

**RULES AND REGULATIONS
FOR
WATER AND WASTEWATER SERVICE**



**EAGLE RIVER
WATER & SANITATION
DISTRICT**

**APPENDIX D
STANDARD SPECIFICATIONS FOR SEWER
MAINS**

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SECTION I – GENERAL REQUIREMENTS

1.1 Authority

The Standard Specifications for Sewer Mains (the “Specifications”) are promulgated by the Eagle River Water & Sanitation District (“District”). The interpretation and enforcement of the Specifications is hereby delegated to the District Regulations Administrator.

1.2 Effective Date of Specifications

The Specifications shall become effective immediately upon formal adoption by the District and shall supersede all former specifications for sewer main construction. The most current version of these Specifications is available at www.erwsd.org.

1.3 Revisions, Amendments, or Additions

The Specifications may be revised and/or amended. Such revisions, amendments, and additions shall be binding and in full force immediately upon formal adoption by the District.

1.4 Definitions

Please reference the Rules and Regulations for Water and Wastewater Service, Article II.

1.5 Development Approval and Infrastructure Acceptance

Please reference the Rules and Regulations for Water and Wastewater Service, Articles VIII and IX, respectively.

1.6 Variance

The District recognizes that the strict and literal interpretation of these Rules and Regulations may not be possible in all cases. Please refer to Article VII for information on the Variance process.

SECTION II – COLLECTION SYSTEM DESIGN AND LAYOUT

2.1 General Requirements

The District requires an Overall Utility Site Plan of the project to be submitted indicating all utilities and their proposed locations for review prior to Construction Plan Approval. All plans submitted shall include a geotechnical report if requested by the District. The design and installation of all facilities shall ensure development of an integrated collection system.

2.2 Corrosion

Corrosive soils are present in the District's service area and may lead to the premature degradation of pipe materials and appurtenances. Please refer to Article IX for corrosive soils procedure.

2.2.1 Dissimilar Materials

Cathodic protection and insulation shall be installed as required by the District. Particular care shall be taken to insulate between dissimilar materials.

2.2.2 Insulating Joints

Whenever it is necessary to join pipe of dissimilar metal, or when designated by the District, a method of insulating against the passage of electrical current, approved by the District, shall be provided. Special care shall be exercised during the installation of these joints to prevent electrical conductivity across the joints.

2.3 Sizing Collection Mains

All mains shall be sized to collect and convey estimated peak wastewater flows of the ultimate population of the tributary area to be served. The applicant shall submit a design report prepared by a registered professional engineer that includes projected peak wastewater flow rates at buildout and a hydraulic evaluation of the collection system. Peak design flow rates shall be based on average per capita wastewater generation rates, a peaking factor, and shall include flow from infiltration. Per capita wastewater generation rates, peaking factors, and infiltration rates for hydraulic design will be provided on request by the District's Engineering Department. The projected peak flows in wastewater mains 12" in diameter or smaller shall convey the flow at a depth of flow no greater than half of the inside diameter of the pipe (depth/Diameter not to exceed 0.50). Peak flows in wastewater mains 15" in diameter or larger shall convey

the flow at a depth of flow no greater than 3/4 of the inside diameter of the pipe (depth/Diameter not to exceed 0.75).

Hydraulic design shall be based upon a Manning's Formula, using a Roughness Coefficient or 'n' value of 0.013. All mains shall be designed to give mean velocities, when flowing full, of not less than two feet per second (2 fps) to insure self-cleaning, and maximum velocities of not more than ten feet per second (10 fps).

The District reserves the right to request oversized mains to provide service for projected future needs. The additional cost for the oversizing may be negotiated between the District and the Applicant and will be reviewed on a case-by-case basis.

2.4 Layout of the Collection System

2.4.1 Easement Width Requirements for Main Installations

All mains shall be installed in dedicated public street right-of-ways or dedicated sewer line easements. The installation of Public Wastewater facilities on developable lots or tracts intended for private use should be avoided to the extent practicable. The standard easement width for all mains shall be a minimum of 20 feet. The main shall be generally centered within the easement. The easement width shall be in accordance with Standard Detail D-09.

2.4.2 Minimum Size

All mains shall be a minimum of eight inches (8") in diameter. All sewer service lines shall be a minimum of four inches (4") in diameter, Refer to Appendix B for Wastewater Service Line Construction Specifications.

2.4.3 Depth of Bury

In general, mains are to be sufficiently deep to receive wastewater from basements and to prevent freezing. The minimum cover above a main shall be four feet six inches (4'-6"). For every foot of cover that is out of compliance with minimum cover requirements, the District will require the installation of 1-inch of insulation board per Appendix E Section 1.14. In addition to maintaining cover from the ground surface, specified cover is required from storm sewer crossings and other cold air sources. Additional depth may be required to allow for adequate cover on service lines. The Applicant shall demonstrate that the pipe materials are suitable for the proposed depth of installation. Any main installation greater than ten feet (10') shall require an increased wall thickness. Any proposed main installation greater than 14 feet (14') shall require an alternatives analysis submittal and District approval.

The maximum depth for a sewer manhole is fourteen feet (14') and shall be measured from the top of rim to the downstream invert. Any proposed applications with manholes

installed at a depth greater than fourteen feet (14') shall require an alternatives analysis submittal and District approval.

2.4.4 Main Insulation Requirements

For every foot of cover that is out of compliance with minimum cover requirements, the District will require the installation of 1-inch of insulation board per Appendix E Section 1.14. In addition to maintaining cover from the ground surface, specified cover is required from storm sewer crossings and other cold air sources.

2.4.5 Minimum Distance from Structures

All main extensions shall be installed at a minimum distance of ten feet (10') from all structures or at a one foot horizontal to one foot vertical (1:1) ratio from the bottom of any structural element, whichever is greater. Encroachments of structures into easements are discouraged and shall only be allowed by written authorization from the District.

