

NORTH MARIN WATER DISTRICT

STANDARD SPECIFICATIONS

SECTION 15061 CEMENT-MORTAR LINED AND TAPE WRAPPED STEEL PIPE AND SPECIALS

PART 1 GENERAL

1.01 DESCRIPTION

This section includes materials, design, fabrication, and installation of cement-mortar lined and tape wrapped steel pipe and specials.

1.02 REFERENCE STANDARDS

The publications listed below form part of this specification 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 standards unless otherwise called for.

AWWA C604	-	Installation of Steel Water Pipe – 4 inch and larger
AWWA C200	-	Steel Water Pipe – 150mm (6") and Larger
AWWA C205	-	Cement-Mortar Lining and Coating for Steel Water Pipe 100mm (4") and larger Shop Applied
AWWA C206	-	Field Welding of Steel Water Pipe
AWWA C207	-	Steel Pipe Flanges For Waterworks Service 100mm (4") and larger
AWWA C208	-	Dimensions for Fabricated Steel Pipe Fittings
AWWA C214	-	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C217	-	Cold-applied Petroleum Tape Coatings
AWWA C606	-	Grooved and Shouldered Joints
AWWA M11	-	Steel Pipe-Guide for Design and Installation
ASTM A 47/A 47M	-	Standard Specification for Ferric Malleable Iron Castings
ASTM A 36/A 36M	-	Standard Specification for Carbon Structural Steel
ASTM A 53	-	Standard Specification for Pipe, Steel, Black & Hot Dipped, Zinc-Coated, Welded, and Seamless
ASTM A 105	-	Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A 183	-	Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A 216	-	Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding for High Temperature Service
ASTM A 283/A 283M	-	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A 307	-	Standard Specification for Carbon Steel Bolts and Studs
ASTM A 536	-	Standard Specification for Ductile Iron Castings
ASTM A 568/A 568M	-	Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality and Cold Rolled
ASTM D 2000	-	Standard Classification System for Rubber Products
ANSI B1.1	-	Unified Inch Screw Threads
ANSI B1.2	-	Gages and Gaging for Unified Inch Screw Threads

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ANSI B1.20.1	-	Pipe Threads, General Purpose (Inch)
ASTM C150	-	Specification for Portland Cement
ANSI/AWWA C602	-	Cement Mortar Lining of Water Pipelines – 4 Inch and Larger – In Place

1.03 RELATED WORK SPECIFIED ELSEWHERE

NMWD Standard Drawings

NMWD Standard Specifications 01000, 02223, 03000, 09910, 13110, 15000, 15041, 15044, 15045, 15074, 15100, 15102, 15108, 15112, and 15300.

1.04 SERVICE APPLICATION

Cement mortar lined and tape wrapped steel pipe shall be used. Cement-mortar lined and coated steel pipe and specials shall be used when shown on the Approved Plans.

1.05 SPECIALS

A special is defined as any piece of pipe other than a normal full length of straight pipe. This includes, but is not limited to, elbows, short pieces, reducers, tees, crosses, spools, sections with outlets, beveled sections and manholes.

1.06 DESIGN REQUIREMENTS

- A. All steel used for pipe or specials shall have a 36,000 psi minimum yield point unless otherwise directed by the Engineer. See material information concerning steel designation below.
- B. Design stress in steel cylinders shall not exceed 50% of the specified minimum yield strength of the steel used. The internal operating pressure used for design shall be a minimum of 150 psi or as called for on the Approved Plans, whichever is greater. If no specific surge analysis has been performed, the internal operating pressure used in circumferential stress calculations shall include at least a 10% increase for surge conditions. No allowance shall be made for the tensile strength of the cement mortar lining and coating.
- C. Specials shall be designed per AWWA M11 and as a minimum shall conform to the pressure rating, grade of steel and cylinder thickness of the adjoining standard pipe sections. Fitting dimensions shall conform to AWWA C208. Reinforcing collars, wrappers, crotch plates, and anchor rings shall be designed and fabricated per AWWA M11.
 1. Outlets may be built into the wall of the pipe or may be fabricated as steel plate specials. Outlets to be installed on straight pipe lengths shall be welded to the steel cylinder of the pipe prior to tape wrapping or application of mortar lining to the cylinder. Outlets of size two (2) inches and smaller in piping four (4) inches and larger shall be of the forged threaded outlet (threadolet) type or shall be extra-heavy half couplings to fit the pipe in accordance with AWWA M11. Outlets shall be three thousand (3,000) pounds. WOG forged steel per ASTM A105. Threads shall comply with ANSI B1.20.1. Outlets larger than two (2) inches shall use a tee or nozzle with a flanged outlet. All outlets larger than two (2) inches in

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diameter shall be provided with steel reinforcing collars, wrapper plates, or crotch plates per AWWA M11. At the option of the manufacturer, wrappers may be used in place of collars, and crotch plates may be used in place of collars or wrappers.

