

Table of Contents

Section 4010 - Sanitary Sewers		Page No.
Part 1 - General		
1.01	Section Includes	1
1.02	Description of Work	1
1.03	Submittals	1
1.04	Substitutions	1
1.05	Delivery, Storage, and Handling	1
1.06	Scheduling and Conflicts	1
1.07	Special Requirements	1
1.08	Measurement and Payment	1
Part 2 - Products		
2.01	Sanitary Sewer (Gravity Mains)	5
2.02	Sanitary Sewer Force Mains	7
2.03	Casing Pipe	8
2.04	Sanitary Sewer Services	8
2.05	Sanitary Sewer Service Relocations	9
2.06	Sanitary Sewer Cleanout	9
Part 3 - Execution		
3.01	Examination	10
3.02	Gravity Sewer Installation	10
3.03	Sanitary Sewer Installed within a Casing Pipe	10
3.04	Gravity Main Pipe Jointing	11
3.05	Force Main Installation	11
3.06	Sanitary Sewer Service Stubs	11
3.07	Sanitary Sewer Service Relocation	12
3.08	Sanitary Sewer Abandonment	13
3.09	Connection to Existing Manhole	13
3.10	Sanitary Sewer Cleanout	13
3.11	Tolerances	13

Section 4010 - Sanitary Sewers (Continued)		Page No.
3.12	Conflicts	14
3.13	Cleaning, Inspection, and Testing	14
Figures		Figure No.
	Sanitary Sewer Service Stub	4010.201
	Sewage Air Release Valve Pit	4010.202
	Sanitary Sewer Cleanout	4010.203
	Relocate Sanitary Sewer Service in Conflict with New Sewer	4010.901
Section 4020 - Storm Sewers		Page No.
Part 1 - General		
1.01	Section Includes	1
1.02	Description of Work	1
1.03	Submittals	1
1.04	Substitutions	1
1.05	Delivery, Storage, and Handling	1
1.06	Scheduling and Conflicts	1
1.07	Special Requirements	1
1.08	Measurement and Payment	1
Part 2 - Products		
2.01	Storm Sewers	4
2.02	Linear Trench Drain	6
2.03	Casing Pipe	6
2.04	Pipe Aprons	6
2.05	Apron Footings	6
2.06	Apron Guard	6
Part 3 - Execution		
3.01	Examination	7
3.02	Pipe Installation	7
3.03	Storm Sewer Installed within a Casing Pipe	7
3.04	Linear Trench Drain	8

Section 4020 - Storm Sewers (Continued)		Page No.
3.05	Pipe Jointing	8
3.06	Aprons	8
3.07	Tolerances	9
3.08	Conflicts	9
3.09	Storm Sewer Abandonment	10
3.10	Connection to Existing Manhole or Intake	10
3.11	Cleaning, Inspection, and Testing	10
Figures		Figure No.
	Storm Sewer Pipe Connections	4020.211
Section 4030 - Pipe Culverts		Page No.
Part 1 - General		
1.01	Section Includes	1
1.02	Description of Work	1
1.03	Submittals	1
1.04	Substitutions	1
1.05	Delivery, Storage, and Handling	1
1.06	Scheduling and Conflicts	1
1.07	Special Requirements	1
1.08	Measurement and Payment	1
Part 2 - Products		
2.01	Pipe Culverts	3
2.02	Pipe Aprons	4
2.03	Apron Footings	4
2.04	Apron Guard	4
Part 3 - Execution		
3.01	Pipe Culvert Installation	5
3.02	Aprons	5
3.03	Cleaning, Inspection, and Testing	5

Section 4030 - Pipe Culverts (Continued)

Figures	Figure No.
RCP Apron Section Footing	4030.221
Circular Concrete Aprons	4030.222
Arch and Elliptical Concrete Pipe Aprons	4030.223
Concrete Pipe Apron Guard	4030.224
Metal Pipe Aprons and Apron Guards	4030.225

Section 4040 - Subdrains and Footing Drain Collectors**Page No.****Part 1 - General**

1.01	Section Includes	1
1.02	Description of Work	1
1.03	Submittals	1
1.04	Substitutions	1
1.05	Delivery, Storage, and Handling	1
1.06	Scheduling and Conflicts	1
1.07	Special Requirements	1
1.08	Measurement and Payment	1

Part 2 - Products

2.01	Footing Drain Collectors	3
2.02	Type 1 Subdrains (Longitudinal Subdrain)	3
2.03	Type 2 Subdrains (Combination Subdrain/Footing Drain Collector)	4
2.04	Porous Backfill Material	4
2.05	Subdrain Outlets	4
2.06	Subdrain or Footing Drain Cleanouts	5
2.07	Engineering Fabric	5
2.08	Storm Sewer Service Stubs	5

Part 3 - Execution

3.01	Subdrains	6
3.02	Footing Drain Collectors	6
3.03	Footing Drain Service Stubs	6

Section 4040 - Subdrains and Footing Drain Collectors (Continued)

Figures	Figure No.
Subdrains	4040.231
Subdrain Cleanouts	4040.232
Subdrain Outlets	4040.233

Section 4050 - Pipe Cleaning and Rehabilitation**Page No.****Part 1 - General**

1.01	Section Includes	1
1.02	Description of Work	1
1.03	Submittals	1
1.04	Substitutions	3
1.05	Delivery, Storage, and Handling	3
1.06	Scheduling and Conflicts	3
1.07	Special Requirements	3
1.08	Measurement and Payment	4

Part 2 - Products

2.01	CIPP Main Lining	8
2.02	CIPP Point Repair	9
2.03	CIPP Service Repair	9
2.04	Chemical Grout	11
2.05	Sewer Dye	11
2.06	Pipe Repair Couplings for Spot Repairs by Pipe Replacement	11
2.07	Sewer Main Pipe (for Spot Repairs)	11

Part 3 - Execution

3.01	Sewer Cleaning and Inspection	12
3.02	Bypassing Sewage	14
3.03	CIPP Main Lining	14
3.04	CIPP Point Repair	17
3.05	CIPP Service Repair	17

Section 4050 - Pipe Cleaning and Rehabilitation (Continued)		Page No.
3.06	Pressure Testing and Grouting of Sewer Joints	19
3.07	Spot Repairs by Pipe Replacement	22
3.08	Cleanup and Closeout	23
Section 4060 - Cleaning, Inspection, and Testing of Sewers		
Part 1 - General		
1.01	Section Includes	1
1.02	Description of Work	1
1.03	Submittals	1
1.04	Substitutions	1
1.05	Delivery, Storage, and Handling	1
1.06	Scheduling	1
1.07	Special Requirements	1
1.08	Measurement and Payment	1
Part 2 - Products		
2.01	Testing Equipment	2
Part 3 - Execution		
3.01	Cleaning	3
3.02	Video Inspection	3
3.03	Sanitary Sewer Leakage Testing	4
3.04	Deflection Testing	6
3.05	Force Main Testing	7

SANITARY SEWERS**PART 1 - GENERAL****1.01 SECTION INCLUDES**

- A. Sanitary Sewer Gravity Mains
- B. Sanitary Sewer Force Mains
- C. Sanitary Sewer Services

1.02 DESCRIPTION OF WORK

- A. Construct sanitary sewer gravity and force mains.
- B. Construct or relocate building sanitary sewer services, stubs, and connections.

1.03 SUBMITTALS

Comply with Division 1 - General Provisions and Covenants.

1.04 SUBSTITUTIONS

Comply with Division 1 - General Provisions and Covenants.

1.05 DELIVERY, STORAGE, AND HANDLING

Comply with Division 1 - General Provisions and Covenants.

1.06 SCHEDULING AND CONFLICTS

Comply with Division 1 - General Provisions and Covenants.

1.07 SPECIAL REQUIREMENTS

None.

1.08 MEASUREMENT AND PAYMENT**A. Sanitary Sewer Gravity Main:****1. Trenched:**

- a. **Measurement:** Each type and size of pipe installed in a trench will be measured in linear feet along the centerline of the pipe from center of manhole to center of manhole.
- b. **Payment:** Payment will be made at the unit price per linear foot for each type and size of pipe.
- c. **Includes:** Unit price includes, but is not limited to, trench excavation; dewatering; furnishing and installing pipe; pipe lining (if specified); furnishing, placing, and compacting bedding and backfill material; wyes and other fittings; pipe joints; pipe connections; testing; and inspection.

2. Trenchless:

- a. **Measurement:** Each type and size of pipe installed by trenchless methods will be measured in linear feet along the centerline of pipe.
- b. **Payment:** Payment will be made at the unit price per linear foot for each type and size of pipe.
- c. **Includes:** Unit price includes, but is not limited to, furnishing and installing pipe; pipe lining (if specified); trenchless installation materials and equipment; pit excavation; dewatering; placing and compacting backfill material; pipe connections; testing; and inspection.

