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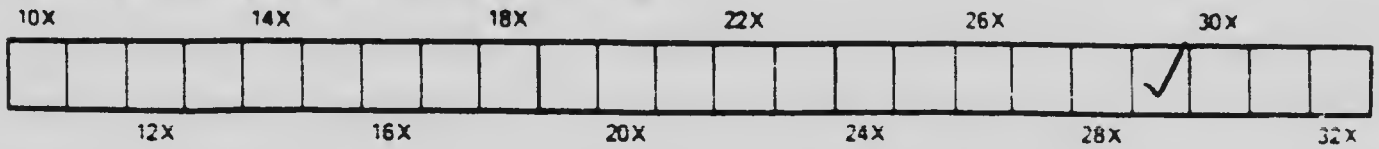
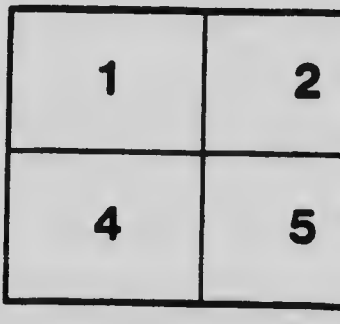
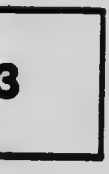
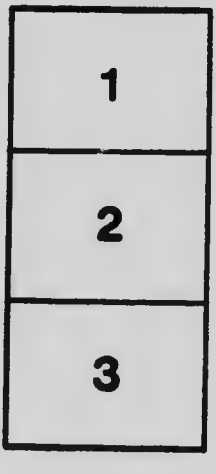
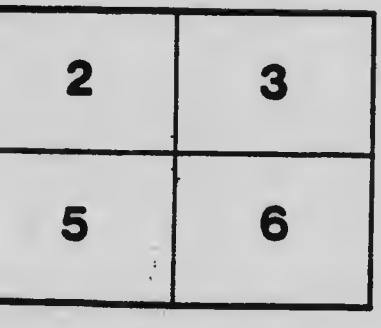










Reprinted from THE CANADIAN ENGINEER for November 13th, 1919

Hydro-Elec ic Power Development at High Falls

Net Head of 80 ft. Utilized at Power Site on the Mississippi River by the Hydro-Electric Power Commission of Ontario—Details of Dam, Intake, Gate House, Pipe Line and Power House—Surface Area Method of Proportioning Materials Shows Excellent Results in Construction of Concrete Dam

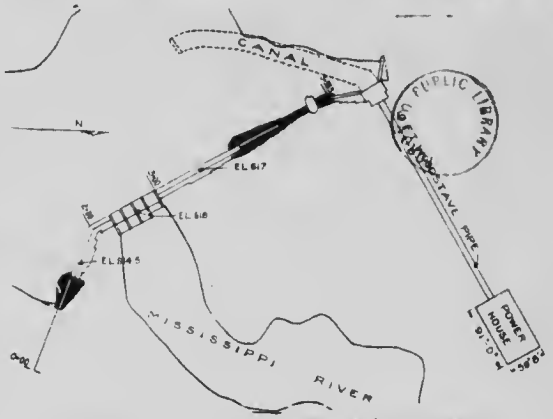
AT HIGH FALLS, on the Mississipp er, in the southern part of Lanark county, Ont., abo .c 25 miles northeast of Perth and ½ mile above Dalhousie lake, the Hydro-Electric Power Commission of Ontario is developing a power site and installing hydro-electric machinery with total capacity of 3,600 h.p. This plant will be the fifteenth generating station to be owned by the "Hydro" Commission, and two others are also under construction, the Nipigon plant (see *The Canadian Engineer*, June 12th, 1919, issue) and the great Queenston undertaking (see the following issues of *The Canadian Engineer*: August 28th, 1919; November 21st, 1918; September 26th, 1918; and June 20th, 1918). The fourteen other plants owned by the "Hydro" are the following:—

Wasdell's Falls, Eugenia Falls, Nipissing Power Co., Erindale Power Co., Trenton, Campbellford, Frankford, Auburn, Falls, Carleton Place, Ontario Power Co., Big Chr y Falls and South Falls.