2. On two (2) inches and smaller outlets where nylon insulation bushings are to be used, the outlet shall be increased in size to accept the bushing.
 3. Tees, wyes, and crosses shall be dimensioned in accordance with AWWA C208, Table 1, or as modified on the Approved Drawings.
 4. Bends shall have a minimum radius of not less than 2½ times the pipe diameter unless otherwise approved by the District Engineer. The maximum deflection at mitered girth seams shall be 22½°. At the option of the Contractor, a bend may be welded to the adjacent pipe section.
 5. All specials shall be marked at both ends of the fitting with "Field Top" indicators.
- D. Minimum cylinder thickness for pipe and specials shall be 0.250 inches (¼ inches) or as directed by the District Engineer.

The wall thickness tolerances for steel pipe twelve (12) inch diameter and larger shall be governed by the requirements of the ASTM specifications to which the plates or sheets are ordered, but in no case shall the thickness be less than 0.250 inches (¼ inches) or as directed by the District Engineer.

- E. Standard pipe sections shall not be less than twenty (20) feet nor more than forty (40) feet in length, except where shorter lengths are required to fit horizontal and vertical alignment or are otherwise shown on the Approved Plans.

- F. Pipe ends shall be as follows:

1. Bell and Spigot with Rubber Gasket (Not Used).
2. Lap Welded Joints: Use expanded bell with matching spigot end. Fabricate lap joints of the bell and spigot type suitable for field welding, and in accordance with AWWA C-200, Section 3.6.2. Provide clearance between faying surfaces of lap joints in accordance with AWWA C-206, Section 5.3. Cold expand bell ends in a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape. The gap between the outside of the spigot and the inside of the bell shall not be greater than 1/8 inch. Form the bell such that the bell slope does not vary more than two (2) degrees from the longitudinal axis of the pipe. Fabricate the bell for field welded lap joints to provide a maximum 2-1/4-inch lap and that with an allowable ¾-inch pull shall result in a minimum of 1-1/2 inch deflected lap. Expanding bells by rolling is not permitted. Preformed welded bell and spigot joints (carnegie shapes) are not permitted.
3. Flanges: Flanges for use in construction of Steel Pipe shall be as described below.
 - a. AWWA C207, Class D flanges (matching ANSI/ASME B16.1, Class 125 flanges for bolt hole size and drilling) shall be used for pressures up to 150 psi.

- b. AWWA C207, Class E flanges (matching ANSI/ASME B16.1, Class 125 flanges for bolt hole size and drilling) shall be used for pressures between 150 psi and 250 psi.
 - c. AWWA C207, Class F flanges (matching ANSI/ASME B16.1, Class 250 flanges for bolt hole size and drilling) shall be used for pressures between 250 psi and 300 psi or when Class 250 butterfly valves or other appurtenances using flanges corresponding to AWWA C207 Class F are required.
 - d. Flanges shall be flat-faced type only. Segmented flanges shall not be used.
4. Butt Straps: Use two-piece rolled steel straps with a minimum thickness of one quarter ($\frac{1}{4}$) inch, and a minimum width of ten (10) inches. Straps shall be fabricated to snugly fit over the plain pipe ends, and shall be centered over the ends of the pipe sections to be joined. Weld one or more standard five (5) inches, three thousand (3000) pound threaded half-couplings to the butt strap section as shown on the Approved Plans. Provide a threaded steel plug for each half-coupling.
 5. Grooved-End or Shouldered Couplings: Use square-cut shouldered or grooved ends per AWWA C606. Grooved-end couplings shall be malleable iron per ASTM A 47, or ductile-iron per ASTM A 536. Gaskets shall be per ASTM D 2000. Nuts and bolts in exposed service shall conform to ASTM A 183, 110,000 psi tensile strength.
 5. Flexible Pipe Couplings: Use plain-end pipe with flexible pipe couplings per AWWA C200. Provide joint harnesses per AWWA M11 where indicated on the Approved Plans.