1.08 MEASUREMENT AND PAYMENT (Continued)**B. Sanitary Sewer Gravity Main with Casing Pipe:****1. Trenched:**

- a. Measurement:** Each type and size of pipe installed with a casing pipe in a trench will be measured in linear feet along the centerline of the casing pipe, from end of casing to end of casing.
- b. Payment:** Payment will be made at the unit price per linear foot for each type and size of carrier pipe.
- c. Includes:** Unit price includes, but is not limited to, furnishing and installing both carrier pipe and casing pipe; pipe lining (if specified); trench excavation; dewatering; furnishing, placing, and compacting bedding and backfill material; furnishing and installing annular space fill material; casing spacers; pipe connections; testing; and inspection.

2. Trenchless:

- a. Measurement:** Each type and size of pipe installed by trenchless methods with a casing pipe will be measured in linear feet along the centerline of the casing pipe from end of casing to end of casing.
- b. Payment:** Payment will be made at the unit price per linear foot for each type and size of carrier pipe.
- c. Includes:** Unit price includes, but is not limited to, furnishing and installing both carrier pipe and casing pipe; pipe lining (if specified); trenchless installation materials and equipment; pit excavation; dewatering; and placing and compacting backfill material; casing spacers; furnishing and installing annular space fill material; pipe connections; testing; and inspection.

C. Sanitary Sewer Force Main:**1. Trenched:**

- a. Measurement:** Each type and size of pipe installed in an open trench will be measured in linear feet along the centerline of the pipe from the outside wall of the pumping station to the center of manhole, or from the center of manhole to the center of manhole.
- b. Payment:** Payment will be made at the unit price per linear foot for each type and size of pipe.
- c. Includes:** Unit price includes, but is not limited to, trench excavation; dewatering; furnishing and installing pipe; furnishing, placing, and compacting bedding and backfill; wyes and other fittings; pipe joints; testing; and inspection.

2. Trenchless:

- a. Measurement:** Each type and size of pipe installed by trenchless methods will be measured in linear feet along the centerline of the pipe.
- b. Payment:** Payment will be made at the unit price per linear foot for each type and size of pipe.
- c. Includes:** Unit price includes, but is not limited to, furnishing and installing pipe; trenchless installation materials and equipment; pit excavation; dewatering; placing and compacting backfill material; pipe connections; testing; and inspection.

D. Sanitary Sewer Force Main with Casing Pipe:**1. Trenched:**

- a. Measurement:** Each type and size of pipe installed with a casing pipe in a trench will be measured in linear feet along the centerline of the casing pipe.
- b. Payment:** Payment will be made at the unit price per linear foot for each type and size of pipe.

1.08 MEASUREMENT AND PAYMENT (Continued)**H. Removal of Sanitary Sewer:**

1. **Measurement:** Each type and size of pipe removed will be measured in linear feet from end to end.
2. **Payment:** Payment will be at the unit price per linear foot for each type and size of pipe.
3. **Includes:** Unit price includes, but is not limited to, removal, disposal, and capping (if specified) of pipe; and furnishing, placing, and compacting backfill material.

I. Sanitary Sewer Cleanout:

1. **Measurement:** Each sanitary sewer cleanout will be counted.
2. **Payment:** Payment will be made at the unit price for each cleanout.
3. **Includes:** Unit price includes, but is not limited to, plug at the end of the main, fittings, riser pipe, cap with screw plug, casting, and concrete casting encasement.

J. Connection to Existing Manhole: Comply with [Section 6010, 1.08, G.](#)**K. Sanitary Sewer Abandonment, Plug:**

1. **Measurement:** Each plug will be counted.
2. **Payment:** Payment will be made at the unit price for each plug installed.
3. **Includes:** Unit price includes, but is not limited to, trench excavation (if necessary), cutting pipe (if required), furnishing and placing plug materials, and placing and compacting backfill material.

L. Sanitary Sewer Abandonment, Fill and Plug:

1. **Measurement:** Each size of sanitary sewer to be abandoned by filling and plugging will be measured in linear feet.
2. **Payment:** Payment will be at the unit price per linear foot for each size of pipe filled and plugged.
3. **Includes:** Unit price includes but is not limited to, trench excavation (if necessary), cutting pipe (if required), furnishing and placing pipe fill material, furnishing and placing plug materials, and placing and compacting backfill material.

PART 2 - PRODUCTS**2.01 SANITARY SEWER (Gravity Mains)****A. Solid Wall Polyvinyl Chloride Pipe (PVC) 8 inch to 15 inch:**

1. Comply with ASTM D 3034, SDR 26, unless SDR 35 is specified.
2. Pipe stiffness per ASTM D 2412.
 - a. SDR 26: Minimum pipe stiffness of 115 psi.
 - b. SDR 35: Minimum pipe stiffness of 46 psi.
3. PVC plastic meeting ASTM D 1784, Cell Classification 12454 or 12364.
4. Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and ASTM F 477.

B. Solid Wall Polyvinyl Chloride Pipe (PVC) 18 inch to 27 inch:

1. Comply with ASTM F 679.
2. Pipe stiffness per ASTM D 2412, 46 psi.
3. PVC plastic meeting ASTM D 1784, Cell Classification 12454 or 12364.
4. Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and ASTM F 477.

C. Corrugated Polyvinyl Chloride Pipe (PVC) 8 inch to 36 inch:

1. Comply with ASTM F 949, smooth interior, corrugated exterior.
2. Pipe stiffness per ASTM D 2412.
 - a. 8 inch to 10 inch: Minimum pipe stiffness of 115 psi, unless 46 psi is specified.
 - b. 12 inch to 36 inch: Minimum pipe stiffness of 46 psi.
3. PVC resin meeting ASTM D 1784, Cell Classification 12454.
4. Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and ASTM F 477.

D. Closed Profile Polyvinyl Chloride Pipe (PVC) 21 inch to 36 inch:

1. Comply with ASTM F 1803.
2. Pipe stiffness per ASTM D 2412, 46 psi.
3. PVC plastic meeting ASTM D 1784, Cell Classification 12364.
4. Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and ASTM F 477.

2.01 SANITARY SEWER (Gravity Mains) (Continued)**E. Polyvinyl Chloride Composite Pipe (truss type PVC) 8 inch to 15 inch:**

1. Comply with ASTM D 2680. Pipe constructed with truss-type structure between inner and outer PVC walls with voids filled with lightweight concrete.
2. Pipe stiffness per ASTM D 2412, 200 psi.
3. PVC plastic meeting ASTM D 1784, Cell Classification 12454.
4. Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and F 477.

F. Reinforced Concrete Pipe (RCP) 18 inch to 144 inch:**1. General:**

- a. Comply with ASTM C 76 (AASHTO M 170).
- b. Minimum Class IV (3000D), Wall B.
- c. Tongue and groove joints.
- d. Rubber O-ring or profile gasket flexible joint complying with ASTM C 443.

2. Pipe Lining:

- a. Epoxy Coal Tar:
 - 1) Coat interior pipe barrel and all joint surfaces with two-component coal-tar epoxy-polyamide black paint or approved equal.
 - 2) Lining Material: Steel Structures Painting Council (SSPC) Specification No. 16, Table 1.
 - a) Minimum epoxy resin content 34% to 35% by dry film weight.
 - b) Minimum sag resistance 40 mils.
 - c) Minimum solids 80% by volume.
 - 3) Apply according to lining material manufacturer's recommendations.
- b. PVC:
 - 1) Minimum thickness of 0.65 inch.
 - 2) Locking extensions extruded from the same material as the liner a minimum of 0.375 inches tall spaced a maximum of 2.5 inches.
 - 3) Liner to cover the entire interior of the concrete pipe.
 - 4) Minimum tensile strength of liner is 2200 psi with a minimum elongation of 200% at breaking.
 - 5) Meet EPA 9090 for chemical resistance.
 - 6) Free of cracks, cleavages, pinholes, or other defects.
 - 7) Joint sealer strip to be from the same material as the liner.
- c. HDPE:
 - 1) Minimum thickness of 0.064 inches according to ASTM D5199.
 - 2) Minimum density of 0.90 g/cm³.
 - 3) Meet EPA 9090 for chemical resistance.
 - 4) Locking extensions made from the same material as the liner with minimum pullout strength of 14,000 pounds per square foot.
 - 5) Free of cracks, cleavages, pinholes, or other defects.
 - 6) Joint sealer strip to be from the same material as the liner.
 - 7) If gasketed joints, comply with ASTM F 477 and ability to withstand a minimum groundwater pressure equal to that of the pipe liner or 20 psi, whichever is greater.

G. Ductile Iron Pipe (DIP) 8 inch to 54 inch:**1. General:**

- a. Comply with AWWA C151.
- b. Minimum thickness Class 52.

2.01 SANITARY SEWER (Gravity Mains) (Continued)**2. Interior Linings:**

- a. Provide interior lining for ductile iron pipe and fittings used for all gravity sewers and drop connections.
- b. Use linings specifically designed for sanitary sewer applications, such as ceramic epoxy. Other lining types may be allowed upon approval of the Engineer.
- c. Apply lining to interior of unlined ductile iron pipe and fittings according to the published specifications from the manufacturer.
- d. Seal all cut ends and repair field damaged areas according to the manufacturer's recommendations.

