

**TO:** MAG Specifications and Details Committee

**DATE:** Aug 9, 2017

**FROM:** Jim Badowich, Chair

**SUBJECT:** MAG Specifications Section 611 Revision

**Case No.:** 17-09

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**PURPOSE:** Update MAG Specifications Section 611; Water, Sewer and Storm Drain Testing, specifically Sections 611.1 and 611.2, to comply with AWWA and AAC as applicable. The flushing section has also been expanded to provide more detailed direction on minimum flushing requirements. The remainder of Section 611 is unchanged.

This latest draft includes the addition of a typical XX .1 DESCRIPTION section as an intro to the entire MAG Spec Section 611 which was never included when 611 was initially created.

Also, the water line related flushing, hydrostatic testing and disinfection specification sections have been cleaned up, re-organized and re-formatted to read more chronological.

## SECTION 611

### WATER, SEWER AND STORM DRAIN TESTING

#### 611.1 DESCRIPTION:

The testing of new water lines, fire lines, force mains, sewer lines, and storm lines shall conform to the applicable testing procedures and inspection requirements as outlined herein, except as otherwise required on the plans, as modified in the special provisions or as directed by the agency.

All lines shall be flushed, vactored cleaned or otherwise thoroughly cleared of any sediment or debris prior to testing.

Pressurized lines including all fittings and connections shall be tested for water-tightness by subjecting each section to hydrostatic testing in accordance with AWWA C-600. [DIP Only?]

Water mains shall be isolated, disinfected, sampled and tested to meet the Safe Drinking Water Requirements per Arizona Administrative Code (A.A.C.) R18-4-215.

Low pressure air testing shall be performed on sewer lines to meet leakage test requirements.

Deflection testing shall be performed on flexible pipe as defined in Section 601.1, used for sanitary sewer lines and storm sewer lines.

Closed Circuit T.V. (CCTV) inspection shall be performed on sewer lines as required by the Contracting Agency. Unless conducted by the agency, contractors shall assume it their responsibility to provide CCTV inspection.

CCTV video inspection shall be performed on all mainline storm sewer lines.

The Contractor shall provide all vents, piping, plugs, bulkheads, valves, bracing, blocking, pumps, and measuring devices and all other equipment necessary for performing the tests including new or good condition pressure gages. If required, Contractor shall pay the Contracting Agency for water used in the performance of the required flushing and pressure testing. Water quantities used shall be calculated or meter measured as directed and approved by the agency.

#### 611.2 FLUSHING AND HYDROSTATIC TESTING:

Water lines, fire lines and force mains including all fittings and connections to shall be pressure tested for water-tightness by subjecting each section to hydrostatic testing in accordance with applicable provisions of AWWA C-600 [DIP Only?], except as modified below.

##### 611.2.1 Flushing Completed Main Lines:

- (A) **Flushing Plan:** If required by the Contracting Agency or its authorized agent, the Contractor shall submit a written flushing plan for review and approval prior to starting any flushing activities. The plan may be a written detailed narrative or a shop drawing submittal depending on complexity of the system or agency requirements. There may be different plans for initial flushing (debris) and a final flushing (high chlorine). The plan shall include and indicate the connection feed point, backflow protection device, measuring meter (if required), all valves and fire hydrants, all permanent or temporary air release points and/or testing ports, discharge outlets, proper de-chlorination procedure (for final flushing) and final disposal location/destination of the flushing water. The plan shall indicate the required sequential phasing to achieve a positive, one directional flushing action.
- (B) **Valve Operation:** Check with the Contracting Agency or its authorized agent for any policy regarding the operation of valves or other appurtenances.

- (C) **Line Filling:** The test section shall be slowly filled with potable water and all air shall be vented from the line. The rate of filling shall be as determined by the Contracting Agency or its authorized agent, with at least 24-hour notice required before tests are scheduled. Measurement of the flow of water into and out of all lines shall be made by means of a pitot gage, current type meter, or other approved device supplied by the Contracting Agency.
- (D) **Preliminary (Debris) Flushing:** All mains 12 inches and smaller shall be flushed using clean potable water, prior to chlorination, as thoroughly as possible with the water pressure and outlets available. Flushing is intended to remove only light debris and should not be relied upon to remove heavy material. Contractors shall exercise care and proper workmanship in the pipe laying operation to not allow dirt and debris to get into the pipe. Excessive amounts of dirt, bedding materials, rocks or other foreign debris, especial large size items, left in installed pipe lines may cause damage to valves and fire hydrants during flushing operations. When excessive or large debris is witnessed exiting the outlets during the flushing operation, the valves and fire hydrants shall be thoroughly inspected to verify that the valves and fire hydrants are in good working order.
- (E) **Required flow and openings (either taps or hydrants) to flush pipelines at 3.0 ft/sec (40 psi residual pressure in water main) \* Reference AWWA C651-14**