2.4.6 Installations in High Groundwater

Installations in areas of high groundwater, as determined in the soils/geotechnical report, may require the following special provisions and evaluated on a case-by-case basis:

- (a) Groundwater barriers, in order to prevent transmission of groundwater along the pipe bedding (See Standard Detail D-07).
- (b) Use of C-900 or Yelomine pressure rated piping and joints
- (c) Engineered design to prevent floatation of the main due to buoyant forces
- (d) High groundwater manholes as identified in 3.3.2

2.5 Slope of Sewer Mains

2.5.1 Minimum Slopes

All sewer shall be designed and constructed to give mean velocities, when flowing full, of 2.0 feet per second or greater, based on Manning's formula using an "n" value of 0.013. The following are the required minimum slopes for sewer mains 42 inches or less. However, slopes greater than these are desirable. If proposed slopes that are at or near the specified minimum, the District may require an increased slope to control sewer gases and/or to maintain self-cleaning velocities. See Table D-1 Minimum and Maximum Sewer Main Slopes.

2.5.2 Maximum Slopes

The maximum slope allowable in pipeline design will be based upon 10 feet per second maximum velocity. Lined pipes may be able to resist scour at high velocities, however, undue turbulence can become an over-riding design consideration as unacceptable levels of odors may be produced from hydrogen sulfide generation. See Table D-1 Minimum and Maximum Sewer Main Slopes.

Table D-1: Minimum and Maximum Sewer Main Slopes

Pipe Diameter (Inches)	Minimum Slope (Feet per 100 linear feet)	Maximum Slope (Feet per 100 linear feet)
8 inches	0.70	6.48
10 inches	0.28	4.82
12 inches	0.22	3.84
14 inches	0.17	3.08
15 inches	0.15	2.81
16 inches	0.14	2.58
18 inches	0.12	2.20
21 inches	0.10	1.79
24 inches	0.08	1.50
27 inches	0.067	1.29
30 inches	0.058	1.11
33 inches	0.052	0.98
36 inches	0.046	0.87
39 inches	0.041	0.79
42 inches	0.037	0.71

2.5.3 Slope between Manholes

A continuous slope shall be maintained on main installations between manholes. Manholes are required at every slope change of the main.

2.5.4 Steep Slope Applications

Steep slope applications with mains longer than 100 feet (100') are required to install a bar screen manhole at the top of the slope per Detail D-03. Grade breaks shall not be permitted in manholes in excess of ten percent (10%) at the bottom of steep slope applications. Mains shall be anchored securely to the manhole and installed with

restrained joint connections per Detail D-04. Sewer mains with slopes of twenty percent (20%) or greater shall require restrained joints to be designed by the Engineer.

2.5.5 Slope across Manholes

The minimum fall across a standard manhole shall be two-tenths of a foot (0.2'). The hydraulic grade line and energy grade line of flow in a manhole shall be designed to stay below the crown of the pipe.

2.5.6 Main Line Horizontal Alignment

All mains shall be installed with a straight horizontal alignment between manholes.

2.5.7 Length of Mains and Slope Measurement

Length of mains shall be measured horizontally, from the center of manhole structure to the center of the manhole structure, not the center of the manhole lid. Main slopes shall be calculated using the outside invert of the upstream manhole to the outside invert of the downstream manhole. These length and slope calculations shall be used for construction submittals as well as for the Drawings of Record submittal.

2.5.8 Manholes

Manholes shall be installed at the following locations:

- (a) The end of each main
- (b) All changes in grade, size, horizontal or vertical alignment
- (c) Sanitary sewer manholes shall be aligned and spaced so that the change of flow direction is not at an acute angle.
- (d) All intersections
- (e) Main distances not greater than four-hundred feet (400')
- (f) Manhole lids shall be located outside of the vehicle wheel path on all road installations

Manholes shall not be located in the following areas:

- (a) Within ten feet (10') of domestic water infrastructure
- (b) Where surface water can accumulate (ie. drainage pans, ditches, floodplains, etc.)
- (c) Within a 100-year floodplain

The manhole access opening shall be a minimum of twenty four inches (24") in diameter. The minimum manhole diameter size shall be based on the largest main penetrating the manhole and adhere to the following:

Table D-2: Manhole Sizing Criteria

Main Diameter	Minimum Manhole Diameter
8 to 18 inches	48-inch
21 to 27 inches	60-inch
30 inches and above	72-inch

Bar screen manholes may be required in new developments to prevent construction debris from entering the collection system. Bar screen manholes shall be required in steep slope applications. Refer to Detail D-03.

Inside Drop manholes shall not be permitted and outside drop manholes will be considered on a case-by-case basis. If a drop manhole is approved, it shall be provided for where a main enters a manhole twenty-four inches (24") or more above the manhole invert. Refer to Standard Detail D-02.

2.5.9 Manhole Clearances

Manholes must be exposed and accessible at all times. A minimum clearance of three (3) feet from the rim of the manhole to the face of any surface obstruction object must be met. The 3 foot minimum must be level. Manholes are not permitted to be in low spots or holes. If the required clearances are not met, ERWSD personnel will remove such obstructions after seven (7) days written notice is given or immediately in cases of emergency, the costs for which may be added as a charge to the property owner’s monthly bill.

2.5.10 Manhole Connections

Any new main connection eight inches (8") or greater within a manhole shall match the crown of pipe to crown of pipe at the highest existing main currently within the manhole.

2.5.11 Location/Marking Tape

All lines connected to District mains in any way shall be marked with the appropriate marking tape per Section 3.6 and shall be placed twenty four inches (24") above the pipe.

2.5.12 Pipe Material

The District requires the same pipe material to be installed from manhole to manhole.

2.5.13 Lift Stations

Lift stations are specifically discouraged. In the event lift stations are approved by the District, they shall be considered Major Facilities and will be designed, constructed and financed by the District in accordance with Article IX.