3. Exterior Coating: Asphalt.**4. Joints:** Push-on complying with AWWA C111.**5. Fittings:** Mechanical complying with AWWA C110 or AWWA C153.**6. Polyethylene Encasement:**

- a. Comply with AWWA C105.
- b. Minimum thickness of 8 mils.
- c. Use for all ductile iron pipe and fittings in buried service.

H. Vitrified Clay Pipe (VCP) 8 inch to 42 inch:

1. Pipe and fittings complying with ASTM C 700.
2. Compression joints complying with ASTM C 425 for plain end pipe or bell and spigot pipe.
3. Test according to ASTM C 301.

I. Double Walled Polypropylene Pipe 12 inch to 30 inch:

1. Comply with ASTM F 2764.
2. Minimum pipe stiffness per ASTM D 2412, 46 psi.
3. Integral bell and spigot joint complying with ASTM D 3212 and ASTM F 477.

J. Triple Walled Polypropylene Pipe 30 inch to 36 inch:

1. Comply with ASTM F 2764.
2. Minimum pipe stiffness per ASTM D 2412, 46 psi.
3. Integral bell and spigot joint complying with ASTM D 3212 and ASTM F 477.

2.02 SANITARY SEWER FORCE MAINS

A. Ductile Iron Pipe (DIP) 4 inch to 54 inch: Comply with the DIP requirements in Section 4010, 2.01. If joint restraints are specified, comply with [Section 5010, 2.03](#).

B. Polyvinyl Chloride Pipe (PVC): Comply with the requirements in [Section 5010, 2.01](#) for PVC pipe. Provide restrained joints when specified.

C. Fusible PVC and HDPE Pipe: Comply with the requirements in [Section 5011, 2.01](#).

2.02 SANITARY SEWER FORCE MAINS (Continued)**D. Sewage Air Release Valve:**

1. **General:** Consists of an elongated tapered or conical body and a float to operate (open and close) under pressure without spillage. Provide valves suitable for pressures up to 150 psi. Use a float with a linkage connection to the seal plug assembly to prevent irregular air release and protect the connecting rod. Ensure the bottom of the valve body is sloped or funnel-shaped to encourage the accumulated sewage and solids to drain from the valve. Preserve a volume of air at all times between the liquid sewage and the seal plug assembly. Provide a flushing port with attachments for backwashing.
2. **Materials:**
 - a. **Body and Cover:**
 - 1) Stainless Steel: ASTM A 351.
 - 2) Cast Iron: ASTM A 126, Grade B.
 - 3) Ductile Iron: ASTM A 536, Grade 65-45-12.
 - 4) Other corrosion resistant materials.
 - b. **Internal Metal Components:** Stainless steel.
 - c. **Float:** Stainless steel, ASTM A 240, Type 304 or Type 316, or foamed polypropylene.
 - d. **Seal Plug Assembly:** Stainless steel, foamed polypropylene, EPDM rubber, Nitrile (Buna-N) rubber, and reinforced nylon.
3. **Tapping Saddle:** Stainless steel or nylon.
4. **Pit:** Construct according to [Figure 4010.202](#).

E. Tracer Wire: Comply with [Section 5010, 2.05](#). Tracer wire will be required on all force mains.

F. Tracer Wire Station:

1. Two internal terminals with shunt.
2. Five to six foot plastic post (color as specified by the Jurisdiction).
3. Removable top cap with lock.
4. Decals indicating "Sewer Force Main" or similar language.

2.03 CASING PIPE

Comply with [Section 3020, 2.02](#) for casing pipe requirements.

2.04 SANITARY SEWER SERVICES**A. Connection to Main:**

1. **PVC Main:**
 - a. Preformed wye or tee service fitting with integral bell and spigot joints with elastomeric seals complying with ASTM D 3034 or ASTM F 949.
 - b. Preformed saddle wye or saddle tee for service tap complying with ASTM D 3034 or ASTM F 949.
 - c. PVC plastic meeting ASTM D 1784, Cell Classification 12454.

2.04 SANITARY SEWER SERVICES (Continued)

- 2. PVC Composite Main:**
 - a. Preformed wye or tee service fitting with integral bell and spigot joints with elastomeric seals complying with ASTM D 3212.
 - b. Preformed saddle wye or saddle tee for service tap complying with ASTM D 2680.
- 3. RCP Main:** Preformed saddle wye or saddle tee service tap designed for use with RCP.
- 4. VCP Main:**
 - a. Precast VCP wye or tee service fitting complying with ASTM C 700 for pipe and ASTM C 425 for compression joints.
 - b. Preformed saddle wye or saddle tee service tap designed for use with VCP.
- 5. DIP Main:**
 - a. Use DIP wye or tee fittings complying with AWWA C110 or AWWA C153.
 - b. Preformed saddle wye or tee services tap designed for use with DIP. Cut the hole for the tap with equipment designed for application.
- B. Wye and Tee Pipe Stop:** All saddle wye or saddle tee fittings must provide integrally molded pipe stop in the branch for positive protection against service pipe insertion beyond the inside of sewer main pipe wall.
- C. Service Pipe:** Use products as required by local plumbing code or regulations, if applicable. Otherwise, use the following:
 - 1. PVC:**
 - a. Comply with ASTM D 3034, minimum thickness SDR 23.5 minimum pipe stiffness of 153 psi as per ASTM D 2412.
 - b. PVC plastic meeting ASTM D 1784, Cell Classification 12454.
 - c. Integral bell and spigot type rubber gasket joint complying with ASTM D 3212.
 - 2. DIP:** As specified for sanitary sewer force main, including polyethylene encasement.
- D. Connection to Existing Service:** Comply with [Section 4050, 2.06](#).

2.05 SANITARY SEWER SERVICE RELOCATIONS

- A. Comply with Section 4010, 2.04 for all materials used for sanitary service relocation.
- B. Use the same nominal size as the existing service being relocated.

2.06 SANITARY SEWER CLEANOUT

Comply with [Figure 4010.203](#).

PART 3 - EXECUTION**3.01 EXAMINATION**

- A. Verify measurements at site. Make necessary field measurements to accurately determine pipe makeup lengths or closures.
- B. Examine site conditions to ensure construction operations do not pose hazards to adjacent structures or facilities.

3.02 GRAVITY SEWER INSTALLATION**A. General:**

- 1. Install watertight plug to prevent water from entering the existing sewer system.
- 2. Clean pipe interior and joints prior to installation. Keep pipe clean during construction.
- 3. Begin at the lowest point in the line. Lay groove or bell end pointing upstream unless otherwise specified.
- 4. Assemble joints according to Section 4010, 3.04.
- 5. Use a saw to cut ends of pipe flush with inside wall of manholes and structures. Do not use hammer or other means to break pipe.
- 6. Provide manholes as specified in the contract documents.
- 7. Install cap, plug, or bulkhead at exposed ends of pipe upon completion of construction or whenever pipe installation is not in progress.

B. Trenched:

- 1. Excavate trench and provide pipe bedding and backfill material as specified in [Section 3010](#).
- 2. Prepare trench bottom to design line and grade so that only minor movement of the pipe is necessary after installation.
- 3. Lay pipe to design line and grade. Set field grades to invert of pipes.
- 4. Provide uniform bearing for full pipe barrel length. Excavate bell holes as necessary for uniform support of pipe barrel on bedding material.
- 5. Do not lay pipe in water or on saturated soil or bedding, or allow water to rise in trench around pipe prior to placing backfill material.
- 6. Do not disturb installed pipe and bedding when using movable trench boxes and shields. Block or anchor pipe as necessary to prevent joint displacement.
- 7. Install wye or tee service fitting at each location specified in the contract documents.

C. Trenchless: Comply with [Section 3020](#).**3.03 SANITARY SEWER INSTALLED WITHIN A CASING PIPE**

Comply with [Section 3020, 3.04](#) for installation of sanitary sewer within casing pipe.

3.04 GRAVITY MAIN PIPE JOINTING**A. General:**

1. Clean joint surfaces to remove soil or foreign material prior to jointing pipe.
2. Assemble joints according to pipe manufacturer's recommendations. Use equipment that does not apply damaging forces to pipe joints.

B. Polyvinyl Chloride Pipe (PVC) and Polyvinyl Chloride Composite Pipe (truss-type):

1. Coat rubber gasket and joint with soap-based lubricant immediately prior to closing joint.
2. Seal ends of PVC composite and closed profile pipe at manholes with the coating recommended by the manufacturer.

C. Reinforced Concrete Pipe (RCP): Coat rubber gasket and joint with soap-based lubricant immediately prior to closing joint.**D. Ductile Iron Pipe (DIP):**

1. Push-on Joint: Coat gasket and joint with soap-based lubricant immediately prior to closing joint.
2. Mechanical Joint: Wash plain end, bell socket, and gasket with soap solution. Press gasket into socket, set gland, and tighten bolts uniformly.