Pipe Diameter	Flow Required to Produce 3.0 ft/sec (approx.) Velocity in Main	Size of Blow Off Used**			Number of Hydrant Outlets**	
		1-in	1½-in	2-in		
<i>In.</i>	<i>gpm</i>	Number of Blow Offs Required on Pipe***			2 ½ -in.	4 ½-in.
4	120	1	---	---	1	1
6	260	---	1	---	1	1
8	470	---	2	---	1	1
10	730	---	3	2	1	1
12	1,060	---	---	3	2	1

\*With a 40-psi pressure in the main with the hydrant flowing to atmosphere, a 2 ½ in. hydrant outlet can discharge approximately 1,000 gpm; and a 4 ½ in. hydrant outlet can discharge approximately 2,500 gpm.

\*\*Contracting Agency has final determination of size, number of blow offs and location of flushing inlets and outlets.

\*\*\*Number of blow offs on pipe based on 3.0-ft/sec discharge through 5 ft. of galvanized iron (GI) pipe with one 90° elbow.

**611.2.2 Hydrostatic Testing:** Pressure testing may be performed before or after final backfilling. If the pipe line is properly and safely center-loaded, a visual inspection for leaks may be made along the pipe line while the test section is under test pressure. Any visible leaks shall be repaired and a retest conducted. However, if mechanical compaction is to be used in the backfilling operations per AWWA C-600, the pressure tests shall not be performed until final backfilling is 100% completed including compaction. Backfill and compaction shall be 100% complete for any restrained pipe line sections for the entire designated restrained distance prior to pressure testing. All pipe sections, stub laterals, fire hydrant laterals, blow-offs, and valves encompassed in the test section shall be verified to be open, water filled and pressurized. Actual hydrostatic monitor testing shall not begin until the pipe line has been filled entirely with water for at least 24 hours to allow for air venting and absorption.

- (A) **Pressure Testing:** Unless otherwise noted in the contract documents, the minimum prescribed test pressure shall be at least 200 psi for lines smaller than 16 inches and 150 psi for lines 16 inches or larger, not to exceed 5 psi over the minimum prescribed test pressure, as measured at the lowest end of the section under test. The duration of each pressure test shall be at least 2 hours, during which time the test section shall not drop below the minimum prescribed test pressure. If the pressure in the pipe test section has not stabilized by the end of the testing period, a hydrostatic retest will be required.

Each section of a new line between sectionalizing valves or between the last sectionalizing valve and the end of the project shall be tested separately as required in AWWA C-600, and/or as modified in these specifications, except that any such section less than 500 feet in length may be tested with the adjacent section, if both sections of line have the same pipe class rating. No section greater than 2,640 feet in total pipe length shall be tested without written permission of the Engineer.

- (B) **Testing Allowance/Makeup Water:** Makeup water volume shall be determined after the pressure test has been satisfactorily completed and all backfilling and compaction has been completed to top of trench. Testing allowance shall be defined as the maximum quantity of makeup water necessary to be supplied into the pipe line section under test to restore the ending test pressure to the beginning test pressure, after the pipe line has been filled with water and all air expelled. The Contractor shall furnish the necessary apparatus and assistance to conduct the test.

The duration of each makeup water test shall be at least 2 hours. To pass the allowance testing, the quantity of makeup water from the pipe line shall not exceed the makeup water quantity allowed by the following formula, from AWWA C-600:

$$M = \frac{SD \sqrt{P}}{148,000}$$

in which

M = testing Allowance (makeup water), in gallons per hour.

S = length of pipe tested, in feet

D = nominal diameter of pipe, in inches.

P = test pressure of the pipe being tested, per 610.15 (A)

Should the test on any section of the pipe line require more makeup water than allowed by the above formula, the Contractor shall locate and repair the defective pipe, fittings, or joint until the makeup water volume is within the specified allowance. All repairs and retests, if required, shall be made at the Contractor's expense.

Ductile iron pipe used in conjunction with ACP will be tested to the ACP standards, unless otherwise directed by the Engineer. High pressure systems of all ductile iron pipe will be tested in accordance with AWWA C-600, Section 4.1.

### 611.3 DISINFECTING WATER MAINS

**611.3.1 Isolation:** New water mains shall be physically isolated from active distribution systems until initial disinfection and satisfactory bacteriological results have been completed. The means for protecting active distribution systems from contamination due to reverse flow shall be according to level of protection required by Arizona Administrative code (A.A.C) R18-4-215.

