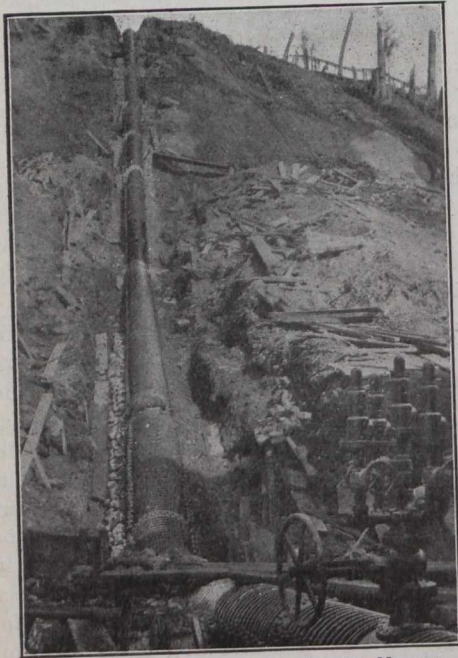


Five combination sand and waste gates are provided along the length of the flume at approximately equal intervals, and a standard weir was built at the lower end where several measurements were taken to determine the carrying capacity with different depths of water. The results of these tests indicates a value of about 122 for the coefficient in Chezy's formula: $v = c \sqrt{rs}$.

The flume has been in continuous operation since November, 1910, and has proven tight, safe, and reliable in every respect, only one short interruption having occurred, due to the loss of one bent destroyed by a small landslide.

Forebay Reservoir.—The forebay reservoir site consists of two small, gently sloping, heavily wooded depressions leading in opposite directions from a low saddle or ridge, lying 1,150 feet above sea-level. Two earth dams were built across the valleys, the material for the embankments being all excavated from the higher ground between. Each embankment is about 35 feet in height, and 1,000 feet in length. The total volume of fill in the two dams is 35,000 cubic yards.

The material available for the embankments was semi-cemented gravel, or hard pan,



Pipe Line at Entrance Power House.

which required drilling and blasting to loosen. A double-sheathed timber diaphragm of cedar planking, connecting with a concrete cut-off wall sunk well into the impervious hardpan, was installed in each dam to insure water tightness, the material from which the dams had to be built not being sufficiently impervious to make them adequately water-tight without diaphragms.

Dam No. 1 was built with wheelbarrows and heavy sleds, hauled with a donkey engine, and hoisted and dumped from an overhead cableway. Dam No. 2 was built under contract, with horses and carts.

No particular attempt was made on either embankment to puddle or compact the material during construction, except that a limit of three feet was placed upon the layers deposited, and a small amount of puddling with water was done immediately in front of the timber diaphragms.

A concrete intake structure, surmounted by a structural steel gate tower, from which were operated two roller bearing 54-inch hydraulic sluice gates, was erected inside the reservoir at the head of the pipe line. Two 44-inch steel riveted pipes are installed through the base of the south dam. From the intake structure to the core wall, the pipes are imbedded in a reinforced concrete casing, and from the core wall to the lower toe of the dam, two open culverts, with common centre wall, and roofed with reinforced concrete slabs, are installed around the pipes, insuring perfect drainage, and allowing access for inspection. Two 6-inch stand-pipes extending up to the floor of the gate tower are installed at the upper end of the pipes.

The reservoir, when full, covers an area of about 12 acres, and the capacity available—4,800,000 cubic feet—is sufficient to operate the single generating unit installed for a period of about 30 hours. To prevent damage to the slopes from wave action, a light timber boom is floated about four feet from the water's edge, and braced at intervals from the bank.

An emergency spillway with flash boards and apron is built in the solid ground at the east end of dam No. 2.

The function of this forebay reservoir is to increase the peak load capacity of the power plant by liberal storage immediately at the head of the pipe line; and also to furnish a reserve supply of water to run the plant for a considerable period in event of accident to the flume line.

Pipe Line.—The pipe line leading from the forebay reservoir to the power station is 9,800 feet in length, and follows a gentle slope for the greater part of its length, the lower 300 feet descending abruptly to the power house. The upper third of the length of this line is designed to deliver water for two generating units of 4,000 kilowatts each, and consists of one riveted steel pipe 44 inches diameter, $\frac{1}{4}$ inch to $\frac{3}{8}$ inch plate. At the lower end of this section a cast-iron "Y" piece, fitted with two 36-inch cast steel gate valves is installed, providing for the extension of two lines to the power house. The lower section of the pipe is designed to deliver water for one generating unit only, and the single line installed consists of lap-welded steel, with riveted round-about joints, in approximately equal lengths of 36-inch, 34-inch, 32-inch and 30-inch diameter, and varying in thickness from 5/16 inch at the "Y" end to 9/16 inch at the lower end.

The pipe line was designed with an ample factor of safety according to current practice in the extensive use of lap-welded pipe. However, owing to the apprehension aroused in the minds of the officials of the company by a reported failure of a similar lap-welded pipe elsewhere, the lower end of the pipe line for a distance of 2,200 feet was reinforced by one inch round steel bands, after the manner of a wood-stave pipe with spacing from 3 $\frac{3}{4}$ to 4 inches.

Several hours after first filling the line with water the 36-inch valve on the dead end at the "Y" burst without warning and the water in the 44-inch pipe above was suddenly discharged. No damage, however, resulted to the pipe line, ample air openings having been provided for its protection. The valve was split almost centrally through the body and bonnet, the lower half being blown a distance of 20 feet away. An investigation of the design of the body showed that an ample factor of safety and no flaws or other defects were disclosed. The valve had been ordered tested before shipment, but this had not been done. The accident emphasizes the unreliability of cast-iron, even for moderate pressures. The cast-iron valve bodies were then discarded, and cast-steel parts installed in their places, and, as an additional precaution, two expansion joints, one in the 44-inch pipe above the "Y" and one in the 36-inch pipe below, were introduced in the line to eliminate any strains due to expansion or contraction to which the cast iron parts might be subjected. Eight 4-inch air valves and 4 manholes were installed along the length of the pipe, and immediately back of the power house a cluster of four automatic pressure relief valves was mounted.

Concrete anchor bolts and supporting piers were erected at proper intervals along the pipe line.

The inclined tramway was installed parallel to the line along its entire length, from which the pipe and other materials were delivered.

The entire pipe line installation, including the furnishing of material and the erection, was done under contract