## TECHNICAL PROVISIONS

### DIVISION 3 – PIPELINE SPECIFICATIONS

#### 3.5 Pipe Materials

##### 3.5.4 Welded Steel Cylinder Pipe (Cement Mortar Lined and Either Outside Wrapped or Cement Mortar Coated)

#### 3.5.4.2 Pipe and Fittings

All pipe and fittings furnished shall conform to AWWA Standards C-200 and C-205 (latest), as modified herein, by the Construction Drawings, by Owner, applicable provisions of AWWA, C-206, C-207, and C-208, and applicable portions of AWWA M11.

The outside diameter of all Steel Cylinder Pipe shall conform to the following dimensions:

<table>
<thead>
<tr>
<th>Pipe Diameter (Inches)</th>
<th>Outside Diameter of Steel Cylinder (Inches)</th>
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All fittings shall be **shop** fabricated from individual sections of pipe, welded together, and the lining and coating of joints shall be hand-applied to provide a finished cement mortar-lined and finished outside coated joint comparable to mechanically-applied lining and coating detailed herein. **Fittings may be either shop or field fabricated as approved by Owner. However, unless noted on the Construction Drawings or specified otherwise, they shall be shop fabricated.**
a. Minimum steel cylinder thickness shall be as designated on the construction drawings. Where no minimum thickness is designated on construction drawings, it shall be computed using the following formula:

\[ \frac{P \cdot D_y}{T_y} = \frac{2(Y/S)}{2} \]

\( T_y = \) Minimum cylinder thickness, inches  
\( D_y = \) Outside cylinder diameter, inches  
\( P = \) Minimum Design pressure, psi  
\( Y = \) Specified yield point of steel, psi  
\( S = \) Factor of safety = 2.0

In no case shall the design stress \((Y/S)\) exceed 16,500 psi. Cylinder thickness shall be 12-gage minimum for pipeline diameters less than 24-inch and 10-gage minimum for pipeline diameters 24-inch and greater. Cylinder thickness shall be 10-gage minimum for all pipe diameters. In no case shall the cylinder thickness be less than \(D/288\).

b. Specials are defined as bends, reducers, wyes, tees, crosses, outlets, manifolds, all above-ground piping, and all piping in structures. The cylinder thickness for specials shall be computed using the equation, as specified above, except the factor of safety \((S)\) shall be equal to 2.5. In no case shall cylinders for specials have less than the following minimum thickness:

See next page for table
Pipe or specials shall be reinforced with reinforcing collars, reinforcing saddles, or plate reinforcement designed and constructed in accordance with AWWA M11. The pipeline test pressure shall be used in the design of said reinforcement.
DIVISION 3

PIPELINE SPECIFICATIONS

3.1 General

3.1.1 Scope

Contractor shall furnish all pipe and fittings together with all material, equipment, and labor and perform all operations necessary to construct water mains and appurtenances as specified, unless otherwise indicated.

3.1.2 Submittals

3.1.2.1 Asbestos Cement Pipe and Polyvinyl Chloride Pipe

Whenever specified by the Construction Drawings or by Owner, Contractor shall prepare detailed installation or laying drawings for the pipe and fittings showing fittings, appurtenances, and station and elevation for each fitting, each change in alignment or slope, and shall submit these to Owner for approval in all cases in time sufficient to allow review and approval as hereinafter specified and to accommodate the rate of construction. Contractor shall furnish copies of an Affidavit of Compliance in accordance with Section 1.3, AWWA C-400 or AWWA C-402 (latest) for asbestos cement pipe and in accordance with Section 1.4, AWWA C-900 and AWWA C-905 (latest) for polyvinyl chloride pipe. Contractor shall also furnish certified copies of test reports containing results of all physical and chemical tests on pipe and couplings to be furnished showing compliance with AWWA C-400 or AWWA C-402 (latest) as modified herein for asbestos cement pipe and AWWA C-900 and AWWA C-905 (latest) as modified herein for polyvinyl chloride pipe.

3.1.2.2 Welded Steel Cylinder Pipe and Concrete Cylinder Pipe

Whenever specified by the Construction Drawings or by Owner, Contractor shall prepare detailed shop fabrication drawings of the pipe, lining and coating, joints, details of reinforcement, fittings, appurtenances, station, and elevation for each outlet and fitting and each pipe joint where a change in pipe class, alignment, or slope occur and shall submit these to Owner for approval in all cases in time sufficient to allow review and approval as hereinafter specified and to accommodate the rate of construction.

3.1.3 Construction Staking

Upon Contractor’s request, the District will provide construction stakes along the pipeline alignment in accordance with lay sheet(s) at maximum 50’ intervals, including all angle points, grade breaks, fittings, and appurtenances and at the boring and receiving pits, as applicable.

Cut sheets will be prepared using flow line of pipe as shown on the Construction Drawings. Staking will be 1” x 2” hubs, or nails and tins, set along pipeline alignment at an offset determined by Contractor. Contractor will be furnished three copies of cut sheets prior to trenching.
Contractor shall notify District a minimum of two weeks prior to start of construction to allow ample time for preparation of cut sheets and construction staking. Contractor shall use the construction stakes and cut sheets for pipeline construction. District will use them for inspection of the work. Contractor shall protect all survey monuments and stakes and shall pay all costs to reestablish any monuments or stakes destroyed or disturbed during construction.

3.2 Excavation

3.2.1 Trenches

Excavation for pipelines and appurtenances shall be open trench to the depth and in the direction necessary for proper construction shown on the Construction Drawings or as otherwise directed by Owner. Excavation for trenches shall include the removal of all material of any nature at Contractor's expense for installation of the pipe or appurtenance and shall include either trench sloping or trench shoring, timbering as may be required, and all necessary dewatering. Contractor to obtain any necessary discharge permits required by regulating agencies.

3.2.2 Limit of Excavation

Trenches shall be excavated not more than 500 feet in advance of pipe laying unless otherwise permitted in writing by Owner. Trenches shall be adequately shored and braced so that the earth will not slide or settle and so that all existing improvements of any kind will be fully protected from damage. Any damage resulting from lack of adequate shoring and bracing shall be repaired or reconstructed at Contractor's expense and he shall bear all other expense resulting from such damage. Trenches shall not be left open overnight without permission of Owner.

3.2.3 Width of Trench

Unless otherwise shown, all pipeline trenches shall, wherever possible, have vertical sides and a minimum width as possible. Whenever the maximum allowable width of trench is exceeded for any reason, Owner may require, at its discretion, that Contractor, at his expense, cradle pipe in Class B concrete or other suitable material approved by Owner prior to its use.

3.2.4 Excess Excavation

Should the excavation for the pipeline be carried below grade without permission, it shall be refilled to proper grade at Contractor's expense for all labor and material with clean sand or sand and gravel tamped in place to 90% minimum compaction.

3.2.5 Excavation in Good Soil

The trench shall have a flat or semi-circular bottom conforming to the grade to which the pipe is to be laid. The bottom of trench shall be graded and prepared to provide firm and uniform bearing throughout the entire length of each joint of pipe. Pipe shall not be laid on earth mounds. It shall be laid so that pipe barrel will bear evenly on the bottom of the trench. Bell holes shall be excavated in the sides and bottom of the trench at pipe
joints. They shall be of such size that the process of making joints and inspection can be performed satisfactorily.

