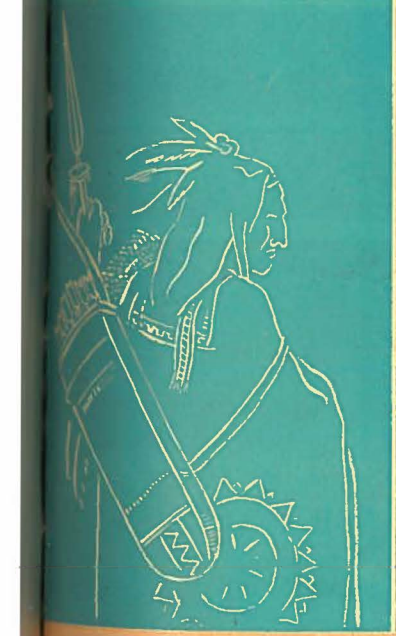
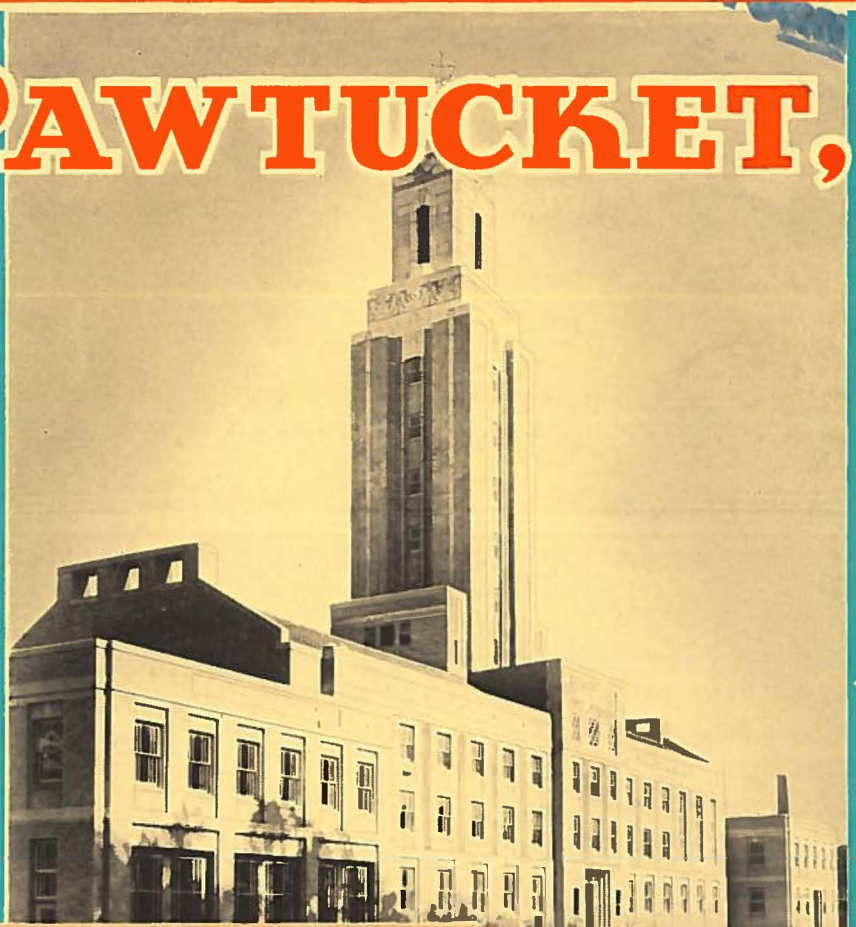
SEPTEMBER 18, 1935

