

WATER AGENCIES' STANDARDS

Design Guidelines for Water, and Sewer Facilities

SECTION 5.1 PRESSURE PIPELINE DESIGN

5.1.1 PURPOSE

The purpose of this section is to provide general guidelines for open trench pressure pipeline design. These design criteria should be considered in the appropriate stage of the design submittals for a pipeline project.

5.1.2 STANDARD TERMS AND DEFINITIONS

Wherever technical terms occur in these guidelines or in related documents, the intent and meaning shall be interpreted as described in Standard Terms and Definitions.

5.1.3 GENERAL

It is the responsibility of the user of these documents to make reference to and/or utilize industry standards not otherwise directly referenced within this document. The Engineer of Work may not deviate from the criteria presented in this section without prior written approval of the Agency's Engineer.

5.1.4 GUIDELINES

This section covers general design parameters for pipelines installed in trenches with minimum depth of cover over top of the pipelines at three to eight feet (3' to 8'). Any variance of these depths requires special design approval by the Agency Engineer.

- A. To the extent possible, distribution and transmission pipelines shall be laid out in the public right-of-way.
- B. Pipeline design plans and specifications shall reference WAS Standard Drawings and Standard Specifications where appropriate.
- C. Pipeline plans shall be prepared in digital format, in accordance with Section 1.2 or Section 1.3.
- D. Pipelines shall be designed in accordance with the requirements of the California Safe Drinking Water Act and the California Water Works Standards, Title 22 of the California Code of Regulations "Blue Book".
- E. Pipeline plans shall conform to the latest standards of the State of California, Department of Health Services, "Criteria for the Separation of Water Mains and Sanitary Sewers".
- F. Geotechnical evaluations may be required in order to determine appropriate trench loading and pipeline material selection.

5.1.5 PIPELINE LAYOUT

- A. For new development the designer must consult with the respective water agency as well as the local City and County government, utility companies (e.g., SDG&E, Cable TV, SBC) to determine the standard for location of new facilities.
- B. For existing development the designer must research existing utility information by reviewing available record drawings from local City and County government, utility companies (e.g.; SDG&E, Cable TV, PacBell, County Water Authority), and other governmental agencies with jurisdiction within the pipeline alignment. The designer shall contact all utility companies and municipal agencies to request record drawings of existing and future planned utilities and verify ownership of facilities. Research with municipalities should include future road and utility improvement and master planned land development projects.
- C. Obtain and review right-of-way and road boundaries. Verify right-of-way or easement acquisition requirements, as identified in the Design Report or Sub-Area Master Plan (SAMP).
- D. With the above information, plot existing utilities and right-of-ways on base maps. Identify potential utility conflicts and pipeline tie-in points. Complete additional field research including pothole information to verify record drawing information.
- E. Dead-end distribution systems (those with a single supply pipeline) tend to reduce water quality and system reliability; therefore, distribution systems shall be designed with two or more separate supply pipelines whenever it is feasible. Distribution systems located in urban areas that serve seventy (70) or more DU, or those located in rural areas that serve 30 or more DU must be designed with two or more separate supply pipelines unless otherwise approved by the Agency Engineer.
- F. Confirm that the proposed alignment complies with the separation requirements of the State Health Department with respect to separation between water, sewer, and recycled water pipelines (refer to WAS Standard Drawings WI-01 through WI-03 for separation requirements). There will also be a minimum horizontal separation of five feet and a vertical separation of one foot between pipelines and other utilities e.g., SDG&E utilities and storm drains. The Design Engineer shall consultation with the respective utilities should occur for larger size pipelines and utilities as they may require these separations be expanded.
- G. Provide final right-of-way requirements for permanent and temporary easements to the Agency Engineer as noted in Section 1.5.
- H. Perform a final field check of the alignment to determine if any field changes have occurred since the previous check. Update plans to reflect field conditions.
- I. Horizontal and vertical curves for PVC pipelines shall be in accordance with WAS Specification Section 15064. Horizontal and vertical curves for pipeline materials other than PVC shall follow the manufacturer's recommendations.
- J. Where the future main is in a major street that would be difficult and expensive to access a pipe stub and cap per WAS shall extend out to the edge of pavement or out ten feet (10') from the main, whichever is the greater distance.

5.1.6 PLAN AND PROFILE

- A. Complete a preliminary alignment with horizontal control data, using the available information from the Design Report or SAMP and as obtained during the record drawing reviews and field investigations.