3.2.6 Excavation in Poor Soil

All soft, spongy, or unstable material shall be removed from the bottom of the trench to a depth determined in the field by Owner and shall be refilled to proper grade, at Contractor's expense, with clean sand or sand and gravel or other suitable material, as approved by Owner. Bedding material shall be tamped to 90% minimum compaction, graded, and prepared to provide a firm and uniform trench bottom.

3.2.7 Excavation in Rock

Where rock is encountered, it shall be removed below grade and the trench backfilled with clean sand, sand and gravel or other suitable material, at Contractor's expense, as approved by Owner, to provide a compacted earth cushion with a thickness under the pipe of not less than four (4) inches. Bedding material shall be tamped to 90% minimum compaction, graded, and prepared to provide a firm and uniform trench bottom.

3.2.8 Excavated Materials

All material excavated from the trench shall be placed as to offer a minimum of obstruction to traffic. Gutters shall be kept clear or other provisions shall be made for handling street or road drainage. Excess material and material that is not approved by Owner for use as backfill shall be disposed of elsewhere by Contractor entirely at his own expense unless otherwise permitted by Owner.

If pipe or other material belonging to Owner is uncovered or removed from the excavation, all pipe or other material which is salvable in the opinion of Owner shall be disposed of, as directed by Owner. Material not considered to be salvable shall be disposed of with other excess excavated material at Contractor's expense.

3.2.9 Blasting

Blasting for excavation will be permitted only after securing approval of Owner and only when proper precautions are taken for the protection of persons and property. Contractor to provide District with copy of blasting permit. The hours of blasting will be fixed by the Owner. Any damage caused by blasting shall be repaired by Contractor at his expense. Contractor's methods of and procedures for blasting shall conform to State and local laws and municipal ordinances. Precautions shall be taken to post signs warning operators of radio equipment to stop transmitting in any area in which blasting operations are in progress. The costs for blasting shall be at Contractor's expense and shall be included in the bid price.
3.3 Backfill

3.3.1 Basic Requirements

Backfill shall be as specified by Owner or in accordance with permits issued by agency having jurisdiction (State, County, City) over rights-of-way in which construction is taking place. Backfill shall not commence without prior approval of Owner or of other aforementioned agency and in no event shall backfill be placed over pipelines until joints are properly made and inspected.

3.3.2 Backfill Adjacent to Pipe

Initial backfilling shall be performed as soon as possible after pipe has been laid. Selected backfill material shall be used and it shall consist of clean, loose earth, sand, or gravel free from stones, lumps, vegetable matter, or other unsatisfactory material. It shall have proper moisture content so that specified compaction can be achieved. Said material shall be \( \frac{3}{4} \)-inch maximum in size for polyvinyl chloride pipe (PVC) and asbestos cement pipe (ACP) and one (1) inch maximum in size for CML&C pipe within six (6) inches of pipe, and it shall be placed in trench simultaneously on each side of pipe.

3.3.2.1 Asbestos Cement Pipe and Polyvinyl Chloride Pipe

Selected backfill material of proper moisture content shall be placed in layers approximately four (4) to six (6) inches in depth, each layer being tamped, until the pipe has been covered by at least twelve (12) inches of well compacted material. Said selected backfill shall have a sand-equivalent value of S.E. 30 and be compacted to a relative density of 90%. Mechanical compacting or water consolidation shall not be used, unless permitted by Owner, until the pipe has been covered by a minimum of twelve (12) inches of well compacted hand-tamped backfill.

3.3.2.2 Welded Steel Cylinder Pipe and Concrete Cylinder Pipe

For pipe diameters sixteen (16) inches or less, selected backfill material of proper moisture content shall be placed simultaneously on each side of the pipe and to a minimum of twelve (12) inches over the top of the pipe and then it shall be thoroughly compacted by a combination of mechanical compaction and water settlement until the specified compaction has been achieved. For pipe diameters greater than sixteen (16) inches, the selected backfill material of proper moisture content shall be placed in two lifts until a minimum 12-inch cover over the top of the pipe has been achieved. The first lift shall not exceed the springline of the pipe. The second lift shall cover the top of the pipe by a minimum of twelve (12) inches. Each lift shall be thoroughly compacted by a combination of mechanical compaction and water settlement until the specified compaction has been achieved. Care shall be exercised in backfilling to avoid any damage to the pipe coating. Whenever pipe is supplied with internal bracing, it shall be left in place until the pipe is installed and backfill operations are completed.

3.3.3 Backfill Above the Pipe

From the top of the selected backfill to ground surface, the material for backfill shall be free of
brush, roots, or organic substances and it shall be free of material exceeding six (6) inches in
greatest dimension and in quantity not exceeding 30% of the volume with said coarse materials
being distributed throughout finer materials (well graded). All backfill material shall be compacted
to a minimum relative compaction of 90% as determined by field compaction tests, unless specified
otherwise. Relative compaction shall be determined in accordance with ASTM D-1557 (latest)
modified to five-layer curve in lieu of three-layer curve.

Compaction shall be obtained by means of water settlement or tamping, depending on the nature of
the material. Sandy, granular soils may be compacted by means of water settlement. Trench to be
backfilled by water settlement shall be diked at suitable intervals not to exceed 300 feet. Impounded
water shall be of sufficient depth so that earth pushed or shoveled into trench will at all times be
falling into water and will be completely saturated. Soils not having a sandy or granular nature shall
be backfilled and compacted by either of the following methods:

a. All material shall be placed in layers not exceeding 8 inches in thickness (loose
measurement) and each layer compacted to the relative compaction specified by
means of hand or pneumatic tampers.

b. All material shall be placed in layers not exceeding 18 inches in thickness (loose
measurement) and each layer compacted to the relative compaction specified by the
use of a "Hydra-Hammer" tamper or similar equipment.

On steep slopes and other locations where compaction by flooding is not practicable, backfill
material shall be compacted by means of either of the above tamping methods.

3.3.4 Imported Backfill Material

Imported material shall be selected, clean, loose earth, sand, or gravel being one-inch maximum in
size. Said material shall be granular and it shall be free of clay, silt, and fine sand. It shall be
suitable for compaction with minimum effort. All material imported because of rock or poor soil
conditions shall be provided at Contractor's expense.

3.3.5 Slurry Backfill - 1 Sack

Where indicated on the plans, slurry backfill shall be placed in pipe trench.

3.3.6 Finish Backfill

Where pavement is not required, trench backfill shall be brought to grade of existing surface and
dressed to provide a firm, stable, and even surface without ruts or irregularities and which is in
conformance with grades of existing surface. Where pavement is required, trench backfill shall be
placed in accordance with paving requirements.
3.3.7  Trench Compaction

Unless noted otherwise, trench backfill and pipe zone backfill shall be compacted pursuant to Standard Drawing RW-25 after all sheeting, shoring, or shields have been removed.

Contractor shall notify District when any segment of backfill is complete and ready for compaction testing. After such notification, District will have all necessary tests made by a soils engineer of its choosing. District will pay for all passing tests. Contractor shall pay for all failing tests.

Compaction tests will be taken in the pipe zone, in the backfill above the pipe zone, and in the subgrade as determined by the District. In addition, compaction tests may be taken along all pipeline appurtenances. Contractor shall assist, at no additional cost to District, soils engineer in taking all compaction tests. Contractor shall furnish all equipment (including shoring), labor, and materials needed for such assistance. Compaction testing shall be completed and accepted by District prior to hydrostatic/leakage testing of the pipeline.

3.4  Pipelines and Appurtenances

3.4.1  Pipeline Construction

3.4.1.1  Pipelines and Appurtenances

Pipelines and appurtenances shall be constructed in accordance with Construction Drawings, Standard Drawings, Specifications, or as specified by Owner.