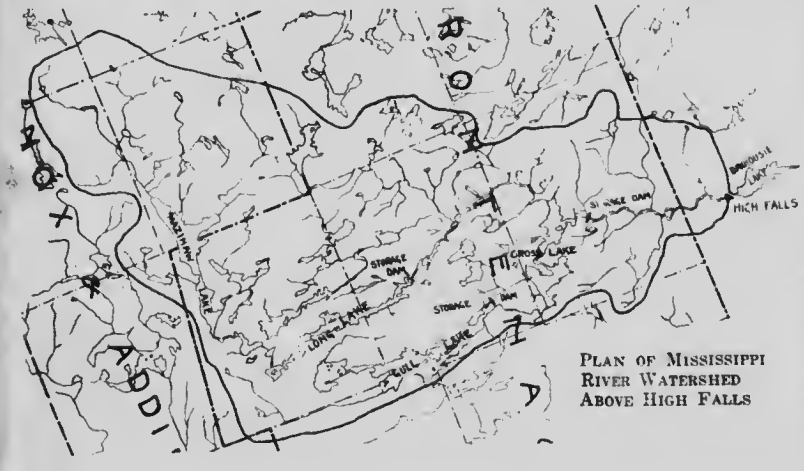
The first two mentioned—Wasdell's Falls and Eugenia Falls—were constructed by the "Hydro," but all of the others were purchased from the former private owners, although in the case of the four last-mentioned plants, the "Hydro" has built extensive additions.

The drainage area of the Mississippi river above High Falls is approximately 450 square miles. The first complete year for which run-off records were obtained by the "Hydro" was November, 1915, to November, 1916, for which twelve months the maximum run-off was 2,940 c.f.s., and the minimum 214 c.f.s., with a mean of 776 c.f.s., or a run-off depth of about 23 inches on the drainage area. For the following year, the maximum run-off was 2,060 c.f.s., the minimum 72 c.f.s., and the mean 426 c.f.s., or a run-off depth of about 12.8 inches on the drainage area. For the year November, 1917, to November, 1918, the maximum run-off was 2,530 c.f.s., the minimum 186 c.f.s., and the mean 499 c.f.s., or a run-off depth of about 15 inches on the drainage area. The watershed is still fairly well forested. The average run-off for the three years recorded was 567 c.f.s.

The plant that is being installed requires 540 c.f.s. when operated at maximum capacity. The water is used under 80 ft. net head. There are three horizontal, double-runner double-discharge hydraulic turbines; one of them is connected to a single generator, but each of the other two turbine, drives a generator at each end of its shaft. This is not a matter of present design, but is due to the fact that practically all of the hydraulic and electrical machinery for this plant was purchased at a low price, as used equipment, from the Hannawa Falls Power Co., of Potsdam, N.Y.



GENERAL PLAN OF HIGH FALLS DEVELOPMENT



PLAN OF MISSISSIPPI RIVER WATERSHED ABOVE HIGH FALLS

There is ample storage area above High Falls, as the Mississippi river flows through a chain of many lakes of various sizes, including Cross, Gull, Long, Mazinaw, Mud, Mississagagon, Kashwakamak, Buckshot and Grindstone lakes. The required storage dams on these lakes are already built and are owned and operated by the Mississippi Improvement Co., a private company that was organized by the power users who have developed other sites further down the river. The expenses of the Improvement Co. are met by assessments on all of the power users on the river, in

EXCAVATION FOR CANAL, LOOKING DOWNSTREAM

proportion to the power developed. The Improvement Co. has acquired the necessary flowage rights on the various lakes. The chief storage dams are those at the outlets of Cross, Gull and Long lakes, and are rock-filled timber cribs. There is also a pondage area of over 500 acres behind the new concrete dam that is being built at High Falls by the "Hydro," this dam also increasing the available head by approximately 12 ft. The "Hydro" purchased the power site at High Falls two years ago from its private owner. The "Hydro" was already a member of the Improvement Co., on

LOOKING UPSTREAM ABOVE DAM SITE

account of its ownership of the Carleton Falls plant further down the Mississippi river.

The accompanying general plan of the development indicates that the concrete dam at High Falls consists of a sluiceway section 76 ft. long, flanked on the south by an overflow section 104 ft. long, and on the north by a gravity section 112 ft. long, and terminating at the south in a core-wall section 38 ft. long and at the north in a core-wall section 140½ ft. long, the north core-wall section being sealed to the gate house by a wing wall 40 ft. long.