G. Angles or Curves in Alignment:

Minor changes of direction in the grade or alignment may be made by a deflection in the joint up to a maximum of three-quarter ($\frac{3}{4}$) inches on one side of the joint. For greater angular deflections, pipe with ends beveled up to a maximum of 5 degrees measured from a plane perpendicular to the pipe's axis may be used. The short point on the bevel shall be so marked on the pipe. Pipe length shorter than twenty (20) feet may be used on curves. Where curves that have a shorter radius than can be accommodated by beveled pipe are required, or where indicated on the Approved Plans, special short-radius bends shall be provided.

H. Mortar Lining:

Use linings conforming to AWWA C205, except as noted below.

1. Minimum Lining Thickness shall be as follows:
 - a. Pipelines sixteen (16) inches and smaller:

<u>Lining Thickness</u>	<u>Tolerance</u>
5/16 inches	-1/16 inches, +1/8 inches

- b. Pipelines eighteen (18) inches and larger:

<u>Lining Thickness</u>	<u>Tolerance</u>
¾ inches	-1/16 inches, +1/8 inches

I. Tape Wrap Coating:

- a. Except where otherwise specifically indicated, provide straight pipe sections with a dielectric coating system on steel pipe consisting of machine applied, three layer polyethylene spiral tape wrap system conforming to AWWA Standard C214 as specified below.
1. Primer layer as recommended and approved by the tape manufacturer.
 2. Filler tape, extruded butyl rubber compound compatible with the primer and tape.
 3. Inner layer, corrosion protection tape (20 mils).
 4. Outer layer, mechanical protection tape (30 mils) with ultraviolet light stabilizers.
 5. Total system thickness shall be 50 mils, complying with AWWA C214, Table 3, for minimum and maximum thickness tolerances.
 6. Provide coating materials supplied by a single manufacturer having a successful application and service history on pipe fabricated in accordance with AWWA C200.
- b. Except where otherwise specifically indicated, provide fittings, specials and field joints with a dielectric coating system consisting of a three layer polyethylene tape system conforming to AWWA C209 and as described below:
1. Primer layer.
 2. Filler tape, extruded butyl rubber compound compatible with the primer and tape.
 3. Inner layer, corrosion protection tape, (35mils).
 4. Outer layer, mechanical and ultraviolet light protection tape, (30 mils, or 15 mils at half lap).
 5. Total system thickness shall be 65 mils, complying with AWWA C209, Table 1, for minimum and maximum thickness tolerances.
 6. Provide coating materials supplied by the same manufacturer as the materials used for straight pipe.
 7. Secure from the pipe manufacturer extra tape and primer to wrap all joints and repair any damage to coating occurring while handling during transit or on the job site.
- c. Storage of Materials. Store materials within the temperature ranges recommended by the manufacturer, using heated or cooled storage areas if necessary. Store adhesive tapes at a minimum temperature of 70 degrees F.

- J. The term "diameter of pipe" as used in these specifications or as shown on the Approved Plans shall mean the net inside diameter of the mortar lining.

1.07 QUALITY ASSURANCE

- A. Steel pipe may be inspected at the supplier's manufacturing plant by the District Engineer. Developer shall be responsible for District Engineer's expenses, including travel, time, meals and overnight accommodations. Overnight accommodations and air travel may be required, at the discretion of the District Engineer, if the manufacturing plant is more than 100 miles from the District Engineer's office.
- B. In addition to the shop hydrostatic testing performed on pipe cylinders required per AWWA C200, all welds of specials and attachments (i.e. joint rings and nozzles) shall be tested by a dye-penetrant process. Certification of such testing shall be submitted to the District.
- C. Field welders shall be certified under Section IX, Part A of the ASME Boiler and Pressure Vessel Code or in accordance with AWWA C206, Section 3. Welders shall present a copy of their certification to the District prior to performing any field welding. Certifications shall be dated within three (3) years of the job to be performed.
- D. Plainly mark each length of straight pipe and each special at the bell end to identify the proper location of the pipe item by reference to the layout schedule.
- E. The top of all pipe and specials shall be clearly identified by marking the top with "T.O.P." for easy identification in the field.
- F. Closed-Circuit Television Inspection: When specified on the approved plans, a closed-circuit television (CCTV) inspection shall be performed by Contractor on all steel pipe 36" and smaller in accordance with Section 15045.