WATER WORKS ENGINEERING

The Journal of the Water Works Profession Since 1877

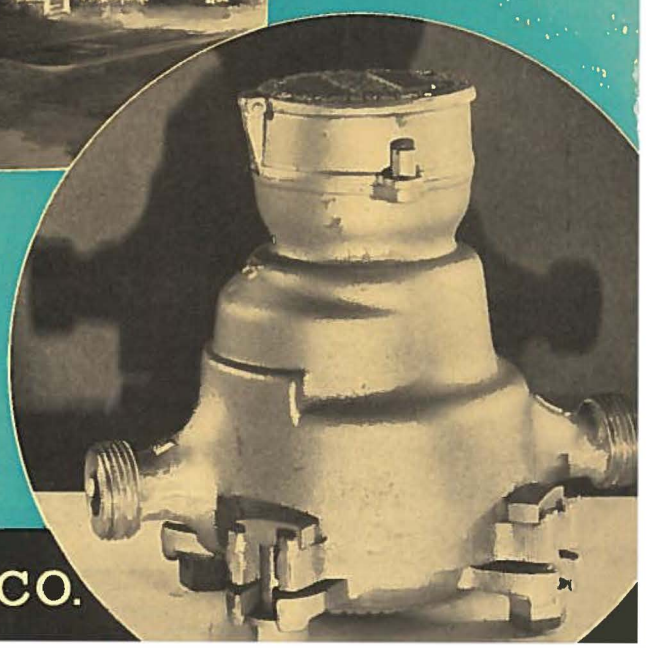
In Pawtucket, R. I.





It's a far cry from the teepee used by the Chief of the Narragansetts when ruling over his tribe, to the modern municipal building being erected through the efforts of Pawtucket's enterprising City Officials. This new structure, the first City Hall owned by the Municipality, will bring together under one roof, all departments of the local government. It is one of the most modern buildings of its kind in the country and the first P. W. A. project started in Rhode Island.

The old, out-moded method of assessing water rents at flat rates is likewise a far cry from the 100% metered system, such as has been in effect in Pawtucket for 25 years, with Pittsburgh Meters accurately measuring the consumption on each individual service and charges being rendered accordingly at just and adequate rates.



ITTSBURGH EQUITABLE METER CO.
MERCO NORDSTROM VALVE CO.

Quabbin Reservoir Work Now in Full Swing

By KARL R. KENNISON,
Assistant Chief Engineer,
Metropolitan District Water Supply
Commission, Boston, Mass.

Karl R. Kennison

WORK on the development of the Ware and Swift Rivers for an additional water supply for Boston and the Metropolitan District has been progressing as planned and much has been accompanied during the past two years. Previous articles in this journal and elsewhere in the engineering press have described the early stages of this development. The existing works of the District were in the main completed about thirty years ago, and the Metropolitan District Water Supply Commission is now charged with the construction of the first major addition to the water supply since the completion of Wachusett Reservoir on the Nashua River at Clinton.

Extension to Ware and Swift Rivers

This extension provides for the partial diversion of the waters of the upper Ware River, and for the diversion of the greater part of the waters of the Swift River. These rivers normally flow westward to the Connecticut River and thence southerly to Long Island Sound. The right of Massachusetts to divert this water from its natural interstate course was upheld by the United States Supreme Court in 1931. The completion of the Ware-Swift supply will insure to the District nearly three times as much water of good quality as is now available. The additional supply is brought into Wachusett Reservoir through a tunnel in rock, known as Quabbin Aqueduct, passing, at a maximum depth of about 800 feet, under the hills of central Massachusetts through seven towns for a distance of 25 miles from the proposed Quabbin Reservoir, in the town of Greenwich, to the westerly end of Wachusett Reservoir, in the town of West Boylston. This tunnel and a similar one recently completed by the city of San Francisco, and only a fraction of a mile longer, are the longest tunnels in the world and are twice as long as the famous Simplon railroad tunnel under the Alps, connecting Switzerland and Italy. The tunnel was driven from 12 shafts varying in depth from about 100 feet to 656 feet and is of a size which would accommodate a one-man trolley car. It is 12 feet, 9 inches high by 11 feet wide, and the excavation of the tunnel required more than 5 million pounds of dynamite.

