Section 2554. Water Mains, Valves, Fire Hydrants, and Appurtenances

2554.01 DESCRIPTION.

This section was developed in conjunction with Division 5 of the SUDAS Standard Specifications, with modifications to suit the needs of the Department.

A. Construct water mains and building service pipes.

B. Install valves, fire hydrants, and appurtenances for water mains.

C. Test and disinfect water mains, valves, fire hydrants, and appurtenances.

2554.02 MATERIALS.

A. Pipe, Fittings, Valves, Fire Hydrants, and Appurtenances.
Apply Section 4150.

B. Testing and Disinfection.

1. Liquid Chlorine: according to AWWA B300 and AWWA B301.

2. Sodium Hypochlorite: according to AWWA B300.

3. Calcium Hypochlorite: according to AWWA B300.

4. All disinfecting agents to be NSF 60 certified. Supply and store in original container.

2554.03 CONSTRUCTION.

A. Pipe and Fittings.

1. Pipe Installation.

a. General.

1) Do not use deformed, defective, gouged, or otherwise damaged pipes or fittings.

2) Keep trench free of water. Clean pipe interior prior to placement in the trench.

3) Install pipe with fittings and valves to the lines and grades specified in the contract documents.

4) Clean joint surfaces thoroughly and apply lubricant approved for use with potable water and recommended by the manufacturer.

5) Push the pipe joint to the indication line on the spigot end of the pipe before making any joint deflections.

6) Limit joint deflections to one degree less than pipe manufacturer's recommended maximum limit.

7) Tighten bolts in a joint evenly around the pipe.

8) Install concrete thrust blocks on fittings 16 inches (400 mm) in diameter or smaller. For fittings larger than 16 inches (400 mm), install restrained joints, and when specified in the contract documents, also install concrete thrust blocks.

9) Keep exposed pipe ends closed with rodent-proof end gates at all times when pipe installation is not occurring.
10) Close ends of installed pipe with watertight plugs during nights and non-working days.
11) Do not allow water from the new pipeline to enter existing distribution system piping until testing and disinfection are successfully completed.

b. Trenched.

1) Excavate trench and place pipe bedding and backfill material as specified in Section 2552.
2) Provide uniform bearing along the full length of the pipe barrel. Provide bell holes.

c. Trenchless.

Apply Section 2553.

2. Additional Requirements for DIP Installation.

a. Utilize full length gaged pipe for field cuts. Alternatively, field gage pipe selected for cutting to verify the outside diameter is within allowable tolerances.

b. Cut the pipe perpendicular to the pipe barrel. Do not damage the cement lining. Bevel cut the ends for push-on joints according to the manufacturer's recommendations.

c. Encase all pipe, valves, and fittings with polyethylene wrap according to Article 2554.03, A, 5.

3. Additional Requirements for PVC Pipe Installation.

a. Cut the pipe perpendicular to the pipe barrel. Deburr and bevel cut the spigot end of the pipe barrel to match the factory bevel. Re-mark the insertion line.

b. When connecting to shallow depth bells, such as on some cast iron fittings or valves, cut the spigot end square to remove the factory bevel. Deburr the end and form a partial bevel on the end.

4. Additional Requirements for Prestressed Concrete Cylinder Pipe Installation.

a. Install according to AWWA M9.

b. Relieve gasket tension by inserting a small rod between the gasket and the gasket groove and running the tool around the pipe twice.

c. Check gasket position using a metal feeler gage after the joint has been assembled.

d. Complete joint exterior grouting after pipe has been properly positioned using non-shrink grout.

5. Polyethylene Encasement Installation.

a. Apply polyethylene encasement to buried ductile iron pipe and to buried fittings, fire hydrants, and appurtenances. The polyethylene encasement is to prevent contact between the pipe and the bedding material, but it need not be airtight or watertight.

b. Install polyethylene encasement according to AWWA C105, using tubes for flat sheets, and the pipe manufacturer's recommendations.

c. Do not expose the polyethylene encasement to sunlight for long periods before installation.

d. Remove lumps of clay, mud cinders, and so forth on the pipe surface before encasing the pipe. Prevent soil or bedding material from becoming trapped between the pipe and polyethylene.

e. Lift polyethylene encased pipe with a fabric type sling or padded cable.

f. Secure and repair encasement material using polyethylene tape, or replace as necessary.