**611.3.2 Disinfection:** The method of chlorination used shall be approved by the Contracting Agency or its authorized agent and must conform to NSF/ANSI 60 & 61 Standards. The Contracting Agency or its authorized agent shall determine the number and locations for sample risers. The contractor is responsible for supplying equipment to properly dose the new main with a chlorine concentration no lower than 10 parts per million (ppm). The Contracting Agency or its authorized agent will verify the chlorine level is at 10 ppm at time of dosing and verify that after 24 hours of high chlorine solution sitting in the pipes that the chlorine concentration is at 10 ppm or above. All valves, hydrants and other appurtenances shall be operated fully to ensure full disinfection from chlorine solution.

After 24-hour verification is complete the water main shall be completely flushed of the high chlorine concentration. A chlorine neutralizing agent may be required during flushing discharge. Check with agency.

- (A) **Methods of Applying Chlorine:** Any of the following methods of application of chlorine (arranged in order of preference) may be used, subject to the approval of the Contracting Agency or its authorized agent.
- Liquid chlorine gas-water mixture.
  - Direct chlorine feed.
  - Calcium or sodium hypochlorite and water mixture.
- (B) **Point of Application:** The preferred point of application of the chlorinating agent is at the beginning of the pipe line extension or any valved section of it and through a corporation stop inserted in the top of the newly laid pipe. The water injector for delivering the chlorine-bearing water into the pipe should be supplied from a tap or other potable water source on the pressure side of the gate valve controlling the flow into the pipe line extension.
- (C) **Rate of Application:** Water from the existing distribution system or other approved potable water source of supply shall be controlled so the rate of flow shall not exceed 500 gpm, unless approved by the Contracting Agency or its approved agent, through a suitable measuring device into the newly laid pipe line during the application of chlorine. The rate of chlorine solution flow shall be in such proportion to the rate of water entering the pipe that the chlorine dose applied to the water entering the newly laid pipe shall produce at least 10 ppm of residual chlorine after 24 hours standing in the pipe. This may be expected with an application of 50 ppm, although some conditions may require more

On lines 12 inches in diameter or less, determination of the rate of flow of water into the line to be treated may be made by starting with the line full of water and measuring the rate of discharge at a hydrant located at the end of the pipe farthest away from the point of chlorine application.

For lines larger than 12 inches in diameter, the disinfection operation is generally started with the line empty.

- (D) **Retention Period:** The highly chlorinated water shall be retained in the pipe long enough to destroy all nonspore-forming bacteria. This period should be at least 24 hours and no more than 48 hours.

If the circumstances are such that less than a 24-hour retention period must be used and upon approval by the Contracting Agency or its authorized agent, the chlorine concentration shall be increased to 100 ppm not to exceed 300 ppm and retained for at least 2 hours. Under these conditions, special care should be taken to avoid attack on pipes, valves, hydrants and other appurtenances.

**611.3.3 Final Flushing, Sampling and Testing:** Following chlorination, all treated water in the newly laid pipeline shall be thoroughly flushed until the replacement water throughout the new pipeline can be proved, by laboratory testing, comparable in quality to the water served to the public from the existing water system. Prior to sampling for laboratory testing, the residual chlorine throughout the length of the pipeline shall be reduced to 2.0 ppm or less. Once the required residual chlorine level in the pipeline is achieved, bacteriological samples shall be taken as outlined below.

The Contracting Agency or its authorized representative will collect all samples for testing of the new water mains. To initiate the sampling and testing, the Contractor will present to the Contracting Agency or

its authorized agent a written request for such work no later than 24 hours prior to the time when samples are to be taken. Samples shall be taken from a tap and riser located and installed in such a way as to prevent outside contamination. Samples shall never be taken from an unsterilized hose or fire hydrant.

The number of sampling locations are determined by the Contracting Agency or its authorized agent and at a minimum shall be as follows:

- Waterlines up to but less than 150 feet in length require one sampling riser installed as near the end as possible.
- Waterlines 150 feet to 300 feet in length, two sampling risers, one near each end of the line. Waterlines 300 feet to 3,000 feet in length, a minimum of three sampling risers. In addition, dead ends on main lines should be represented with a sampling riser.

The number of samples taken at each sampling location shall be determined by the Contracting Agency or its authorized agent based on one of the following methods.