E. Polypropylene Pipe: Coat gasket and bell with lubricant immediately prior to closing joint.**F. Connections between Dissimilar Pipes:**

1. Use manufactured adapters or couplings approved by the Engineer.
2. Where adapters or couplings are not available, the Engineer may authorize use of a Type PC-2 concrete collar as shown on [Figure 4020.211](#).

3.05 FORCE MAIN INSTALLATION**A. General:** Install according to [Section 5010](#).**B. Tracer Wire:**

1. Required for all force main installations. Comply with [Section 5010](#).
2. Install tracer wire station at each end of the force main and at additional locations specified in the contract documents.
3. Bury end of tracer wire station 2 feet and compact.

3.06 SANITARY SEWER SERVICE STUBS**A.** Provide sanitary sewer service stubs at locations specified in the contract documents.**B.** Install wye or tee for each service connection.

1. Connection of sanitary service to new sewer main, except RCP:
 - a. Use only factory wye or tees.
 - b. Install according to manufacturer's requirements and Section 4010, 2.04 and 3.04 for joints.

3.06 SANITARY SEWER SERVICE STUBS (Continued)

2. Connection to existing sewer main and new RCP:
 - a. Cut sewer main for service tap with hole saw or sewer tap drill.
 - b. Use preformed saddle wye or saddle tee for service tap. Use a gasketed saddle with rigid pipe mains and a solvent-cemented saddle with PVC mains.
 - c. Install according to the manufacturer's requirements, but always attach with at least two stainless steel band clamps.
- C. Install service stub from sewer main to a location 10 feet beyond the right-of-way line or as specified in the contract documents. Comply with [Figure 4010.201](#).
 1. Install according to Section 4010, 3.02.
 2. Install service stub with a slope between 2% and 5% for 4 inch pipes, and between 1% and 5% for pipes 6 inches and greater.
 3. Terminate end of service stub 10 to 12 feet below finished ground elevation or as specified in the contract documents.
 4. If the depth of the sewer main causes the service to exceed a depth of 12 feet or a slope of 5%, install a service riser.
 5. For undeveloped properties, place watertight stopper, cap, or plug in end of sanitary sewer service. Mark the end of the service line as required by the Jurisdiction or as specified in the contract documents.
 6. For reconnection of new service pipe with existing service pipe, comply with the Jurisdiction's plumbing code.

3.07 SANITARY SEWER SERVICE RELOCATION

- A. Relocate existing sanitary sewer services that conflict with new storm or sanitary sewer installations. Existing services located within a conflict zone from 6 inches below the bottom of the proposed sewer pipe to 2 inches above the top of the proposed sewer pipe require relocation.
- B. When a conflicting service is encountered:
 1. Determine grades and elevations of the existing service and proposed main.
 2. Determine the extent of service replacement necessary to relocate the service outside of the conflict zone while maintaining a minimum 1% slope on the sewer service.
 3. If it is not feasible to maintain a minimum slope of 1% on the relocated service, a special design and additional work may be required. Stop work and contact the Engineer. Do not remove sewer service unless directed by the Engineer.
 4. If service relocation with a minimum slope of 1% is feasible, proceed with removal and replacement of the existing sanitary sewer service.
 - a. Length of replacement varies. Remove the existing service to the extent necessary to move the service out of the conflict zone.
 - b. Use all new materials complying with Section 4010, 2.04.
 - c. Re-install the service according to Section 4010, 3.02.
 - d. Maintain a minimum 1% grade on relocated service.

3.08 SANITARY SEWER ABANDONMENT**A. Plug:**

1. Prior to placing the sewer plug, the Engineer will verify the sewer line is not in use.
2. Construct sewer plug by completely filling the end of the pipe with concrete. Force concrete into the end of the pipe for a distance of 16 inches, or one-half the pipe diameter, whichever is greater.

B. Fill:

1. Prior to filling the sewer, the Engineer will verify the sewer line is not in use.
2. If specified in the contract documents, fill the line to be abandoned with flowable mortar, foamed cellular concrete, or CLSM (comply with [Section 3010](#)) by gravity flow or pumping.
3. Batching, mixing, and placing may be started when temperature is 34°F and rising. Cease mixing and placing when temperature is 38°F or less and falling.

3.09 CONNECTION TO EXISTING MANHOLE

Comply with [Section 6010, 3.05](#).

3.10 SANITARY SEWER CLEANOUT

Provide cleanouts where specified in the contract documents. Comply with [Figure 4010.203](#).

3.11 TOLERANCES

Apply the following tolerances to utilities installed by open trench construction. For trenchless construction, comply with [Section 3020](#).

A. Gravity Main:

1. Do not allow horizontal and vertical alignment to vary from design line and grade at any structure by more than 1% of the inside diameter of the pipe or 1/4 inch, whichever is larger.
2. Do not allow the horizontal alignment of the pipe to vary from design line at any point along the pipe by more than 1% of the inside diameter of the pipe.
3. Low spots holding water exceeding the following depths for each pipe size will be considered unacceptable and must be removed and reinstalled to proper grade.

Pipe Diameter	Maximum Low Spot Depth
8"	1/2"
10"	1/2"
12"	3/4"
15"	3/4"
18" and Larger	5% of Pipe Diameter*

* Measured to the nearest 1/2"

- B. Force Main:** Do not allow horizontal and vertical alignment of trenched force mains to vary from design line and grade by more than 3 inches.

3.12 CONFLICTS**A. Horizontal Separation of Gravity Sanitary and Combined Sewers from Water Mains:**

Separate gravity sanitary and combined sewer mains from water mains by a horizontal distance of at least 10 feet unless:

1. The top of a sewer main is at least 18 inches below the bottom of the water main, and
2. The sewer is placed in a separate trench or in the same trench on a bench of undisturbed earth at a minimum horizontal separation of 3 feet from the water main.
3. When it is impossible to obtain the required horizontal clearance of 3 feet and a vertical clearance of 18 inches between sewers and water mains, provide a linear separation of at least 2 feet and one of the following:
 - a. Construct sanitary and combined sewers of water main materials meeting the requirements of [Section 5010, 2.01](#).
 - b. Enclose the water main in a watertight casing pipe with an evenly spaced annular gap and watertight end seals.

B. Horizontal Separation of Water Mains from Sanitary and Combined Sewer Manholes:

Ensure water pipes do not pass through or come in contact with any part of a sanitary or combined sewer manhole. Maintain a minimum horizontal separation of 3 feet.

C. Separation of Sanitary Sewer Force Mains from Water Mains: Separate sanitary sewer force mains and water mains by a horizontal distance of at least 10 feet unless:

1. The force main is constructed of water main materials meeting a minimum pressure rating of 150 psi and the requirements of [Section 5010, 2.01](#) and
2. The sewer force main is laid at least 4 linear feet from the water main.

D. Separation of Sanitary and Combined Sewers and Water Main Crossovers:

1. Vertically separate sanitary sewers crossing under any water main by at least 18 inches when measured from the top of the sewer to the bottom of the water main. If physical conditions prohibit the separation, do not place the sewer closer than 6 inches below a water main or 18 inches above a water main. Maintain the maximum feasible separation distance in all cases.
2. Where the sanitary sewer crosses over or is less than 18 inches below a water main, utilize one of the following within 10 feet measured edge-to-edge horizontally, centered on the crossing:
 - a. Construct sewer pipe of water main material.
 - b. Enclose the water main in a watertight casing pipe with an evenly spaced annular gap and watertight end seals.

