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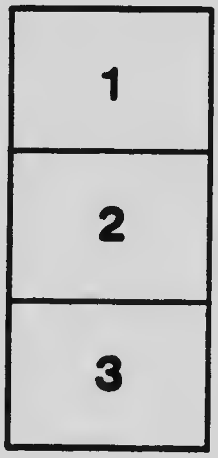

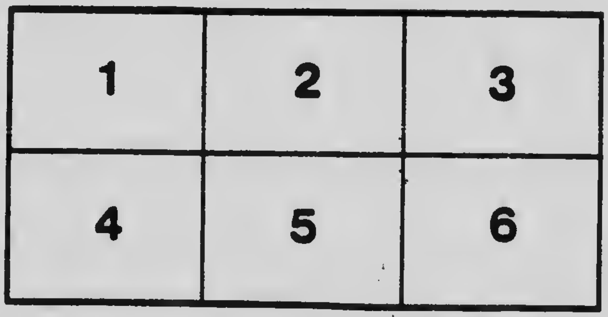

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Chippawa Power Development in all Phases is a Higher Efficiency Enterprise

Canada's Largest Piece of Construction Being Carried Through by a Unified Organization, Working with Equipment of Record Breaking Order

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[Reprinted from Contract Record, June 25th, 1919]

Chippawa Power Development in all Phases is a Higher Efficiency Enterprise

Canada's Largest Piece of Construction Being Carried Through by a Unified Organization, Working With Equipment of Record Breaking Order

THE development of industry is quite largely a matter of dependable and cheap power. Coal, except in the immediate vicinity of the mine, does not produce cheap power. Further, its supply is limited and uncertain and constantly increasing in price, due to increased cost in labor and transportation over which, except in a very general way, we have no control.

We fall back then, necessarily, on our water power, of which fortunately we have a large supply. Water power is never-failing, inexhaustible over any term of years, subject in only a minor way to increased costs of other commodities and, finally, ideally capable of application to manufacturing and construction industries of every kind.

It follows, then, that if Canada is to become a nation of efficient workers, in any or all lines of industrial life, our water powers must be utilized to their fullest extent.

That is the reason a description of the great Chippewa power development of the Hydro-electric Power Commission of Ontario finds its proper place in this "Higher Efficiency" number of the "Contract Record."

To begin with, this big development was undertaken so that two (and more) horsepower may be developed out of the same water which up to the present time has developed only one horsepower—that is higher efficiency at its best. Further, it is being put through at a time when many people entertain anticipations of a coal shortage and at the moment when young Canada (industrial) is upon the very threshold of an era of wonderful development. A third reason why a description of this work finds a place in our efficiency issue is found in the fact that this whole gigantic enterprise is being carried through as a unit, the same engineers and officers controlling the whole work, all plans being laid with a view to dovetailing in the various sections of the work—a condition that would be impossible if work on the different sections were being carried forward by different contractors. In a word, the work is one big organized unit, allowing of no duplications. This again spells greatest efficiency.

Thirteen-Mile Canal

The route of the big canal which will carry the water to the turbines at Queenston is shown in the map herewith. This route is about 12 ¾ miles long, with the intake on the Niagara River a Hog Island, Chippawa, about two miles above Niagara Falls. The tailrace is on the Niagara River about one mile above Queenston. The intake will be in what is known as the Grass Island Pool of the Niagara River. The mean monthly elevation of this pool varies about one foot.

The normal mean elevation of Lake Erie is 573 feet; of Grass Island Pool, 563; of the proposed power house site, 247; and of Lake Ontario, 245. Probably no river has a more uniform regimen than the Niagara. The minimum flow is about half the maximum, and over a period of fifty years the maximum difference in mean monthly levels under normal conditions, either at Queenston or Chippawa, amounts to only about six feet.