- B. Confirm point of connection (POC) with the respective water agency and obtain pothole information at potential utility conflicts. If the alignment of the existing main is in question, additional potholes should be performed to determine the horizontal and vertical alignment of the existing main at the POC location. Pothole data should be obtained as necessary for utility mains, conduits, and service laterals that are six inch (6") and larger, that cross or are parallel to the proposed pipeline. Pothole data should include depth to top of pipe, pipe diameter, pipe material, and length to nearest point.
- C. Plot pothole data on the plan and profile drawings.
- D. Check the proposed alignment for conflicts and make revisions as required.
- E. Add stationing and horizontal control data to the pipeline plan and profile views in accordance with Section 1.1.
- F. Accurately detail and locate tie-in connections and appurtenances. Provide coordinates and vertical control data to provide precise locations of tie-ins, valves, blow-offs, air valves, vaults, fire hydrants and etcetera. Review location and layout of appurtenances to determine accessibility for operations and maintenance personnel and ensure constructability.
- G. The Engineer of Work shall arrange for the preliminary alignment centerline (P-line) to be marked-out in the field by a land surveying crew. Mark-out of the P-line shall consist of spray paint within paved or developed area or wood lath and flagging for undeveloped areas. The Engineer of Work and the Agency Engineer (when applicable) shall field check the P-line layout for constructability issues.
- H. Identify conflicts between existing utilities and appurtenant facilities. Revise design to address utility conflicts.

5.1.7 PIPELINE MATERIALS

- A. General: The material for pressure pipelines shall be in accordance with the WAS Approved Materials List for Water Facilities.
 - 1. In general, pipelines buried between three feet (3') and eight feet (8') of cover shall be PVC. Materials for pipelines exposed to atmosphere, buried with less than three feet (3') or more than eight feet (8') of cover shall be determined by the Engineer of Work and shall be approved by the District Engineer.

The Engineer of Work should consider the following factors in determining the appropriate material including lining and coatings:

- Fabrication and installation costs
 - Flow conditions (e.g., higher velocity flows or periods of dry pipe conditions)
 - Potential conflicts with existing and future utilities
 - Safety and security of the pipeline
 - Geotechnical conditions
 - Maintenance
- B. PVC Pipe: A dimension ratio (DR) is used to standardize the specification of PVC pipe. Dimension ratios (DR=O.D./t) provide a method of specifying product dimensions to maintain mechanical properties regardless of size. For a given dimension ratio, pressure capacity and pipe stiffness remain constant for all pipe sizes.

PVC pipe for distribution mains six inches (6") through twelve inches (12") in diameter shall conform to AWWA C900 (*Standard for Polyvinyl Chloride Pressure (PVC) Pressure Pipe, 4 In. through 12 In., for Water Distribution*), Class 305 (DR14).

PVC pipe fourteen inches (14") through thirty inches (30") in diameter used for transmission mains shall conform to AWWA C905 (*Standard for Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 In. through 36 In.*), Class 165 (DR 25) or Class 235 (DR18).

Solvent cement or mechanical joints are not acceptable for pipe-to-pipe connections. Use bell and spigot pipe only. Exceptions may be allowed to use restrained joints but are subject to the approval of the Agency Engineer. Pipe-to-fitting connections shall be in accordance with the latest edition of the WAS Approved Materials List for Water Facilities.

Concrete encasement with PVC pipe is not allowed. Higher strength pipe (steel or ductile iron) supported by design calculation shall be used in lieu of encasement.

C. Steel Pipe: Steel pipe shall be designed per "*AWWA Manual of Water Supply Practices, Steel Pipe - A Guide for Design and Installation, M-11.*" Minimum pipe wall thickness for distribution and transmission mains shall be one quarter inch ($\frac{1}{4}$ ") unless otherwise directed by the Agency Engineer. Minimum pipe wall thickness for pump station, pressure reducing valve station, and all above ground pipe applications shall be one quarter inch ($\frac{1}{4}$ "). Non-Welded (push-on joints) steel pipe shall not be allowed.

1. Lining: Steel pipe shall be designed with a cement lining. However, cement material will not be used when the pipeline is design for intermittent use only resulting in being out of service for extended periods of time. The alternative material (e.g., polyurethane) design will be submitted to the Agency Engineer for approval.
2. Coatings: For below ground applications, the coating of steel pipe can be cement, poly tape, or a combination of these materials. For above ground applications the steel pipe shall be paint-coated unless otherwise Directed by the District Engineer.
3. Cathodic Protection (CP): Steel pipe that is subjected to corrosion may require the installation of either a passive or active CP system.

D. Ductile Iron Pipe (DIP): Minimum thickness design shall conform to AWWA C150 (*American National Standard for Thickness Design for Ductile Iron Pipe*) and AWWA C151 (*American National Standard for Ductile Iron Pipe, Centrifugally Cast, for Water and Other*).

1. Lining: All DIP shall be designed with a cement lining. However, cement material will not be used when the pipeline is design for intermittent use only resulting in being out of service for extended periods of time. The alternative material (e.g., polyurethane) design will be submitted to the Agency Engineer for approval.
2. All ductile pipe installed underground shall be factory-coated with a bituminous material in accordance with AWWA C151 (*American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids*) and polyethylene film wrap per AWWA C105 (*American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems*), Installation Method A. The polyethylene film wrap shall be a minimum eight (8) mil thick, overlapped by twelve inches (12") at joints and secured with two inch (2") wide black polyethylene adhesive tape.