6. Tracer System Installation.

a. Install with all buried water main piping. Refer to the contract documents for details of tracer wire installation.

b. Begin and terminate the system at all connections to existing mains.

c. Install wire continuously along the lower quadrant of the pipe. Do not install wire along the bottom of the pipe. Attach wire to the pipe at the midpoint of each pipe length. Use 2 inch (50 mm) wide by 10 mil (250 µm) thick polyethylene pressure sensitive tape.

d. Install splices only as authorized by the Engineer. Allow the Engineer to inspect all below grade splices of tracer wire prior to placing the backfill material.

e. Install ground rods adjacent to connections to existing piping and at locations specified in the contract documents.

f. Bring two wires to the surface at each fire hydrant location and terminate with a tracer wire station.

g. Final inspection of the tracer system will be conducted at the completion of the project and prior to acceptance by the Engineer. Verify the electrical continuity of the system. Repair discontinuities.

7. Conflicts

a. Horizontal Separation of Gravity Sewers from Water Mains.

1) Separate gravity sewer mains from water mains by a horizontal distance of at least 10 feet (3 m) unless:

- The top of a sewer main is at least 18 inches (450 mm) below the bottom of the water main, and
- The sewer is placed in a separate trench or in the same trench on a bench of undisturbed earth at a minimum horizontal separation of 3 feet (1 m) from the water main.

2) When it is impossible to obtain horizontal clearance of 3 feet (1 m) and a vertical clearance of 18 inches (450 mm) between sewers and water mains, the sewers shall be constructed of water main materials meeting the requirements of Article 4150.02, A. However, provide a linear separation of at least 2 feet (600 mm).

b. Separation of Sewer Force Mains from Water Mains.
Separate sewer force mains and water mains by a horizontal distance of at least 4 linear feet (1.2 m).

c. Separation of Sewer and Water Main Crossovers.

1) Vertical separation of sanitary sewers crossing under any water main should be at least 18 inches (450 mm) when measured from the top of the sewer to the bottom of the water

main. If physical conditions prohibit the separation, the sewer may be placed not closer than 6 inches (150 mm) below a water main or 18 inches (450 mm) above a water main. Maintain the maximum feasible separation distance in all cases.

2) Where the sewer crosses over or less than 18 inches (450 mm) below a water main, locate one full length of sewer pipe of water main material so both joints are as far as possible from the water main. The sewer and water pipes shall be adequately supported and have watertight joints. Use a low permeability soil for backfill material within 10 feet (3 m) of the point of crossing.

8. Transitions in Piping Systems.

Where the specified material of a piping system entering or exiting a structure changes, make the change at the outside of the structure wall, beyond any wall pipe or wall fitting required, unless specified otherwise.

9. Structure Penetrations.

a. Wall Pipes.

1) Install where pipes penetrate and terminate at a wall or floor surface of a concrete structure, or where the pipe protrudes through the concrete wall or floor and the protrusion is otherwise unsupported.

2) Provide a waterstop flange near the center of the embedment length. The waterstop shall be cast integrally with the wall pipe, or fully welded to it around the pipe circumference.

b. Wall Sleeves.

1) Install where a pipe passes through a structure wall.

2) Sleeves in concrete walls are to be supplied with a waterstop collar, fully welded, and cast-in-place in the concrete.

10. Water Service Stub.

a. Install water service pipe, corporations, stops, and stop boxes according to the contract document.

b. Install 1 inch (25 mm) and smaller corporation valves tapped at 45 degrees above horizontal at a minimum distance of 18 inches (0.5 m) from pipe bell, or other corporation. Install 1 1/2 inch (38 mm) and 2 inch (50 mm) corporation valves tapped horizontal a minimum distance of 24 inches (600 mm) from pipe bell or other corporation.

c. Construct trench and place backfill material according to Section 2552.

B. Valves, Fire Hydrants, and Appurtenances.

Remove valves, fire hydrants, and appurtenances contaminated with mud and surface water from the site. Do not use in construction unless thoroughly cleaned, inspected, and approved by the Engineer.