- (A) One sample from each sampling location which is examined and analyzed in the laboratory over a three day (72 hour) period. (Heterotrophic Plate Count (HPC) method).
- (B) One Sample from each sampling location taken 24 hours after flushing high chlorine is examined in the laboratory. (Total Coliform (TC) method).
- (C) Two samples taken on separate days from each sampling location. Satisfactory water quality of the new main shall continue for a period of at least two days (48 hours) as demonstrated by laboratory examination of these samples. Total Coliform (TC) method).

Upon completion of laboratory testing, results of all tests shall be sent by the laboratory to the Contracting Agency. Results of laboratory analysis will be interpreted by the Contracting Agency, and reported to the Contractor. Under no circumstance shall the Contractor contact the laboratory. If there is need for test results before written reports are submitted, such information shall be obtained only from the Contracting Agency or its authorized representative.

Laboratory and field analysis shall be done by methods approved by the Arizona Department of Health Services (ADHS)

**611.3.4 Final Connections:** Any temporary air release blow-offs and test sample risers shall be left exposed and protected during backfilling until all testing is complete. After all testing is complete and passed acceptance, they shall be properly lowered and terminated as directed by the Contracting Agency.

Connections to the existing pipelines or existing valves shall not be made until after all or that specific section of new pipe main line has satisfactorily passed all required hydrostatic and disinfection tests.

**611.3.5 Repetition of Chlorination Procedure:** Should the initial treatment fail to result in the conditions specified above, the original chlorination procedure shall be repeated until satisfactory results are obtained.

SECTION 611

WATER, SEWER AND STORM DRAIN TESTING

**611.1 DESCRIPTION HYDROSTATIC TESTING:**

The testing of new water lines, fire lines, force mains, sewer lines, and storm lines shall conform to the applicable testing procedures and inspection requirements as outlined herein, except as otherwise required on the plans, as modified in the special provisions or as directed by the agency.

All lines shall be flushed, vactored cleaned or otherwise thoroughly cleared of any sediment or debris prior to testing.

Pressurized lines including all fittings and connections shall be tested for water-tightness by subjecting each section to hydrostatic testing in accordance with AWWA C-600. [DIP Only?]

Water mains shall be isolated, disinfected, sampled and tested to meet the Safe Drinking Water Requirements per Arizona Administrative Code (A.A.C.) R18-4-215.

Low pressure air testing shall be performed on sewer lines to meet leakage test requirements.

Deflection testing shall be performed on flexible pipe as defined in Section 601.1, used for sanitary sewer lines and storm sewer lines.

Closed Circuit T.V. (CCTV) inspection shall be performed on sewer lines as required by the Contracting Agency. Unless conducted by the agency, contractors shall assume it their responsibility to provide CCTV inspection.

CCTV video inspection shall be performed on all mainline storm sewer lines.

The Contractor shall provide all vents, piping, plugs, bulkheads, valves, bracing, blocking, pumps, and measuring devices and all other equipment necessary for performing making the tests, including new or good condition pressure gages. If required, Contractor and shall pay the Contracting Agency for water used in the performance of the required flushing and pressure testing. Water quantities used shall be calculated or meter measured as directed and approved by the agency.

**611.2 FLUSHING AND HYDROSTATIC TESTING:**

Water lines, fire lines and force mains including all fittings and connections to the water mains shall be pressure tested for water-tightness by subjecting each section to hydrostatic testing in accordance with applicable provisions of AWWA C-600 [DIP Only?], except as modified below, and shall consist of pressure testing and allowance testing.

The test section shall be slowly filled with potable water and all air shall be vented from the line. The rate of filling shall be as determined by the Contracting Agency or its authorized agent Superintendent of Water Distribution, with at least 24 hour 24-hour notice required before tests are scheduled.

**611.2.1 Flushing Completed Main Lines:**

(A) Flushing Plan: If required by the Contracting Agency or its authorized agent, the Contractor shall submit a written flushing plan for review and approval prior to starting any flushing activities. The plan may be a written detailed narrative or a shop drawing submittal depending on complexity of the system or agency requirements. There may be different plans for initial flushing (debris) and a final flushing (high chlorine). The plan shall include and indicate the connection feed point, backflow protection device, measuring meter (if required), all valves and fire hydrants, all permanent or temporary air release points and/or testing ports, discharge outlets, proper de-chlorination procedure (for final flushing) and final disposal location/destination of the flushing water. The plan shall indicate the required sequential phasing to achieve a positive, one directional flushing action.

**(B) Valve Operation:** Check with the Contracting Agency or its authorized agent for any policy regarding the operation of valves or other appurtenances.