First Stage—Ware Supply

The construction was started in 1926 and is being carried out in three stages. The easterly portion of the tunnel, about 13 miles long, was first used to divert water from the Ware River into Wachusett Reservoir in March, 1931, the diversion works being located at Shaft 8 in the Town of Barre. Here the water from the Ware River, which is 656 feet above sea level, is dropped down a shaft, so designed as to absorb the energy of the falling water without injury to the structure, into the tunnel and thence by gravity to Wachusett Reservoir, which when full is 395 feet above sea level. The drop into the tunnel creates a waterfall which, although entirely concealed from view, is actually 50 per cent higher than Niagara Falls.

Second Stage—Extension of Aqueduct to Swift River

The tunnel has now been extended westerly about 12 miles to the Swift River Valley where Quabbin Reservoir when filled will be 530 feet above sea level. The water diverted from the Ware River will, when the new works are completed, be stored in either Quabbin or Wachusett Reservoirs as desired and Quabbin Reservoir will be drawn as needed into Wachusett Reservoir; thence by existing conduits to the consumer in the Metropolitan District. The contract for the westerly extension of the tunnel was let April 23, 1931, and this extension of Quabbin Aqueduct to the Swift River Valley, forming the second stage of construction, was sufficiently advanced early in this year to have permitted diversion of water from the Swift River into Wachusett Reservoir had the storage in this reservoir been sufficiently depleted to have required it. The final inspection of the completed bore was made August 9, 1935.

The inspection party entered through the rack bars of the lower intake in the bottom of the future Quabbin Reservoir. The accompanying photograph of this intake was taken before the stop logs were inserted which permanently close off the bays at the lower level. The party continued easterly, travelling in canoes wherever the depth of water standing on the tunnel invert was deep enough to permit, and unbolted the doors of a heavy

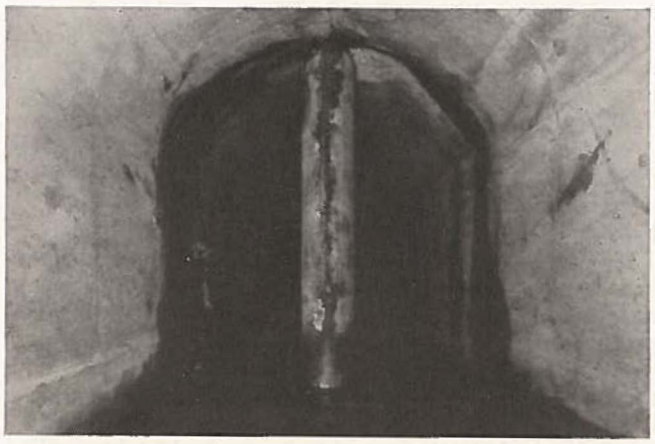
Foundations for the Dike of Quabbin Reservoir

steel bulkhead which had been used throughout the period of construction to keep the waters diverted from the Ware River from entering the westerly half of the tunnel. This bulkhead, which is of massive construction, using 18-inch I-beams, is shown on an accompanying photograph. It is in effect a hugh check valve and its doors swing easily on nearly vertical hinges of hardened stainless steel. As soon as the reservoir is ready for filling, this entire bulkhead will be cut away, by burning around the edges, and removed in pieces through Shaft 9, which is about 10,000 feet west of the bulkhead. The inspection party left through this shaft. A head house is to be built here and easy access to the tunnel has been provided by a 200-foot ladder, with platforms every 30 feet.