The best intake and power house locations were first determined upon, with a view to the maximum utilization of the available head, and contours and borings were then studied to decide by what route a canal could connect those two points to the best hydraulic and economic advantage. The intake was located at Hog Island partly on account of that point being just above the ... tion at which the water begins to speed ... passage over the Falls. Location furth... river would have meant a larger canal a... downstream would have necessitated a lo... Another reason equally important for lo... the intake at Chippawa was the use which could be made of the natural channel of the Welland River—often called Chippawa Creek—which comprises about 4¼ miles of the route of the Canal, leaving only about 8½ miles to be excavated, although the Welland River will have to be somewhat deepened. The flow of the Welland River, which is a sluggish stream with a very flat gradient, will be reversed for this 4¼ miles.

8½ Miles of Excavation

This 8½ miles of excavated section compared with 19½ miles for the old Jordan-Erie scheme, and the net head is 305 feet, compared with a possible 299 feet for the Jordan-Erie project. (see map)

The gradients adopted for the canal average about one foot per mile, or a total of about eight feet in the 8½ miles of excavated canal. The loss of head in the penstocks, due to friction, may amount to upwards of two and a half feet, and the loss in the Welland River from Hog Island to Montrose, where the excavated canal begins, will be about 6 inches, under maximum load, so that the total loss of head will be about 11 feet, making the net effective head about three hundred and five feet under normal conditions.

Thus, of the 327 feet normal difference in level between the two lakes, only 22 feet head will be lost—10 feet between Lake Erie and Hog Island, 11 feet between the intake and the tailrace, and two feet between the point of discharge of the tail water and Lake Ontario.

The power house will be located in the bottom of the gorge, about three-quarters of a mile above the Lewiston Bridge, just below where the last rough water disappears. The cliffs are nearly vertical at this point, and as the gatehouse will be on the cliff immediately above the power house, the penstocks will be nearly vertical and only about 450 feet long, thus reducing cost and head loss to a minimum.

With this scheme of development about 30 h.p. will be obtained from each second-foot of water used, compared with about 14 h.p. per second-foot obtained by the existing plants at Niagara Falls. With ases