1.08 DELIVERY, STORAGE, AND HANDLING

Delivery, storage, and handling of the pipe and specials shall be as follows:

- A. Pipe and fittings shall be carefully handled and shall be protected against damage to linings and coatings due to impact shocks. Pipe shall not be placed directly on rough ground but shall be supported in a manner which will protect the pipe against damage whenever stored at the site or elsewhere. Pipe shall be handled and stored per these requirements and in accordance with the Manufacturer's recommendations.
- B. Temporary internal bracing shall be installed in all pipe sixteen (16) inches and larger prior to shipment to the job site. Temporary internal bracing shall be four x four (4 x 4) inch wooden struts installed in both the horizontal and vertical directions. Each set of struts shall be nailed together as a unit. Wooden wedges may be used to maintain the proper tight fit of the internal bracing. The bracing shall be located twelve (12) inches in from each end of the pipe section for all pipe, and additionally at the mid-point for piping twenty-four (24) inches and larger. Maintain internal bracing as specified under Pipe Installation.
- C. Transport pipe to the job site on padded bunks with nylon tie-down straps or padded bonding to protect the pipe.
- D. Pipes and specials shall only be handled with appropriate spreader bars and wide nylon slings. Chains or wire rope slings shall not be used. Under no circumstances shall pipe or specials be pushed or dragged along the ground. All pipe sections over twenty (20) feet in length shall be lifted at the quarter points from each end.

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- E. Store pipe on earth berms or timber cradles adjacent to the trench in the numerical order of installation. Place the supports at about the one-quarter point from the pipe ends.
- F. Maintain plastic end caps on all pipe and specials in good condition until the pipe is ready to be installed in the trench. Periodically open the plastic end caps and spray potable water inside the pipe for moisture control.

1.09 SUBMITTALS

The following items shall be submitted to the District for review and approval prior to fabrication of steel pipe and specials:

- A. An affidavit of compliance with AWWA C200, C205 and C214.
- B. Name of the Manufacturer/Supplier and location of the factory.
- C. Tabulated layout schedule including:
 - 1. Order of installation and closures.
 - 2. Pipe station and bottom of pipe (BOP) elevation at each change of grade and alignment.
 - 3. Elements of curves and bends, both in horizontal and vertical alignment.
 - 4. ASTM class or grade of steel. Pipe internal diameter, wall thickness, and internal design pressure.
 - 5. Locations of bulkheads for field hydrostatic testing. (Testing against valves shall not be permitted).
 - 6. Locations of closures, including cut-to-fit allowances, for length adjustment and for construction convenience.
 - 7. Locations of valves, flanges, appurtenances and other mechanical equipment.
- D. Details of all specials, and of the lining and coating. Thickness of cement mortar lining and type of cement used. Coating type, materials and thickness, including field applied tape coatings.
- E. Calculations supporting the sizing of reinforcing collar plates, wrapper plates or crotch plates.
- F. Calculations supporting selected wall thickness of pipe and specials.
- G. Calculations supporting welded joint design and joint welding details.
- H. Current shop welder and field welder certifications.
- I. Mill test reports on each heat from which steel is rolled, at the discretion of the District Engineer.
- J. Certification of dye-penetrant shop-weld testing.

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- K. Cathodic Protection design and installation details.
- L. Length of pipe sections.
- M. Markings. The following shall be clearly stenciled by the pipe manufacturer/supplier on each pipe section:
 - 1. Wall thickness of steel cylinder
 - 2. T (for field top) of the pipe for fittings and pipe spools other than straight pipe
 - 3. Internal diameter in inches (after pipe lining)
 - 4. Name of manufacturer
 - 5. Date of manufacture
 - 6. Piece number correlating pipe to tabulated layout schedule

1.10 RECYCLED WATER IDENTIFICATION

Cement-mortar lined and tape wrapped steel pipe and specials for recycled water shall be identified with purple colored wrapping, purple polyethylene sleeves, identification labels, or signs in accordance with Section 15151.

1.11 WAX TAPE

Wax tape shall be installed in accordance with Section 13100 as shown on the Approved Plans or as directed by the District Engineer.

1.12 TRACER WIRE (Not Used)

1.13 WARNING/IDENTIFICATION TAPE

Warning/Identification Tape shall be installed on all cement-mortar lined and coated steel potable and recycled water mains in accordance with Section 15000.

PART 2 MATERIALS

2.01 STEEL PIPE AND SPECIALS

Steel pipe and specials shall conform to the requirements of the AWWA C200 and C205, and AWWA M11, except as modified herein.

- A. Steel for fabricated cylinders shall conform to ASTM A 36/A 36M, ASTM A 283/ A 283M, Grade D, or ASTM A 1011/A 1011M, Grade 36. Other steel grades may be used only upon approval of the District Engineer.