- E. Other material: For pipeline material designed for other than those listed above the designer must submit a request to the Agency Engineer for approval.

5.1.8 BURIED PIPELINE DESIGN

A. General:

1. Depth of pipe: The minimum depth of cover for potable water pipelines up to sixteen inches (16") is generally three feet (3'). The minimum depth of cover for recycled water pipelines up to sixteen inches (16") is generally four feet (4'). Water mains sixteen inches (16") and larger shall be a minimum of one foot (1') deeper than indicated above.

The Engineer of Work must perform calculations to determine the appropriate wall thickness of a pipeline where there are unusual external (i.e., depths less than three feet (3') or greater than eight feet (8') and bridge installations), internal conditions (e.g., surge pressure), and/or use of steel or ductile iron pipe.

2. The Engineer of Work shall recognize that in order to calculate trench loads, both dead loads and live loads must be considered.
3. Water and sewer trench dead loads shall be calculated using the Prism Load Method.
4. Geotechnical investigations shall be completed to determine unit soil weights for soil load calculations.

B. Dead Loads:

1. The prism load is the superimposed load due to the weight of the soil column for the full height of the backfill directly above the pipe. The prism load is considered to be the maximum load that will be imposed by the soil on a buried pipe. The prism load condition provides a conservative design approach.
2. The unit weight of the soil shall be determined during the geotechnical investigations completed for the pipeline design.
3. The Prism Load Method: The design trench loads shall be calculated using the following equation:

$$W_c = HwB_c$$

Where:

W_c = Design Trench Load on Conduit (lbs/lf)
 H = Depth of Cover over Pipe (ft)
 w = Unit Weight of Soil (lb/cf)
 B_c = Outside Diameter of Pipe (ft)

4. The design trench load (W_c) shall be used in the pipe strength and deflection calculations to determine the appropriate pipe strength and wall thickness for flexible pipe materials.

C. Live Loads:

1. Live loads shall be calculated using standard H20 highway loading for pipe depths of up to eight feet (8').

2. For depths greater than eight feet (8'), live loads can be assumed to be negligible when compared to dead loads.
- D. Internal Pressure:
1. Operating Pressure
 2. Field Testing Pressure
 3. Surge Pressure
- E. Assumptions for Pipeline Installation:
- The Engineer of Work shall assume that the contractor of work installing pipelines will follow the WAS for methods related to trench preparation, backfill material, and methods and relative compaction.
- F. Other Construction: Refer to Section 9 for design of pipelines at pump stations and Section 12 for design for other conditions (e.g., trenchless, highlining) of the Design Guidelines.

5.1.9 REFERENCE

- A. Should the reader have any suggestions or questions concerning the material in this section, contact one of the member agencies listed.
- B. The publications listed below form a part of this section to the extent referenced and are referred to in the text by the basic designation only. Reference shall be made to the latest edition of said publications unless otherwise called for. The following list of publications, as directly referenced within the body of this document, has been provided for the user's convenience. It is the responsibility of the user of these documents to make reference to and/or utilize industry standards not otherwise directly referenced within this document.
1. Water Agencies' Standards (WAS):
 - a. Design Guidelines:
 1. Section 1.1, Drafting Guidelines
 2. Section 1.2, AutoCAD Guidelines
 3. Section 1.3, MicroStation Guidelines
 4. Section 1.5, Easements and Encroachments
 - b. Standard Specifications:

Section 15064, Polyvinyl Chloride (PVC) Pressure Pipe
 - c. Standard Drawings:

WI-01 through WI-03
WP Series
WT Series
 - d. Approved Materials List for Water Facilities

2. American Water Works Association (AWWA):
 - a. AWWA Manual M11, Steel Pipe; A Guide for Design and Installation
 - b. AWWA Manual M23, PVC Pipe; Design and Installation
 - c. AWWA C105, Standard for Polyethylene Encasement for Ductile Iron Pipe
 - d. AWWA C110, Standard for Ductile Iron and Gray Iron Fittings 3” through 48”
 - e. AWWA C150, Standard for Thickness Design of Ductile Iron Pipe
 - f. AWWA C151, Standard for Ductile Iron Pipe, Centrifugally Cast, for Water
 - g. AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings 4” through 12” for Water Distribution
 - h. AWWA C905, Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings 14” through 48” for Water Transmission and Distribution

3. Others:
 - a. California Safe Drinking Water Act
 - b. California Water Works Standards, Title 22 of the California Code of Regulations “Blue Book”
 - c. State of California, Department of Health Services, Criteria for the Separation of Water Mains and Sanitary Sewers

END OF SECTION