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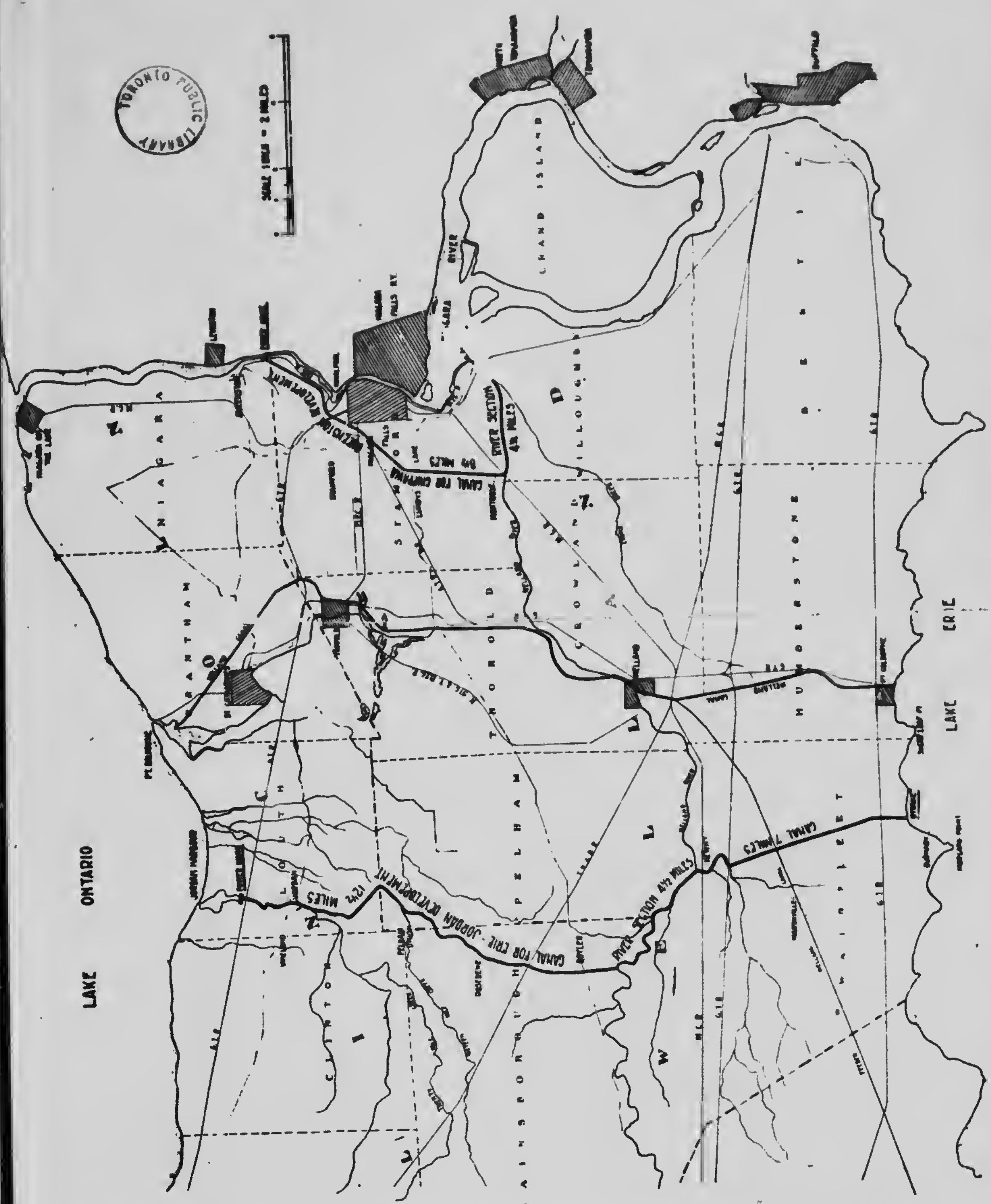

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Map showing the general route of the Queenston development canal, four and a quarter miles up Welland River, eight and a half miles rock and earth cut. Compare Erie-Jordan route with nineteen and a half miles cut

Excavation east from Bowman's Ravine late in 1918

Dredging Welland River—bucket dumping. Load about 3 yards

An electric locomotive and train of 20-yard dump cars. The usual train is 10 cars

Bucyrus in act of dumping a tons of earth

An electric locomotive and train of 20-yard dump cars   The usual train is 10 cars

Bucyrus in act of dumping 8 tons of earth

Assembling one of the bi[illegible] ... Lifts 8 to [illegible] cubic yards ... ea[illegible] time