2.02 MORTAR LINING

- A. Cement used in mortar lining shall be Portland Cement per ASTM C 150, Type V for coating and Type II or Type V for lining.
- B. Cement mortar grout for field joints shall consist of a mixture of 1½ to 2 parts sand to 1 part Type II or Type V Portland Cement with enough clean, potable water to permit packing and troweling without crumbling. The sand shall be washed, well-graded sand such that all will pass a No. 8 sieve. The quantity of water to be used in the preparation of grout shall be the minimum required to produce a mixture sufficiently workable for the purpose intended. Grout shall attain a minimum compressive strength of 1,800 psi in 28 days.
- C. Mortar lining shall have NSF 61 certification.
- D. In certain circumstances, rapid-setting mortar may be required. Acceleration admixtures may be used in the mix as permitted by the District Engineer. Calcium chloride shall not be used in the mix.

2.03 PAINTING AND COATING

- A. Paint and coating products for exterior surfaces of all pipe and appurtenances not otherwise tape wrapped shall be in accordance with Section 09910 and the Approved Materials List.
- B. Paint and coating products for areas in contact with potable water such plain ends of pipe, grooved and shouldered ends of pipe and exposed inside surfaces of threaded outlets and blind flanges shall be in accordance with Section 15000 and selected from the Approved Materials List.

2.04 BOLTS AND NUTS FOR FLANGES

Bolts and nuts shall be in accordance with Section 15000 and the Approved Materials List.

2.05 GASKETS

- A. Rubber-ring gaskets shall comply with AWWA C200 according to the applicable joint type and pressure rating of the piping system. (NOT USED)
- B. Flange gaskets shall comply with AWWA C207. Flange gaskets shall be one-eighth (1/8) inch thick acrylic or aramid fibers bound with nitrile for all sizes of pipe. Gaskets shall be full-face type with pre-punched holes or ring-type extending to the inner edge of the bolt circumference of the flange.
- C. In the event of encountering organic solvents or petroleum products during the course of the work, alternate gasket materials or joint treatment will be required as directed by the District Engineer.

2.06 JOINT BONDING AND CATHODIC PROTECTION

Joint bonding, flange insulation kits, internal epoxy linings, and cathodic protection materials shall be provided as indicated on the Approved Plans and in accordance with Section 13110 and the Approved Materials List.

2.07 PIPE AND TRENCH ZONE MATERIAL

Material for use in pipe and trench zones shall be in accordance with Section 02223.

2.08 CONCRETE

Concrete used for thrust and anchor blocks shall be in accordance with Section 03000.

2.09 WAX TAPE

Wax tape materials shall be in accordance with Section 13110 and the Approved Materials List.

2.10 CLOSED-CIRCUIT TELEVISION INSPECTIONS

When specified on the approved plans, the Contractor shall furnish all equipment and materials required for CCTV inspections in accordance with Section 15045.

2.11 TRACER WIRE (Not Used)

2.12 WARNING/IDENTIFICATION TAPE

Warning/Identification Tape materials shall be in accordance with Section 15000 and the Approved Materials List.

PART 3 EXECUTION

3.01 GENERAL

At all times when the work of installing pipe is not in progress, including worker break times, the ends of the pipe shall be closed with a vermin-proof and child-proof cap or plug. Do not permit trench water to enter the pipe. Do not place tools, clothing, or other materials in the pipe. The Contractor shall maintain the interior of the pipe in a sanitary condition free from foreign materials.

3.02 TRENCH EXCAVATION, BACKFILL AND COMPACTION

Trenching, backfilling and compaction shall be performed in accordance with Section 02223.

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3.03 DEWATERING

The Contractor shall provide, and maintain at all times during construction, ample means and devices to promptly remove and dispose of all water from any source entering trench excavations or other parts of the work in accordance with Section 02223. Any damage caused by flooding of the trench shall be the Contractors responsibility.

Dewatering shall be performed by methods that will maintain a dry excavation, preservation of the final lines and grades and protection of all utilities. If flooding of the trench does occur, the Contractor shall immediately dewater and restore the trench. Damaged or altered pipeline appurtenances shall be repaired or replaced as directed by the Engineer.

3.04 PIPE INSTALLATION

When the work requires and the size of the pipe allows entry of personnel into the pipe, the Contractor shall comply with all Federal and State regulations for confined space entry. Work inside pipelines shall not be undertaken until all the tests and safety provisions of the Code of Federal Regulations 1910.146, and the General Industry Safety Orders of the California Code of Regulations, Title 8, Section 5159 for confined space entry have been performed and the area is verified as safe to enter. Generally, the aforementioned safety provisions apply to pipe twenty-four (24) inch and larger. Note that for pipe less than twenty-four (24) inch diameter, more stringent safety procedures apply.