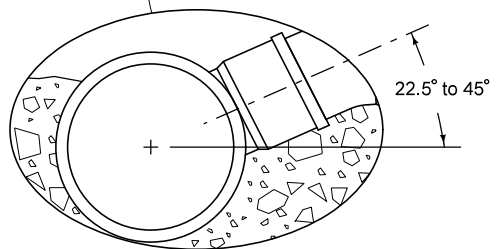
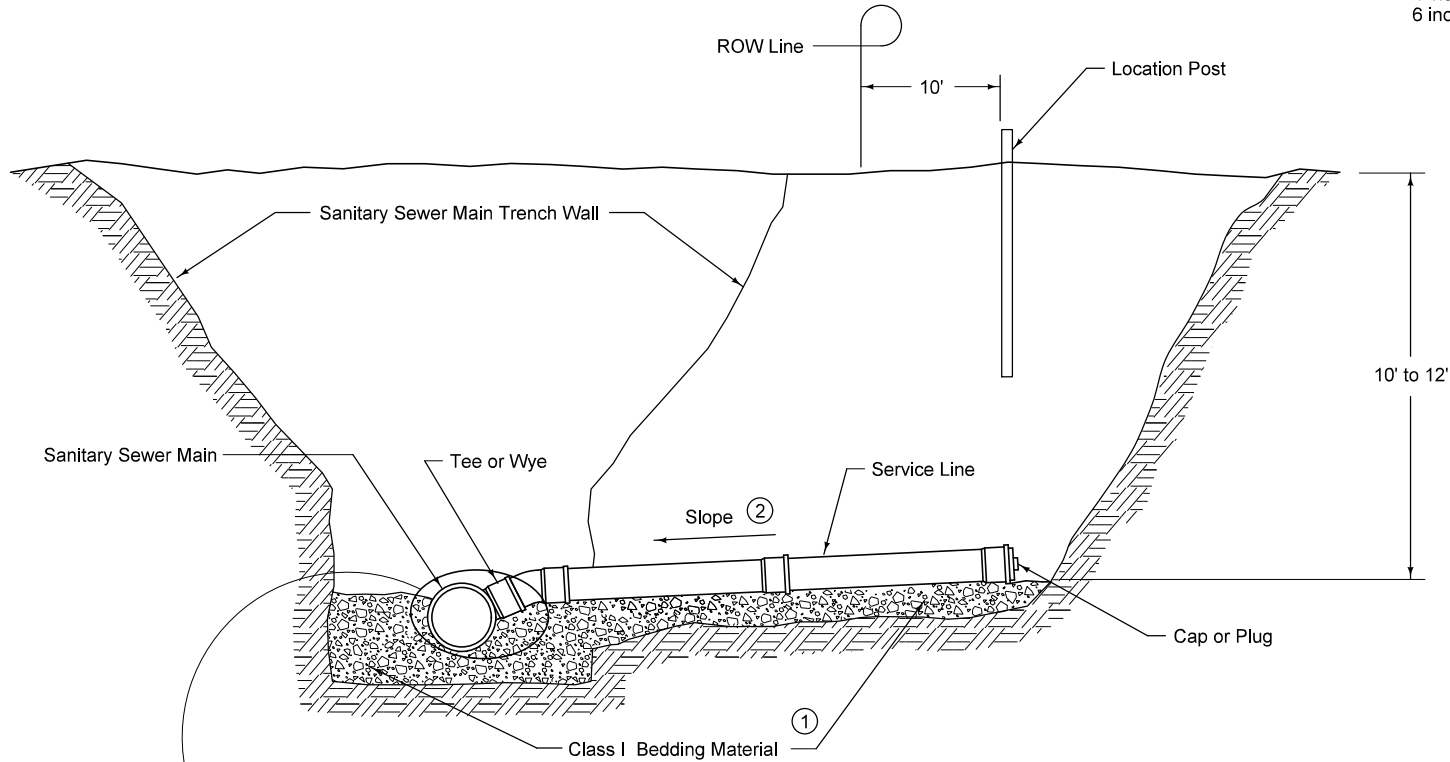
3.13 CLEANING, INSPECTION, AND TESTING

Clean, inspect, and test sanitary sewer per [Section 4060](#).

END OF SECTION

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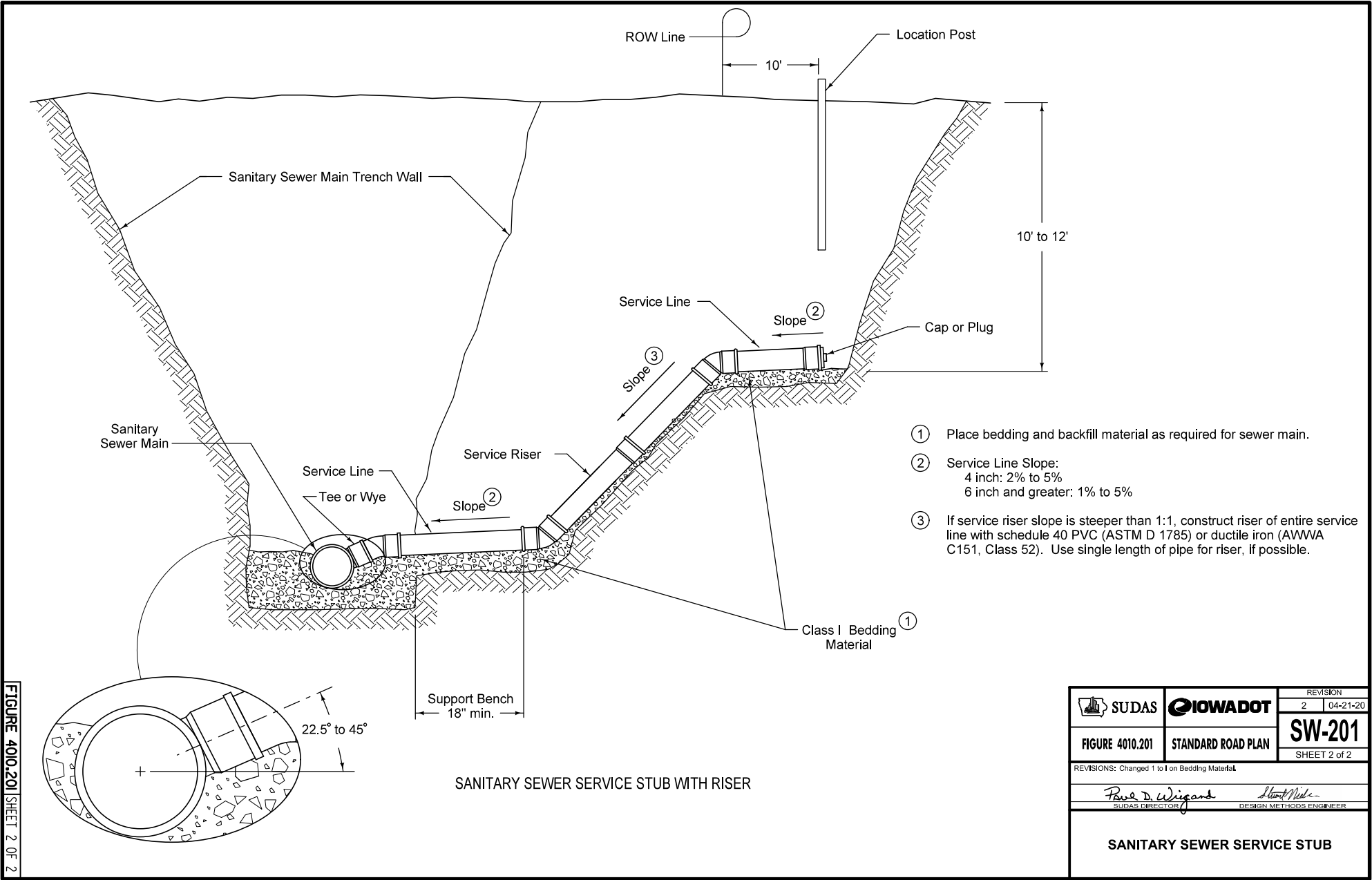
- ① Place bedding and backfill material as required for sewer main.
- ② Service Line Slope:
4 inch: 2% to 5%
6 inch and greater: 1% to 5%



SANITARY SEWER SERVICE STUB

FIGURE 4010.201 SHEET 1 OF 2

SUDAS	IOWADOT	REVISION	
		2	04-21-20
FIGURE 4010.201	STANDARD ROAD PLAN	SW-201	
		SHEET 1 of 2	
REVISIONS: Changed 1 to 1 on Bedding Material.			
 FRED D. WIGAND SUDAS DIRECTOR		 STUART MILLER DESIGN METHODS ENGINEER	
SANITARY SEWER SERVICE STUB			

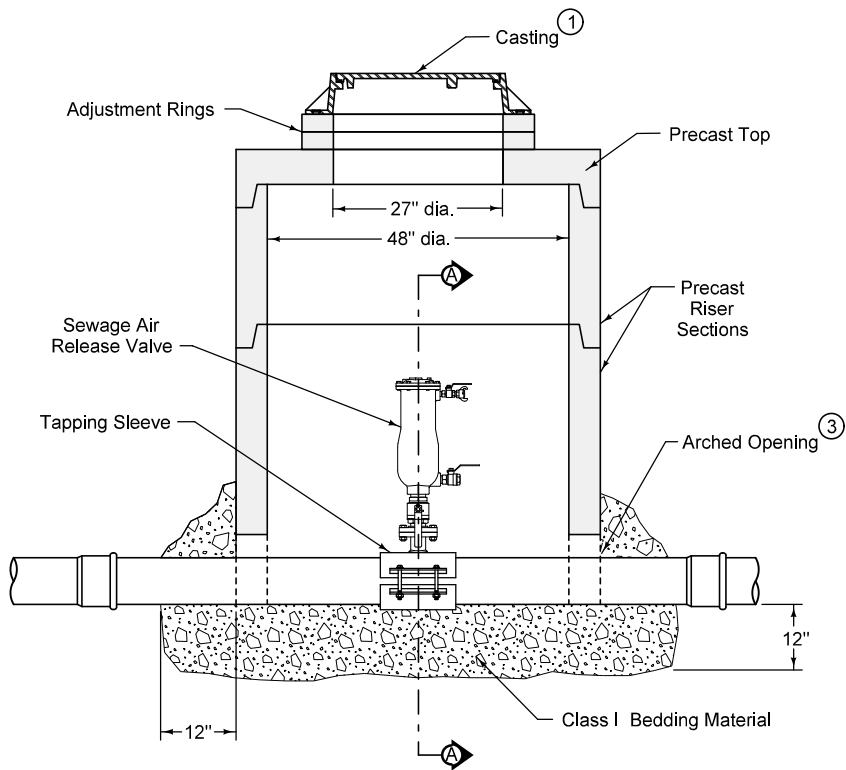


- ① Place bedding and backfill material as required for sewer main.
- ② Service Line Slope:
4 inch: 2% to 5%
6 inch and greater: 1% to 5%
- ③ If service riser slope is steeper than 1:1, construct riser of entire service line with schedule 40 PVC (ASTM D 1785) or ductile iron (AWWA C151, Class 52). Use single length of pipe for riser, if possible.