Bucyrus shovel lifting 8 cubic yards of earth and loading cars 78 feet above

Big Bucyrus shovel loading cars, 8 tons at a time

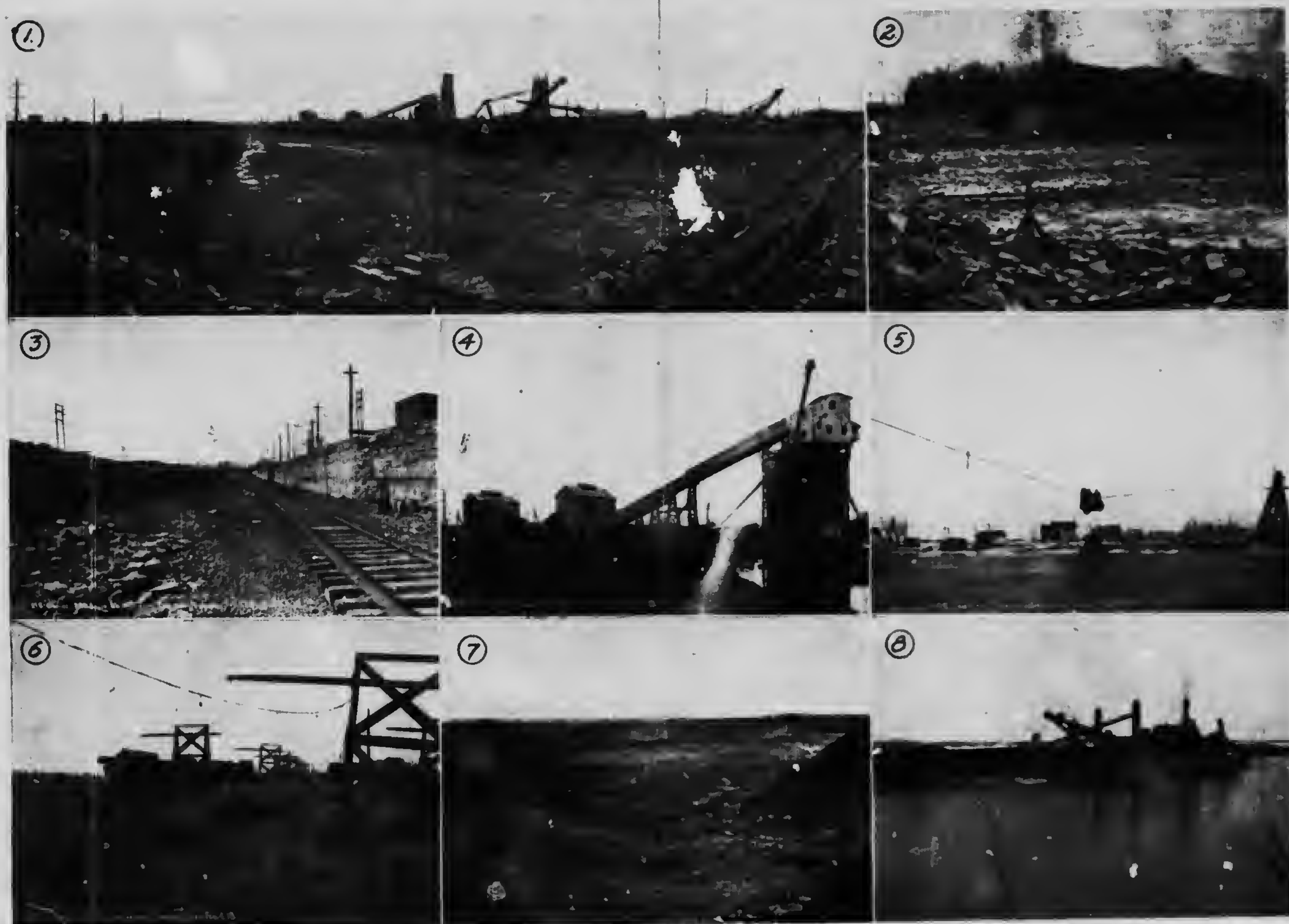


Fig. 1. View of forebay taken from electric railway track which rests on the immediate crest of the bank above the proposed site of the power plant at Queenston—solid rock, showing about 25 feet in depth excavated. (2) View of forebay immediately following shot. (3) Looking up canal excavation from forebay (4) Crusher plant The rock is coarse crushed in the building at the left, ported on belt conveyor to the second building containing secondary crushers, and finally hoisted to the screen house on the extreme right of the picture (5) Showing Lidgerwood cable bucket in operation, just rising with its 3-ton load, this bucket makes a trip every 2 minutes (6) Large disposal area, showing load being dumped, also movable trolley-pole line (7) Another view of disposal area; train of cars in distance being unloaded (8) Dredging work under way at Hog Island, at entrance to Welland river; scows in distance being unloaded

36,000, the whole treaty allotment of second feet available, over 1,000,000 h.p. can be developed.

All of the excavated section of the canal will be in solid rock, with the exception of 1¼ miles of earth section running north from the Welland River and half a mile of earth section across the whirpool ravine. These sections will be trapezoidal in shape, lined with rip-rap. The section at the whirpool will also be faced with concrete.

