

Water Main Flushing

by Bangalore T. Lakshman, P.E.

The Artesian Water Co. is an investor-owned, regulated public water utility operating in the northern part of the state of Delaware. It has approximately 34,000 customers and serves a population of about 130,000 spread over the 90 sq. miles of its service territory.

The company has about 490 miles of pipeline of 2 to 20 in.-size. About 48 percent of the pipeline is composed of unlined, cast-iron pipe and about 9 percent of unlined, galvanized-iron pipe. The remaining 43 percent consists of asbestos cement pipe (28 percent) and cement-lined, ductile iron pipe (15 percent). There are about 1,400 hydrants in the system.

The basic source of supply is groundwater, derived from 40 wells. Eighty percent of its well supply is soft and corrosive because of low pH (5.4-5.6) and high carbon dioxide (30-40 ppm). In years past, the company did not have rigorous water quality control. The aggressive water worked on unlined, cast-iron and galvanized-iron pipe, contributing to corrosion deposits and related water quality problems. For the last eight years, a rigorous water quality control program has been pursued through aeration, pH adjustment, chlorination and fluoridation. Also, there has been a program of testing and monitoring water quality throughout the system around the clock. During these years the quality of water has substantially improved and the processed water has become relatively noncorrosive.

About the Author

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In order to improve both water quality and system efficiency, the company instituted a periodic flushing program in 1974. Table 1 shows the relative merits of a flushing program and indicates how water quality has improved from one flushing cycle to the next. There is a trend in the drop of iron content and turbidity from cycle to cycle. The trend in the increase of residual chlorine in the distribution system is quite apparent. Note too, there is a steady drop in the amount of water wasted per hydrant to clear the discolored water, which speaks for the improvement of water quality from cycle to cycle. Half of the system is covered every year (i.e., a complete cycle every two years.) The system is relatively complex. Flushing operations are performed at night between 9:00 p.m. and 5:00 a.m. in order to minimize the inconvenience to its customers. Night operation aids in expeditious and continuous operation inasmuch as there is very little vehicular traffic and pedestrian crossings.

Prior Planning Necessary. Prior planning enables the field crew to carry on the flushing program expeditiously and without confusion. Pertinent system maps are selected and hydrants and valves marked to be operated as a part of the flushing program. These pipeline maps are used in the field to locate the valves and hydrants. Sectionalizing and controlling the direction of flows at the intersection has the advantage of controlling the flows to create high velocities, but to make the operation foolproof and fast, it is better to plan and regionalize the operation on the basis of de-

velopment-to-development or block-to-block. Depending upon the hydraulics of the system and the location of hydrants, prudent judgment may be used to skip certain hydrants. It is not necessary to open and flush all the hydrants except to make sure that they are operable. Completion of flushing each zone or region is scheduled by the end of each day's or night's operation. A two-man crew is generally sufficient, but for an extensive operation involving more hydrants at one time, a three-man crew may be required.

General program guidelines.

1. Briefly describe the intent and object of flushing and advise the customers of the dates and time of flushing through billing, newspaper ads and local radio announcements.

2. Make a list and notify individual customers who might be on dialysis machines, plus hospitals, restaurants, laundromats, etc.

3. Equip the field crew with tarpaulins or lead-off discharge devices to avoid possible damage to streets and lawns from hydrant discharge.

4. Require field crew to exercise care and avoid opening or closing valves and hydrants rapidly in order to minimize the effect of water hammer.

5. Open a hydrant fully for a period long enough (5-10 minutes) to stir up the deposits inside the water main; then throttle the hydrant flow half-way or needed to clear the discolored water.