3.4.1.2  Pipeline Valves and Appurtenances

Pipeline valves at pipeline intersections shall be connected directly to pipeline intersection fitting (cross, weld saddle, or tee) and all mainline or side outlet valves shall be located three feet minimum from any curb facing unless specified otherwise. Valves shall not be placed under curb or gutter or in parkway unless approved by Owner. All valves will be installed with Victaulic couplings, steel pipe only. All appurtenances, including but not limited to air valve installations, blowoff installations, and related facilities such as fire hydrants, fire services, and water services shall not be installed within five feet of curb returns, curb depressions, and driveway approaches, or in an inaccessible location or locations where interferences may restrict operation of facility unless specified otherwise.

3.4.1.3  Pipeline Length

All pipeline lengths noted by the Construction Drawings or specified otherwise or referenced shall mean net horizontal constructed length and said length shall extend through all fittings and appurtenances including bends, outlets, tees, flanges, and valves unless otherwise specified. Contractor shall provide all pipe necessary to accommodate any vertical alignment of the pipeline and said pipe shall be represented by the net horizontal constructed length. Payment for pipeline shall be based on net horizontal length.
3.4.1.4 Pipeline Alignment

All pipelines shall be constructed with no basic variation in horizontal alignment as shown by the Construction Drawings. Pipelines shall be constructed parallel with centerlines of streets or rights-of-way and appurtenances shall be constructed perpendicular thereto unless the Construction Drawings specify otherwise. Contractor will be permitted, subject to approval of Owner, to construct pipelines with variations in vertical alignment as shown by the Drawings, in all non-critical areas, in which case Contractor will be permitted to make full use of pulled joints, short joints, and elbows to vary the pipelines from the profiles shown. Critical areas shall include areas of pipeline connections, underground interferences, and minimal pipeline cover. Owner will not approve variation in vertical alignment until the proposed revised alignment has been determined to be proper and modifications are found to be in order.

3.4.1.5 Pipeline Cover

Pipeline cover as shown by the Construction Drawings is hereby defined as design cover over the top of pipeline. Should field conditions determined at time of construction staking show that pipe grade changes are required to provide design cover, Owner reserves the right to direct said changes in pipeline grade and Contractor shall construct pipeline accordingly. Pipeline cover shall not be less than 48 inches from top of pipe to ground surface over pipeline. Where ground surface elevation over pipeline has been established and where actual ground surface is greater, pipeline cover shall be referenced to the established ground surface elevation and not the actual ground surface.

3.4.1.6 Thrust Protection

All tees, angles, etc. shall be protected from vertical and horizontal movement. The plans and specifications shall indicate the limits and type of thrust protection. Thrust protection shall consist of welded joints (steel pipe), or mechanical restraint fittings (PVC and ductile iron pipe), as approved by the Owner.

3.5 Pipe Materials

3.5.1 General

All pipe furnished shall be manufactured by an organization which has had not less than ten (10) years successful experience in the manufacture of the type of pipe specified. Owner shall at all times have the right to inspect all work and materials in the course of manufacture. Manufacturer shall furnish Owner reasonable facility for obtaining such information as he may desire regarding the progress and manner of the work and the character and quality of materials used.

3.5.2 Asbestos Cement Pipe

3.5.2.1 Scope

Asbestos cement pipe furnished and installed under these Specifications shall conform to applicable AWWA Standards (latest), as modified herein, by the Construction Drawings, or by Owner.
3.5.2.2 Pipe and Couplings

All pipe and couplings furnished shall conform to AWWA C-400 or AWWA C-402 (latest) and shall also conform to the following additional requirements:

   a. Pipe, including standard, random, and special short lengths, and couplings, shall be DR 14, unless specified otherwise. Ninety-five percent of all pipe of any specific class and size, excluding special short lengths, shall be furnished in standard lengths. The remaining 5% may be furnished in random lengths.

   b. Standard lengths of pipe shall have a nominal length of 13 feet 0 inches, plus or minus 1 inch, and shall have ends machined for couplings. Random lengths of pipe shall not be less than 9 feet 9 inches, plus or minus 1 inch, and shall have ends machined for couplings. Half lengths of pipe shall have a nominal length of 6 feet 6 inches, plus or minus 1 inch, and shall have ends machined for couplings. Quarter lengths of pipe shall have a nominal length of 3 feet 3 inches, plus or minus 1 inch, and shall be machined entire length or fully machined.

   c. Each standard and random length of pipe shall be furnished with an asbestos cement coupling and rubber gaskets. Couplings for 6-inch, and 8-inch pipe shall be 6 to 7½ inches in length. Couplings for 12-inch pipe shall be 6 to 8½ inches in length. Standard, random, and half lengths of pipe shall have couplings installed at the factory. Quarter lengths of pipe shall be furnished without couplings.

   d. All rubber gaskets used to seal the joints of asbestos cement pipe and asbestos cement couplings shall be identical to the rubber rings used to seal the joints of the asbestos cement pipe at cast iron fittings having Ring-Tite, Fluid Tite, or equal, bells. All gaskets and stop rings which are not an integral part of pipe and couplings shall be furnished separately in cardboard cartons.

   e. Pipe, including standard, random, and special short lengths and couplings, shall have sufficient strength to withstand an internal hydrostatic pressure of four times the rated operating pressure for its class and to withstand an external crush load as indicated for its class in Table 2, AWWA C-400 or AWWA C-402 (latest). Sections 2.2.1 and 2.2.2, AWWA C-400 or AWWA C-402 (latest) shall be modified as herein specified.

3.5.2.3 Fittings

All fittings shall be ductile iron and shall conform to AWWA C-110 or C153 which shall have Fluid Tite, Ring-Tite, Grip-Tite, or equal bells unless mechanical joint or flanged fittings are specified otherwise. Fittings shall have a pressure rating at least equivalent to that of the pipe and shall be cement mortar lined, per AWWA C104, standard thickness. Fittings shall be as listed in the general catalog of the ductile iron fittings manufacturer.
3.5.2.4 Testing

All pipe, including standard, random and special short lengths, and couplings furnished, shall be tested in the State of California in accordance with Section 5.2, AWWA C-400 or AWWA C-402 (latest) except that Sections 5.2.2.2 on hydrostatic testing to four times the class operating pressure and 5.2.4 on crushing tests shall be modified to include the testing of one random length of pipe, one special short length of pipe, and one coupling for each 300 identical lengths or couplings or portion thereof furnished, and the portions of the lengths or couplings tested shall meet the requirements set forth in said Sections 5.2.2.2 and 5.2.4. Owner will witness hydrostatic and flexural testing unless Contractor has been specifically notified to the contrary, in which case certified test reports will be acceptable.

3.5.3 Polyvinyl Chloride Pipe

3.5.3.1 Scope

Polyvinyl chloride pipe (PVC) furnished under these Specifications shall conform to AWWA Standard Specification C-900 and C-905 (latest) as modified herein, by the Construction Drawings, or by Owner.

3.5.3.2 Pipe

All 4- through 12-inch PVC pipe shall be rated at a minimum pressure rating of 235 psi with a minimum Dimension Ratio (DR) of 18 conforming to all dimensional requirements of AWWA C-900, Table 1, or as specified on the approved drawings.

All 16- through 48-inch PVC pipe shall be rated at a minimum pressure rating of 235 psi with a minimum Dimension Ratio (DR) of 18 conforming to all dimensional requirements of AWWA C-905, Table 2 (Cast Iron Outside Diameter) or as specified on the approved drawings.