~~Measurement of the flow of water into and out of all lines shall be made by means of a pitot gage, current type meter, or other approved device supplied by the Contracting Agency.~~

**(C) Line Filling:** The test section shall be slowly filled with potable water and all air shall be vented from the line. The rate of filling shall be as determined by the Contracting Agency or its authorized agent, with at least 24-hour notice required before tests are scheduled. Measurement of the flow of water into and out of all lines shall be made by means of a pitot gage, current type meter, or other approved device supplied by the Contracting Agency.

**(D) Preliminary (Debris) Flushing:** All mains 12 inches and smaller shall be flushed using clean potable water, prior to chlorination, as thoroughly as possible with the water pressure and outlets available. Flushing is intended to remove only light debris and should not be relied upon to remove heavy material. Contractors shall exercise care and proper workmanship in the pipe laying operation to not allow dirt and debris to get into the pipe. Excessive amounts of dirt, bedding materials, rocks or other foreign debris, especial large size items, left in installed pipe lines may cause damage to valves and fire hydrants during flushing operations. When excessive or large debris is witnessed exiting the outlets during the flushing operation, the valves and fire hydrants shall be thoroughly inspected to verify that the valves and fire hydrants are in good working order.

**(E) Required flow and openings (either taps or hydrants) to flush pipelines at 3.0 ft/sec (40 psi residual pressure in water main) \* Reference AWWA C651-14**

Pipe Diameter	Flow Required to Produce 3.0 ft/sec (approx.) Velocity in Main	Size of Blow Off Used**			Number of Hydrant Outlets**	
		1-in	1½-in	2-in		
<i>In.</i>	<i>gpm</i>	Number of Blow Offs Required on Pipe***			2 ½ in.	4 ½ in.
4	120	1	---	---	1	1
6	260	---	1	---	1	1
8	470	---	2	---	1	1
10	730	---	3	2	1	1
12	1,060	---	---	3	2	1

\*With a 40-psi pressure in the main with the hydrant flowing to atmosphere, a 2 ½ in. hydrant outlet can discharge approximately 1,000 gpm; and a 4 ½ in. hydrant outlet can discharge approximately 2,500 gpm.

\*\*Contracting Agency has final determination of size, number of blow offs and location of flushing inlets and outlets.

\*\*\*Number of blow offs on pipe based on 3.0-ft/sec discharge through 5 ft. of galvanized iron (GI) pipe with one 90° elbow.

~~The Contractor shall provide all vents, piping, plugs, bulkheads, valves, bracing, blocking, pumps, and measuring devices and all other equipment necessary for making the tests, including pressure gages, and shall pay the Contracting Agency for water used in the tests.~~

**611.2.2 Hydrostatic Testing:** Pressure testing may be ~~performed~~<sup>made</sup> before or after final backfilling, ~~but backfilling must be completed before allowance testing.~~ If the pipe line is properly and safely center-loaded, a visual inspection for leaks may be made along the pipe line while the test section is under test pressure. ~~Any, and all~~ visible leaks shall be repaired and a retest conducted. However, if mechanical compaction is to be used in the backfilling operations ~~per as spelled out in~~ AWWA C-600, the pressure tests shall not be ~~performed~~<sup>made</sup> until final the backfilling is 100% completed ~~including and~~ compactioned. Backfill and compaction shall be 100% complete for any restrained pipe line sections for the entire full designated restrained distance encompassed by restrained/welded joints shall be completed prior to pressure testing. All pipe section connections, stub laterals, fire hydrant laterals, blow-offs, hydrants and valves encompassed in the test section shall be verified to be open, water filled and pressurized. tested with the main as far as is practicable. Actual ~~H~~hydrostatic monitor testing shall not begin until the pipe line has been filled entirely with water for at least 24 hours to allow for air venting and absorption.

- (A) **Pressure Testing:** Unless otherwise noted in the contract documents, the minimum prescribed test pressure shall be at least 200 psi for lines smaller than 16 inches and 150 psi for lines 16 inches or larger, not to exceed 5 psi over the minimum prescribed test pressure, as measured at the lowest end of the section under test. The duration of each pressure test shall be at least 2 hours, during which time the test section shall not drop below the minimum prescribed test pressure. If the pressure in the pipe test section has not stabilized by the end of the testing period, a hydrostatic retest will be required.

Each section of a new line between sectionalizing valves or between the last sectionalizing valve and the end of the project shall be tested separately as required in AWWA C-600, and/or as modified in these specifications, except that any such section less than 500 feet in length may be tested with the adjacent section, if both sections of line have the same pipe class rating. No section greater than 2,640 feet 1/2 mile in total pipe length shall be tested without ~~special~~ written permission of the Engineer.