1. General.

a. Install according to the contract documents.

b. Apply polyethylene wrap to all iron pipe, valves, fire hydrants, and fittings.
c. Set tops of valve boxes to finish grade.
d. Check the working order of all valves by opening and closing through entire range. Before opening the valves, check with the Engineer on operating requirements.
e. Test and disinfect all valves, fire hydrants, and appurtenances as components of the completed water main according to Article 2554.03, C.

2. Flushing Device (Blowoff).
Install and construct as specified in the contract documents.

3. Fire Hydrant.
a. Install according to the contract documents.
b. If the fire hydrant valve is positioned adjacent to the water main, attach it to an anchor tee.
c. If the fire hydrant valve is positioned away from water main, restrain all joints between the valve and water main.
d. **Fire Hydrant Depth Setting.**
1) Use adjacent finished grade to determine setting depth.
2) Set bottom of breakaway flange between 2 and 5 inches (25 and 125 mm) above finished grade.
3) If finished grade is not to be completed during the current project, consult with the Engineer for proper setting depth.
e. Coordinate installation with tracer wire installation.
f. Orient fire hydrant nozzles as directed by the Engineer.

4. Adjustment of Existing Valve Box or Fire Hydrant.
a. **Minor Valve Box Adjustment.**
For existing adjustable boxes that have sufficient adjustment range to bring to finished grade, raise or lower valve box to finished grade.
b. **Valve Box Extension.**
For existing valve boxes that cannot be adjusted to finished grade, install valve box extensions as required.
c. **Valve Box Replacement.**
For existing valve boxes that cannot be adjusted to finished grade, remove and replace the valve box.
d. **Fire Hydrant Adjustment.**
1) Add extension barrel sections and stems as necessary to set existing fire hydrant at finished grade.
2) Paint exterior of new barrel section to match existing fire hydrant unless otherwise specified.

C. Testing and Disinfection.
Notify the Engineer at least 2 working days in advance of testing or disinfection operations to coordinate the operations. The Engineer will be in attendance during testing or disinfection.

1. **Sequence of Testing and Disinfection**
   Perform operations according to AWWA C651 in the sequence below. Successfully complete each operation before continuing to the next operation. The Engineer will provide reasonable quantities of water for flushing and testing.
   a. **Continuous Feed or Slug Method (After Water Main Installation).**
      The sequence of testing and disinfection may be modified with approval of the Engineer.
      1) Perform initial flush.
      2) Perform disinfection.
      3) Flush after disinfection.
      4) Perform pressure and leak testing.
   b. **Tablet Method (Concurrent with Water Main Installation).**
      Use this method only if approved by the Engineer. Modify the procedure for flushing, disinfection, and pressure and leak testing as needed if tablet method is used.
      1) Perform disinfection.
      2) Flush after disinfection.
      3) Perform pressure and leak testing.

2. **Initial Flushing.**
   a. **Flushing.**
      1) Coordinate flushing with the Engineer.
      2) Flush pipe prior to disinfection using potable water.
      3) Measure flushing velocity.
      4) Obtain a minimum flushing velocity of 2.5 feet (0.76 m) per second in the pipe to be disinfected.
   b. **Minimum Flushing Rate.**
      According to AWWA C651, Table 3, based on 40 psi (276 kPa) residual pressure (see Table 2554.03-1 below).

Table 2554.03-1: Minimum Flushing Rate

Pipe Diameter, inches (mm)	Flow Rate for Flushing, gallons/minute (L/s)	Number of Taps[(b)]			Number of 2 1/2 inch (63.5 mm) Fire Hydrant Outlets[(a)]
		1 inch (25 mm)	1 1/2 inch (38 mm)	2 inch (50 mm)	
4 (100)	100 (6.3)	1	-	-	1
6 (150)	200 (12.6)	-	1	-	1
8 (200)	400 (25.2)	-	2	1	1
10 (250)	600 (37.9)	-	3	2	1
12 (300)	900 (56.8)	-	-	2	2
16 (400)	1600 (100.9)	-	-	4	2

(a) With a 40 psi (276 kPa) pressure in the main with the hydrant flowing to atmosphere, a 2 1/2 inch (63.5 mm) fire hydrant outlet will discharge approximately 1000 gallons (3780 L) per minute; and a 4 1/2 inch (115 mm) fire hydrant will discharge approximately 2500 gallons (9460 L) per minute

(b) Number of taps on pipe based on discharge through 5 feet (1.5 m) of galvanized iron pipe with one 90 degree elbow.

c. Property Protection.
Protect public and private property from damage during flushing operations.