The total length of the dam and wing wall is about 510 ft. This is about the correct length of the whole dam as

LOOKING DOWNSTREAM BELOW DAM SITE

constructed, but since the lay-out was made from which the accompanying general plan was copied, the dam was located slightly further upstream, with a consequent lengthening of the overflow section and a shortening of the northern core-wall section. The overflow section as constructed is also more nearly on a straight line with the remainder of the dam than is indicated by the accompanying general plan.

The four sluiceways each have a 14-ft. clear opening. Each of the four rollways is 8 ft. 7¼ ins. wide at top, with a batter of 9 in 12. The reinforced concrete deck is 17 ft. 4 ins. wide. The height of the top

PORTION OF SLUICEWAY SECTION OF DAM, SHOWING THREE OF THE FOUR ROLLWAYS

of the deck above the base of the dam is about 26 ft. for sluiceways Nos. 1, 2 and 3, and about 22 ft. for sluiceway No. 4. The clearance from the top of the rollways to the deck is 14 ft. 2 ins. The deck is 10 ins. thick. The piers have a batter of 7½ in 12. The overflow section has a top width of 4 ft. 5½ ins., and a batter of 7 in 12. The gravity section has a top width of 3 ft. and a batter of 7 in 12. The core walls have a maximum thickness of 2 ft., and a minimum thickness of 1 ft. The rock fill is 6 ft. wide at top and has

POWER HOUSE SITE BEFORE UNWATERING, LOOKING ALONG PIPE LINE

a 1 to 1 slope on each side. The whole dam rests upon a rock foundation.

A canal, or intake channel, has been excavated for a distance of about 217 ft., extending upstream from the gate house at the north end of the dam. After the removal of the cofferdam that was built in order to divert the flow of the river and so unwater the site of the dam, this channel will be entirely under water excepting for a distance of 150 ft. from the gate house. The bottom of the canal is 8 ft. wide, and the sides are sloped 1½ to 1. The bottom and sides are protected by riprap excepting where they are in solid rock. The bottom of the canal is level for 100 ft. from the gate house, then the grade is 2% for 100 ft., then 4% for 36 ft., and 40% for about 11 ft. at the intake.

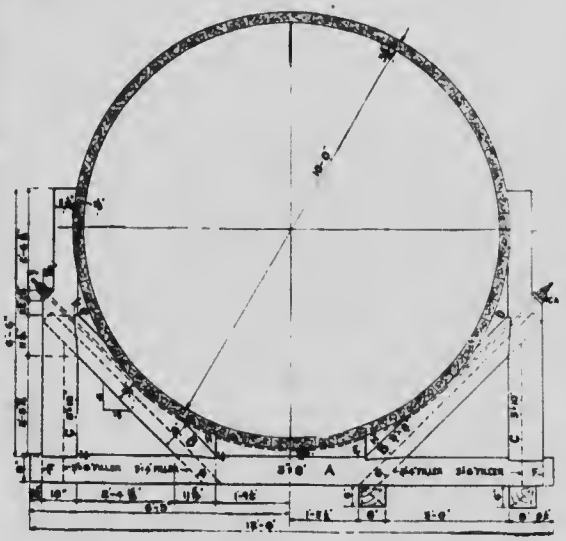
The gate house substructure is 27 ft. wide by 30 ft. long and 22 ft. high to the floor of the superstructure. Be-

ELEVATION OF DAM AT HIGH FALLS, ON THE MISSISSIPPI RIVER

hind the racks the width tapers to 17 ft. The water section varies from 20 ft. in width by 13 ft. in height to a circular section 10 ft. in diameter, ending in a reinforced concrete elbow which connects with the continuous-wood-stave pipe line leading to the distributor in the power house.

The wood-stave pipe line is 10 ft. inside diameter, approximately 320 ft. long, and is built of British Columbia fir staves 3⅝ ins. thick. It is supported by timber saddles spaced at 6-ft. centres.