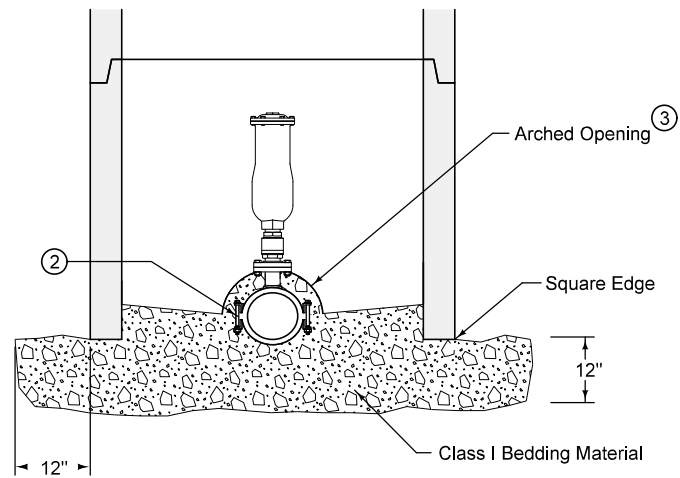
SANITARY SEWER SERVICE STUB WITH RISER

FIGURE 4010.201 SHEET 2 OF 2

SUDAS	IOWADOT	REVISION
		2 04-21-20
FIGURE 4010.201	STANDARD ROAD PLAN	SW-201
REVISIONS: Changed 1 to 1 on Bedding Material		SHEET 2 of 2
Paul D. Wigand SUDAS DIRECTOR		Steve Miller DESIGN METHODS ENGINEER
SANITARY SEWER SERVICE STUB		



TYPICAL SECTION

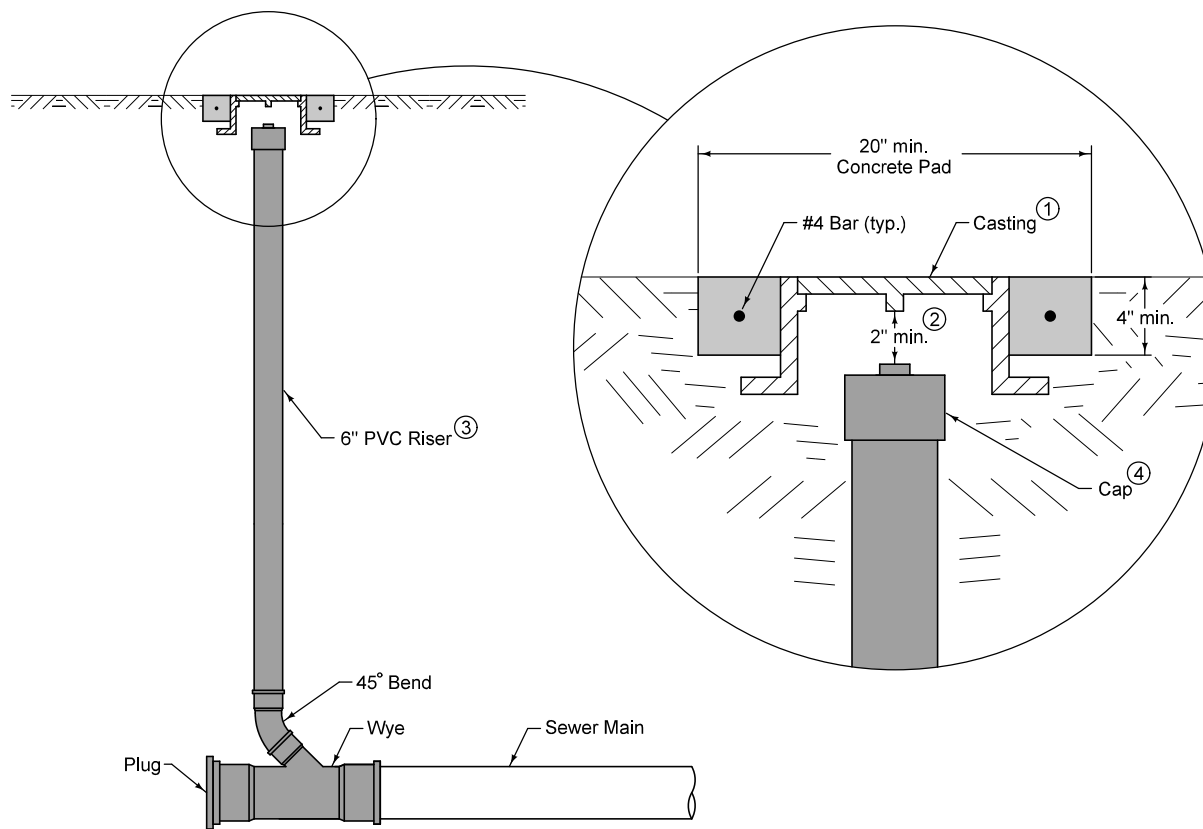


SECTION A-A

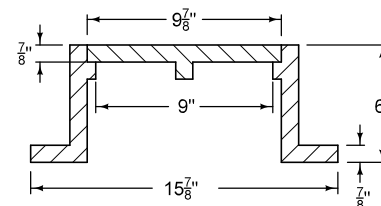
- ① SW-601 Type A or SW-602 Type G casting.
- ② Place bedding material to springline of pipe.
- ③ Prevent riser from bearing on pipe by providing an arched opening with a diameter up to 6 inches larger than pipe diameter.

FIGURE 4010.202 SHEET 1 OF 1

SUDAS	IOWADOT	REVISION
		2 04-21-20
FIGURE 4010.202	STANDARD ROAD PLAN	SW-202
		SHEET 1 of 1
REVISIONS: Changed 1 to 1 on Bedding Material		
Paul D. Wigand SUDAS DIRECTOR		Stuart Nadeau DESIGN METHODS ENGINEER
SEWAGE AIR RELEASE VALVE PIT		



- ① Standard duty casting complying with AASHTO M 306. Mark lid with "Sanitary" or "Sanitary C.O."
- ② Do not allow casting to bear on top of riser pipe.
- ③ 6 inch PVC Service Pipe
- ④ Threaded PVC cap or iron body ferrule with brass screw plug



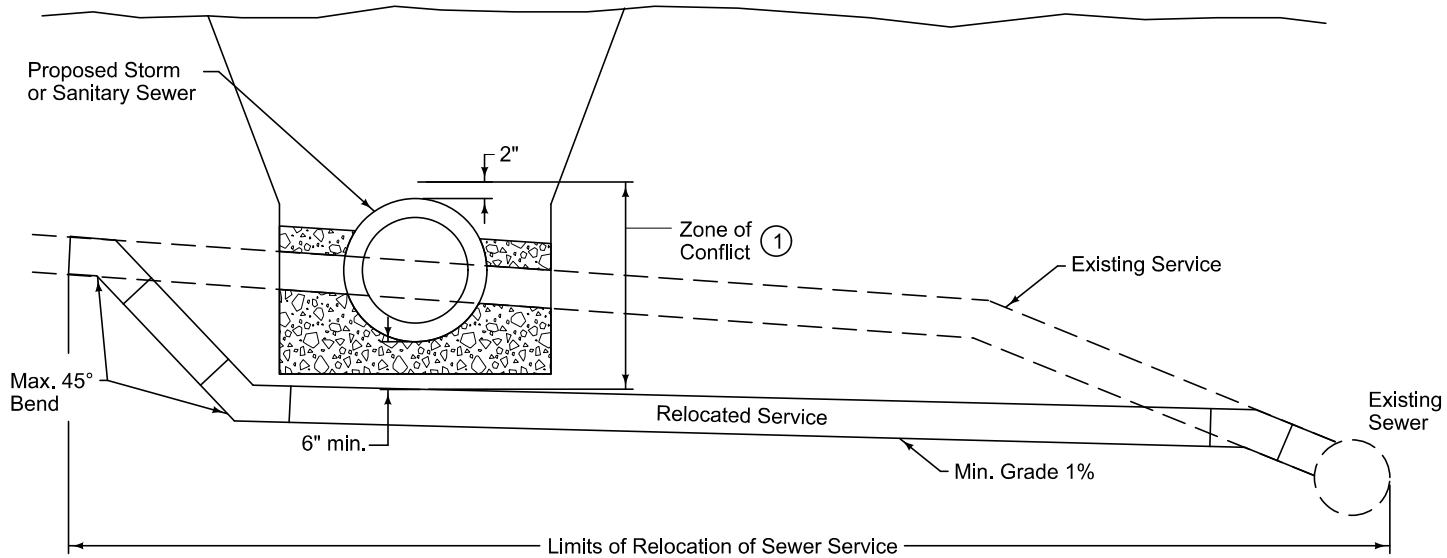
CASTING ①
(Dimensions are nominal)

CLEANOUT

FIGURE 4010.203 SHEET 1 OF 1

SUDAS	IOWADOT	REVISION
		1 04-17-18
FIGURE 4010.203	STANDARD ROAD PLAN	SW-203
		SHEET 1 of 1
<small>REVISIONS: Replaced Iowa DOT and SUDAS logos.</small>		
<i>Paul D. Wigand</i> SUDAS DIRECTOR		<i>Brian Smith</i> DESIGN METHODS ENGINEER
SANITARY SEWER CLEANOUT		

① Zone of conflict is from 6 inches below the bottom of sewer pipe to 2 inches above the top of pipe.