3. Disinfection.

a. General.

1) Disinfect according to AWWA C651. The tablet method contained in AWWA C651 shall not be used unless approved by the Engineer.

2) Keep piping to be chlorinated isolated from lines in service and from points of use.

3) Coordinate disinfection and testing with the Engineer.

4) Obtain and test water samples, unless otherwise provided by the Engineer.

b. Procedure.

1) Induce a flow of potable water through the pipe.

2) Introduce highly chlorinated water to the pipe at a point within 5 pipe diameters of the pipe's connection to an existing potable system, or within 5 pipe diameters of a closed end, if there is no connection to an existing system.

3) Introduce water containing a minimum of 25 mg/L free chlorine until the entire new pipe contains a minimum of 25 mg/L free chlorine.

4) Retain chlorinated water in the pipe for at least 24 hours and no more than 48 hours.

4. Final Flushing.

a. Flush pipe using potable water until chlorine residual equals that of the existing potable water system.

b. Dispose of chlorinated water to prevent damage to the environment. Dechlorinate highly chlorinated water from testing before releasing into the ground or sewers. Obtain Engineer approval prior to flushing activities.

1) Check with the local sewer department for the conditions of disposal to the sanitary sewer.

2) Chlorine residual of water being disposed will be neutralized by treating with one of the chemicals listed in Table 2554.03-2:

Table 2554.03-2: Amounts of Chemicals Required to Neutralize Various Residual Chlorine Concentrations in 100,000 Gallons (378,500 L) of Water

Residual Chlorine Concentration mg/L	Sulfur Dioxide (SO_2) pounds (kg)	Sodium Bisulfite ($NaHSO_3$) pounds (kg)	Sodium Sulfite (Na_2SO_3) pounds (kg)	Sodium Thiosulfate ($Na_2S_2O_3 + 5H_2O$) pounds (kg)	Ascorbic Acid ($C_6O_8H_6$) pounds (kg)
1	0.8 (0.36)	1.2 (0.54)	1.4 (0.64)	1.2 (0.54)	2.1 (0.95)
2	1.7 (0.77)	2.5 (1.13)	2.9 (1.32)	2.4 (1.09)	4.2 (1.91)
10	8.3 (3.76)	12.5 (5.67)	14.6 (6.62)	12.0 (5.44)	20.9 (9.48)
50	41.7 (18.91)	62.6 (28.39)	73.0 (33.11)	60.0 (27.22)	104 (47.17)

5. Pressure and Leak Testing.

- **a.** Remove debris from within pipe. Clean and swab out pipe if required.
- **b.** Secure unrestrained pipe ends against uncontrolled movement.
- **c.** Isolate new piping from the existing water system.
- **d.** Fill and flush all new piping with potable water. Ensure all trapped air is removed.
- **e.** Pressurize the new pipe to the test pressure at the highest point in the isolated system. Do not pressurize to more than 5 psi (34 kPa) over the test pressure at the highest point in the isolated system.
- **f.** Test and monitor the completed piping system at 1.5 times the system working pressure or 150 psi (1035 kPa), whichever is greater, for 2 continuous hours.
- **g.** If at any time during the test the pressure drops to 5 psi (34 kPa) below the test pressure, repressurize the pipe by pumping in potable water in sufficient quantity to bring the pressure back to the original test pressure.
- **h.** Accurately measure the amount of water required to repressurize the system to the test pressure.
- **i.** Maximum allowable leakage rate according to AWWA C600:

English Units

$$L = \frac{(S)(D)(P)^{0.5}}{148{,}000}$$

Where:
L = allowable leakage, in gallons per hour.
S = length of pipe tested, in feet.
D = pipe diameter, in inches.
P = average test pressure, in pounds per square inch.

Metric Units

$$L = \frac{(S)(D)(P)^{0.5}}{794{,}797}$$

Where:
L = allowable leakage, in liters per hour.
S = length of pipe tested, in feet.
D = pipe diameter, in millimeters.
P = average test pressure, in kilopascals.