- (B) **Testing Allowance/Makeup Water:** Makeup water volume shall be determined after the pressure test has been satisfactorily completed and all backfilling and compaction has been completed to top of trench. Testing allowance shall be defined as the maximum quantity of makeup water necessary to be supplied into the pipe line section under test to restore the ending test pressure to the beginning test pressure, after the pipe line has been filled with water and all air expelled. The Contractor shall furnish the necessary apparatus and assistance to conduct the test.

The duration of each makeup water test shall be at least 2 hours. To pass the allowance testing, the quantity of makeup water from the pipe line shall not exceed the makeup water quantity allowed by the following formula, from AWWA C-600:

$$M = \frac{SD \sqrt{P}}{148,000}$$

in which

M = testing Allowance (makeup water), in gallons per hour.

S = length of pipe tested, in feet

D = nominal diameter of pipe, in inches.

P = test pressure of the pipe being tested, per 610.15 (A)

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Should the test on any section of the pipe line require more makeup water than allowed by the above formula, the Contractor shall locate and repair the defective pipe, fittings, or joint until the makeup water volume is within the specified allowance. All repairs and retests, if required, shall be made at the Contractor's expense.

~~Connections to the existing pipelines or existing valves shall not be made until after that section of new construction has satisfactorily passed the hydrostatic tests.~~

Ductile iron pipe used in conjunction with ACP will be tested to the ACP standards, unless otherwise directed by the Engineer. High pressure systems of all ductile iron pipe will be tested in accordance with AWWA C-600, Section 4.1.

**611.23 DISINFECTING WATER MAINS**

**611.2.1 Flushing Completed Pipe Lines:**

~~(A) **Preliminary (Debris) Flushing:** All mains 12 inches and smaller shall be flushed using clean potable water, prior to chlorination, as thoroughly as possible with the water pressure and outlets available. Flushing shall be done after the pressure test has been made. It must be understood that flushing removes only the lighter solids and cannot be relied upon to remove heavy material allowed to get into the main during laying. It is difficult to flush mains over 12 inches in diameter, so in such instances the requirements above, must be rigidly adhered to.~~

~~Heavy duty, factory bushed, tapped couplings, with corporation stops shall be located at all high points in the lines to allow the air to be removed prior to testing the water lines and at disinfection points as may be required. Field taps will not be permitted.~~

~~The couplings, at high points and disinfection points, shall be left exposed during backfilling until the testing is complete. Couplings and corporation stops shall be left on the mains upon completion of water mains.~~

~~(B) **Valve Damage by Foreign Material:** Unless proper care and thorough inspection are practiced during the laying of water mains, small stones, pieces of concrete, particles of metal, or other foreign material may gain access to mains newly laid or repaired. If it is believed that such foreign material(s) may be in the main, all hydrants on the line shall be thoroughly flushed and carefully inspected after flushing to see that the entire valve operating mechanism of each hydrant is in good condition.~~

~~Valve Operation: Check with the Contracting Agency or its authorized agent for any policy regarding the operation of valves or other appurtenances.~~

~~Required flow and openings (either taps or hydrants) to flush pipelines at 3.0 ft/sec (40 psi residual pressure in water main) \* Reference AWWA C651-14~~

<u>Pipe Diameter</u>	<u>Flow Required to Produce 3.0 ft/sec</u>	<u>Size of Blow Off Used**</u>	<u>Number of Hydrant Outlets**</u>
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	<u>(approx.) Velocity in Main</u>	<u>1-in</u>	<u>1½-in</u>	<u>2-in</u>		
<u>In.</u>	<u>gpm</u>	<u>Number of Blow-Offs Required on Pipe***</u>			<u>2½-in.</u>	<u>4½-in.</u>
<u>4</u>	<u>120</u>	<u>1</u>	<u>---</u>	<u>---</u>	<u>1</u>	<u>1</u>
<u>6</u>	<u>260</u>	<u>---</u>	<u>1</u>	<u>---</u>	<u>1</u>	<u>1</u>
<u>8</u>	<u>470</u>	<u>---</u>	<u>2</u>	<u>---</u>	<u>1</u>	<u>1</u>
<u>10</u>	<u>730</u>	<u>---</u>	<u>3</u>	<u>2</u>	<u>1</u>	<u>1</u>
<u>12</u>	<u>1,060</u>	<u>---</u>	<u>---</u>	<u>3</u>	<u>2</u>	<u>1</u>

---\*With a 40-psi pressure in the main with the hydrant flowing to atmosphere, a 2½ in. hydrant outlet will discharge approximately 1,000 gpm; and a 4½ in. hydrant outlet will discharge approximately 2,500 gpm.

---\*\*Contracting Agency has final determination of size, number of blow offs and location of flushing inlets and outlets.