	Service Status	Contractor's Responsibility	Compensation
1.	Service located outside zone of conflict	Provide protection; if damaged, repair according to local government's plumbing code	Incidental to other work
2.	Service located in zone of conflict	Relocate service according to Section 4010, 3.07	Bid item; sanitary sewer service relocation
3.	Service located in zone of conflict, but elevations do not allow simple relocation as detailed above; special design required	Relocate service as directed by the Engineer	Change order

FIGURE 4010.901 SHEET 1 OF 1

	REVISION 1 10-21-14
	SUDAS 4010.901
	SHEET 1 of 1
SUDAS Standard Specifications	
RELOCATE SANITARY SEWER SERVICE IN CONFLICT WITH NEW SEWER	

STORM SEWERS**PART 1 - GENERAL****1.01 SECTION INCLUDES**

- A. Storm Sewers
- B. Abandonment of Storm Sewers

1.02 DESCRIPTION OF WORK

- A. Construct storm sewers.
- B. Abandon storm sewers.

1.03 SUBMITTALS

Comply with Division 1 - General Provisions and Covenants.

1.04 SUBSTITUTIONS

Comply with Division 1 - General Provisions and Covenants.

1.05 DELIVERY, STORAGE, AND HANDLING

Comply with Division 1 - General Provisions and Covenants.

1.06 SCHEDULING AND CONFLICTS

Comply with Division 1 - General Provisions and Covenants.

1.07 SPECIAL REQUIREMENTS

None.

1.08 MEASUREMENT AND PAYMENT**A. Storm Sewer:****1. Trenched:**

- a. **Measurement:** Each type and size of pipe installed in a trench will be measured in linear feet along the centerline of the pipe from center of intake or manhole to center of intake or manhole. Where the end of the pipe discharges to a ditch or waterway, measurement will be to the end of the pipe, exclusive of aprons. Lengths of elbows and tees will be included in the length of pipe measured.
- b. **Payment:** Payment will be made at the unit price per linear foot for each type and size of pipe.
- c. **Includes:** Unit price includes, but is not limited to, trench excavation; dewatering; furnishing and installing pipe; furnishing, placing, and compacting bedding and backfill material; joint wrapping; wyes and other fittings; pipe joints; pipe connections; testing; and inspection.

1.08 MEASUREMENT AND PAYMENT (Continued)**2. Trenchless:**

- a. **Measurement:** Each type and size of pipe installed by trenchless methods will be measured in linear feet along the centerline of the pipe.
- b. **Payment:** Payment will be made at the unit price per linear foot for each type and size of pipe.
- c. **Includes:** Unit price includes, but is not limited to, furnishing and installing pipe; trenchless installation materials and equipment; pit excavation; dewatering; placing and compacting backfill material; pipe connections; testing; and inspection.

B. Storm Sewer with Casing Pipe:**1. Trenched:**

- a. **Measurement:** Each type and size of pipe installed with a casing pipe in a trench will be measured in linear feet along the centerline of the casing pipe from end of casing to end of casing.
- b. **Payment:** Payment will be made at the unit price per linear foot for each type and size of pipe.
- c. **Includes:** Unit price includes, but is not limited to, furnishing and installing both carrier pipe and casing pipe; trench excavation; dewatering; furnishing, placing, and compacting bedding and backfill material; furnishing and installing annular space fill material; casing spacers; pipe connections; testing; and inspection.

2. Trenchless:

- a. **Measurement:** Each type and size of pipe installed by trenchless methods with a casing pipe will be measured in linear feet along the centerline of the casing pipe from end of casing to end of casing.
- b. **Payment:** Payment will be made at the unit price per linear foot for each type and size of carrier pipe.
- c. **Includes:** Unit price includes, but is not limited to, furnishing and installing both carrier pipe and casing pipe; trenchless installation materials and equipment; pit excavation; dewatering; placing and compacting backfill material; casing spacers; furnishing and installing annular space fill material; pipe connections; testing; and inspection.

C. Linear Trench Drain:

1. **Measurement:** Measurement will be in linear feet from end to end.
2. **Payment:** Payment will be at the unit price per linear feet of linear trench drain installed.
3. **Includes:** Price includes, but is not limited to, furnishing and installing the linear trench drain including all appurtenances; furnishing and placement of PCC transition; furnishing, excavation, and backfill of discharge pipe; connection to manhole or intake, if required; installation of apron, if required.

D. Removal of Storm Sewer:

1. **Measurement:** Each type and size of pipe removed will be measured in linear feet from end to end.
2. **Payment:** Payment will be made at the unit price per linear foot for each type and size of pipe removed.
3. **Includes:** Unit price includes, but is not limited to, removal, disposal, and capping (if specified) of pipe; and furnishing, placing, and compacting backfill material.

1.08 MEASUREMENT AND PAYMENT (Continued)

E. Connection to Existing Manhole or Intake: Comply with [Section 6010.1.08.G](#).

F. Storm Sewer Abandonment, Plug:

1. **Measurement:** Each plug will be counted.
2. **Payment:** Payment will be made at the unit price for each plug installed.
3. **Includes:** Unit price includes, but is not limited to, trench excavation (if necessary), cutting pipe (if required), furnishing and placing plug materials, and placing and compacting backfill material.

G. Storm Sewer Abandonment, Fill and Plug:

1. **Measurement:** Each size of storm sewer to be abandoned by filling and plugging will be measured in linear feet.
2. **Payment:** Payment will be at the unit price per linear foot for each size of pipe filled and plugged.
3. **Includes:** Unit price includes but is not limited to, trench excavation (if necessary), cutting pipe (if required), furnishing and placing pipe fill material, furnishing and placing plug materials, and placing and compacting backfill material.

H. Aprons: Comply with [Section 4030](#) for pipe aprons, apron footings, and apron guards.

PART 2 - PRODUCTS**2.01 STORM SEWERS****A. Reinforced Concrete Pipe (RCP):**

1. Comply with ASTM C 76.
2. Minimum Class III, Wall B (Iowa DOT Class 2000D).
3. Use tongue and groove joints wrapped with engineering fabric, unless a rubber O-ring or profile gasket complying with ASTM C 443 is specified.

B. Reinforced Concrete Arch Pipe (RCAP):

1. Comply with ASTM C 506.
2. Minimum Class A-III (Iowa DOT Class 2000D).
3. Use tongue and groove joints wrapped with engineering fabric, unless a rubber O-ring or profile gasket complying with ASTM C 443 is specified.

C. Reinforced Concrete Elliptical Pipe (RCEP):

1. Comply with ASTM C 507.
2. Minimum Class HE III (Iowa DOT Class 2000D) or Class VE III (Iowa DOT Class 2000D).
3. Use tongue and groove joints wrapped with engineering fabric, unless a rubber O-ring or profile gasket complying with ASTM C 443 is specified.

D. Reinforced Concrete Low Head Pressure Pipe (RCLPP):

1. Comply with ASTM C 361; minimum Class C 25.
2. Use tongue and groove joints. Comply with ASTM C 361 for rubber O-rings or profile gaskets.

E. Polyvinyl Chloride Pipe (PVC):

1. Use pipe complying with the following:
 - a. Types of PVC pipes:
 - 1) Corrugated exterior, smooth interior, ASTM F 949.
 - 2) Solid wall, ASTM D 3034 or ASTM F 679.
 - 3) Closed profile, ASTM F 1803.
 - 4) Composite, ASTM D 2680.
 - b. PVC plastic meeting ASTM D 1784, Cell Classification 12454.
 - c. Minimum pipe stiffness of 46 psi.
 - d. Integral bell and spigot joints with elastomeric seals according to ASTM D 3212 and ASTM F 477.
2. Use of this pipe material requires specific approval by the Engineer.