Standard lengths of pipe shall have a nominal length of 20 feet, 0 inches, plus or minus 1 inch. Random lengths of pipe shall not be less than 10 feet, 0 inches, plus or minus 1 inch. Special short lengths, minimum 5 feet, 0 inches, shall only be furnished where needed to accommodate specified fitting.

PVC pipe shall be marked for identification according to AWWA C900 and C905. In addition, PVC pipe shall be color-dyed for the following types of applications:

1. Potable Water: white or blue
2. Sewer Force Main: green
3. Reclaimed Water: purple

3.5.3.3 Fittings

All fittings shall be ductile iron and shall conform to AWWA C110 or C153. Fittings shall be designed and manufactured to fit cast iron pipe equivalent outside diameter and fittings shall be
cement mortar-lined per AWWA C104, standard thickness. Fittings to be included shall be as listed in the general catalog of the ductile iron fitting manufacturer.

All joint gaskets shall be Tyler Grip-Tite or Trinity (Tyton).

3.5.3.4 Testing

All pipe, including standard, random, and special short lengths, shall be tested in the United States in accordance with Section 3.3, AWWA C-900 (latest).

3.5.4 Welded Steel Cylinder Pipe (Cement Mortar Lined and Either Outside Wrapped or Cement Mortar Coated)

3.5.4.1 Scope

All welded steel cylinder pipe furnished and installed under these Specifications shall conform to AWWA Standards C-200 and C-205 (latest) as modified herein.

3.5.4.2 Pipe and Fittings

All pipe and fittings furnished shall conform to AWWA Standards C-200 and C-205 (latest), as modified herein, by the Construction Drawings, by Owner, applicable provisions of AWWA, C-206, C-207, and C-208, and applicable portions of AWWA M11.

The outside diameter of all Steel Cylinder Pipe shall conform to the following dimensions:

<table>
<thead>
<tr>
<th>Pipe Diameter (Inches)</th>
<th>Outside Diameter of Steel Cylinder (Inches)</th>
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<td>6 5/8</td>
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<td>40 7/8</td>
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<td>43 7/8</td>
</tr>
</tbody>
</table>
All fittings shall be shop fabricated from individual sections of pipe, welded together, and the lining and coating of joints shall be hand-applied to provide a finished cement mortar-lined and finished outside coated joint comparable to mechanically-applied lining and coating detailed herein.

a. Minimum steel cylinder thickness shall be as designated on the construction drawings. Where no minimum thickness is designated on construction drawings, it shall be computed using the following formula:

$$
\frac{PDy}{2(Y/S)}
$$

$Ty =$ Minimum cylinder thickness, inches  
$Dy =$ Outside cylinder diameter, inches  
$P =$ Minimum Design pressure, psi  
$Y =$ Specified yield point of steel, psi  
$S =$ Factor of safety = 2.0

In no case shall the design stress $(Y/S)$ exceed 16,500 psi. Cylinder thickness shall be 10-gage minimum for all pipe diameters. In no case shall the cylinder thickness be less than $D/288$.

b. Specials are defined as bends, reducers, wyes, tees, crosses, outlets, manifolds, all above-ground piping, and all piping in structures. The cylinder thickness for specials shall be computed using the equation, as specified above, except the factor of safety $(S)$ shall be equal to 2.5. In no case shall cylinders for specials have less than the following minimum thickness:

<table>
<thead>
<tr>
<th>DESIGN PRESSURE</th>
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<tbody>
<tr>
<td>Nominal Pipe Diameter (in inches)</td>
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<tr>
<td>under 14</td>
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<tr>
<td>14 to 24</td>
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<tr>
<td>25 to 48</td>
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<tr>
<td>over 48</td>
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</tbody>
</table>

c. Pipe or specials shall be reinforced with reinforcing collars, reinforcing saddles, or plate reinforcement designed and constructed in accordance with AWWA M11. The pipeline test pressure shall be used in the design of said reinforcement.
3.5.4.3 Pipe Joints

Unless specified otherwise, joints shall conform to the following types. Joints shall be as specified on the Construction Drawings or by Owner.

a. Rubber Gasket Joints

All rubber gasket joints shall conform to AWWA Standard C-200.

b. Flanged Joints

Gaskets shall be non-asbestos per AWWA Standard C-207. All steel welding flanges shall conform to the following:

<table>
<thead>
<tr>
<th>Nominal Pipe Diameter</th>
<th>Standard</th>
</tr>
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<tbody>
<tr>
<td>4-inch and larger</td>
<td>AWWA C-207, Class E, Maximum Design Pressure up to and including 275 psi</td>
</tr>
<tr>
<td>4-inch and larger</td>
<td>AWWA C-207, Class F, Maximum Design Pressure up to and including 300 psi</td>
</tr>
</tbody>
</table>

c. Swedged Lap Welded Joints

The bell end shall be formed integrally with the steel cylinder and shall be swedged out by machine to be circular in shape and so designed and fabricated to withstand design pressure of the class of pipe specified and to permit the spigot end (plain end) to enter the belled end approximately one (1) inch with a clearance of approximately 1/32-inch.

d. Banded Lap Welded Joints

Where lap welded joints are required and swedged lap welded joints cannot be fabricated, banded bell ends shall be formed by welding bands of steel to outside circumference of plain ends of pipe, resulting in circular shape, and so designed and fabricated to withstand design pressures stated herein and to permit spigot end (plain end) to enter belled end approximately one (1) inch with a clearance of approximately 1/32 inch.

e. Coupled Joints

Pipe ends for sleeve-type couplings (Dresser or equal) shall have the weld bead ground flush. Mortar coating or wrapping shall terminate twelve (12) inches back from pipe end. Pipe ends for bolted, segmental, clamp-type couplings (Victaulic or equal) shall be equipped with shouldered grooved adapters or grooved pipe nipple transitions welded to pipe ends and appropriate for the coupling style designated on the construction drawings. Victaulic nipples shall be welded to the pipe with wedding bands.
f. Cut-to-Fit Joints

Where cut-to-fit joints with butt-strap straps are required, they shall be designed and fabricated to withstand design pressures of the class of pipe specified. For pipe diameters less than 24-inch, butt-strap straps shall be provided with 5-inch diameter hand holes to allow repair of pipe lining. Pipe coatings at cut-to-fit joints shall be held back as required to permit construction of joint and thereafter added in the field.

g. Shop Testing of Joints and Joint Ends

Every pipe section, standard or special, shall be hydrostatically tested after joint ends have been completely shop formed and attached in place by welding, as applicable, or dye check tested provided pipe cylinders have been previously hydrostatically tested.