Table 2554.03-3 assumes an average test pressure (P) of 150 psi (1035 kPa) and 1000 feet (300 m) of test section:

Table 2554.03-3: Maximum Allowable Leakage Rate

Pipe Diameter		Maximum Allowable Leakage Rate	
inches	**mm**	**gallons/hour/1000 feet of pipe**	**liters/hour/300 meters of pipe**
4	100	0.33	1.21
6	150	0.50	1.82
8	200	0.66	2.43
10	250	0.83	3.04
12	300	0.99	3.64
14	350	1.16	4.25
16	400	1.32	4.86
18	450	1.49	5.46
20	500	1.66	6.07
24	600	1.99	7.29
30	750	2.48	9.11
36	900	2.98	10.93

j. If the average measured leakage per hour exceeds the maximum allowable leakage rate, repair and retest the water main.
k. If the measured pressure loss does not exceed 5 psi (34 kPa) the test will be considered acceptable.
l. Repair all visible leaks regardless of the amount of leakage.

6. Bacteria Sampling.
Test water mains according to AWWA C651. If the initial disinfection procedure fails to produce satisfactory bacteriological results or if other water quality is affected, repeat the disinfection procedure.

7. Putting Water Main in Service
Put the completed water system in service only after obtaining permission of the Engineer.

2554.04 METHOD OF MEASUREMENT.

A. Pipe and Fittings.

1. **Water Main.**
   a. **Trenched.**
      Measurement for each type and size of pipe installed in an open trench will be in linear feet (meters) along the centerline of the pipe, including the length through the fittings.
   b. **Trenchless.**
      Measurement for each type and size of pipe installed by trenchless methods will be in linear feet (meters) along the centerline of the casing pipe.

2. **Water Main with Casing Pipe.**
   a. **Trenched**
      Measurement for each type and size of pipe with a casing pipe installed in an open trench will be in linear feet (meters) along the centerline of the casing pipe from end of casing to end of casing.
   b. **Trenchless.**
      Measurement for each type and size of pipe installed by trenchless methods with a casing pipe will be in linear feet (meters) along the centerline of the casing pipe.

3. **Fittings.**
   One of the following methods will be specified for measurement of water main fittings:
   a. **Fittings by Count.**
      Measurement for each type and size of fitting installed as specified in the contract documents or as required for proper installation of the water main will be counted.
   b. **Fittings by Weight (Mass).**
      Measurement for each type and size of fitting installed as specified in the contract documents or as required for proper installation of the water main will be counted. Determine the total weight (mass) of fittings counted in pounds (kilograms) based on the standard fitting weights (masses) published in AWWA C153 for ductile iron compact fittings.

4. **Water Service Stubs.**
   Each type and size of water service and stub from the water main to the stop box will be counted.

B. Valves, Fire Hydrants, and Appurtenances.

1. **Valve (Butterfly or Gate).**
   Each type and size of valve will be counted.

2. **Tapping Valve Assembly.**
   Each size of tapping valve assembly will be counted.

3. **Fire Hydrant Assembly.**
   Each fire hydrant assembly will be counted.

4. **Flushing Device (Blowoff).**
   Each size of flushing device will be counted.

5. **Valve Box Adjustment, Minor.**
   Minor adjustment of an existing valve box by raising or lowering the adjustable valve box will not be measured.

6. **Valve Box Extension.**
   Each existing valve box adjusted to finished grade by adding a valve box extension will be counted.

7. **Valve Box Replacement.**
   Each existing valve box replaced with a new valve box will be counted.

8. **Fire Hydrant Adjustment.**
   Each existing fire hydrant adjusted to finished grade by addition of an extension barrel section and stem will be counted.

9. **Other Fixture Adjustment.**
   Adjustment of other fixtures by raising or lowering them will not be measured.

C. Testing and Disinfection.
None.

2554.05 BASIS OF PAYMENT.

A. Pipe and Fittings.

1. **Water Main.**
   a. **Trenched.**
      1) Payment will be the contract unit price per linear foot (meter) for each type and size of pipe.
      2) Payment is full compensation for trench excavation, dewatering, furnishing bedding material, placing bedding and backfill material, tracer system, testing, disinfection, and polyethylene wrap for ductile iron pipe and ductile and gray iron fittings.
   b. **Trenchless.**
      1) Payment will be the contract unit price per linear foot (meter) for each type and size of pipe.
      2) Payment is full compensation for:
      - Furnishing and installing pipe,
      - Trenchless installation materials and equipment,
      - Pit excavation, dewatering, and placing backfill material,
      - Tracer system,
      - Testing, and
      - Disinfection.

