the cities in any one article which is offered in the municipal market will be of sufficient moment to warrant the spending of a little money on investigation and study.

In no line, I think, is this more true than in my own; for were a careful engineering report secured by such a Union as this upon certain pavements which are being laid, and copies submitted to the various member cities, I think that pavement promoters would grow less fat and municipalities go less into debt and occasionally into a state which approaches bankruptcy.

Such a bureau, be it purchasing or any other, should have as its board of directors the purchasing or other interested officials of its member cities, and the super-purchasing agent should be their employee,—not their boss. Much greater efficiency, in many cases, comes from the bottom up, and I am inclined to think that the success of the Union of Quebec Municipalities is largely going to depend upon whether or not those entrusted wits its launching will properly understand this principle and use their best energies in setting it to work. These are not days to talk of abandoning the principle of Home Rule for cities, even for the purpose of forming a municipal union. One ounce of voluntary effort is worth a pound of forced co-operation.

"Engineering Profession Principally Involved"

One great value the Union will have for its member municipalities will be in supplying them with reliable information and advice when they have to deal with professionals, especially from out of town; and here the engineering profession, of which I am a member, is principally involved, though the lawyers and the doctors also come in for their share of municipal work.

It may be true that when the Union attempts to handle engineering matters for the member cities, if great care is not exercised, there will be a slight danger of injustice to some of the profession; but I do not think this danger is to be compared to that which the cities encounter when they go out, unaided, to seek engineering or other professional advice and services. High-class engineers are frequently not nearly so good at selling their wares as some other engineers who would do the country much less harm as commercial travellers.

There are, as we all well know, shysters in all the trades and professions to-day, for our present social system seems to encourage and reward their efforts in many directions. Under the plan of co-operative administration I have already outlined, where the engineering bureau would be in the hands of the engineers—subject, of course, to the general administration—it seems to me that the shyster would have a much less rosy path than he has to-day.

Says "Canadian Engineer" Mistaken

The Canadian Engineer of October 23rd, in its editorial column, shows grave concern about what it thinks the Quebec municipalities are about to do; but I am sure its attitude is based on a misconception of the plan. To me, it seems that more and not less professional services will be employed because of the existence of this Union. Cities will learn from their own representatives at headquarters, whom they will have reason to trust, just when and to what extent professional services are a good investment for them. To-day, they do not know, and have not a sufficiently unbiased and trustworthy source of information; and they frequently go without rather than risk employing some shyster.

I am quite sure that it was also a misunderstanding which led *The Canadian Engineer* to remark about the doubtful value of "free" engineering or other professional services. The Union will be paid by its supporting member municipalities through memberships, as far as its general work is concerned; and each city will probably pay extra for special services rendered. We have never heard the engineers complain when several private corporations formed a union or trust and amalgamated their engineering staffs, and such combinations are far more destructive of individual initiative and competition among engineers than the Union of Quebec Municipalities could ever hope to be.

Impugns One Firm's Integrity

One good which the engineering profession should get out of the formation of this Union is the better application of the energies of its members.

I have one particular case in mind where a firm of engineers undertook a piece of work in which they certainly were not specialists. The contract was let; and, not having an intimate knowledge of the subject, these engineers left it to the contractor to do the work in accordance with his own theories, which happened not only to be based on a limited experience and wrong, but were known by all specialists in that line to be wrong. The work, after one year, now shows signs of failure. It is bad enough to have to follow defective principles when it is not possible to follow the correct ones; it is inexcusable to do so through ignorance of those principles which have been proven correct in practice, and are generally accepted among the specialists in that field of engineering.

The leading member of the engineering firm referred to above, whose name professional courtesy prevents me from mentioning, at the time this work was being done in accordance with wrong practice (because to insure correct practice they would either have had to call in specialists and pay them out of their own very liberal fee or not attempt the work) said to me:—

"We never take a chance. If we are building a wall, we figure the usual factor of safety required by good engineering practice, and then add at least 20%. Our work is a monument to us, and our reputation is the very highest."