6. Procure hydrant flow-test data using a pitot tube and pressure gauge for one hydrant in each block or development. These hydraulic data will be

Table 1
Artesian Water Co.
Comparison of Relative Merits of Hydrant Flushing Program

Year(s)	Service Level	Hydrants Flushed	No. of Days Flushed	Approx. Overtime Amt. Paid	No. of Problem Hyd. Found	Hydrants Sampled	Avg. Amt. of Water Wasted per Hydrant (gal.)	Avg. Iron per Hydrant Initial Sample*	Avg. Chlorine per Hydrant Initial Sample	Avg. Turbidity per Hydrant Initial Sample
1974	A & B	450	27	300.00	18	144	38,000	67.0	0.08	247
1975	A	280	16	600.00	11	173	39,000	2.1	0.20	24
1976	B	171	11	400.00	10	163	41,000	1.8	0.13	14
1977	A	365	15	500.00	8	257	22,000	1.7	0.19	11
1978	B	196	9	700.00	7	189	30,600	0.3**	0.17	7
1979	A	325	17	800.00	25	325	28,000	4.8†	0.22	43
1974	A & B	450	27	300.00	18	144	38,000	67.0	0.08	247
1975 & 1976	A & B	451	27	1,000.00	21	336	40,000	1.95	0.17	19
1977 & 1978	A & B	561	24	1,200.00	15	446	25,000	1.1	0.18	9

* Sampled after about three minutes of opening hydrants.

** Sampled after five minutes because of NPDES permit requirements.

† Sampled too soon—a minute or two after opening hydrants.

A & B = Service Levels #1, #2, #3 and #4.

A = Service Levels #1 and Part of #2.

B = Service Levels #3, #4 and Part of #2.

Periodic program provides tangible and intangible benefits to water systems.



able identification and correction of any fire-flow deficiencies in the area.

7. Collect two water samples for each flowing hydrant, one in the beginning (after about 2-3 minutes of opening the hydrant) and the second one when discolored water clears (just before closing the hydrant). These samples will enable a check of the water quality for certain basic parameters and the development of water quality trends for comparison.

8. In areas where the water does not become clear, instruct the operating foreman to use his judgment as to relative color and turbidity and decide when to shut down. A water sample in a clear glass bottle will enable the foreman to visually judge the color from time to time.

9. Make sure all closed valves for the flushing operation are fully reopened immediately after completing the flushing operation.

10. Instruct the field crew to fill in the flushing log sheet (Table 2) and furnish hydraulic and water quality information to the engineer as needed. Such information should properly be evaluated to readjust and modify the procedure for the flushing program from year to year.

Tangible benefits.

- Improvements in the water quality as reflected by a reduced amount of iron and turbidity and an increase in residual chlorine content. Also by a reduced number of customer complaints as to the taste and odor.

- Location of inoperable or closed valves and hydrants.

- Results in the generation of a good hydraulic data. This data, in turn, helps the water systems to pinpoint system deficiencies (low pressure and problem areas), as well as areas of fire flow deficiencies.

- In many cases, it helps comply with the requirements of regulatory agencies.

Intangible benefits. Such a program helps improve the hydraulic efficiency of the water system. This means to some extent it will help to improve and restore the carrying capacity of the water mains, which is somewhat intangible to assess. This improvement also saves operation costs in terms of reduced cost of pumping (electric bills), which is again to some extent intangible in nature.

Conclusions. A water main flushing program is one of the wisest and most realistic programs for any and all water systems to improve both the water quality and the system efficiency. The water systems that have already instituted this program may wish to refine according to the aforementioned guidelines and continue from year to year. Water systems that have no such flushing programs should institute one to realize the benefits. Water systems that maintain a separate crew for valve and hydrant maintenance should make the periodic flushing program a part of its assignment. Relatively speaking, a water main flushing program does not cost . . . it pays. ■

Table 2
Artesian Water Company
Data Sheet for Flushing Water Mains

Data Reported By _____ Date of Flushing _____

Development and Location of Hydrant	Pressure (psi)		Pitot Read. (psi)	Outlet Size of Hydr. (in.)	Flow Rate (Gpm)	Time		No. of Hydr. Oper.	Amount of Water wasted (gal.)	Remarks
	Static	Resid.				Started	Completed			