---\*\*\*Number of blow offs on pipe based on 3.0 ft/sec discharge through 5 ft. of galvanized iron (GI) pipe with one 90° elbow.

--- Contractor shall provide a flushing plan to the Contracting Agency or its authorized agent that outlines the flushing plan for the preliminary (debris) flushing and flushing plan for the final flushing of high chlorine water. The plan shall outline the proper dechlorination procedures and the disposal of flushing water.

**611.23.21 Isolation of New Water Mains:** New water mains shall be physically isolated from active distribution systems until initial disinfection and satisfactory bacteriological results have been completed. The means for protecting active distribution systems from contamination due to reverse flow shall be according to level of protection required by Arizona Administrative code (A.A.C) R18-4-215. **Chlorine Residual:** Before being placed in service, all new mains and repaired portions of, or extensions to existing mains shall be chlorinated so that a chlorine residual of not less than 10 ppm remains in the water after 24 hours standing in the pipe.

**611.2.3.2 Disinfection of New Water Mains:** The method of chlorination used shall be approved by the Contracting Agency or its authorized agent and must conform to NSF/ANSI 60 & 61 Standards. The Contracting Agency or its authorized agent shall determine the number and locations for sample risers. The contractor is responsible for supplying equipment to properly dose the new main with a chlorine concentration no lower than 10 parts per million (ppm). The Contracting Agency or its authorized agent will verify the chlorine level is at 10 ppm at time of dosing and verify that after 24 hours of high chlorine solution sitting in the pipes that the chlorine concentration is at 10 ppm or above. (NOTE: aAll valves, hydrants and other appurtenances shall be operated fully to ensure full disinfection from chlorine solution.)

After 24-hour verification is complete the water main shall be completely flushed of the high chlorine concentration. (Note: A chlorine neutralizing agent may be required during flushing discharge. Check with agency/local regulations).

(A) **Methods of Applying Chlorine:** Any of the following methods of application of chlorine (arranged in order of preference) may be used, subject to the approval of the Contracting Agency or its authorized agent/Engineer.

- Liquid chlorine gas-water mixture.
- Direct chlorine feed.
- Calcium or sodium hypochlorite and water mixture.

~~611.2.4 Application of Liquid Chlorine: A chlorine gas-water mixture shall be applied by means of a solution-feed chlorinating device or, if approved by the Engineer, the dry gas may be fed directly through proper devices for regulating the rate of flow and providing effective diffusion of the gas into the water within the pipe being treated. Chlorinating devices for feeding solutions of the chlorine gas or of the gas itself must provide means for preventing the backflow of water into the cylinder.~~

~~611.2.5 Chlorine-Bearing Compounds in Water: On approval of the Engineer, a mixture of water and a chlorine-bearing compound of known chlorine content may be substituted for liquid chlorine.~~

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(A) ~~Compounds to be used: The chlorine-bearing compounds that may be used are: calcium hypochlorite\*, and sodium hypochlorite\*\*.~~

(B) ~~Preparation of mixture: High-test calcium hypochlorite must be prepared as a water mixture for introduction into the water mains. The powder should first be made into a paste and then thinned to approximately a 1 percent chlorine solution (10,000 ppm). The preparation of a 1 percent chlorine solution requires the following proportions of powder to water:~~

Product	Amount of Compound	Quantity of Water (Gallons)
High-test calcium hypochlorite (65–70% Cl)	1 lb.	7.50
Liquid laundry bleach (5.25% Cl)	1–2 pts.	12.6

(B) ~~611.2.46 Point of Application:~~ The preferred point of application of the chlorinating agent is at the beginning of the pipe line extension or any valved section of it and through a corporation stop inserted in the top of the newly laid pipe. The water injector for delivering the chlorine-bearing water into the pipe should be supplied from a tap or other potable water source on the pressure side of the gate valve controlling the flow into the pipe line extension.

(C) ~~611.2.57 Rate of Application:~~ Water from the existing distribution system or other approved potable water source of supply shall be controlled so the rate of flow shall not exceed 500 gpm, unless approved by the Contracting Agency or its approved agent/Superintendent of Water Distribution, through a suitable measuring device into the newly laid pipe line during the application of chlorine. The rate of chlorine solution flow shall be in such proportion to the rate of water entering the pipe that the chlorine dose applied to the water entering the newly laid pipe shall produce at least 10 ppm of residual chlorine after 24 hours standing in the pipe. This may be expected with an application of 50 ppm, although some conditions may require more

On lines 12 inches in diameter or less, determination of the rate of flow of water into the line to be treated may be made by starting with the line full of water and measuring the rate of discharge at a hydrant located at the end of the pipe farthest away from the point of chlorine application.

