PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 52 June 3, 1922 No. 22

Pine Hill Dam

Main Section, Spillway, Bridge and Walls contain 55,000 yards of concrete. Foundations 62 feet deep built in 10 sections with iron stop plates in construction joints. Water cushion formed by weir. Part of main dam built in narrow long sections temporarily serving as cofferdams. Bypass eliminated. Foundations 62 feet deep grouted 30 feet deeper. Crushed stone used for sand.

The Pine Hill Dam, about 1,000 feet long and 113 feet in extreme height above the bottom of the lowest foundation, is now in an advanced state of construction and has been built by day forces of the city of Worcester, Mass.

It has cost to the present time about $800,000, while nearly $1,500,000 has been expended on the entire project connected therewith.

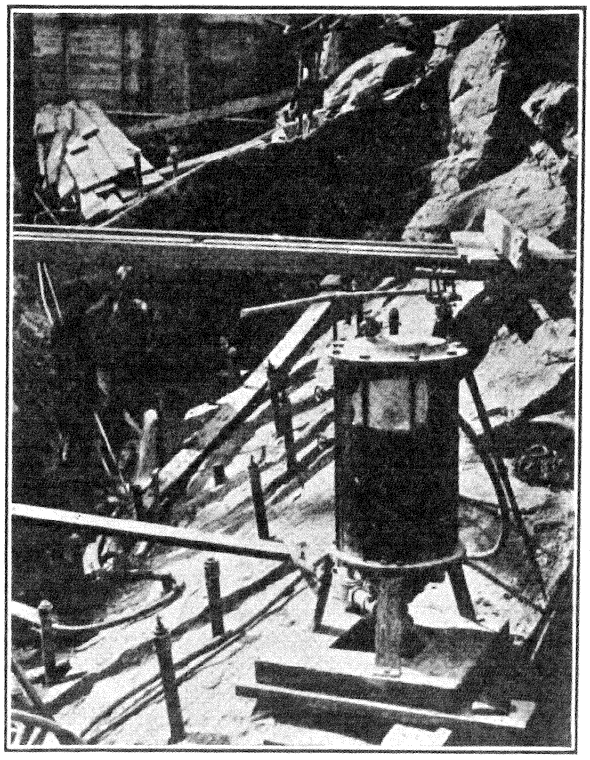
It will impound 2,997,000,000 gallons of water in the Pine Hill reservoir constructed on Asnebumskit brook in the towns of Holden, Paxton and Rutland and is located some ten miles from the city.

The 6.90 square miles of area draining into it was originally a part of the watershed of the Nashua river, feeding into the great Wachusett reservoir of the Metropolitan Water Works, but provision for the taking of this area by the city of Worcester was made by the State Legislature in the act creating the Metropolitan Water Board in 1895.

MAIN SECTION AND SPILLWAY

The dam has a central portion of cyclopean concrete masonry with expansion joints about every 40 feet and is 373 feet long, 80 feet wide in the deepest sections and 17½ feet on top. At each end of this main structure is a buttress from which a concrete core wall continues into the hill on either end. These concrete core walls are reinforced by earth embankments with a total width of 25 feet on top and with slopes of 2 to 1.

The up-stream face of the main section is perpendicular, while the down-stream face is on a vertical curve and slope running from the 17½ feet width on top to the width of 80 feet in the maximum section. An 83-foot spillway is provided in the central portion of the dam at an elevation of 10 feet below its top, and across this is a three-arch reinforced concrete bridge.



GROUTING FOUNDATION HOLES 30 FEET DEEP UNDER DOUBLE MAXIMUM HYDROSTATIC PRESSURE

As the water passes over this spillway it is guided down the face of the dam by walls on either side which lead it into a semi-circular pool having a massive concrete floor and reinforced concrete baffle blocks to break up the velocity of the water as it falls into the 7-foot cushion of water, retained by a weir wall.

CONSTRUCTION JOINTS

The foundation for the concrete portion of the dam in the bed of the valley was carried down to solid rock at a maximum depth of 62 feet below the surface, and this portion of the dam was built in 10 sections

separated by transverse vertical joints providing construction expansion joints. In the spillway fourteen vertical bonding grooves 12 inches wide and 2½ inches deep were provided.

In addition there is a set of vertical longitudinal 12 x ½-inch ingot iron stop plates imbedded 6 inches in one section of the dam and projecting 6 inches into the adjacent section and reaching full height from top to bottom of dam, 5½ feet from the vertical or up-stream face.

About nine feet down stream from this stop plate, in the same transverse vertical plane, there is a full depth 6 x 12-inch drainage well communicating with a horizontal 4 x 6-foot inspection gallery that runs from end to end of the concrete dam at about the same grade and elevation as the original surface of the ground.

The supply from the reservoir is carried through the dam in a 30-inch cast-iron pipe built into the concrete 60 feet below the crest of the spillway. This pipe enters the bottom of the supply well, which is provided with inlet gates at three levels in the up-stream face of the dam. The lower end of the pipe is controlled by a gate installed in a gate house at the ground level just below the toe of the dam.