Third Stage—Quabbin Reservoir

The third step, the building of Quabbin Reservoir to provide for storing the waters of the Ware and Swift Rivers, is now under way. This reservoir is notable for its size and average depth. It will submerge parts of ten towns and eliminate three towns, with consequent revision of the boundary lines of six towns and three counties. There have been or will be acquired for the reservoir and its sanitary protection about 100 square miles of land, of which about 39 square miles will be flooded. The total storage of 415 billion gallons is more than six times the quantity stored in Wachusett Reservoir and would be sufficient to cover the entire land area of the city of Boston for a depth of over 45 feet. The area of this reservoir will be more than half that of Lake Winnipesaukee, in New Hampshire, and more than three times as large as the largest reservoir supplying the city of New York. The reservoir submerges about 16 miles of the Athol Branch of the Boston and Albany Railroad and requires its abandonment from Bondsville to Athol, about 30 miles. The removal of rails was recently completed on July 31, leaving only a connection to serve as a siding for freight to the main dam site. The reservoir will have an average depth in excess of 50 feet and the largest steamship ever built could be navigated from the dam for 16 miles up the main body of the reservoir and for over 10 miles up the west branch. There will be 70 islands in the reservoir, several of which, such as Mt. Pomeroy and Mt. Lizzie, will be precipitous islands reaching some 400 feet above the water surface. The total length of the shore will be over 150 miles. Many cemeteries, containing more than 5,000 bodies, are to be moved. A new cemetery has been provided outside the drainage area of the reservoir below the Dike in which about 1,300 bodies have now been interred. Many miles of road will be abandoned and already about 26 miles of substitute roads have been built. A high-tension electric transmission line of the New England Power Company has also been relocated for a distance of 8½ miles. The area to be flooded will be cleared of buildings, trees and other vegetation.

Intake to Quabbin Aqueduct Tunnel



Temporary Steel Bulkhead in Quabbin Aqueduct

Main Dam and Dike

Two dams are required to complete the rim of the Quabbin Reservoir, one, known as the Main Dam, across the Swift River at the junction of the towns of Ware, Belchertown and Enfield, and the other, known as the Dike, across the valley of Beaver Brook near the town line between Enfield and Ware. The following table gives the dimensions of these structures:

	Main Dam	Dike
Height above lowest ledge, feet.....	290	264
Maximum height above valley, feet.....	170	135
Maximum depth of water, feet.....	150	115
Length in feet	2,640	2,140
Volume above original surface in cu. yds.	4,000,000	2,500,000

The work at the main dam is in full swing at a very interesting stage of the construction. A water-tight cut-off to sound ledge is being constructed by sinking a row of reinforced concrete caissons through the glacial material in the bed of the river to sound ledge. The Swift River at this point has a drainage area of 186 square miles. It has already been diverted from the site of the construction by means of a tunnel about 30 feet in diameter through the hill west of the site. The bottom of the channel, approaching the diversion tunnel, is lined with concrete to cut down the leakage into the ground of water in the river and thus lessen the quantity required to be pumped at the caisson pumping plants. These caissons will be sealed end to end to form a continuous wall projecting into the water-tight interior of the embankment of the dam. This core wall is of the same design as a similar wall which was successfully completed last year at the dike. The wall at the main dam will require 40 caissons, each 45 feet long by 9 feet wide, with a maximum height from bedrock to the top of the wall of about 125 feet. Three of these caissons were completed under previous contracts for exploratory use and to enable an early start to be made in the lowering of the ground water level. Of the remaining 37, the first shoe was set June 22, and now after two months, 28 of the caissons are in the process of sinking.

As a preparation for this work, pumps were installed at the bottoms of the exploratory caissons and the ground water was lowered about 80 feet below the river bed over a considerable area, thus materially reducing the

air pressure which will be necessary to complete the wall and seal it to the ledge. This was done by pumping for a year and a half before the contract was let, the rate during the last eight months averaging about 3,500 gallons per minute.

At the dike, which will be nearly as large as the main dam, work has already been started on the final contract which is for building the earth embankment itself by hydraulic sluicing. The contract was let December 5, 1934. The foundation embankments, to form the beaches for the sluicing operations, are about completed and the pump, sluice lines, etc., are now being installed preparatory to the commencement of the hydraulic operations. An accompanying photograph shows how the caisson core wall was completed in readiness for the hydraulic fill construction. The open cut, from the bottom of which the caissons were sunk, has been filled with impervious material around and over the tops of the caissons which can be seen projecting only at the sides of the valley.