Rock Section

The rock section is 48 feet wide at the bottom, with perpendicular sides, the average wetted section being 35 feet deep and lined with concrete. The velocity in the rock section will be about 6 feet per second when the plant is under maximum load. The earth overburden above the rock surface will be generally sloped 1½ to 1, but a flatter slope is provided for where local conditions require it.

The Commission has purchased a tract of land as a right-of-way which will be sufficient for all present and future needs. This right-of-way includes about 200 acres near St. David's which will be used as a dump for the disposal of excavated earth and rock.

At a point 2,400 feet distant from the gatehouse, the canal begins to widen into the forebay, the forebay gradually increasing in width to four hundred feet, which will be the approximate overall length of the gate house. The initial development provides for four steel penstocks each about 14 feet in diameter, 450 feet long; and one exciter penstock, about 5 feet diameter.

Provision is being made for the installation of four main generating units each of 50,000 h.p. capacity. Both the gate house and the power house are so designed that they may be extended whenever conditions warrant.

The surveys for the work were begun in 1914 and continued for nearly two years. During the year 1917 the construction plant was brought onto the job and assembled, and during the first part of 1918 the camps were completed.

The Three Largest Shovels Ever Built

The main equipment for the earth and rock excavation consists of the three largest electrically driven shovels ever built. They are of the revolving type, built by the Bucyrus Company, and are fitted with an 8-cubic-yard bucket for excavation in earth, and a 5-cubic-yard for rock work. The boom on these shovels is about 90 feet long, and the dipper stick 58 feet. Either shovel can load dump-cars which stand on a track the level of which is 62 feet above the level of tracks on which the shovel stands. The shovel rests on two tracks (four rails) 30 feet centre to centre and is mounted on 16 wheels. The nominal horsepower of each of the two shovels is 715 h.p., upon a half-hour intermittent rating. Each shovel weighs over 300 tons, contains 75 tons of ballast, and has a capacity of 3,000 to 5,000 cubic yards per 10 hour day when handling earth.

There are also five other electrically-driven shovels at work, having dipper capacities ranging from ⅞ cubic yards to 4½ cubic yards.

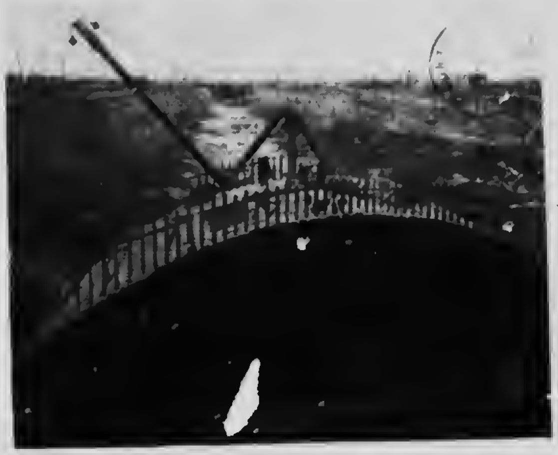
On the Welland River section of the canal, a Lidgerwood cable excavator is at work, fitted with a 3-cubic-yard Anderson-Evans clam. The cableway has an 80-foot head tower and 60-foot tail tower, and a span of ... feet. The excavated material is being disposed of along the north bank of the river. The width of the Welland River at the water line averages about 300 feet.

The Commission has purchased one hundred and fifty 20-yard Western airdump cars, each of 80,000 pounds capacity; also seven 40-ton steam locomotives and twelve 50-ton electric locomotives. The steam locomotives are switchers purchased from the Pennsylvania Railroad. The electric locomotives were built by the National Steel Car Company, Limited, of Hamilton, Ontario, six of them being constructed with General Electric equipment and six with Westinghouse equipment. Two pile-drivers are at work on the river section. There are three 40-ton and two 15-ton Bay City locomotive cranes for general utility work.