2.5.14 Maintenance Access

All mains, whether in easements or right-of-way, shall allow for vehicular access to conduct maintenance activities. Access benches shall have a minimum width of twelve feet (12'), a centerline grade of no more than ten percent (10%), and a maximum cross slope of six percent (6%) per Detail D-06. Vehicular turnarounds shall be provided at all dead end mains in conformance with Detail D-08.

2.6 Protection of Potable Water Supplies

When wastewater mains are proposed near any potable water supply facilities, the following requirements of the Colorado Department of Public Health and Environment's (CDPHE) Potable Water System Design Criteria Manual shall apply:

2.6.1 Cross Connections Prohibited

There shall be no physical connections between a public or private potable water supply system and a main or appurtenance thereto which would permit the passage of any wastewater or polluted water into the potable supply. No water pipe shall pass through or come into contact with any part of a sewer main or manhole. There shall be no physical connections between a stormwater conveyance system and a main or appurtenance thereto which would permit the passage of any storm water into the wastewater collection system. No stormwater water pipe shall pass through or come into contact with any part of a sewer main or manhole.

2.6.2 Relation to Water Works Structures

Minimum distances from public water supply wells or other water supply sources and structures shall be provided.

2.6.3 Horizontal and Vertical Separation from Potable Water Mains

Refer to detail D-11.

(a) Parallel Main Installations and Appurtenances:

SECTION II – COLLECTION SYSTEM DESIGN AND LAYOUT

Sewer mains and sewer service lines shall be installed at least ten feet (10') horizontally from any existing or proposed water main. The distance shall be measured edge to edge. In cases where it is not practical to maintain a ten foot (10') separation, the District may allow installation of the sewer main closer to a water main utilizing encasement or pressure rated joints, provided that the water main is on a separate trench or on an undisturbed earth shelf located on one side of the main and at an elevation so the bottom of the water main is at least eighteen inches (18") above the top of the sewer main. The District requires a ten-foot (10') separation between water and sewer appurtenances including manholes. If a manhole is installed, it will be measured from outside of manhole to outside of water attribute.

(b) Perpendicular Crossings – Sewer under Water:

If the sewer pipe crosses under the water main but less than eighteen inches (18") of clear space will exist, either the water main or sewer main must be installed with secondary containment. Acceptable options include a pipe casing extending no less than nine feet (9') each side of the crossing. The pipe casing shall be of watertight material with no joints. The casing pipe materials may be steel, ductile iron, fiberglass, fiberglass reinforced polymer mortar (FRPM), or polyvinylchloride (PVC) with suitable carrier pipe supports and casing pipe end seals. Alternatively, concrete or Controlled Low Strength Material (ex. flowable fill) encasement of either pipe extending no less than ten-feet (10') each side of the crossing may be used.

(c) Perpendicular Crossings – Water under Sewer:

If the sewer pipe will cross above or over the water main, either the sewer pipe or water pipe shall be installed with secondary containment unless the vertical distance exceeds five feet (5'). Acceptable options include a pipe casing extending no less than 9- feet each side of the crossing. The casing must be a single section of steel or ductile iron pipe. The design must include a means to support the interceptor or sewer main to prevent settlement and permit maintenance of the water main without damage to the sewer pipe. Alternatively, concrete or Controlled Low Strength Material (ex. flowable fill) encasement of either pipe extending no less than 10-feet each side of the crossing may be used. Crossings involving jointless pipe such as HDPE, fusible PVE or welded steel do not require installation of secondary containment.

SECTION III – MATERIAL SPECIFICATIONS

3.1 General Requirements

All materials must conform to these Material Specifications and shall be new and undamaged.

Acceptance of materials, or the waiving of inspection thereof, shall in no way relieve the Applicant of the responsibility for furnishing materials that meet the requirements of these Specifications.

3.2 Pipe and Fittings

The following materials are approved for District mains:

3.2.1 Polyvinyl Chloride (PVC) gravity pipe

Main installations from eight to fifteen inches (8" to 15") in diameter shall conform to ASTM D3034, and shall be either SDR-35/PS46 or SDR-26/PS115.

Main installations from eighteen to twenty-seven inches (18" to 27") in diameter shall conform to ASTM F679 and shall be SDR-26/P115. Push on joints and molded rubber gaskets shall conform to ASTM D3212.

Maximum pipe segment lengths shall be twenty feet (20'). Joint lubricant shall be non-toxic and water-soluble and supplied by the pipe manufacturer.

3.2.2 Polyvinyl Chloride (PVC) pressure pipe

(a) Yelomine

Yelomine pipe shall be SDR-21, restrained joint PVC pressure pipe and fittings having a minimum cell classification of 12454 as defined in ASTM D1784 and materials in conformance with ASTM D2241.

(b) C-900

AWWA C-900 pipe may be used for 8 " through 12" diameter pipe, and shall be pressure class 235 psi, DR18, with push-on joints and flexible elastomeric seals ASTM D3139/ASTM F477. All spigot ends shall be beveled to manufacturer's specifications with gaskets meeting ASTM F477 and joints in compliance with ASTM D3139.

3.2.3 Ductile Iron Pipe (DIP)

Ductile Iron Pipe shall be per ASTM A746, Class 52, 350 psi, AWWAC151. Push-on joints shall be ANSI/AWWA C111/A21.11. Factory applied Protecto 401, or equivalent, ceramic epoxy interior lining for DIP & fittings. Manufactured by U.S. Pipe and Foundry Company/Griffin Pipe Products or approved equal.

3.2.4 Service Line Taps

Factory wyes shall be used for all service line connections with new main installations See Appendix B for requirements for new service line connections to existing mains.

3.2.5 Transition Adapter

If permitted on a case-by-case basis, Harco transition adapters or Shear Guard couplers may be used for pipe material transitions with prior approval. Fernco couplers shall not be permitted.