Yes,—building monuments to the reputation of their firm by the unjustified expenditure of public money, which expenditure also increased their percentage fee. The cities are, to-day, almost helpless before such engineering malpractice; in fact, on the part of unscrupulous engineers, it is an excellent way to acquire a very fine appearing though falsified reputation which will bring more business. The point in this instance is that this firm was willing to take all sorts

*Excerpta from paper read at the organization meeting of the Union of Quebec Municipalities, at Montreal, Que., December 16th, 1919.

of chances with their reputation to save themselves a few extra dollars, but was perfectly willing to buy the best reputation at any cost whatever with city money. One good engineer on the bureau staff, keeping in touch with the field, would soon detect and expose such malpractices as these.

Many cities are to-day repating the mistakes made by other cities, and thereby learning through their own costly experience what they might much more cheaply know from the dearly bought experience of other municipalities. I have in mind one city in particular which is now going ahead with a certain type of paving work which was tried out and abandoned in other places many years ago. It thinks it has discovered something new.

Suggests Visiting Engineering Specialists

What we need is a clearing house for knowledge and experience, where a city may inquire about what has been done elsewhere and what were the results. The Union of Quebec Municipalities promises to furnish such a clearing house for this province, and I believe the results will be most gratifying. A step still further would be advisable; and it may be practical at some future date to have a staff of visiting engineering specialists go around and see what the cities are doing in the way of following wrong practices without even suspecting it themselves.

Another service that may be facilitated by the union is the exchange of expert operators between the different cities. This fall, the city of Charlottetown, Prince Edward Island, which has installed a municipal asphalt plant, needed some expert laborers for operation. We appealed to Mr. Doucet, the director of public works, and to Mr. Blanchard, his engineer of roads, of the city of Montreal, and they were glad to go out of their way to accommodate a small city in a sister province. Montreal men went to Charlottetown, and did their work so well that Charlottetown now knows what kind of a public works department Montreal has. What was arranged in this case would be done much more frequently between cities who are members of the same union.

All of the foregoing shows very clearly the need of the bureau or clearing house for information which it is proposed to establish in connection with this union. Not only can the experience of one Quebec city be made available, in fact be reported to all the other Quebec cities, but, if the organization falls into very active hands, much valuable information can be secured from the outside municipalities and supplied to the proper official in each of the Quebec municipalities. Such a bureau need not wait until it is requested for information which some city finds it needs; it can go out into the highways and byways and seek out information which will be of benefit to its member cities but of which they do not happen to have even heard.

While we do not all want to be alike, economy and efficiency certainly demand that we do be alike in most things where there is no good reason, practical or artistic, for being different. Some advantage will accrue from a sort of interchangeability of parts, even to municipalities; and I think much can be done by this union towards a sane amount of standardization.

Standardization of Municipal Equipment

If three cities are using different models of a given machine which each is building or buying, why should not the representatives of these three cities get together, decide, if they can, which machine is the best, or possibly design a new one which will be a composite of the three and superior to all, and adopt that as a standard until something new develops? The street railways of North America have standardized the rails they use, for instance; and it is standardization like this which I have in mind. Such standardization might also be made to operate in favor of Canadian manufacturers, whenever possible, without appreciable loss to the cities.

Just now, the commission-manager form of government, with proportional representation, has the centre of the municipal stage. My study of the subject finds me very much in favor of this type of machinery for city government; but I would very much like to know what a committee appointed by the Union of Quebec Municipalities, from among their own members, would say about it. After careful study, this committee would either recommend this type of commission-manager charter for Quebec municipalities, would offer some improvement upon or amendment thereof, or would reject it as not so satisfactory for Quebec as the present type of charters. At least, we would get action upon such a matter; and it would not be left for a few public-spirited men to spend their lives going from one city to another recommending this change.

There are, of course, a certain number of persons and interests in every community who prefer things-as-they-are. Some of these folk are just too lazy to move in a new direction; others are securing special privileges under the present order and fear they may lose them during the change. There are a certain number of business firms selling to cities, a certain number of contractors doing business with cities, who do not want any bureau of information which may tell their customer cities how badly they are being over-reached. The job holders who do not want any new-fangled ideas which will mean more work may also be relied upon to speak against any such innovation as a municipal union which means business; but I am confident that most municipal employees will respond to the call for more efficient organization with alacrity.

As far as the firm of which I am a member is concerned, we believe the formation of this union can produce nothing but good for us, for we think it will mean a greater appreciation on the part of the member municipalities of the value of the kind of work we do. Moreover, if the day ever comes when the union thinks it necessary to municipalize us, or any part of us, and a workable plan is forthcoming, there will be no opposition on my part. I believe in municipal ownership up to the hilt; a municipally owned municipal league and all that may logically grow out of it.