15,000,000 Cubic Yards of Excavation

It is estimated that 9,000,000 cubic yards of earth and 4,000,000 cubic yards of rock must be removed from the excavated section; and from the river section, 2,000,000 cubic yards of material, mostly earth.

At the present time the material which is being



Centering for one of the concrete bridges over the Chippawa power canal

excavated from the Whirlpool sections is being used to fill the old Whirlpool gulley, but the main dump, as already noted, will be at St. David's. A double-track railway line runs the full length of the canal from Montrose to the forebay, and a 2½ mile span connects the main line with the St. David's dump.

There will be various other branches of the railway constructed from time to time as needed. A railway will probably be built from the power house to connect with the Michigan Central at Queenston to bring in the machinery and to take out the materials excavated from the power house substructure.

The railroad lines are all electrified, the trolley wires being offset on one side of the track, and carried in clamps devised by the Commission's line construction department. These clamps and the hangers which suspend them from the poles are all made up of standard material, and are so arranged that the temporary use of the material does not injure it.

Framed timber trestles are set alongside the dump and other temporary tracks to carry the trolley wire. These trestles are mounted on wheels or skids and can

Fig. 1. View of forebay taken from electric railway track which rests on the immediate crest of the bank above the proposed site of the power plant at Queenston—solid rock, showing about 25 feet in depth excavated. (2) View of forebay immediately following shot. (3) Looking up canal excavation from forebay. (4) Crusher plant. The rock is coarse crushed in the building at the ... ported on belt conveyor to the second building containing secondary crushers, and finally hoisted to the screen house on the extreme right of the picture. (5) Showing Lidgerwood cable bucket in operation, just rising with its 3-ton load, this bucket makes a trip every 2 minutes. (6) Large disposal area, showing load being dumped, also movable trolley-pole line. (7) Another view of disposal area; train of cars in distance being unloaded. (8) Dredging work under way at Hog Island, at entrance to Welland river; scows in distance being unloaded.

One of the electric locomotives. Note the double trolley arrangement, two poles on each side

be removed readily by a locomotive crane when it is necessary to shift the track.

In the Whirlpool yards is located a large repair shop containing drills, shapers, planers, lathes, forges, steam-hammers and wood-working machines. The Commission has built about eighty buildings, including bunk houses, freight houses, offices, machine shop, storehouses, substation, etc.; also a number of buildings are used which were on various parcels of purchased property.

Gunite Buildings

Most of the buildings are of frame construction, but are being "gunited" on the outside over tar paper and wire mesh, using 1 to 3 mix of cement and sand. Sharp concrete sand is being used and the "gunite" applied with cement-guns. The substation, machine shop and all of the more important buildings have already been fireproofed in this manner, and it is the intention to "gunite" most of the other buildings. The bunkhouses are comfortably arranged on the cottage plan.

The crushing plant is located on the forebay. It is equipped with three secondary crushers of the gyratory type and one 84 in. x 60 in. Taylor jaw crusher which will have a minimum capacity of 2,000 cubic yards of crushed stone per day.

The rock excavation at the forebay is loaded into skips which are picked up by a locomotive crane and which dump into a bin. A belt conveyor carries the stone from the bin to the crushers and from thence by another conveyor to the cars.

There are four railway bridges to be constructed over the canal, one for the Niagara, St. Catharines and Toronto Railway (electric), one for the Wabash Railroad, one for the Michigan Central Railroad, and one for the Grand Trunk and Michigan Central Railroads. These will be reinforced concrete arch bridges. There will also have to be constructed a number of highways and foot bridges to carry the various roads across the canal. In the concrete work to date, both Canada and St. Mary's cement have been used.

Several hydraulic models are being prepared at Dufferin Islands, near the Ontario Power Company's intake in the Niagara River. These models are based on designs prepared by the Commission and are for the purpose of studying the design of tbe intake at Hog Island. The design of the intake works will be based upon the results of these studies.