3.3 Manholes

3.3.1 Manhole

Manhole sections, base, riser, conical top sections, flat slab tops, and joint sealants between manhole sections shall be in accordance with ASTM C 478. Concrete used in cast in place-manhole bases shall be per Section 3.3.10. All cone sections shall be the eccentric type. Openings through manhole risers shall be cored or cast-in, and access opening shall be twenty four-inch (24") diameter. Flat lid slabs are required on manholes with a depth of less than five feet (5') and must be eccentric.

3.3.2 Water Tightness

Manholes shall be watertight and constructed of precast concrete. Barrel sections, cones and frame joints shall all be sealed with a double Rub R Nek, or other equivalent material approved by the District. In areas of high groundwater or otherwise required by the District, a bituminous coating, or approved equal waterproofing material, shall be applied to the exterior of the manhole. Manhole vacuum testing shall be required by the District on all manholes in all areas of high groundwater.

3.3.3 Rings and Covers

Manhole rings and covers shall be heavy duty castings ASTM A 536 or gray cast iron per ASTM A 48 and all components shall be traffic rated to AASHTO HS-20. Ring and cover combined weight shall be greater than 245 pounds and machined to fit securely with a non-rocking cover. Manhole covers shall be twenty-four inch (24") in diameter and have a minimum of twenty-two and one-eighth inches (22-1/8") diameter clearance, have a waffle pattern with a flat lid and the lettering "SEWER" cast on the cover. Covers

shall be D & L brand model A-1043 or accepted equal. Precision Cover Systems, Inc. (PCSI) fully-adjustable manhole covers with variable grade rings shall be installed in roadways.

3.3.4 Grade Rings

Grade rings shall be in accordance with ASTM C 478 and the maximum height of grade rings shall not exceed eleven inches (11”).

3.3.5 Manhole steps

Steps shall be comprised of grade 60 deformed rebar encased in a polypropylene copolymer plastic with a tread width of fourteen inches (14”). The steps shall be M.A. Industries No. PS2-PF or PS2-PF-DF or approved equal. Steps shall be cast in place during manufacturing of the manhole sections and shall be six inches (6”) from face of manhole. The top most step shall be installed between eighteen (18”) and twenty-four inches (24”) from the rim of the manhole. Manhole steps shall be vertically aligned and plumb. Steps shall be typically spaced at twelve inches on-center vertically with a maximum spacing of sixteen inches (16”). Steps shall not be installed in the "chimney" portion of the manhole. Entry steps shall be located in the barrel and cone sections of the manhole. See Standard Manhole Detail D-01.

3.3.6 Joint Sealant

Joints shall be sealed with Rub-R-Nek LTM or approved equal installed on the inner and outer ring. Sealant shall be a flexible gasket-type of Butyl rubber, Federal Specifications SS-S-210 (210-A), per ASTM C990-09, AASHTO M-198 75 1. Sealant shall be applied on all surfaces between precast concrete adjusting ring and casting, individual precast concrete adjusting rings, and precast concrete adjusting ring and cone joints. A compatible primer or solvent as recommended by manufacturer of butyl base material shall be used to prepare surfaces prior to application of butyl base material and riser rings. Two gaskets with a minimum cross sectional area equivalent to one inch (1”) in diameter are required per joint on forty-eight inch (48”) diameter manholes. Gaskets for manholes greater than forty-eight inches (48”) in diameter shall have a minimum cross sectional area of one and one-half inches (1 ½”).

3.3.7 Pipe to Manhole Seal

KOR-N-Seal, A-Lok, or approved equal flexible rubber boot in a cored hole per ASTM C 923 shall be used for installations in pre-cast bases.

For installations in cast-in-place bases (upon approval and on existing mains only), all pipe-to-manhole connections shall use two elastomeric Kor-N-Seal, or approved equal, “O”-ring water stops minimum per ASTM F477.

3.3.8 Flow Channel

The flow channel straight through a manhole should be made to conform as closely as possible in shape and slope to that of the connecting mains and shall have two tenths of a foot (0.2') minimum fall through the channel for a standard manhole. Channel depth and width shall equal the largest pipe diameter. The channel walls should be formed or shaped to the full height of the crown of the outlet main in such a manner as to not obstruct maintenance, inspection or flow in the sewers.

3.3.9 Bench

All manholes shall be constructed with a full bench configuration, in which the top of the invert channel walls shall match the crown of pipe elevation. The horizontal bench surface shall be sloped at a minimum of one-half inch ($\frac{1}{2}$ ") per foot, maximum of one inch (1") per foot with a medium broomed finish, perpendicular to the main direction of flow.

3.3.10 Manhole Base

The foundation for each manhole base shall be prepared by replacing unsuitable material with sub grade stabilization material in accordance with Appendix E-Earthwork.

The manhole base shall be precast (in accordance with ASTM C478) unless the manhole ties into an existing main, in which case a cast-in-place base may be used. The invert shall be formed and smoothly finished to match the shape and elevation of all pipes connected to the manhole. Where the sewer line is designed with a continuous grade through the manhole, the pipe shall be laid through the manhole location, the top half of the pipe cut out and the manhole base formed around the bottom half of the pipe.

All concrete used in construction of cast-in-place manholes and bases shall be CDOT Class D. Concrete reinforcement shall be epoxy-coated steel reinforcing bars in accordance with ASTM A-615, Grade 60. In instances where a manhole ties into an existing main and a cast-in-place base is used, the first pre-cast manhole section shall be placed on the concrete base structure before the base has taken initial set, or the section shall be grouted into a suitable groove formed in the top of the manhole base. The first section shall be adjusted to the proper grade and alignment so that it is uniformly supported by the base concrete and not bearing on any of the pipes. The manhole steps shall be located one-foot left or right of the main inflow pipe.

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The remaining pre-cast sections shall be placed and aligned to provide vertical sides and alignment of the ladder rungs. Plumbness shall be checked as each barrel section is added. A bitumastic or other approved sealer shall be placed between pre-cast sections so that the completed manhole is rigid and watertight. The sealer shall be placed both on the inside lip as well as the outside lip of each section.