3.5.4.4 Interior Coating (Cement Mortar Lining)

a. General

Cement mortar lining for welded steel cylinder pipe shall conform to AWWA C-205 (latest) unless specified otherwise herein.

b. Preparation of Surfaces

Prior to lining, the pipe shall be cleaned of all loose mill scale, moisture, rust, sand, dust, oil, grease, and other objectionable matter both inside and outside.

c. Materials

The mortar shall consist of one part Portland cement to 2½ parts by weight of clean, sharp sand. Cement used for cement mortar shall conform to ASTM Specification C150 (latest), Type II. Sand shall consist of clean, inert, sharp, durable material of a size so that 100% will pass a sieve having clear openings of the size nearest to one-half the specified minimum thickness of the lining. Mortar shall be thoroughly mixed and made workable with a minimum quantity of clear, potable water. All cement mortar shall develop an ultimate compressive strength of 3,000-4,000 psi at 28 days as determined by Paragraphs 19 and 20 of ASTM Specification C39 (latest).

d. Application and Treatment

The mortar shall be applied to the interior surface of the pipe by means of equipment specifically designed for that purpose using a retracting feed line in such a manner that uniform distribution throughout the length of pipe is achieved. The pipe shall be slowly rotated with its axis in a horizontal position while the mortar is being introduced to assist in uniformity of distribution. Both ends shall be provided with suitable end dams during the spinning operation. These dams shall assist in controlling the thickness of the mortar coating being applied and shall provide a square-finished end for the lining at the joint ends. After application of the mortar,
the rate of rotation of the pipe shall be uniformly increased to a speed that will compact the mortar. Said speed shall be maintained until all excess water has been forced to the surface. During the spinning operation, surplus water shall be expelled from the pipe by means of a blower or other suitable means. The peripheral speed and the length of spinning time shall be sufficient to obtain a dense, well-compacted lining with a smooth surface free from all defects. Minimum lining thickness shall be as follows:

<table>
<thead>
<tr>
<th>Nominal Pipe Diameter (in.)</th>
<th>Lining Thickness (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 14-inch</td>
<td>(\frac{5}{16})</td>
</tr>
<tr>
<td>14 to 18-inch</td>
<td>(\frac{3}{8})</td>
</tr>
<tr>
<td>20 to 42-inch</td>
<td>(\frac{1}{2})</td>
</tr>
<tr>
<td>Over 42-inch</td>
<td>(\frac{3}{4})</td>
</tr>
</tbody>
</table>
Immediately after completion of lining operation, pipe shall be water-cured without being disturbed for at least one (1) day in a manner that will prevent loss of moisture.

3.5.4.5 Exterior Coating (Cement Mortar Coating)

a. Materials

Materials for the exterior cement mortar coating shall be the same as those specified in Section 3.5.4.4c of these Specifications except the cement shall conform to ASTM Specification C-150 (latest), Type II and mortar shall consist of one (1) part Portland cement to three (3) parts (by weight) of clean, sharp sand.

b. Application and Treatment

After the interior of the pipe has been lined, a cement mortar coating shall be applied to the outside of each section of pipe by means of nozzles or belts through which the mortar is forcibly expelled against the outside surface of the pipe in such a manner as to form an even, dense, and tightly adhering coating. The coating shall have a minimum thickness of \( \frac{3}{4} \) inch unless designated otherwise on the construction drawings. The standard reinforcing for the cement mortar coating for welded steel cylinder pipe shall be spirally wound steel reinforcing wire embedded in the center of the coating. The wire shall be a bright basic wire of low carbon, open hearth steel, not annealed after the last draw, with an approximate ultimate tensile strength of 80,000 psi and shall be No. 14 gage at a pitch of one-inch.

Immediately after coating has been completed, the outside of each end of each section shall be cleansed to bare metal and shall have the mortar trawled and shaped to suit the type of joint being used. All bare metal exposed at the ends of each section of pipe shall be cleansed and protected against corrosion as specified herein. The completed pipe shall then be water cured for at least seven (7) days without being disturbed.

3.5.5 Concrete Cylinder Pipe

3.5.5.1 Scope

Concrete cylinder pipe shall consist of a welded steel cylinder with steel joint rings welded to the cylinder, a centrifugally cast cement mortar lining, steel reinforcing (bar or wire) wrapped helically under measured tension around the cylinder, and a dense cement mortar coating over the wrapped reinforcement. All concrete cylinder pipe furnished and installed under these Specifications shall conform to AWWA Standard C-303 (latest) as modified herein.
3.5.5.2 Pipe and Fittings

a. The minimum thickness of the steel cylinder shall be in accordance with AWWA C-303 (latest), but in no case shall the thickness be less than 10-gage.

b. Fittings are required for all tees, crosses, and angles with a deflection of five degrees or greater.

c. The minimum diameter of rod or wire for wrapped reinforcement shall be 7/32-inch.

d. The average circumferential stress in the steel cylinder and wrapped reinforcement shall not exceed 16,500 psi or 50 percent of the specified yield strength of the steel used in the cylinder using the following formula:

\[
\frac{6PDi}{As} = \frac{Fs}{Fs}
\]

with:

- \(As = Ay + Ar\), inches/feet
- \(Ay\) = Cross-section area of steel cylinder, inches/feet
- \(Ar\) = Cross-section area of bar reinf., inches/feet
- \(P\) = Design working pressure, psi
- \(Di\) = Inside cylinder diameter, inches
- \(Fs\) = Circumferential stress in the steel cylinder and wrapped reinforcement, psi

e. The cross-sectional area of the wrapped reinforcement shall not exceed 50% of the total required area of steel and shall not be less than 0.23-inch per linear foot or 1% of the steel cylinder diameter, whichever is greater. The maximum center to center spacing of wrapped reinforcement shall not exceed 2.0 inches. The minimum center to center spacing of wrapped reinforcement shall be two bar diameters.

f. Fittings shall be as specified in AWWA C-303 and C-208.

g. Pipe and fittings shall be reinforced with reinforcing collars, reinforcing saddles, or plate reinforcement designed and constructed in accordance with AWWA M11. The pipeline test pressure shall be used in the design of said reinforcement.

3.5.5.3 Pipe Joints

Unless specified otherwise, joints shall have a bell and a spigot of steel joint rings welded to the steel cylinder. The spigot ring shall have a groove in its exterior for the purpose of retaining a rubber gasket which shall seal the joint under all conditions of service including expansion, contraction and earth settlement. Gaskets shall be of sufficient volume to substantially fill the space...
provided when the joint is assembled. Joints shall be self-centering and designed so that when the pipe is laid, the gasket will not support the weight of the pipe and will function solely to seal the joint.

The total cross-sectional steel area of the bell plus the circumferential reinforcement around the bell shall be equal to that required in the body of the pipe. The minimum thickness of bell rings shall be as specified in AWWA C-303. Joints shall be as specified on the construction drawings or by Owner.

All rubber gasket joints shall conform to AWWA Standard C-303 (latest). Banded lap welded joints, mechanical joints, and shop testing of joints and joint ends shall conform to Section 3.5.4.3 of these Specifications.

3.5.5.4 Interior Coating (Cement Mortar Lining)

Cement mortar lining for concrete cylinder pipe shall conform to Section 3.5.4.4 of these Specifications except AWWA Standard C-303 (latest) shall be used in lieu of AWWA Standard C-200 and the minimum lining thickness shall be ½-inch for pipeline diameters of 16-inch and less, and ¾-inch for pipeline diameters greater than 16-inch.

3.5.5.5 Exterior Coatings (Cement Mortar Coating)

Cement mortar coating shall conform to Section 3.5.4.5 of these Specifications except an application of a cement paste consisting of one sack of cement to not more than 10 gallons of water shall be applied uniformly over the steel surface (cylinder and rod reinforcement) immediately preceding the application of mortar coating.

3.6 Installation

3.6.1 Construction Tolerances

The pipeline shall be constructed so that actual (vertical) flow line elevations are within 0.1’ of design flow line elevations. Pipeline, when installed, shall have continuous upgrade or downgrade, corresponding with design slope, without any high spots. Pipeline shall be constructed so that actual (horizontal) pipeline centerline is within 0.1’ of design pipeline centerline. Line and grade tolerances for steel casings pipe shall be within 3”. Said tolerances apply at all points along the alignment.