The dam and its appurtenances are to contain about 55,000 cubic yards of 1:2½:5 concrete and 67,000 cubic yards of earth embankment. It will also require the excavation of 40,000 cubic yards of earth and 11,000 cubic yards of rock; as well as the quarrying of some 75,000 cubic yards of stone from the quarry located nearby.

The site selected for the dam's location presented somewhat difficult conditions. The southerly end was located on a foundation of irregular rock formation which was practically entirely exposed, without any covering of earth. Starting at the foot of this hill, however, and crossing the valley in a northerly direction the strata of rock fell away so rapidly that there was a depth of nearly 62 feet of earth covering the ledge at the northerly buttress, just beyond which point the concrete section was narrowed to a core wall. This wall was continued into the hill, being well bedded in heavy clay hard pan.

EXCAVATION

The rock excavation on the southerly hill had a maximum depth of 45 feet owing to its seamy structure. This depth of excavation ran southerly to a depth of 12 feet and northerly to a depth of 5 feet. These various depths of soft rock were removed by drilling, barring and wedging before reaching a solid foundation. This excavated material was disposed of by guyed derricks to trains on the narrow-gauge railroad, to be taken to the crusher, saved for riprap or disposed of as waste, just as the nature of the material seemed to warrant.

GROUTING

While the rock excavation was thus carried down to what appeared to be a solid foundation, yet the ledge was treated for seams and fissures to a depth of from 25 to 30 feet below the bottom of this excavation.

Three lines of 2-inch holes, averaging about 6 feet apart, were drilled to these depths running the entire length of the main dam and into the southerly hill.

They were parallel to and ranged from 1 to 12 feet from the up-stream face of the dam. These were grouted under a pressure equal to twice that of the water when the reservoir is filled. It is believed that the seams were thus thoroughly sealed and all danger of serious upward pressure on the foundation was eliminated by the use of about 350 barrels of cement required for the grout.

The first excavation made for the dam was to provide an earthern channel to care for the stream at the toe of the northerly hill. With this in operation the foundation for the southerly end of the dam was made and the structure raised to the elevation of the old stream.

CONCRETE FORMS COFFERDAM

Temporary concrete wing walls were then built to connect with the part of the dam finished, and with these as coffer dams the water was turned across the partly completed section.

This effective method saved the building of any flume, and made a channel absolutely water tight so far as any leakage was concerned. This has made the care of the water a simple one during construction and thus little pumping has been required except to care for the surface water.

This section which has been left low during construction can be raised and completed when desired, the 30-inch pipe being sufficient to care for the stream during the dry season.

As the excavation was carried northerly across the valley it was made first in open cuts, with slopes, to a depth of about 20 feet into the earth, beyond which, however, sheeting was used. Parallel trenches each 16 feet wide with 2-inch sheeting were opened up, one on the upper and the other on the toe sides of the dam and were carried down to bed rock. When this excavation was completed and in readiness, concrete was filled in, which then acted as retaining walls to permit the removal of the section left between them.

These walls were immediately raised to a sufficient height so that by the use of guyed derricks it was possible to deposit this earthern core back of them as a part of the embankment.

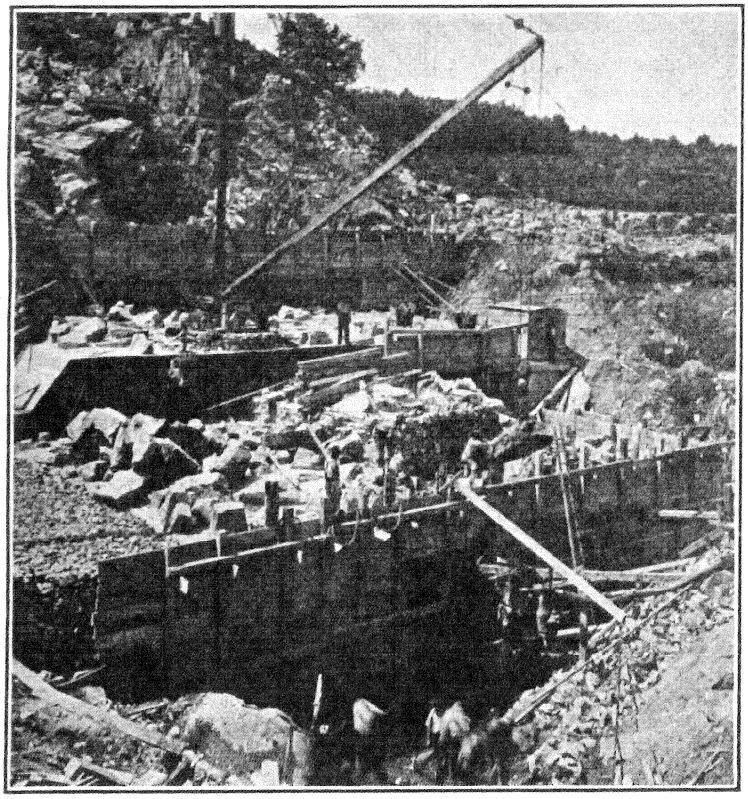
CONCRETING AND PLANT

The bottom of the rock excavation was left very jagged and irregular, affording a splendid bond with the ledge, and the concrete was laid in subdivisions to break joints so far as possible except where the expansion joints were designed.