3.3.11 Interior Coatings

For drop manholes (or other applications as identified by the District), manhole interiors shall be coated with a Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy Top Coat such as Tnemec Epoxoline Series L69 or equivalent. Preparation and application shall be per manufacturers' recommendations.

3.4 Concrete/Grout

3.4.1 General Requirements

Contractor shall provide the District Inspector with a specification sheet or mix design from the concrete supplier.

3.4.2 Concrete

All concrete used in construction of cast-in-place manholes and bases shall be CDOT Class D. Construction shall be in conformance with the Detail D-01.

3.4.3 Mortar and Grout

Non-shrink mortar and grout used in the shaping of inverts, grade ring gaps, sealing penetrations, or setting and anchoring cast iron shall consist of one part Type II Portland Cement and two parts of fine, clean sand. Only sufficient water shall be added to provide a stiff, workable cement mixture for proper troweling. Hydrate lime or masonry cement shall not be used. Where relatively thin portions of grout are to be applied (to a flow channel or top of bench) an approved epoxy bonding coat shall be applied to the exposed concrete surfaces prior to grouting.

3.5 Locating Disk

The District will provide green 3M brand Full-Range Disk Marker locating disks to the contractor for stubouts. The contractor shall ensure their correct installation.

3.6 Marking Tape

The installation of green marking tape is required on all sewer mains and service lines. The tape shall be installed approximately 24 inches (24") above the main or line. The tape shall meet the following specifications:

- (a) Five (5)-mil thick Polyethylene material.
- (b) Solid green color with black lettering.
- (c) Six inches (6") in width.

3.7 Casing Material and Spacers

Carrier pipes to be installed inside casings shall be installed with self-restraining casing spacers. Casing spacers shall provide axial thrust restraint to prevent pipe joint deflection during and after installation. They shall also provide dielectric insulation between the carrier pipe and the casing and facilitate installation of the carrier pipe into the casing. See Sewer Main Casing Detail D-5. Pipe casing shall be smooth wall welded steel ASTM A-53 Grade B cylinder fabricated in accordance with AWWA C200. External loading shall be AASHTO HS-20 highway or E-80 railroad loading, railroad loading plus jacking load. Casing joints shall have ends beveled for field welding, be butt welded with complete joint penetration welds around the entire circumference of the pipe, and be formed and accurately manufactured so that when pipes are placed together and welded they form a continuous casing with a smooth and uniform interior surface. Interlocking joints shall be Permalok Interlocking Pipe Joining System. Casing spacers shall be stainless steel, two piece bolt-on style, minimum fourteen (14) gauge thickness and a minimum length of eleven inch (11"); casing spacers shall be installed every six feet (6') of the pipeline to support the pipe barrel and the weight of its contents, or at an appropriate spacing as determined by the engineer. The four runners shall be eleven inches (11") long at a minimum and manufactured of high abrasion resistant, low coefficient of friction, glass filled polymer. Runner heights shall be set to center the carrier pipe in the casing. Risers shall be ten (10) gauge maximum, and the coating shall be fusion-bonded epoxy or heat fused PVC. Casing spacer models shall be Uni-Flange Series UFRCS1300, Advance Products and Systems, Inc. SI-12; Pipeline Seal and Insulator, Inc. C12G or approved equivalent. Restrained casing spacers shall be provided at all pipe joints. Restrained casing spacers shall be Uni-Flange Series UFRCS1390 P or approved equivalent.

Casing end seals shall be preformed and designed to prevent entry of water or loss of material from casing. The end seals shall be made of one-eighth inch (1/8") thick 60 durometer EPDM or neoprene rubber held together with mastic strips to seal the edges. The seals shall overlap the casing pipe by two inches (2") and shall be held on with AISI 304L stainless steel worm gear clamps. Casing end seals shall be Advance Products and Systems, Inc. AC or AW; Pipeline Seal and Insulator, Inc. C or W; or approved equivalent.

SECTION IV – PIPE INSTALLATION & CONSTRUCTION

4.1 Safety

Job site safety shall be the responsibility of the contractor. The District Inspector may refuse to enter a jobsite if deemed unsafe by Occupational Health and Safety Act (OSHA) standards. Failure to provide a safe jobsite may prevent the District from conducting an inspection.

4.2 Handling of Materials

Pipe and fittings shall be loaded and unloaded by lifting so as to avoid shock or damage. Under no circumstances shall material be dropped. If, however, any part of the pipe is damaged, the replacement or repair of the damaged pipe shall be done to the satisfaction of the District. Any pipe or fittings that are not acceptable to the District shall be removed from the job site immediately. All pipe-handling equipment and pipe handling methods shall be in accordance with the methods and equipment recommended by the manufacturer.

Under NO circumstance shall forks be inserted into any pipe and or fitting. Pipe shall be stored and handled in accordance with manufacturer's recommendations. Any pipe with UV degradation or bowing may be rejected by the District Inspector. All pipe shall be delivered to the project site and stored with factory applied end caps intact.

4.3 Inspection and Preparation of Pipe and Fittings

Before placing pipe in the trench, each pipe or fitting shall be thoroughly cleaned of all foreign material, kept clean at all times thereafter, and carefully examined for cracks, warping, or any other defects before installation. Bell ends and spigot ends are to be examined and free of defects. Following the inspection, end caps shall be replaced prior to placing the pipe in the trench.

All lumps, blisters and excess coatings shall be removed from the pipe and fitting, and the outside of the spigot and the inside of the bell shall be wiped clean, dry and free from oil and grease before the pipe or fitting is installed. Dirt and any other material must be removed from the barrel of the pipe before installation.

4.4 Cutting and Fitting of Pipe

Pipe shall be cut in accordance with manufacturer's recommendations, whenever necessary, to conform to location of fittings, line, or grade. All cuts, when required, shall be straight, true and beveled and may be made with plastic pipe cutters or completed per the DIPRA Guidelines for Field Welding and Cutting Ductile Iron Pipe (August 2015).