2. **Water Main with Casing Pipe.**
    a. **Trenched.**
        1) Payment will be the contract unit price per linear foot (meter) for each type and size of water main.
        2) Payment is full compensation for furnishing and installing both water main and casing pipe, trench excavation, dewatering, furnishing bedding material, placing bedding and backfill material, casing spacers, furnishing and installing annular space fill material, tracer system, testing, and disinfection.
    b. **Trenchless.**
        1) Payment will be the contract unit price per linear foot (meter) for each type and size of water main.
        2) Payment is full compensation for:
            - Furnishing and installing both water main and casing pipe,
            - Trenchless installation materials and equipment,
            - Pit excavation, dewatering, and placing backfill material,
            - Casing spacers,
            - Furnishing and installing annular space fill material,
            - Tracer system,
            - Testing, and
            - Disinfection.

3. **Fittings.**
    One of the following methods will be specified for payment of water main fittings:
    a. **Count.**
        Payment will be the contract unit price for each type and size of fitting. Payment is full compensation for restrained joints and thrust blocks.
    b. **Weight (Mass).**
        Payment will be made at the contract unit price per pound (kilogram). Payment is full compensation for restrained joints and thrust blocks.

4. **Water Service Stubs.**
    a. Payment will be made at the contract unit price for each type and size of water service stub.
    b. Payment is full compensation for corporation, service pipe, stop, and stop box.

B. Valves, Fire Hydrants, and Appurtenances.

1. **Valve (Butterfly or Gate).**
    a. Payment will be the contract unit price for each type and size of valve.
    b. Payment is full compensation for all components attached to the valve or required for its complete installation, including underground or above ground operator, square valve operating nut, valve box and cover, valve box extension, and valve stem extension.

2. **Tapping Valve Assembly.**
   - **a.** Payment will be the contract unit price for each tapping valve assembly.
   - **b.** Payment is full compensation for tapping sleeve, tapping valve, the tap, valve box and cover, valve box extension, and valve stem extension.

3. **Fire Hydrant Assembly.**
   - **a.** Payment will be the contract unit price for each fire hydrant assembly.
   - **b.** Payment is full compensation for the fire hydrant, barrel extensions sufficient to achieve proper bury depth of anchoring pipe and height of fire hydrant above finished grade, and components to connect the fire hydrant to the water main, including anchoring pipe, fittings, thrust blocks, pea gravel or porous backfill material, and fire hydrant gate valve, except tapping valve assembly if used.

4. **Flushing Device (Blowoff).**
   Payment will be at the contract unit price for each flushing device.

5. **Valve Box Adjustment, Minor.**
   When shown in the contract documents, minor adjustment of an existing valve box by raising or lowering the adjustable valve box is incidental. When not shown or tabulated, adjustment will be paid for according to Article 1109.03, B.

6. **Valve Box Extension.**
   Payment will be at the contract unit price for each valve box extension.

7. **Valve Box Replacement.**
   - **a.** Payment will be at the contract unit price for each valve box replacement.
   - **b.** Payment is full compensation for:
     - Removal of existing valve box,
     - Excavation,
     - Furnishing and installing new valve box,
     - Furnishing and placing backfill material,
     - Compaction, and
     - All other necessary appurtenances.

8. **Fire Hydrant Adjustment.**
   - **a.** Payment will be at the contract unit price for each adjustment of an existing fire hydrant.
   - **b.** Payment is full compensation for:
     - Removal and reinstallation of the existing fire hydrant,
     - Furnishing and installing the extension barrel section and stem, and
     - All other necessary appurtenances.
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9. Other Fixture Adjustment.
When shown in the contract documents, adjustment of other fixtures by raising or lowering them is incidental. When not shown or tabulated, adjustment will be paid for according to Article 1109.03, B.

C. Testing and Disinfection.
Testing and disinfection of water systems is incidental to the construction of pipe and fittings.