Representatives of the Dominion and Manitoba governments conferred last week with delegates from the United States, who visited Winnipeg, on the problem of prevention of floods in the Red river valley. Large areas of Manitoba, Minnesota and North Dakota are flooded every spring from that river's overflow, and seeding operations are delayed. Schemes were suggested which the United States representatives declared would mean a saving of $100,000,000 during the next thirty years.

J. G. Sullivan, formerly chief engineer for the C.P.R.; J. C. Holden, C.P.R. district engineer; B. Stewart McKenzie, consulting engineer; and W. P. Brereton, city engineer, all of Winnipeg, Man., have advised the Greater Winnipeg Water Board that in order to prevent gradual disintegration of the Shoal lake aqueduct, it is necessary to underdrain the section in which the conduit is exposed to the action of water heavily charged with alkali. John Woodman, consulting engineer, disagreed and gave his opinion that the aqueduct is quite safe from alkali action. The engineers had been called in by the board to express their opinions as to what should be done in connection with an underdrainage scheme submitted by Chief Engineer Chace and which will involve an expenditure of from $300,000 to $400,000.

Speaking at the evening session of the United Farmers' convention, December 17th, at Massey Hall, Toronto, Hon. Mr. Biggs, Ontario minister of public works, said that the government proposes to abolish statute labor. He suggested aid for township roads, using the revenue received from auto licenses for this purpose, and giving special consideration to the poorer townships which are not in a position to help themselves, by setting aside $2,000,000 for loans to them, repayable in five-years without interest. Mr. Biggs stated that the federal government has allotted $6,000,000 to the province of Ontario for provincial highways, and he thought that the Ontario government should avail itself of the full amount and "construct 1,600 miles of provincial county roads." "I would say," he continued, "that we do not intend to build any hard-surface roads at any place, unless the cost of building them is less than a macadam road."

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PRINCIPAL CONTENTS

HAPPY NEW YEAR!

NEXT Thursday will be the happiest New Year's Day that Canada has experienced in half a decade. That the war has been conclusively settled is now beyond doubt, and equally certain is it that the troubles of the reconstruction period are being rapidly overcome. The new year will be a very busy one in engineering circles. There will undoubtedly be satisfactory employment for every engineer and plenty of profitable business for all engineering firms. Let's go! Let's produce! Make the wheels hum in 1920! Happy New Year!

MORE FLUSHING, LESS DISEASE

WHEN suddenly enveloped in a whirling cloud of dust from dirty, unflushed pavements, we encounter a positive danger almost as deadly in its possibilities as a gas attack. What we are possibly too accustomed to regard as an unavoidable annoyance has been demonstrated by scientists to be one of the gravest causes of some of the most deadly diseases that affect mankind,—those of the respiratory organs.

Pneumonia alone has an enormous yearly death-rate in this country. The fact that pneumonia germs can live for a considerable time in dust is well known, but apparently little thought has been given to the extreme danger of communicating this disease by means of the dust thus infected. Dr. Rufus Cole, of the Rockefeller Institute, says: "We have been so interested in better water supplies, better sewerage systems, etc., that we have forgotten the importance of dust in spreading infection, especially in spreading the acute respiratory diseases which now cause more deaths than all the other acute communicable diseases combined."

This reminder is a good one for all municipal engineers and street superintendents to ponder, for it is to them that the public must look for adequate protection from the dangers of unlaid dust. Typhoid has been practically conquered by municipal engineers; they should now give earnest attention to the dust evil, and, by making arrangements for thorough flushing, add one more to their long list of public benefactions.

SALARY SCHEDULE FOR HIGHWAY ENGINEERS

AT the convention of the American Association of State Highway Officials, held this month in Louisville, Ky., a resolution was passed endorsing a list of recommended salaries for engineers in state highway service. This list had been prepared by a committee of the American Association of Engineers.

A. N. Johnson, consulting highway engineer of the Portland Cement Association, who was chairman of the American Association's committee, in addressing the convention stated that the recommended salaries had been established by first selecting three places in the schedule: The highest, the middle position, and the lowest.