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All burrs shall be removed from the ends of cut pipe and the ends of the pipe lightly rasped or filed.

4.5 Pipe Alignment and Grade

Manholes shall be installed at staked locations and elevations. Main installation stakes for alignment and grade shall be set by a surveyor under the guidance of a Professional Land Surveyor who is registered in the State of Colorado.

Pipe shall be installed at a constant grade from manhole to manhole. No grade breaks or low spots will be accepted. Pipe shall be installed with the bell ends facing in the direction of installation, unless directed otherwise by the District. Where pipe is to be installed on a grade of ten percent (10%) or greater, the installation shall start at the bottom and shall proceed upward with the bell ends of the pipe up grade.

4.6 Temporary Plugs

A mechanical pipe plug shall be used as a temporary plug during line installation to isolate the mainline extension from the existing collection system. All temporary plugs shall be provided by the Contractor.

4.7 Frost

No pipe or appurtenant structure shall be installed upon a foundation into which frost has penetrated, or if at any time there is danger of ice formation. No pipe or appurtenant structure shall be installed unless backfilling can be completed before the formation of ice and frost.

4.8 Lowering of Material into the Trench

Proper implements, tools and facilities satisfactory to the District shall be provided and used by the Contractor for the safe and convenient performance of the work. All pipe, manholes, and accessories shall be carefully lowered into the trench piece by piece by means of suitable tools and equipment, in such a manner as to prevent damage to the materials. Under no circumstances shall the materials be dropped or dumped into the trench.

If damage occurs to any pipe, manholes or main accessories in handling, the District inspector may reject the damaged material at the discretion of the inspector.

4.9 Installation of Pipe

4.9.1 General Requirements

Factory applied end caps shall remain installed on the pipe while it is being placed in the trench to prevent foreign material from entering the pipe. The end cap shall be left in place until the connection is to be made to the adjacent pipe. During installation, no debris, tools, clothing or other foreign materials shall be placed in the pipe.

As each length of pipe is placed in the trench, the spigot end shall be centered in the bell and the pipe inserted to the manufacturer's recommended depth with a slow steady pressure without jerky or jolting movements and brought to correct line and grade. The pipe shall be secured in place with bedding material tamped under it, except at the bells. Precautions shall be taken to prevent dirt from entering the joint space. No wooden blocking shall be left at any point under the pipeline. All pipe joints shall be uniform and smooth transitions shall exist from joint to joint or fitting. See Appendix E for bedding, backfill and compaction requirements.

4.9.2 Ductile Iron Pipe

Push-On Joints: The inside of the bell, the outside of the spigot end, and the rubber gasket shall be thoroughly cleaned to remove oil, grit, excess coating, and other foreign matter. The rubber gasket shall be flexed inward and inserted into the gasket recess of the bell socket. NSF-61 approved gasket lubricant per the manufacturers recommendations shall be applied to either the inside face of the gasket, and the spigot end of the pipe, per the manufacturer's recommendations.

The spigot end of the pipe shall be placed in the bell end with care to prevent the joint from contacting the ground. Pipe furnished without a depth mark on the spigot end shall be marked before assembly to ensure insertion to the manufacturer's recommended depth. The pipe shall be kept in straight alignment and the joint shall be completed by inserting the pipe to the manufacturer's recommended depth with a slow, steady pressure by using a long pry bar, jack, lever puller, or backhoe bucket. A timber header should be used between the pipe and the jack or backhoe bucket to avoid damage to the pipe.

Upon completion of joining push-on joint pipe, an inspection shall be made to ensure that the gasket is correctly aligned in the gasket recess of the bell socket and not twisted or turned.

4.9.3 Polyvinyl Chloride Pipe

Elastomeric Gasket Joints: Immediately before joining two (2) lengths of PVC pipe, the inside of the bell or coupling, the outside of the spigot and the elastomeric gasket shall be thoroughly cleaned to remove all foreign material.

Lubrication of the joint and rubber gasket shall be done in accordance with the pipe manufacturer's specifications.

Care shall be taken that the correct elastomeric gasket, compatible with the annular groove of the bell, is used. Insertion of the elastomeric gasket in the annular groove of the bell or coupling must be in accordance with the manufacturer's recommendations.

The spigot and bell or coupling shall be aligned and inserted to the manufacturer's recommended depth or reference line. Installation or pushing shall be done in a smooth, steady motion. Upon completion of joining the pipe, an inspection shall be made to assure that the gasket is correctly aligned in the gasket recess of the bell socket and not twisted or turned. NO deflection will be allowed at a joint of PVC pipe.

4.9.4 Yelomine Pipe

Installation of Yelomine pipe shall be in accordance with the manufacturer's recommendations and specifications. Cleanout caps shall be installed with non-permanent gaskets where applicable.

4.9.5 Job-Mixed Concrete

Job-mixed concrete shall be thoroughly mixed to combine aggregates, cement, and water into a uniform mass.

4.9.6 Ready-Mixed Concrete

Said materials must be proportioned, mixed and transported in accordance with ASTM C94. Any concrete not plastic and workable when it reaches project shall be rejected. See Section 3.4 for material specifications.