For lines larger than 12 inches in diameter, the disinfection operation is generally started with the line empty.

~~Measurement of the flow of water into and out of all lines shall be made by means of a pitot gage, current type meter, or other approved device supplied by the Contracting Agency.~~

~~**611.2.8 Preventing Reverse Flow:** Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Check valves shall be used to accomplish this.~~

~~(D) **611.2.69 Retention Period:** The highly chlorinated Treated water shall be retained in the pipe long enough to destroy all nonspore-forming bacteria. This period should be at least 24 hours and no more than 48 hours, and should produce no less than 10 ppm residual chlorine at the extreme end of the line at the end of the retention period.~~

~~**NOTE:** If the circumstances are such that less than a 24-hour 24-hour retention period must be used and upon approval by the Contracting Agency or its authorized agent, the chlorine concentration shall be increased to 100 ppm not to exceed 300 ppm and retained for at least 2 hours. Under these conditions, special care should be taken to avoid attack on pipes, valves, hydrants and other appurtenances.~~

~~**611.2.10 Chlorinating Valves and Hydrants:** In the process of chlorinating newly laid pipe, all valves or other appurtenances shall be operated while the pipeline is filled with the chlorinating agent. All valves in lines being disinfected shall be opened and closed several times during the 24 hour period of disinfection.~~

~~**611.23.3714 Final Flushing, Sampling and Testing:** Following chlorination, all treated water in the newly laid pipeline shall be thoroughly flushed until the replacement water throughout the new pipeline can be proved, by laboratory testing\*, comparable in quality to the water served to the public from the existing water system. Prior to sampling for laboratory testing, the residual chlorine throughout the length of the pipeline shall be reduced to 24.0 ppm or less. Once the required residual chlorine level in the pipeline is achieved, bacteriological samples shall be taken as outlined below.~~

~~\*Comparable to commercial products known as HTH, Perchloron, and Pittchlor.~~

~~\*\* Known commercially as liquid laundry bleach.~~

The Contracting Agency or its authorized representative will collect all samples for testing of the new water mains. To initiate the sampling and testing, the Contractor will present to the Contracting Agency or its authorized agent a written request for such work no later than 24 hours prior to the time when samples are to be taken. Samples shall be taken from a tap and riser located and installed in such a way as to prevent outside contamination. Samples shall never be taken from an unsterilized hose or fire hydrant, because such samples will seldom meet bacteriological standards.

The number of sampling locations are determined by the Contracting Agency or its authorized agent and at a minimum shall be as follows:

- Waterlines up to but less than 150 feet in length require one sampling riser installed as near the end as possible;
- Waterlines 150 feet to 300 feet in length, two sampling risers, one near each end of the line;
- Waterlines 300 feet to 3,000 feet in length, a minimum of three sampling risers. In addition, dead ends on main lines should be represented with a sampling riser.

~~(A)~~ The number of samples taken at each sampling location shall be determined by the Contracting Agency or its authorized agent based on one of the following methods.

- (A) One sample from each sampling location which is examined and analyzed in the laboratory over a three day (72 hour) period-period. (Heterotrophic Plate Count (HPC) method).
- (B) One Sample from each sampling location taken 24 hours after flushing high chlorine is examined in the laboratory. (Total Coliform (TC) method).
- (C) Two samples taken on separate days from each sampling location. Satisfactory water quality of the new main shall continue for a period of at least two days (48 hours) as demonstrated by laboratory examination of these samples. Total Coliform (TC) method).

Upon completion of laboratory testing, results of all tests shall be sent by the laboratory to the Contracting Agency. Results of laboratory analysis will be interpreted by the Contracting Agency, and reported to the Contractor. Under no circumstance shall the Contractor contact the laboratory. If there is need for test results before written reports are submitted, such information shall be obtained only from the Contracting Agency or its authorized representative.

-Laboratory and field analysis shall be done by methods approved by the Arizona Department of Health Services (ADHS)

611.3.4 Final Connections: Any temporary air release blow-offs and test sample risers shall be left exposed and protected during backfilling until all testing is complete. After all testing is complete and passed acceptance, they shall be properly lowered and terminated as directed by the Contracting Agency.

Connections to the existing pipelines or existing valves shall not be made until after that all or that specific section of new pipe main line construction has satisfactorily passed all required the hydrostatic and disinfection tests.

**611.23.125 Repetition of Chlorination Procedure:** Should the initial treatment fail to result in the conditions specified above, the original chlorination procedure shall be repeated until satisfactory results are obtained.