The highest position was that of the chief engineer of the state highway department. The middle position was "considered to be one requiring an engineer having at least four or five years' experience since graduation from college,—a man who, it may be expected, will be married. Such a position should, therefore, carry with it a salary to enable a young engineer with a small family to live in comfortable and appropriate surroundings. The lowest position was established as one filled by a recent graduate.

"The salaries established for these three positions are $8,000 to $15,000 for the highest; $3,600 to $5,000 for the middle position; and $1,200 to $1,500 for the lowest.

"If practical results are to follow suggestions regarding salaries of engineers in public service or in any other service," said Mr. Johnson, "the first essential is unity of opinion and purpose amongst engineers themselves. One of the chief drawbacks to higher salaries for engineers in public service has been, in the past, the opposition of these very engineers themselves. This may seem at first paradoxical, but here is an instance: A legislative committee gives a hearing on the subject of salary increases for a a certain position and behold, there appears before the committee a number of engineers who state that even lower salaries than those paid at present are paid to engineers, and that engineers may be easily secured for the present salaries. What is a legislator to think?"

CENTRAL ELECTRIC STATIONS IN CANADA

EARLY this year announcement was made of the intention of the Dominion Bureau of Statistics to publish a volume of statistics obtained by a census of the central electric power stations in Canada. At the same time it was stated that the Dominion Water Power Branch, working in co-operation with the Dominion Bureau of Statistics, would publish a directory of the stations.

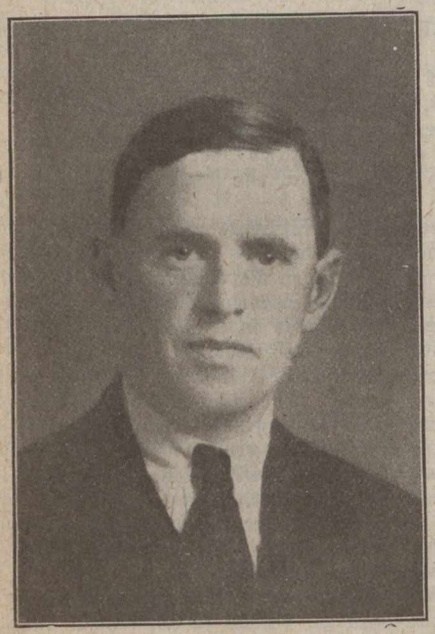
Both of these volumes are now ready for distribution. The census statistics, in French and English, fill a volume of about eighty pages, 6½ by 9¾ ins. The directory is a volume of 252 pages of the same size, and includes a large folded map showing the location of the stations.

For copies of the statistics volume, applications should be made to R. H. Coats, Dominion Statistician, Ottawa. For copies of the directory of central stations, applications should be made to J. B. Challies, Director of Water Power, Ottawa.

It was unanimously resolved at a meeting held in Toronto to discuss compulsory vaccination, that the provincial government be petitioned to enact legislation whereby sanitary engineers should be substituted for the present medical officers of health, and to make illegal the appointment to that office of any practitioner of any system of medicine.

PERSONALS

W. A. SIBBETT, of Bracebridge, Ont., has sailed for South America, where he has been employed by the Columbian government to survey the Barranquilla Harbor and to plan extensive water-front improvements. Mr. Sibbett was born November 4th, 1890, in Bracebridge, Ont., and was educated at Barrie Collegiate and the University of Toronto, where he graduated with honors in civil engineering with the class of 1911. He joined the staff of W. H. Fairchild, of Brantford, Ont., in order to study for the O.L.S. degree, and in 1912 he passed the necessary examinations. The following two years were spent with Mr. Fairchild in surveying and municipal work, and Mr. Sibbett was then appointed surveyor of the North Bay division of the C.P.R. In January, 1915, he joined a staff of engineers who were surveying harbors in British Columbia for the Dominion government, but in December, 1915, he resigned this position and enlisted as a private in the 122nd Muskoka Battalion, although he obtained a commission before he went overseas in April, 1917. While waiting to be sent overseas Mr. Sibbett studied for the D.L.S. examinations, obtaining that degree in 1916. The military unit to which Mr. Sibbett was attached was sent directly from Canada to France, and there he was promoted to the rank of captain, and in April, 1918, he was transferred to the headquarters' engineering staff of the Canadian Forestry Corps. Last January he returned to Canada and obtained a provincial government survey contract for work in Northern Ontario, which contract he had just completed when he was recommended to, and accepted by, the Columbian government for the work above mentioned. Mr. Sibbett's present address is c/o Pinedo, Weeber & Co., Barranquilla, Colombia, South America.