4.10 Manholes

Manholes shall be precast, watertight and constructed in accordance with the District's standard details and per Section 3.3. For precast manhole bases, the area underneath the manhole base shall be excavated and bedding material shall be placed and compacted to the required elevation. The manhole base shall then be lowered into the trench and checked for proper bearing on the subgrade, proper elevation and orientation to receive the incoming and outgoing sewers at the designated invert

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elevation. If the invert elevation varies by more than plus or minus one half inch (1/2") from the designated invert elevation, the base shall be removed and reset. The concrete invert channel and bench shall be constructed following the connection of all sewer pipes to the manhole. The flow channel shall be smooth and true to the sewer pipe invert elevations, with uniform cross section and slope, either straight or with a continuous curve between inlet and outlet of pipes. To eliminate free fall conditions in a manhole resulting from invert elevation differentials between incoming and outgoing pipes, the Contractor shall form and construct suitable channels in the bottom of the manhole connecting the inverts. Shape channel base and bench per Sections 3.3.8 and 3.3.9, respectively. New manholes shall have pre-formed holes for pipe installation and existing manholes shall be cored to install pipe and connector. Chip existing concrete bench inside manhole and shape smooth continuous invert for connections to existing manholes. All pipe-to-manhole connections and grade adjustment rings shall be sealed and grouted with non-shrink materials and be watertight. All lift holes shall be filled with non-shrink grout.

All dimensions, locations and elevations shall be coordinated by the Applicant and Contractor and meet the requirements of the District. Cast-in-place manhole bases will only be allowed when connecting to an existing main.

4.11 Service Lines

Refer to Appendix B, Section II.

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5.1 General Requirements for Connections

Connections to the District system shall be inspected and approved by the District prior to backfilling.

5.1.1 Service Connections

Refer to Appendix B.

5.1.2 Connections to Manholes

All connections shall match the crown of pipe to crown of pipe at the highest existing main or per the direction of the District. All new main installations shall require reformed benches that meet all District standards.

5.2 Testing – Sewer Mains

5.2.1 Alignment

Straight alignment shall be checked by using either a laser beam or lamping.

5.2.2 Low Pressure Air Testing – General Requirements

The air test shall, as a minimum, conform to the test procedure described in ASTM F 1417 Standard Practice for Installation Acceptance of Plastic Non-Pressure Sewer Lines Using Low-Pressure Air. Deflection testing should occur prior to air test.

5.2.3 Low Pressure Air Testing Procedure

- (a) Lines must be cleaned by flushing or by other means before the low pressure air test is to begin.
- (b) Isolate the sewer line to be tested and ensure that all other outlets from which air could escape are properly sealed. In this step of the procedure, it is necessary to inspect the manhole invert being plugged to be sure that it has no damage which will be covered by the plug and not detected with the low-pressure air test.
- (c) Determine the duration of the test by using the accompanying tables at the end of this section.

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- (d) Begin the test by connecting the air source to the inlet tap. Slowly add air until the internal pressure of the test section reaches a pressure 4.0 psig. If ground water back pressure exists, it must be quantified by the Engineer prior to testing.
- (e) After the constant pressure of 4.0 psig is obtained, regulate the air supply so that the pressure is maintained between 3.5 to 4.0 psig for at least 2 min. Depending on air/ground temperature conditions, the internal air temperature will stabilize in equilibrium with the temperature of the pipe walls. The pressure will normally drop slightly until equilibrium is obtained; however, a minimum of 3.5 psig is required.
- (f) Once the pressure has stabilized to 4.0 psig (plus the average ground water back pressure, if applicable) disconnect the air supply from the control panel. Observe the continuous monitoring gauge and decrease the internal pressure to no less than 3.5 psig. At a reading of 3.5 psig or within the range of 3.5 to 4.0 psig, stop decreasing the pressure and commence timing with a stopwatch or watch with a second hand or digital readout in minutes and seconds with an accuracy of 0.1.s.
- (g) Once the predetermined time period from the formula or table above has elapsed, observe the continuous monitoring gauge to obtain the amount of pressure lost during the test duration. If the pressure drop is found to be less than 1.0 psig (or 0.5 psig in circumstances where a shorter test duration is desired), the section is presumed to be free of any leaks or defective joints. If the pressure drop is 1.0 psig or greater (0.5 psig or greater in circumstances where a shorter test duration is desired), the test section has failed due to excessive pressure loss. When low-pressure air testing of a sewer line results in a failure the Contractor, at his/her own expense, shall detect the leak or defect and repair or replace whatever is necessary to remedy such defect in a manner acceptable to the Owner.

TABLE D-3: Minimum Time for a 1.0 psig Pressure Drop for Size and Length of Pipe for Q = 0.0015

Pipe Diameter, in.	Minimum Time, min: s	Length for Minimum Time, ft	Time for Longer Length, s	Specification Time for Length (L) Shown, min:s								
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft	
4	3:46	597	0.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24	11:24
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48	17:48
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38	25:38
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04	40:04
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41	57:41
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31	78:31
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33	102:33
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48	129:48
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15	160:15

NOTE 1—See Practice UNI-B-6.

NOTE 2—Consult with pipe and appurtenance manufacturer for maximum test pressure for pipe size greater than 30 in. in diameter.

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Table D-4: Minimum Time for a 0.5 psig Pressure Drop for Size and Length of Pipe for Q = 0.0015

Pipe Diameter, in.	Minimum Time, min:s	Length for Minimum Time, ft	Time for Longer Length, s	Specification Time for Length (L) Shown, min:s							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	1:53	597	0.190 L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	0.427 L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	0.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7:05	159	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653 L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54
30	14:10	80	10.683 L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07

NOTE 1—Consult with pipe and appurtenance manufacturer for maximum test pressure for pipe size greater than 30 in. in diameter.

5.3 Manhole Testing – General Requirements

Manhole vacuum testing shall be required by the District on all manholes in all areas of high groundwater via the vacuum test per ASTM C1244, “Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) prior to backfill.

5.3.1 Manhole Testing Procedure

- (a) Plug all inlets and outlets.
- (b) Install the vacuum tester head assembly on the manhole.
- (c) Attach the vacuum pump assembly to the proper connection on the test head assembly. Make sure the vacuum inlet/outlet valve is in the closed position.
- (d) Inflate the sealing element to twice the test pressure to be used. Do not over inflate.
- (e) Start the vacuum pump assembly engine and allow preset RPMs to stabilize.
- (f) Open the inlet/outlet ball valve and evacuate the manhole to ten-inch (10") Hg (mercury) that is equivalent to approximately 5 PSIG (0.3 bar) backpressure.
- (g) Close the vacuum inlet/outlet ball valve, disconnect the vacuum pump and monitor the vacuum for one (1) minute.
- (h) Allowable leakage - less than one-inch (1") Mercury (Hg) in one (1) minute.
- (i) All manholes that do not meet the minimum amount for the leakage rests must be repaired and re-tested.