Pipeline construction shall conform with Construction Drawings in accordance with the above specified tolerances. Contractor shall assist District as required to confirm compliance with construction tolerances. Contractor shall make or assist in making all necessary measurements as determined by District.
3.6.2 Loading, Transporting, and Unloading

After the pipe has been manufactured and tested, it shall be loaded on rubber-tired vehicles, adequately supported and chocked to prevent any damage during transportation, and delivered job site. During the unloading and stringing operations, the pipe shall be moved in such a manner as to prevent injury to the pipe. Unloading shall be accomplished in a workmanlike manner as directed by the District. The Contractor shall use double straps, placed equal distance from each other and the ends of the pipe, to unload the pipe. Under no circumstances are pipe sections to be dropped or bumped in handling.

3.6.3 Defective or Damaged Material

The pipe shall be carefully inspected for defects. Any pipe found to be defective in workmanship or materials or so damaged as to make repair and use impossible shall be rejected and removed from the job site. In the event a portion of a length of pipe is damaged, it shall be replaced with an undamaged section. Contractor shall be responsible for any and all damage to material and he shall stand the expense of repairing or replacing same. Proper precautions shall be taken to assure that the rubber rings are protected from oxidation or undue deterioration.

3.6.4 Asbestos Cement Pipe and Polyvinyl Chloride Pipe

All pipe shall be laid true to line and grade and at the locations shown by the Construction Drawings. Asbestos cement pipe shall be installed in accordance with applicable provisions of AWWA C-603 (latest), and manufacturer's directions, all as modified herein. Polyvinyl chloride pipe shall be installed in accordance with applicable provisions of AWWA C-900 or AWWA C-905 (latest), AWWA Manual No. M23, and manufacturer's directions, all as modified herein. Bell ends shall be placed uphill unless otherwise permitted. Bell ends shall always be placed uphill on steep slopes (10% or more).

The trench bottom shall be constructed to provide a firm, stable uniform support for the full length of the pipe. The minimum clear width of unsheeted or unshored trench measured at the springline of the pipe shall be 18 inches or 1 foot greater than the outside diameter of the pipe, whichever is greater. The maximum clear width of trench at top of the pipe shall not exceed the outside diameter of the pipe plus 2 feet.

After pipe has been set in trench, exterior of spigot end and interior of bell end shall be thoroughly cleaned. A lubricant as recommended by the pipe manufacturer and as approved by Owner shall be applied to the rubber gasket. The lubricant shall be water soluble, nontoxic, shall impart no objectionable taste or odor to the water, shall have no deteriorating effects on the rubber gaskets, and shall not support growth of bacteria. Excess lubricant shall be removed. The ends shall be aligned and the spigot end of the pipe pushed into the bell.

Under no conditions shall asbestos cement pipe be sawcut.

A pipe locator wire shall be installed along the top of the pipe. The locator wire shall be No. 14-gage UF coated solid copper and shall be held in place by No. 14 AWS coated copper ties or duct
tape with a minimum of two ties per joint. Locator wire shall be color coded: white - potable water; purple - reclaimed water; green - sewer force main.

As the work progresses, a pipe cleaning tool as approved by Owner shall be drawn through the pipe to remove dirt, rocks, or other similar foreign material.

At the end of each day's work, all openings in the pipeline shall be plugged with watertight expandable plugs or approved equal.

Pipe manufacturer and fitting manufacturer shall have free access to the work during installation.

3.6.5 Welded Steel Cylinder Pipe and Concrete Cylinder Pipe

All pipe and fittings shall be laid true to line and grade and at the locations shown by the Construction Drawings or as specified. Welded steel cylinder pipe and fittings shall be installed in accordance with applicable sections of AWWA M11, Steel Pipe Manual. Concrete cylinder pipe and fittings shall be installed in accordance with applicable sections of manufacturer's installation handbook.

Special care shall be taken to avoid damaging lining or coating during lowering of pipe into trench and making of field joints. The Contractor shall use double straps, placed equal distance from each other and the ends of the pipe, during the lowering of the pipe into the trench. Field joints shall be bell and spigot rubber gasket joints unless specified otherwise. Flanged joints, welded joints, and mechanical joints may be specified for particular applications; however, caulked joints, drive slip joints, and similar joints will not be specified and they will not be permitted.

a. Bell and Spigot Rubber Gasket Joints

Exterior of spigot and interior of bell shall be thoroughly cleaned and lubricants as recommended by the pipe manufacturer and as approved by Owner shall be applied to the rubber gasket. The gasket shall then be snapped into place and excess lubricant removed. The lubricant shall be water soluble, nontoxic, shall impart no objectionable taste or odor to the water, shall have no deteriorating effects on the rubber gaskets, and shall not support the growth of bacteria.

The bells shall be hand-mortared and the joints made by forcing spigots into bells. Joints shall be gauged to ensure that gaskets have been properly seated. Bell ends shall always be placed uphill unless otherwise permitted by Owner (permission will be granted only under extenuating circumstances warranting change).

b. Joint Deflection

Curved alignment by use of pulled joints will be permitted. Maximum deflections shall be as specified by manufacturer.
c. Joint Interiors

For pipe less than 24 inches in diameter, the interior joining ends of the pipe shall be mortared with cement mortar in sufficient quantities to completely fill the space between the respective mortar linings. Excess mortar shall be removed by drawing an approved pipe cleaning tool through the pipe after joints have been made (pipe sections have been joined).

For pipe 24 inches in diameter and larger, the interior joint lining shall be hand mortared from inside pipe and pipe interior shall be cleaned of all excess mortar and debris by hand or by means acceptable to Owner.

d. Continuity Bonds

All joints except field welded joints and insulated joints shall be continuity bonded. The bond shall be welded to both spring lines of the pipe joint and all major parts of any couplings. The bond shall be approved by the Owner before the joint exterior is coated. Upon completion of the project, the Contractor, at his own expense, shall hire a qualified testing firm to test the continuity of all bonds. All test data shall be submitted to the Owner for review and approval. Contractor, at his own expense, shall repair all bonds that fail the continuity test and shall retest those sections for continuity.

e. Joint Exteriors

The exposed steel between pipe joints shall be completely coated with cement mortar prior to backfilling. Said mortar joints shall be formed by the use of heavy-duty pipe diapers as furnished by the pipe manufacturer. Cement mortar shall be mixed and placed to completely fill the pipe diaper and completely coat all exposed steel. Pipe joints shall not be backfilled until inspected by District.

f. Cement Mortar Mix

Composition of mortar for caulking, buttering, or coating of joints shall be composed of cement, sand and water, well mixed and of such consistency as to produce a dense, homogeneous mortar that will adhere firmly to the pipe surface. Sufficient hand plastering of the joint prior to placing of the mortar is to be encouraged, to enhance the bond between the pipe and mortar.

1) Cement shall be Type V Portland Cement (sulfate resistant)
2) Water for mixing mortar shall be clean and free from mud, oil, organic material, or other deleterious substances.
3) Aggregate sand shall be silica sand passing at No. 16 mesh screen; or “plaster” sand at least 80% passing at No. 16 mesh screen; or other well graded inert, granular material produced from hard rock, with strong, durable, uncoated grains, upon prior approval of the District.
Proportions of cement and sand in joint mortar shall be one part of Portland cement to one and one-half parts of sand by volume. The exact proportion shall be determined by the characteristics of the sand used, and approved by the Engineer.

Water content shall be kept to the minimum allowing workability, as approved by the District, recognizing that better flow characteristics are required for placement in diapers around the pipe than for placement by caulking or buttering.