The pipe is laid to a 22.4% g the difference in elevation between the two ends being out 70 ft. It is banded with 1,025 bands (⅞-in. diamet of two sections

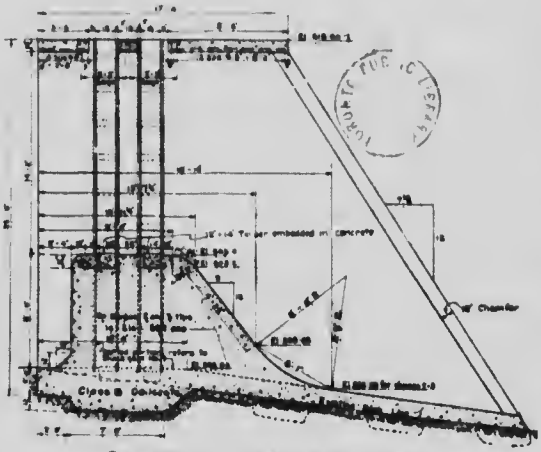


WOOD-STAVE PIPE, SHOWING SADDLE DETAILS

each, these bands being spaced as follows, starting from the gate house: 99 at 7 ins. c. to c.; 79 at 5½ ins.; 91 at 4¾ ins.; 108 at 4 ins.; 123 at 3½ ins.; 144 at 3 ins.; 157 at 2¾ ins.; and 224 at 2½ ins.

The bill of quantities for the pipe line included 2,050 shoes, 62 saddles, 124 saddle rods, 1,030 F.B.M. sills, 124 washers and 75 cu. yds. of 2-in. stone for use in bringing rock fill to grade.

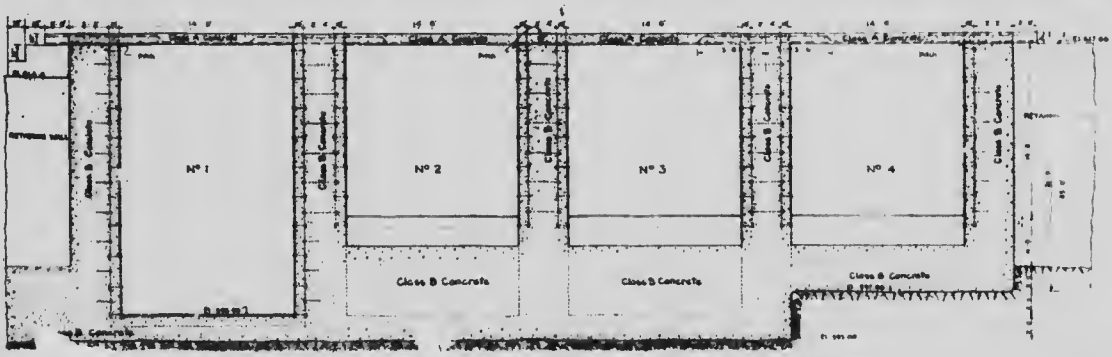
The power house is situated on the river bank, and its substructure is approximately 94 ft. long by 62 ft. wide. The greater part of the power house substructure is mass



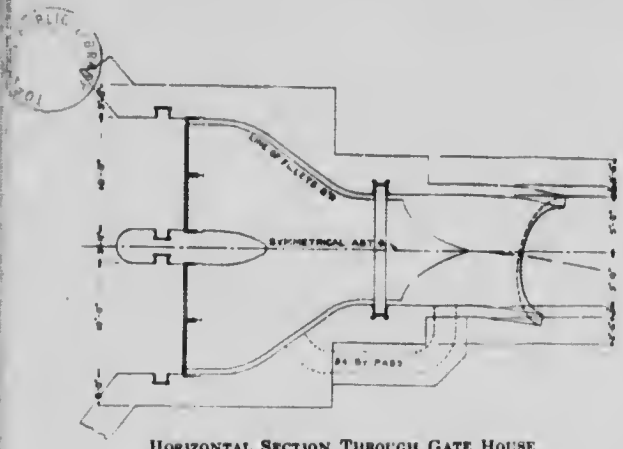
CROSS-SECTION THROUGH SLUICEWAY

concrete, but the distributor which carries the water from the wood-stave pipe to the turbines is moulded in reinforced concrete. The turbine casings are steel plate, as are also the draft tubes. The tail water level is 532.5 when the forebay is at 614.0, so the gross head on the plant is 81.5 ft. at high level. The velocity in the pipe line at full load is about 6½ ft. per second.