GEORGE J. GUY, chairman of the Hamilton Harbor Commission, has been appointed vice-chairman of the Canadian Deep Waterways and Power Association.

HENRY HYMMEN, who has been water works superintendent of Kitchener, Ont., for the past 19 years, has resigned in order to take charge of the plant of the Dominion Products Co., Guelph, Ont.

J. CAMPBELL BRADY, of the British Columbia public works department, has been promoted to the rank of district engineer and will be in charge of No. 6 district, with jurisdiction over Cranbrook, Fernie and Columbia ridings.

LEWIE D. WALKER has been appointed water works engineer and inspector for the Canadian Fire Underwriters' Association, Toronto. Mr. Walker returned from overseas last March and joined the engineering staff of the British-American Nickel Corporation, at Deschenes, Que. Before going overseas he was employed at Sault Ste. Marie, Ont., in dock construction for the Department of Public Works of Canada.

W. BLAZER, civil engineer of the Government Service for Water Power and Electricity, Dutch East Indies, and whose headquarters are at Bandoeng, Java, is visiting Canada and the United States under a commission from the Netherlands' government to study water power stations. It is understood that the water power potentialities in the islands of the Dutch East Indies total several million horsepower. The government has developed and is operating several plants generating power for railway shops, etc., there are over three hundred private water power plants for plantations and other industries, and the government is pursuing an active development policy. Mr. Blazer intends also to visit Switzerland.

OBITUARY

JOHN DOBSON, for many years the senior member of the firm of Dobson & Jackson, contractors, Winnipeg, died in that city December 15th.

ROAD CONSTRUCTION IN BRITISH COLUMBIA

SPEAKING of the development of roads in British Columbia, J. Campbell Brady, a district engineer with the provincial public works department, said that the intention for the coming season is to improve and complete the road from Windermere to Cranbrook, making it come up to the standard of the Banff-Windermere highway, which the Dominion government recently took over and proposes to finish as an auto highway within the next two years. When these roads are completed, it will be possible to drive on a hard-surfaced road through Cranbrook to Spokane, via Yakh and Kingsgate.

From Golden to Windermere is approximately eighty miles, and most of this highway is in very fair condition. Twelve miles before Windermere is reached is the point at which the Banff-Windermere road converges. This road, which has only been partly developed by the provincial government and by the Canadian Pacific railway, now becomes a part of the Dominion government's park system.

A zone of five miles wide on each side of the highway has been set apart as a park area. At the Columbia, or Radium, hot springs, two miles from the junction of the Banff-Windermere highway with the road from Golden, there is every likelihood of a new tourist resort being established.

The annual meeting of the Ontario Good Roads Association will be held in Toronto March 3rd to 5th, 1920. The Ontario county roads superintendents will also convene at Toronto March 1st to 3rd.

In a speech at Brockville, Ont., Hon. F. C. Biggs, minister of public works for Ontario, dealt with the road system in that province. He said that the government hopes to add materially to it, and that instead of being 500 miles in length, the provincial highway should be 1,500 miles, touching every country. Unless this could be done to some extent, opposition to trunk roads will develop. He stated his belief that the provincial highway is the best advertising medium that Ontario has, and he strongly advocated further help from the government for the townships in road construction, and urged the appointment of permanent township road superintendents. Rural depopulation, said the minister, could be offset by good roads, improved rural schools, and the "Hydro."

Representing practically every municipality east of Kingston, a deputation waited on the Ontario government recently and requested that the Hydro-Electric Power Commission be instructed to proceed with the development of power at Chats Falls, Ont., and also with the development of the St. Lawrence river, in order that electric power may be furnished to industries which now wish to establish manufacturing plants in the eastern section of the province. W. E. Smallfield, chairman of the Utilities Commission of Renfrew, Ont., stated that 120,000 to 150,000 h.p. could be developed at Chats Falls, which is 30 miles from Ottawa, at a cost of from $5,000,000 to $8,000,000. This development, he claimed, could be undertaken at once, whereas it might take ten to fifteen years to get power from the St. Lawrence river.