The Contractor shall furnish and install all pipe, specials, fittings, closure pieces, valves, supports, bolts, nuts, gaskets, jointing materials, and all other appurtenances as shown on the Approved Plans and as required to provide a complete and workable installation.

Pipe installation shall be as shown on the Approved Plans and Shop Drawings in accordance with the following:

- A. No pipe shall be installed where the linings or coatings show cracks that may be harmful as determined by the District Engineer. Such damaged linings and coatings shall be repaired or new, undamaged pipe sections shall be provided.
- B. Pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.
- C. The Contractor shall inspect each pipe and fitting to insure that there are no damaged portions of the pipe. The Contractor shall remove or smooth out any burrs, gouges, weld splatter, or other small defects prior to laying the pipe.
- D. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the work as noted above.
- E. Electrical Inspection of Dielectric Pipe Coating. Prior to lowering the pipe into the trench, conduct an electrical inspection of dielectric pipe coatings by means of Tinker-Razor electrical flaw detector or approved equivalent. Apply voltage levels using the flaw detector as follows:

Voltage Level Table			
<u>Generic Type</u>	<u>Composition</u>	<u>Test Method</u>	<u>Voltage Level</u>
Tape	Tape wrap	with wand	20,000
Tape	Tape wrap	with garter spring	36,000

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Repair small areas of the coating that fail the electrical flaw detection inspection as specified hereinafter. Where inspection discovers failure over large areas in any length of pipe, reject subject length of pipe as unfit and immediately remove from the site of the Work.

- F. Abrasions. Avoid abrasion of the pipe coating during installation. Repair damaged coating as specified in Paragraph 3.07 unless in the judgment of the District the damage is so extensive as to deem the pipe irreparable by this method. In this case, remove the pipe from the work site and return to the factory for recoating or replace by a new length, all without cost to the District.
- G. Pipe shall be laid directly on the bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings and to permit visual inspection of the joint. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coatings on field joints.
- H. Installation Tolerances: Each section of pipe shall be laid in the order and position shown on the approved layout schedule to the proper lines and grades in accordance with the following:
 - 1. Each section of pipe having a nominal diameter less than forty-eight (48) inches shall be laid not to vary more than two (2) inches horizontally or one (1) inch vertically from the alignment and elevations shown on the Approved Plans.
 - 2. Each section of pipe having nominal diameter forty-eight (48) inches and larger shall be laid not to vary more than five percent (5%) of the pipe diameter horizontally or two and one half percent (2.5%) of the pipe diameter vertically.
 - 3. In addition to the horizontal and vertical tolerances above, lay the pipe so that no high or low points occur along the pipeline other than those shown on the approved layout schedule.
- I. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the District Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed seventy five percent (75%) of the maximum deflection recommended by the pipe manufacturer. No joint shall be deflected any amount that will be detrimental to the strength and water tightness of the finished joint. In all cases the joint opening, before finishing with the protective mortar inside the pipe, shall be the controlling factor.
- J. Pipes shall be laid uphill on grades exceeding 10 percent. Pipe that is laid on a downhill grade shall be blocked and held in place until the following pipe section has been installed to provide sufficient support to prevent movement.
- K. Temporary internal pipe bracing shall be left in place in pipe sizes larger than twenty-four (24) inches until pipe zone compaction has have been completed. Bracing in pipe smaller than twenty-four (24) inches may be removed immediately after the pipe has been laid into the trench. If requested by the District, the Contractor shall employ a testing firm to

testing firm to monitor pipe deflection by measuring pipe inside diameter before bracing is removed and 24 hours after struts are removed. Pipe deflection shall not exceed 3 percent in 24 hours after the bracing has been removed. After the backfill has been placed, the struts shall be removed.

- L. Cold Weather Protection: No pipe shall be installed upon a foundation onto which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled prior to formation of ice and frost.
- M. Pipe and Specials Protection: The openings of all pipe and specials where the pipe and specials have been mortar-lined in the shop shall be protected with suitable bulkheads to maintain a moist atmosphere and to prevent unauthorized access by persons, animals, water, or any undesirable substance. The bulkheads shall be designed to prevent drying out of the interior of the pipe. The Contractor shall introduce water into the pipe to keep the mortar moist where moisture has been lost due to damaged bulkheads.