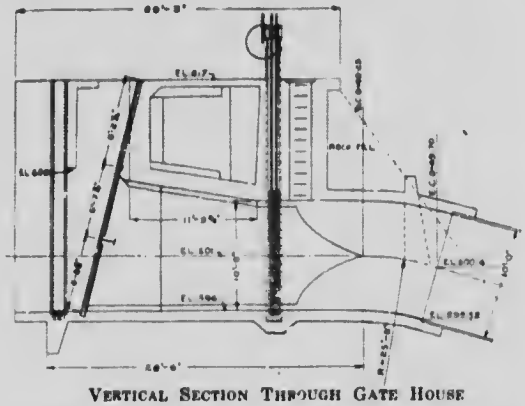
It is of interest to note that the Heath-Edwards surface area method of proportioning materials for concrete was used for the dam, this being the first time that it was used by the "Hydro." Under the "Hydro's" new specifications, concrete is no longer classed as 1:2:4, 1:3:6, etc., but is called "Class A," "Class B," and "Class C" concrete. Class B concrete, which was used for the mass work at High Falls, is concrete developing a strength of 2,000 lbs. Class A concrete, which is used with reinforcing, is concrete developing a strength of 2,500 lbs. Test cylinders of Class B



LONGITUDINAL SECTION THROUGH SLUICEWAYS OF HIGH FALLS DAM



Horizontal Section Through Gate House



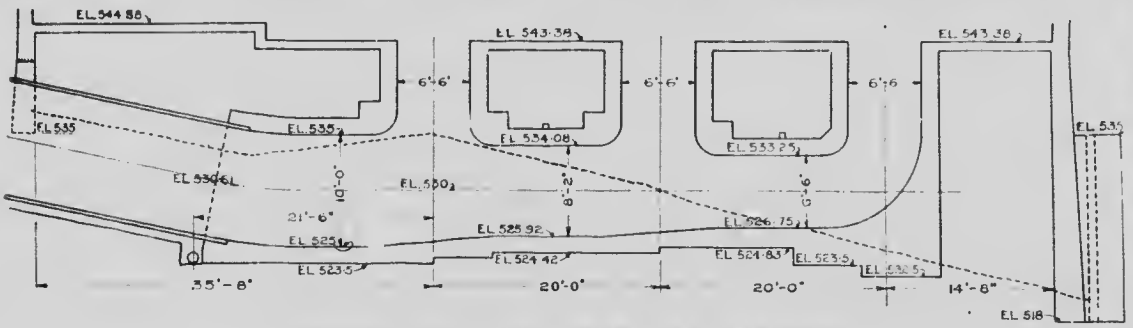
Vertical Section Through Gate House

concrete taken from the forms at High Falls ... ved from 2,500 to 2,700 lbs. strength. At first lower ... s were obtained, but by cutting down the amount of wa...r used and exercising greater care in the proportioning of the materials, the higher strengths were soon secured. Some samples of Class A concrete did not fail at 4,000 lbs., which is the limit of the "Hydro's" machine, so they were held there for three minutes and then tested no further. Crushed stone and gravel were used as aggregate. The stone is a trap of high quality.

Dam Site, Showing Cofferdam for Diversion of Stream During Construction

Work on the High Falls plant started in October, 1918, and is now about 75% completed. The dam is finished, the gate house partially constructed, the foundations and walls for the power house are poured, the canal has been excavated and the pipe line graded. The pipe has not yet been constructed but the material is on the job, as is also all of the hydraulic and electrical machinery for the power house. The plant will probably "turn over" next spring. It will supply power to the "Hydro's" Rideau system at 23,000 volts, 3-phase, 60 cycles. The construction is being handled throughout by the ...ction department of the "Hydro." The wood-stave pip... is supplied by the Pacific Coast Pipe Co., Ltd., of Vancou...r. The structural steel was fabricated by the Dominion Bridge Co., Ltd., of Toronto and Montreal. The cement used was purchased from the Canada Cement Co., Ltd., and the reinforcing steel from the Steel Co. of Canada, Ltd., of Hamilton.

Hon. Sir Adam Beck is chairman of the Hydro-Electric Power Commission of Ontario; W. W. Pope, secretary; and Frederick A. Gaby, chief engineer. The design and construction of the High Falls plant, with the exception of the electrical work and the power-house superstructure, are under the direction of the Commission's hyraullic department, of which Henry G. Acres is the hydraulic engineer; Thos. H. Hogg, assistant hydraulic engineer; and Max V. Sauer, designing engineer. E. T. Brandon is the electrical engineer of the Commission; and Arthur H. Hull, assistant electrical engineer. The resident engineer at High Falls is A. L. Malcolm. E. V. Trimble, engineer of the Commission's construction department, is represented on the work by E. F. Lynn.



Longitudinal Section Along Centre Line of Power House