Mixing of the mortar should be long enough (approximately 3 minutes in paddle-type mixers, or 1 minute in turbine mixers) to obtain maximum plasticity. The mortar shall be used before initial set; therefore, only enough mortar shall be mixed at a time for immediate use even to the extent of discarding mortar already mixed in the event of delay in the pipelaying operation.

g. General Requirements

Joints shall be completed to provide continuous interior lining and exterior coating. Field lining and coating must be equal to or better than shop lining and coating when completed with respect to strength, uniformity, and density and there shall be no voids between lining or coating and steel cylinder.

At the end of each day's work, all openings in the pipeline shall be plugged with watertight, expandable plugs or approved equal.

Pipe manufacturer and fitting manufacturer shall have free access to the work during installation. Contractor shall use assistance provided by either manufacturer where required for proper installation of either pipe or fittings; however, Contractor shall limit role of either manufacturer to advisory service.

3.6.6 Field Welding of Welded Steel Pipe

Whenever field welded joints or other field welding of welded steel cylinder pipe is specified on the Construction Drawings, Contractor shall attach welding machine ground to pipe only with "C" clamps or other means acceptable to Owner unless an alternative means is specified. All joints within a specified distance (distance shall be 120 feet if not specified otherwise) of any standard or special fitting shall be fully welded. Full welds shall be made with pipe having ends belled for welding or with filler rods of proper diameter, length, and curvature furnished by pipe manufacturer; bell ends shall not be deformed to accomplish welding.

3.6.7 Joint Restraints for Polyvinyl Chloride Pipe

Whenever joint restraints for Polyvinyl Chloride Pipe is specified on the Construction Drawings, the Contractor shall install the joint restraints per manufacturer’s specifications. All joints within the specified distance (distance shall be 120 feet if not specified otherwise) of any standard special fitting shall be fully restrained.
3.6.8 Field Coating of Flanges, Valves, Fittings, Couplings, and Fasteners

After installation and assembly of the pipe system, and prior to backfill on below-grade installations, field coating of steel and/or iron appurtenant pipeline elements shall be performed as follows:

3.6.8.1 Steel Pipe Systems

Below-grade: steel and/or iron appurtenant pipeline elements (including flanges, bolts, nuts, and other fasteners) that are outside of the limits of cement mortar coating shall be field primed and coated with a 3-part cold-applied wax tape system meeting the requirements of AWWA C217. Factory-coated AWWA-style valves shall be polyethylene encased pursuant to Section 3.6.8.2, herein, unless indicated otherwise.

Above-grade: steel and/or iron appurtenant pipe elements (including flanges, bolts, nuts, and other fasteners) shall be primed and coated in accordance with Division 8 of the Technical Provisions, unless indicated otherwise.

3.6.8.2 PVC Pipe Systems

Below-grade: steel and/or iron appurtenant pipeline elements (including valves, flanges, fittings, bolts, nuts, and other fasteners) shall be wrapped/sleeved with two layers of 8 mil. polyethylene encasement meeting the requirements of AWWA C105. Prior to installation of polyethylene encasement, all damage to factory-applied coatings on the steel and/or iron appurtenant pipeline elements shall be repaired with a like coating system, in accordance with the manufacturer’s requirements and as directed by the District. Also, a non-drying petrolatum grease type corrosion inhibiter shall be applied to all bolts, nuts, and other fasteners prior to installing polyethylene encasement.

3.7. Interior Pipe Joint Inspection

3.7.1 General

Contractor shall furnish all equipment, labor, and material for performing interior pipe joint inspection. All mortar-lined pipe shall be inspected. Video inspection of appurtenances will not be required.

3.7.2 Video Inspection

For pipeline sizes 24” and smaller, the Contractor shall provide closed circuit television inspection (CCTV) as a post-construction method to determine if the pipeline has been installed as required and all interior pipe joints have been properly finished. CCTV system shall have a rotating lens camera with articulating head. Each joint will be scanned 360 degrees. The television camera shall be specifically designed and constructed for water pipe inspection. The camera shall be operative in 100% humidity conditions. Lighting for the camera shall minimize relative glare. Lighting and camera quality shall be suitable to provide a clear, in focus picture of the entire periphery of the
water pipe for all conditions encountered during the work. Focal distance shall be adjustable through a range of 6” to infinity. The remote reading footage counter shall be accurate to one percent (1%) over the length of the particular section being inspected. The camera, television monitor and other components of the color video system shall be capable of producing a minimum of 350 line resolution. Documentation consisting of a color video tape and a written report detailing the condition of the mainline and joints shall be submitted to RCWD for approval prior to pressure testing.

Any defects in the pipe lining or joints, shall be repaired and another video taken of the repaired section and submitted for approval by RCWD prior to pressure testing. For domestic water systems, all video equipment must be certified for DOMESTIC WATER LINE INSPECTION ONLY, and NEVER to have been utilized in a non-potable system.

3.8 Testing

3.8.1 General

Contractor shall furnish all equipment, labor and material, exclusive of water, for testing and disinfecting the pipelines. Water used for testing will be furnished by Owner, but Contractor shall provide the necessary means to deliver water from the nearest available connection to the points of use. All tests of pressure piping shall be made in the presence of the Owner. All pipelines shall be thoroughly flushed with water prior to testing. Contractor shall test the pipelines in sections after backfilling operations are completed and prior to placement of permanent surfacing. Permanent surfacing at intersections may be done prior to testing.

3.8.2 Filling

Cement mortar-lined pipe shall not be filled with water until a minimum period of eight (8) hours has elapsed after the last joint in any section has been made and the pipeline shall not be tested before the mortar lining and coating on all pipe lengths have attained an age of 14 days. The pipeline shall be isolated by placing temporary bulkheads in the pipe at the point of connection to the existing system. The pipeline shall slowly be filled with water. All air valves shall be open during the filling. After the line, or section thereof, has been completely filled, it shall be allowed to stand under a slight pressure for a minimum of 48 hours to allow the mortar lining to absorb water and to allow the escape of air. During this period, bulkheads, valves, and connections shall be examined for leaks. If any are found, they shall be stopped or in case of leakage through valves in the main line or through bulkheads, provisions shall be made for measuring such leakage during the test.

3.8.3 Testing

The test shall consist of holding the test pressure on each section of line for a period of four hours. The test pressure at the lowest point the line, or section of line, shall be 10 percent higher than the minimum pipeline design pressure. The water necessary to maintain this pressure shall be measured through a meter or by other means satisfactory to Owner. The leakage shall be considered the amount of water entering the pipeline during the test, less the measured leakage through valves and
bulkheads. For asbestos-cement pipe, the leakage shall not exceed the quantity specified in AWWA 603. For polyvinyl chloride pipe, the leakage shall not exceed the quantity specified in AWWA Manual No. M23. For cement mortar-lined or concrete cylinder pipe, the allowable leakage shall not exceed 25 gallons per inch of diameter per mile per 24 hours.

Any noticeable leaks shall be stopped and any defective pipe or equipment shall be replaced with new pipe or equipment until the leakage is reduced to the specified quantity. After the pipe has met all test requirements specified herein, the entire pipeline shall be filled with water and so maintained until the completion of the contract unless otherwise ordered by Owner.