Personnel of the Commission

The Metropolitan District Water Supply Commission, charged with these extensions of the sources of supply, consists of Eugene C. Hultman, Chairman, Charles M. Davenport and Thomas D. Lavelle. Frank E. Winsor, past President of the New England Water Works Association, is Chief Engineer. The construction of the Main Dam is under the field supervision of William W. Peabody, the dike, N. LeRoy Hammond, and the tunnel, Richard R. Bradbury, Division Engineers.

WHAT TYPE OF CURB STOP IS FAVORED FOR WATER WORKS USE?

An Engineering Analysis of a Round Table Discussion on Curb Stops Published in Water Works Engineering

Homer Rupard, Principal Assistant Engineer, Indianapolis Water Company, has made an independent analysis of the replies that were received to the Round Table discussion on curb stops. This analysis was made from a somewhat different angle than the one made by the staff of WATER WORKS ENGINEERING and printed in the issue of June 12. The analysis by Mr. Rupard is presented through the courtesy of W. C. Mabee, Chief Engineer, Indianapolis Water Company.

SIXTY-EIGHT replies were received to the fifteen questions on curb stops sent out by WATER WORKS ENGINEERING. Six questionnaires were sent directly by the Indianapolis Water Company concerning the keeping of a record of service line maintenance.

A preliminary classification into two groups was made; one for cities over 100,000 population and one for cities under 100,000 population. As the answers were tabulated and studied, it was found that population was not a factor in any ot the trends shown by the answers. This population classification was dropped in making the following summary:

Question 1: Do you keep a record of service line maintenance, including a separate record of curb stop failures? (Sent to six cities only.)

Answer:	
Yes	3
Yes, but not separated	1
No	2

Question 2: Does the Water Department or the consumer furnish and maintain the curb stop?

Answer:	Number	Per Cent
Water Department furnishes and maintains	38	59
Customer furnishes and maintains	16	25
Customer furnishes and Water Department maintains	10	15
Water Department furnishes and customer maintains	1	1
	65	100

Question 3: Do curb stops in your service lines have positive checks limiting open and shut positions?

Answer:	Number	Per Cent
Yes	37	57
No	24	37
Use both types	4	6
	65	100

Question 4: To open a curb stop do you turn the handle clockwise or counterclockwise?

Answer:	Number	Per Cent
Clockwise	17	26
Counterclockwise	24	37
Either (no stop to control direction)	24	37
	65	100

Question 5: Do you install the inverted key or the regular curb stop exclusively?

Answer:	Number	Per Cent
a. Use inverted key type exclusively	34	52
b. Use regular type exclusively	22	34
c. Use both in selected sizes	5	8
d. Use both indiscriminately	2	3
e. No choice expressed	2	3
	65	100

Question 6: What is the basis for your choice?

Answer:

	Type of stop chosen: Inverted		Regular	
Reason for Choice	Number	Per cent	Number	Per cent
a. Easier operation	18	30	0	0
b. More dependable—less leakage	4	6+	4	6+
c. Ease of maintenance	3	6	0	0
d. Choice from experience	4	6+	4	6+
e. Lower cost	0	0	2	3+
f. Established custom	1	2—	2	3+
g. No reason	9	15	9	15
Total, 60 answers	39	65	21	35

Question 7: Has your experience with the inverted key curb stop been satisfactory or otherwise?

Question 8: Has your experience with the regular solid tee head curb stop been satisfactory or otherwise?

Answer: These two questions are complementary and the answers have been placed together to obtain the following analysis:

Answer to Question 7	Answer to Question 8	Number	Per Cent of 39
Group Favoring Inverted Type:			
a. Satisfactory experience.	Unsatisfactory experience	22	56
Group Favoring Solid Tee Head Type:			
b. Unsatisfactory experience.	Satisfactory experience 7	9	23
c. Unsatisfactory experience.	Satisfactory in small sizes 2		
Noncommittal Group:			
d. Satisfactory experience.	Satisfactory experience	8	21
Group Reporting No Experience with One Type			
e. No experience	Satisfactory 15	24	
f. Satisfactory	No experience.. 9		
Total (omit no experience group)		39	100

NOTE: It is felt that the persons reporting experience with but one type are not qualified to judge the relative merits of