DESIGN OF A TILTING DAM*

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THE water supply of Baltimore, Md., is taken from the Gunpowder River, the headwaters of which lie in York County, Pa., near the Maryland line. The river then flows through Baltimore County, Md., in a southeasterly direction, emptying into the Chesapeake Bay about ten miles northeast of Baltimore city. The river, though small, has steep slopes, with a drainage area of 308 square miles. Its main tributary below the fall line is the Little Gunpowder Falls, which has the same general characteristics as the larger river. There are several small power developments along its course, of which the Warren and Phœnix Mills are the largest. The condition of water supply in this river and others in the vicinity is different from that of all rivers of the north



Loch Raven Tilting Dam, Showing One Section Held in Open Position by an Obstruction at the Toe. Water Surface Elevation, 191.5 Ft.

because of the fact that its location is south of the limits of glacial action. The water is muddy immediately after rains, and subsequently, after the rain is over and the streams are supplied wholly by water coming from the ground, the water becomes clear. It frequently takes two or three days for the water of the Gunpowder River to clear, which clearing up is due mainly to the fact that the clear water following the muddy water forces the latter over the dams, and it is not due to the subsidence of the finer suspended particles which the water is passing through the impounding reservoir. The mineral constituents of the water are fairly low, hardness being about 40 parts per million.

Annual Yield of Gunpowder River

The annual yield of the Gunpowder River, according to the records kept for 35 years past by the water department, has averaged about 280,000,000 gallons daily, much of which runs off in floods, and by suitable storage this flow could be conserved. Previous to 1913 the city of Baltimore received part of its water supply from an impounding reservoir in the Gunpowder Valley, this supply having first been used in 1881. The works for taking this water consist of a stone dam about 25 feet high across the river, about seven miles northeasterly from the

*Abstracted from paper read before the American Water Works Association. city limits, creating a small reservoir, known as Loch Raven, with an original capacity of 510,000,000 gallons, and an area of water surface of 105 acres. Elevation of crest of dam 171.2 ft. A.M.T. At this time the city possessed the right to divert 170,000,000 gallons per day from the Gunpowder River. This capacity became largely reduced by the deposit of silt, until, in 1900, it was reduced to 178,000,000 gallons. At this time dredging was begun, and continued until 1909, with an average cost per year of \$25,000.

Plans for Increased Capacity

Starting in 1906, the water department made plans for increased storage capacity. Because of the fact that only \$5,000,000 was available for the construction of a new dam and purification plant, the water department decided to build a dam designed for a width of base at foundation line (approximately elevation 140.0 A.M.T.) to elevation '153.0 A.M.T., for a head at elevation 305.0 ft. A.M.T.,

this being the maximum height at which an impounding reservoir would be practicable. The area of water surface at this elevation would be approximately 9,500 acres, and a total capacity of reservoir of 142,300,000 gallons. This base to serve for dam at elevation of crest (spillway section) of 270.0 ft. A.M.T. Area of water surface at this elevation, 4,928 acres, and a total capacity of 58,871,000,-000 gallons. From elevation 155.0 ft. A.M.T. to elevation 164.0 ft. A.M.T. base for dam (spillway section) was designed for a head at elevation 240.0 ft. A.M.T. The area of water surface at elevation 240.0 ft. A.M.T. is approximately 2,391 acres, and has a total capacity of reservoir of 23,660,000,000 gallons. From elevation 164.0 ft. A.M.T., starting with width at this elevation of 29.79 ft., the dam was made of stepped section on down-stream side with a rise of 5.0 feet and a tread of

5.0 feet successively to elevation 184.0 feet A.M.T., and at elevation 188.0 ft. a width of 9.59 ft. The reason for making dam of stepped section on the down-stream side was because of the fact that no excavation or cofferdam construction will be necessary at the time of the raising of dam to any future height.

Warren Company Files Injunction

In 1911 the Warren Manufacturing Co. filed an injunction prohibiting the city of Baltimore from building the low dam, their reason for filing same being the probability of injury to their water power at the Warren Mills by the raising of the dam to the height as proposed by the city of Baltimore. In order not to affect the Warren Mills it was decided to build a masonry dam at elevation 188.0 ft. A.M.T. and then an automatic superdam or tilting dam from 188.0 ft. to 192.0 ft. A.M.T. The masonry dam, at elevation 188.0 ft. A.M.T., was completed on November 1st, 1913, and in 1917 the tilting dam was installed.

Dimensions of Spillway

The present spillway has a length of 321.0 ft. at elevation 188.0 ft. A.M.T., and as this crest has keyways affecting future raising of dam, the centre one was utilized for the location of anchor block, which in turn acts as pivot for tilting dam. To provide a tilting or otherwise movable superdam in this spillway, in one unit, was impracticable, for structural reasons. More so, how-