3.05 FIELD WELDED JOINTS

- A. Welded joints shall be completed in the trench per AWWA C206.
- B. Both the bell and spigot ends shall be cleaned of foreign matter prior to welding.
- C. For pipe diameters less than twenty-four (24) inches the exterior of the joint shall be welded. For pipe diameter twenty-four (24) inches and larger, the joint shall be welded in accordance with the approved submittal. All welded joints shall remain exposed until inspection has been performed.
- D. Welding electrodes shall be as recommended by the pipe manufacturer. Typically, electrodes shall be E6010 for root passes and E7018 for additional passes. Do not deposit more than one-eighth (1/8) inch of throat thickness per pass.
- E. Weld material shall be deposited in successive layers. Wire brush and clean each pass around the entire circumference of the pipe before commencing the next pass.
- F. The minimum number of passes in the completed weld shall be as follows:

<u>Steel Cylinder Thickness</u> <u>Inches</u>	<u>Fillet Weld Minimum</u> <u>Number of Passes</u>
one-quarter (1/4) inch or less	2
greater than one-quarter (1/4) inch	3

- G. To minimize longitudinal stresses due to temperature variations, it is necessary to leave unwelded one joint per each four hundred (400) feet of pipeline. This joint shall be left unwelded until all the joints on both sides of it are welded, and it shall be welded at the coolest time of the working day. The District Engineer shall decide if and when this procedure is warranted.
- H. Tack-welding the joint may be permitted to hold the pipe in place. If the joint is to be circumferentially welded, sufficient time shall elapse to allow for an initial set of interior joint lining prior to proceeding with joint welding. Rapid-setting mortar may be used in accordance with this Section. In some cases, the District Engineer may require hand holes.

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- I. Field welders shall be certified in accordance with ASME Section 9 (pipe welders) or AWS D1.1 (plate welders). Welders shall present a copy of their certification to the District Engineer prior to performing any field welding.
- J. Prior to butt-strap welding, the pipe and pipe joint shall be properly positioned in the trench using line-up dams so that, in the finished joint, the abutting pipe sections shall not be misaligned by more than one-sixteenth (1/16) inch.
- K. The pipe ends shall be cut straight on joints where butt straps are used for realignment, adjustment, or deflection, and fillet welds shall be made as indicated.
- L. Inspection of Field Welded Joints:
 - 1. The District shall arrange for the welds to be inspected. Inspection of welds shall take place as soon as possible following the completion of the welds.
 - 2. The Contractor shall coordinate and supply ventilation, lighting, and other equipment deemed necessary for inspection. The Contractor shall be responsible for providing safe entry into and out of the trench, safety of inspection personal, traffic control and other safety precautions deemed necessary for the inspections.

3.06 INTERIOR JOINT FINISH - PIPE LESS THAN TWENTY-FOUR (24) INCHES

Complete interior mortar joints for pipe sizes less than twenty-four (24) inches by drawing through a tight-fitting swab or squeegee. Coat the face of the cement mortar lining at the bell with a sufficient amount of stiff cement mortar to fill the gap. Immediately after joining the pipes, draw the swab through the pipe to remove all excess mortar and expel it from the open pipe end. Do not move the pipe after the swab has been pulled past the joint. See requirements under "Field Welded Joints" for these joints requiring welding.

3.07 INTERIOR JOINT FINISH - PIPE TWENTY-FOUR (24) INCHES AND LARGER

- A. Complete interior mortar joints for pipe sizes twenty-four (24) inches and larger by the trowel method. Prior to applying interior mortar at the joints all backfill in the area shall be completed. After cleaning the interior joint, pack cement mortar into each joint. Finish the surface with a steel trowel to a smooth finish and equal thickness to match the adjoining pipe mortar.
- B. Where more than a four (4) inch joint strip of mortar is required, place galvanized welded wire mesh reinforcement in two x four (2 x 4) inch pattern of No. 13 gauge over the exposed steel. Install the mesh so that the wires on the two (2) inch spacing direction run circumferentially around the pipe. Crimp the wires on the four (4) inch spacing to support the mesh three-eighths (3/8) inches from the metal surface. Steel-trowel finish the interior mortar to match adjoining mortar-lined pipe sections.

3.08 CLOSED-CIRCUIT TELEVISION INSPECTIONS

When specified on the approved plans, closed-circuit television inspections shall be performed by the Contractor in accordance with Section 15045.