5.4 Television Inspection – General Requirements

Prior to construction/final acceptance of any sanitary sewer line by the District, the main shall be inspected internally by television as outlined in this Section. Leakage testing shall be performed prior to televising. The complete job is ready for television inspection when the following work has been completed.

- (a) All sewer pipelines are installed and backfilled.
- (b) All attributes are in place, all inverts are complete and pipelines are accessible.
- (c) All other underground facilities, utility piping and conduits are installed.
- (d) Pipelines have been jet cleaned.
- (e) Final air test has been completed.

When the above work is complete, the Contractor shall arrange for the television inspection. The Contractor of the project will notify the District in writing as to the scheduled date of the television inspection.

After conditions a through e as outlined above, are met, the entire job will be televised.

- (a) A video, accompanied by Standard Form 6.3 shall document defects requiring correction.
- (b) If no deficiencies are observed, the work will be considered satisfactory.

There is no acceptance tolerance for defects such as high and low spots, joint separations, offset joints, chipped ends, cracked or damaged pipe, dimples or bumps in the pipe, or groundwater infiltration.

5.4.1 Inspection Format

Sanitary sewer lines shall be inspected by means of remote CCTV. All CCTV work shall conform to current NASSCO-PACP standards. Contractor shall provide the District with CCTV inspections (video and data collected) entirely in electronic format. Mains shall be tested with three and a half (3.5) gallons of water per minute flowing during televising and shall follow the direction of flow. The camera must be centered in the pipe and the speed of travel shall be slow enough to inspect each pipe joint, and tee connection, and should not, at any time, be faster than 30 feet per minute. The documentation of the work shall consist of PACP CCTV Reports, PACP database, logs, electronic reports, etc. noting important features encountered during the inspection. All CCTV video observations shall be identified by audio and recorded on the District Standard Form 6.3 and is required to accompany each submittal.

5.4.2 CCTV Video Content

Submitted CCTV videos shall include:

- (a) Footage indicator
- (b) Running time
- (c) Date
- (d) Location
- (e) Beginning (upstream) and ending (downstream) manhole numbers for each run. Manhole numbers corresponding with the District's GIS mapping system shall be obtained by the District field inspector.

5.4.3 District Review

The Contractor will be notified in writing of any deficiencies revealed by the television inspection that require repair. If corrective work is indicated and the Contractor wishes to view CCTV videos, he shall contact the District to set a time for the viewing.

5.4.4 Correction of Deficiencies

Those segments of the pipeline system that have been corrected must be re-televised. The procedure outlined in above will be repeated until all deficiencies observed by television inspection have been corrected to the complete satisfaction of the District. Prior to submittal to the District, the CCTV videos shall be reviewed by the Engineer, Applicant, and Contractor for any defect that may be visible. If CCTV videos and cut sheets are submitted to the District that are deemed "unacceptable," the Contractor shall be charged for the time taken by District personnel to review the CCTV videos. The minimum charge shall be one hundred dollars (\$100).

5.5 Sewer Main Repairs

All proposed repairs must be approved by the District Inspector prior to actual repair. Once repair has been made, inspection will be required by a District Inspector. There will be no exception to this requirement. If a repair and/or correction is made in a sewer line segment, the entire line segment shall be required to be re-televised with water flowing. A line segment is defined as the entire length of sewer line from manhole to manhole.

5.6 Protection of Existing Sewer System

On the outlet of the connection point to the existing District sewer main, a mechanical plug shall be installed to prevent any flow, debris and or material from the newly constructed main line from entering the District's system. The plug shall be normally set on the downstream outlet of the manhole. Plugs shall be installed per the direction of

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the District's Inspector. The plug shall be a mechanical-type device and is to be secured to the existing manhole to prevent loss of plug. The plug shall not be removed until Construction Acceptance has occurred.

The Contractor shall be required to make routine inspections of the mechanical plug to insure that no leaking is occurring. If a leak is found, the Contractor shall immediately notify the District and take corrective action.

The District may perform a video inspection of existing sewer mains that could potentially be impacted by construction activities prior to the start of construction and after the completion of construction. Any damage to existing facilities caused by the Contractor shall be repaired at the Contractor's expense.

5.7 Manhole Abandonment

Manholes to be abandoned in place shall have all pipes entering or exiting the structure plugged with lean concrete or controlled low strength material backfill (Flo-Fill). For manholes with existing pipes too large to plug with fill, a bulkhead shall be constructed on the inside of the manhole to prevent the fill from entering the pipes.

Manhole tops or cone section shall be removed to the top of the full barrel diameter section or to a point not less than eighteen (18) inches below final grade. The structure shall then be backfilled with lean concrete or Flo-Fill. Surface restoration shall be completed to match the surrounding areas.

SECTION VI – FORMS

Form 6.1: Pre-Construction Meeting Checklist for Sewer Main Installation

Form 6.2: Sewer System Acceptance Procedure

Form 6.3: Flushing and Televising Cut Sheet

Form 6.4: Bill of Sale – Sewer Main

Form 6.5: Sewer Easement

Form 6.6: Lender's Consent

D-01: Standard Manhole

D-02: Drop Manhole

D-03: Bar Screen Manhole

D-04: Anchor Manhole

D-05: Casing Detail

D-06: Sewer Maintenance Access

D-07: Groundwater Barrier

D-08: Arm Design Turnaround

D-09: Easement Width Detail

D-10: Sewer Pipe Installation

D-11: Water and Sanitary Sewer Separation