3.9 Disinfection of Pipelines and Neutralization of Testing Water Solution

3.9.1 General

Contractor shall furnish all equipment, labor, and materials for the proper disinfection of all pipelines and appurtenances and for the proper neutralization of the test water solution. Contractor may disinfect pipelines and appurtenances either before or after they are subjected to hydrostatic and leakage tests and Contractor shall be completely responsible for providing an adequately disinfected pipeline before it shall be accepted. If Contractor elects to disinfect before hydrostatic and leakage tests, he shall be required to again disinfect all or portions of tested pipeline if repairs or replacements are found necessary after said tests. Upon completion of the disinfection process, the Contractor shall neutralize the test water solution prior to its disposal.

3.9.2 Disinfection of Pipelines and Appurtenances

The method of disinfection shall conform to provisions of AWWA-C651 (latest). The chlorinating agent, normally liquid chlorine (gas under standard conditions), shall be applied as prescribed by Owner and at locations selected by or designated by Owner. The concentration of the dosage applied to the water within the pipe line shall be at least 50 ppm and it shall not exceed 200 ppm. Liquid or gas chlorine shall be used for disinfection solutions, unless specified otherwise or special permission is granted by Owner to use calcium hypochlorite granules, sodium hypochlorite solutions or calcium hypochlorite tablets. Said permission shall be obtained prior to disinfection.

Chlorinated water must be retained in the pipeline long enough to destroy all non-spore-forming bacteria. Said period shall be at least 24 hours. After the chlorine-treated water has been retained for the required time, the chlorine residual at the pipe extremities and at other representative locations shall be at least 25 ppm.

Following chlorination, Contractor shall flush all pipelines and appurtenances in the manner and with the procedure prescribed by Owner. Flushing shall continue until all chlorine, debris, and foreign materials have been removed from pipelines and appurtenances. Contractor is responsible and liable for disposal of chlorinated water. If so directed by Owner, Contractor shall remove portions of certain appurtenances such as air valve installations, blowoff installations, and service installations in order to accomplish complete flushing and replace same without adversely affecting disinfected pipelines and appurtenances. Should the initial treatment fail to produce satisfactory disinfection of the pipeline as evidenced by chlorine residual and bacteriological analysis, the disinfection procedure shall be repeated until acceptable results are obtained.

Chlorine residual and bacteriological analysis tests shall be arranged with the District and paid for
by the District. If the initial tests fail, the Contractor shall pay for all additional tests.

Following disinfection, pipelines and appurtenances shall remain isolated from any operational water system facilities until evidence has been submitted to Owner demonstrating that said pipelines and appurtenances have been adequately and properly disinfected. Said evidence shall consist of the aforementioned Affidavits of Compliance together with said bacteriological test results. Normally, said pipelines and appurtenances shall be isolated for at least 48 hours, longer if so determined by Owner.

3.9.3 De-Chlorination During Flushing Operation

Upon acceptance of completed chlorine residual and bacteriological analysis testing, the Contractor shall flush the entire waterline system. Chlorinated water shall not be allowed to enter any drainage area until it is completely de-chlorinated. Chlorinated flush water shall be temporarily impounded and treated with one of the chemicals listed in Appendix C, Table C-3 of AWWA Standards, Section C-651 (latest). Upon neutralization, the impounded water can be disposed of as approved by the District’s representative.

3.10 Connection to Existing Facilities

Following the completion of pipeline pressure testing, disinfection, and acceptance by Owner, the Contractor shall connect the new facilities into the existing facilities. The connections shall be made by a "hot-tap" into the existing facilities, or by a system shutdown and connecting into a "dry" facility.

3.10.1 Hot-tap Connection

At the Owner’s discretion, the Contractor will be allowed to “hot-tap” connect into the fully pressurized District facility. “Hot-tap” connections will be allowed on PVC, ACP, and CML/C Steel Cylinder pipes with a maximum branch pipe diameter to trunk pipe diameter ratio of 75%. No "hot-tap" connections will be allowed on pre-tensioned, rod wrapped steel pipe. Approved, tees, tapping saddles, pipe flanged nipples, valves, etc. shall be in place prior to the "hot-tap" connection. The minimum distance between “hot-tap” connections is five (5) feet for CML/C Steel pipe. Only one “hot-tap” connection is allowed for each joint of PVC and ACP pipe. The Contractor or his subcontractor performing the “hot-tap” connection shall have a minimum five (5) years experience in making these types of connections. The tapping machine shall be in good working condition and all bits and cutters shall be sharpened prior to the "hot-tap”. The Contractor shall supply all labor, materials, and equipment necessary to connect to the existing system including pumps, lights, barricades, and any other equipment required to complete the connection in a safe and timely manner.

3.10.2 System Shutdown Connection

The Contractor shall supply the Owner with a three-week written notice requesting a system shutdown according to the Plans and Specifications. All connections or tie-ins to the existing facilities requiring system shutdown and draining of the existing facilities shall be done at night or as approved by Owner. The Owner shall operate all valves required to shut the system down to drain the Owner’s facilities. The Contractor is responsible to drain and de-water the existing pipeline after the Owner has shut the system down prior to making the tie-in. The Contractor
shall supply all labor, materials, and equipment necessary to connect to the existing system including pumps, lights, barricades, and any other equipment required to complete the connection in a safe and timely manner. The Contractor shall be solely responsible for obtaining all de-watering permits and the cleanup associated with the de-watering operation.

The Contractor shall swab all pipe, fittings, and appurtenances with a minimum 1% hypochlorite solution. The Contractor shall assure adequate flushing has been conducted after completion of connection.

3.11 Conductor Casings and Carrier Pipes

Wherever required, conductor casings shall be installed. Said casings shall be comprised of either welded steel cylinder pipe or reinforced concrete pipe as specified. Conductor casing shall be bored or jacked or bored and jacked into place unless open trench installation is permitted; it shall not be sluiced or jetted into place. Conductor casing shall be bored or jacked into place from one direction only.

Conductor casing shall be installed to the lines, grades, and depths as specified. Contractor will be permitted a tolerance from exact grade of one (1.0) percent or from exact alignment of one-tenth (0.1) percent unless specified otherwise. Unless specified otherwise, the methods and equipment used shall be as selected by Contractor and as approved by Owner. Said approval shall not relieve Contractor of any responsibility with regard to conductor casing construction. Conductor casing shall have an inside diameter at least 12 inches larger than outside diameter of carrier pipe.

Prior to any boring or jacking or boring and jacking operations, Contractor shall submit to Owner a construction plan consisting of a schedule of operations, details of methods of construction, types of equipment to be used, details of boring or jacking pit including lengths, widths and depths, and shoring and bracing required. Said construction plan shall be approved by Owner before any construction is commenced.

Contractor shall take all necessary precautions to prevent subsidence of or lifting of existing roadbeds, roadways, and pavements there on. Material excavated during boring or jacking or boring and jacking operations shall be removed carefully so as to prevent caving. Voids created during construction shall be backpacked promptly to the extent practicable with soil cement or grout which shall consist of a slightly moistened mixture of one part cement to five parts granular material unless specified otherwise. After conductor casing has been constructed, casing spacers shall be placed around the carrier pipe according to manufacturer’s specifications and then installed in conductor casing in accordance with aforementioned construction plan as approved by Owner. The annulus between conductor casing and carrier pipe shall not be filled with sand unless specified otherwise. Contractor shall install rubber end seals at each end of the conductor casing to prevent intrusion of water into the casing.

Contractor shall backfill boring or jacking pit with material specified for pipeline backfill. Said backfill material shall be compacted to the relative compaction specified which shall be not less than 90%. Contractor shall remove conductor casing and carrier pipe remnants, shoring materials, asphalt, concrete, and all other work-related debris. Contractor shall restore paved surfaces unless directed otherwise.