The concrete was mixed in plants established at each end of the dam and was delivered to the work by ⅝-yard buckets handled by a trolley hoist on a cableway installed approximately on the center line of the top of the dam. It was also delivered by derricks and placed by either or both as was most convenient.

The plums for the cyclopean concrete were delivered on the service tracks and were placed by three derricks seated on the dam and shifted from time to time as the concreting advanced.

The cyclopean concrete contained about 20 per cent of large stone up to one yard in volume and was placed at a maximum rate of 2,000 yards per month.



CONSTRUCTION OF LOWER PART OF FIRST THREE SECTIONS OF DAM WITH EXPANSION JOINTS BETWEEN THEM

A home-made bag duster built on the general plan of an old time cylindrical carpet duster has added much to the comfort of employees engaged in bundling bags for return shipment to the cement mills. Incidentally it has helped salvage nearly enough cement to pay for its operation as well as having cut the weight of empty bag shipments in half. It has made it possible to return and get credit for nearly 96 per cent of the bags originally received.

The first concrete in this dam was placed in August, 1916, but due to the war and the shortage of help immediately following, but slight progress was made until the summer of 1921.

At the close of that season's operations about 65 per cent of the work was finished and another year ought to see the entire undertaking completed.

The dam was designed and its location determined by former city engineer Frederick A. McClure, under whose direction and supervision the construction was begun and nearly half finished.

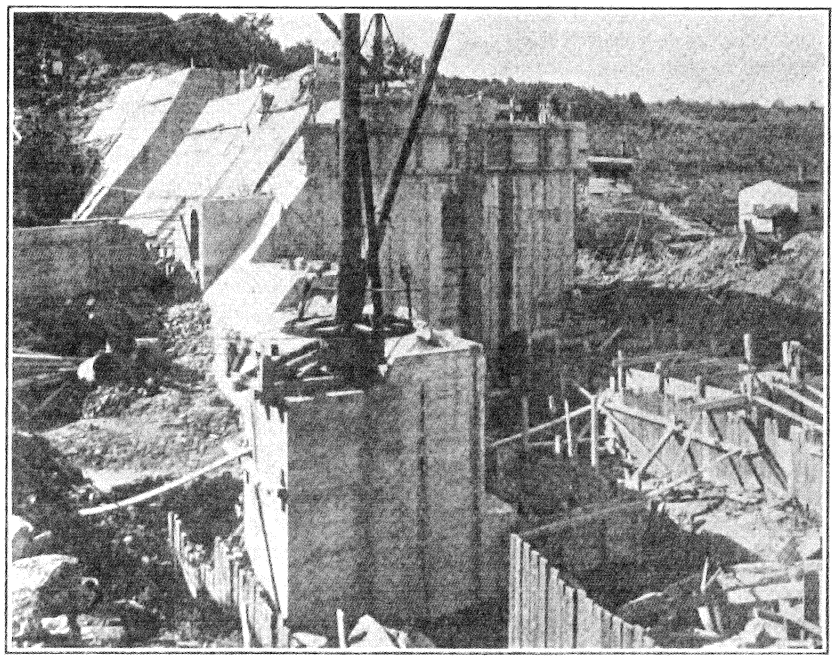
Its construction has been under the joint supervision of the Engineering and Water Departments. George W. Batchelder, the water commissioner, has furnished all materials and supplies, while city engineer David M. Earle directs and supervises the work, assisted by Leon A. Goodale, who has served as superintendent since the beginning of the work.

The average force employed was about 215 men and the wages paid in 1921 varied from $4.00 per 8-hour day for common labor to $7.00 for skilled men. The work has been done entirely without the use of teams.

The principal items of plant and equipment included one Lidgerwood cableway, one 10½D Acme stone crusher, four 8-ton locomotives, four hoisting engines, two concrete mixers, one Telsmith intercone mill, two air compressors, two locomotive type boilers for operating stone crusher and cableway, and five derricks.

SAND AND CEMENT

The crushing plant was designed in three units, made necessary by the fact that all sand used in the concrete has been made from stone, due to an absence of sand in this vicinity. The result has been accomplished by crushing and then running the required per cent of broken stone through a Cages Telsmith intercone mill and sand rolls until a product has been obtained superior to standard sand.



DOWN STREAM FACE OF DAM, SHOWING INSPECTION GALLERY AND ENTRANCE TO IT. SHORT PILE COFFER DAMS IN FOREGROUND FOR UP AND DOWN STREAM SECTIONS OF FOUNDATIONS.