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3.09 EXTERIOR COATING

- A. Clean the exterior of all joints for pipe and fitting, after assembly has been completed, then wrap the joint exterior with tape wrap as specified herein.
- B. Dielectric or Tape Wrap Coating. Where pipe is furnished with a factory applied hot applied tape coating, field coat exterior of joints on pipe and fitting in accordance with the following requirements.
 - 1. After the application of an approved and compatible primer, firmly wrap tape circumferentially on the pipe or appurtenance overlapping each previous wrap by not less than 5/8 the width of the tape. Do not permit wrinkles, air pockets, or loose wrap. Remove improper wrapping, clean the pipe and re-prime as required by manufacturer's specifications or by the District, and rewrap.
 - 2. Use approved tape specified in the material list or approved equivalent.
 - 3. Apply primers and tapes in strict conformance with manufacturer's specifications.
- C. Use tape coatings where their application will allow the tapes to be applied without wrinkles or air pockets.
- D. Field Repair of Coatings. When permitted by the District, perform minor field repair of damaged coatings using the material and method of application as specified above in this paragraph. Major damage to the pipe coating shall be cause for rejection.
- E. Testing of Field Coating (tape and dielectric coating). Inspect and test all applied coatings, including field repairs of coatings, for flaws. The decision of the District regarding test results shall be final. Repair areas of the coating that fail the test until the coating successfully passes the test.

3.10 BUTT STRAP JOINTS

Butt strap closure joints shall be installed where shown on the Approved Plans in accordance with AWWA C206.

- A. Butt straps shall be field welded to the outside plain end of the pipe along both edges with a full circumferential weld. A minimum of two weld passes shall be used.
- B. The interior of the joints shall be filled with a rapid-set non-shrink NSF61 and District approved mortar and finished off smoothly to match the pipe interior diameter.
- C. Clean the butt strap with a wire brush removing all sealing and loose debris and apply a cement and water wash coat prior to applying cement mortar.
- D. Galvanized wire mesh, two x four (2 x 4) inches x No. 13 gauge shall be installed to the exterior of the joint prior to applying the mortar coating.
- E. Coat the exterior of the closure assemblies with mortar to cover all steel with a minimum of one and one-quarter (1¼) inches.
- F. Seal weld the steel plug to the hand hole after the interior of the joint has been inspected and approved by the District Engineer.
- G. Following grouting, the joint shall then be wrapped with two layers of polyethylene encasement in accordance with Section 15000.

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3.11 FLANGED CONNECTIONS

Flanged connections shall be installed where indicated on the Approved Plans.

- A. Bolt holes shall straddle the horizontal and vertical centerlines.
- B. The bolts, nuts and flange faces shall be thoroughly cleaned by wire brush prior to assembly.
- C. Bolts and nuts shall be lubricated with a District-approved anti-seize compound.
- D. Nuts shall be tightened in an alternating "star" pattern to the manufacturer's recommended torque.
- E. Slip-on type flanges intended for field fit-up and welding shall be welded inside and outside in accordance with AWWA C207.
- F. Coat the exterior of exposed flanges, bolts and nuts in accordance with Section 09910.

3.12 FLANGED COUPLING ADAPTERS

Flanged coupling adapters shall be installed in accordance with the manufacturer's recommendations. Bolts shall be tightened with a torque wrench at torque value recommended by the manufacturer.

3.13 JOINT BONDING/CATHODIC PROTECTION INSULATION

Bonding of joints to provide continuity, flange insulation kits, internal epoxy linings, and other cathodic protection items and materials shall be installed where shown on the Approved Plans in accordance with the Standard Drawings and Section 13110. Continuity and flange insulation kits shall be tested prior to bury.

3.14 WAX TAPE

Wax tape shall be installed as shown on the Approved Plans or as directed by the District Engineer in accordance with Section 13110 and the Standard Drawings.

3.15 CONCRETE

Where required, concrete thrust and anchor blocks shall be installed in accordance with Section 03000 and as shown on the Approved Plans. Prior to filling the pipeline with water, refer to Section 03000 for the minimum concrete curing time required.

3.16 TRACER WIRE (NOT USED)

3.17 WARNING/IDENTIFICATION TAPE

Warning/Identification Tape shall be installed in accordance with Section 15000 and the Standard Drawings.

3.18 DISINFECTION AND BACTERIOLOGICAL TESTING

Disinfection, bacteriological testing, and flushing shall be performed in accordance with Section 15041.

3.19 HYDROSTATIC TESTING

Field hydrostatic testing shall be performed in accordance with Section 15044.

3.20 FIELD PAINTING AND COATING

- A. Exterior surfaces of all pipe and appurtenances not otherwise tape wrapped shall be field painted in accordance with Section 09910.
- B. Areas in contact with potable water such plain ends of pipe, grooved and shouldered ends of pipe and exposed inside surfaces of threaded outlets and blind flanges shall be coated in accordance with Section 15000.

END OF SECTION