2.01 STORM SEWERS (Continued)**F. High Density Polyethylene Pipe (HDPE):**

1. Use pipe complying with the following:
 - a. AASHTO M 294, Type S corrugated exterior and smooth interior.
 - b. Minimum pipe stiffness at 5% deflection according to ASTM D 2412.
 - c. Integral bell and spigot joints with elastomeric seals complying with ASTM F 477.
 - d. Maximum 5% deflection of the average inside diameter by testing after installation according to [Section 4060, 3.04](#).
2. Use of this pipe material requires specific approval by the Engineer.

G. Corrugated Metal Pipe (CMP):

1. Use pipe complying with the following:
 - a. AASHTO M 36, Type I.
 - b. Zinc coating complying with AASHTO M 218.
 - c. Corrugated steel circular section with annular or helical corrugations.
 - d. Gage of pipe according to [Iowa DOT Standard Road Plan DR-104](#) or as specified in the contract documents.
 - e. Coupling bands with annular or helical corrugations to match pipe ends.
2. Use of this pipe material requires specific approval by the Engineer.

H. Spiral Rib Pipe:

1. Use pipe complying with the following:
 - a. ASTM A 760 Type 1R.
 - b. Corrugation profile of 3/4 inch by 3/4 inch by 7 1/2 inches.
 - c. Type 2 aluminized steel complying with ASTM A 929.
 - d. Minimum thickness of 0.064 inch. Use gage of pipe according to manufacturer's requirements.
 - e. Coupling bands complying with manufacturer's recommendations.
2. Use of this pipe material requires specific approval by the Engineer.

I. Coated Corrugated Metal Pipe:

1. Use in corrosive soil or effluent conditions, or where specified in the contract documents or required by the Engineer.
2. Comply with AASHTO M 274. Use gage of pipe according to [Iowa DOT Standard Road Plan DR-104](#) or as specified in the contract documents.
3. Use of this pipe material requires specific approval by the Engineer.

J. Corrugated Metal Arch Pipe (CMAP):

1. Use pipe complying with the following:
 - a. AASHTO M 36, Type II.
 - b. Zinc coating complying with AASHTO M 218.
 - c. Corrugated steel Type I pipe reformed into a pipe-arch having an approximately flat bottom.
 - d. Coupling bands with annular corrugations or helical corrugations to match pipe ends.
 - e. Gage of pipe according to [Iowa DOT Standard Road Plan DR-104](#).
2. Use of this pipe material requires specific approval by the Engineer.

2.01 STORM SEWERS (Continued)**K. Spiral Rib Arch Pipe:**

1. Use pipe complying with the following:
 - a. ASTM A 760 Type IIR.
 - b. Corrugation profile of 3/4 inch by 3/4 inch by 7 1/2 inch.
 - c. Type 2 aluminized steel complying with ASTM A 929.
 - d. Minimum thickness of 0.064 inch. Use gage of pipe complying with manufacturer's requirements.
 - e. Coupling bands complying with the manufacturer's recommendations.
2. Use of this pipe material requires specific approval by the Engineer.

L. Polypropylene Pipe:

1. Comply with the following for 12 inch to 30 inch pipe:
 - a. Double walled pipe meeting ASTM F 2764.
 - b. Minimum pipe stiffness per ASTM D 2412, 46 psi.
 - c. Integral bell and spigot joint complying with ASTM D 3212 and ASTM F 477.
2. Comply with the following for 30 inch to 60 inch pipe:
 - a. Triple walled pipe meeting ASTM F 2764.
 - b. Minimum pipe stiffness per ASTM D 2412, 46 psi.
 - c. Integral bell and spigot joint complying with ASTM D 3212 and ASTM F 477.
3. Use of this pipe material requires specific approval by the Engineer.

M. Bituminous Joint Primer: Material intended for use in priming concrete joints. Comply with the requirements of ASTM D 41.

N. Engineering Fabric: Comply with [Iowa DOT Article 4196.01](#).

O. Non-Shrink Grout: Comply with [Iowa DOT Materials I.M. 491.13](#).

2.02 LINEAR TRENCH DRAIN

Comply with approved manufacturer's requirements and [Iowa DOT Materials I.M. 449 \(MAPLE\)](#), as well as complying with [Figure 6010.521](#). Provide certification indicating continuous trench drain meets AASHTO M 306 for 40,000 pound proof load.

2.03 CASING PIPE

Comply with [Section 3020, 2.02](#) for casing pipe requirements.

2.04 PIPE APRONS

Comply with the requirements of Section 4020, 2.01 and [Section 4030, 2.01](#) for the pipe material of which the apron is constructed. Supply concrete pipe aprons according to [Figure 4030.222](#) and [Figure 4030.223](#). Supply CMP pipe aprons according to [Figure 4030.225](#).

2.05 APRON FOOTINGS

Comply with the requirements of [Section 6010](#) for reinforcing steel and structural concrete used in apron footings.

2.06 APRON GUARD

Use smooth or deformed steel bars, ASTM A 615, Grade 40 or Grade 60, or merchant quality, in the construction of the apron guard. Hot dip galvanize the apron guard according to ASTM A 123.

PART 3 - EXECUTION**3.01 EXAMINATION**

- A. Verify measurements at site; make necessary field measurements to accurately determine pipe makeup lengths or closures.
- B. Examine site conditions to ensure construction operations do not pose hazards to adjacent structures or facilities.

3.02 PIPE INSTALLATION**A. General:**

- 1. Clean pipe interior and joints prior to lowering into trench. Keep pipe clean during construction.
- 2. Begin at the lowest point in the line. Lay groove or bell end pointing upstream unless otherwise specified.
- 3. Place pipe with lifting holes at the top of the pipe and fill lift hole with non-shrink grout or manufactured plugs.
- 4. Assemble joints as specified by the pipe manufacturer.
- 5. Use a saw to cut ends of pipe flush with inside wall of manholes, intakes, and structures. Do not use hammer or other means to break pipe.
- 6. Provide manholes and intakes as specified in the contract documents.
- 7. Use watertight stopper, plug, or other approved means to protect the exposed upstream ends of the pipe and prevent soil sediment from entering the storm sewer system.

B. Trenched:

- 1. Excavate trench and provide pipe bedding and backfill material as specified in [Section 3010](#).
- 2. Prepare trench bottom to design line and grade so that only minor movement of the pipe is necessary after installation.
- 3. Lay pipe to design line and grade. Set field grades to invert of pipe.
- 4. Provide uniform bearing for full pipe barrel length. Excavate bell holes as necessary for uniform support of pipe barrel on bedding material.
- 5. Do not lay pipe in water or on saturated soil or bedding, or allow water to rise in trench around pipe prior to placing backfill material.
- 6. Do not disturb installed pipe and bedding when using movable trench boxes and shields. Block or anchor pipe as necessary to prevent joint displacement.

C. Trenchless: Comply with [Section 3020](#).**3.03 STORM SEWER INSTALLED WITHIN A CASING PIPE**

Comply with [Section 3020, 3.04](#) for installation of storm sewer within casing pipe.

3.04 LINEAR TRENCH DRAIN

- A. Install according to the manufacturer's requirements and the contract documents.
- B. Use duct tape or wood block to prevent intrusion of concrete during installation and paving.
- C. Connect to existing intake or manhole according to [Section 6010, 3.05](#) or discharge to an open drainageway/ditch.

3.05 PIPE JOINTING**A. General:**

- 1. Clean joint surfaces to remove soil or foreign material prior to jointing pipe.
- 2. Assemble joints according to pipe manufacturer's recommendations. Use equipment that does not apply damaging forces to pipe joints.

B. Reinforced Concrete Pipe (RCP), Reinforced Concrete Arch Pipe (RCAP), and Reinforced Concrete Elliptical Pipe (RCEP):

- 1. Comply with [Figure 4020.211](#) for pipe joint wrapping. Secure engineering fabric in place to prevent displacement while placing backfill material.
- 2. If a rubber O-ring or profile gasket is specified for RCP, coat the rubber gasket and joint with soap-based lubricant immediately prior to closing the joint.
- 3. Place pipe such that joint openings on the outside or inside of the pipe do not exceed 1/2 inch.

C. Reinforced Concrete Low Head Pressure Pipe (RCLPP); Polyvinyl Chloride Pipe (PVC) and Corrugated PVC Pipe; Polypropylene Pipe; and High Density Polyethylene Pipe (HDPE): Coat gasket and joint with soap-based lubricant immediately prior to closing the joint.**D. Corrugated Metal Pipe (CMP) and Corrugated Metal Arch Pipe (CMAP):** Lap coupling bands to form a tightly closed joint upon installation.**E. Connections between Dissimilar Pipes:**

- 1. Use manufactured adapters or couplings approved by the Engineer.
- 2. Where adapters or couplings are not available, the Engineer may authorize use of a concrete collar as shown in [Figure 4020.211](#).

3.06 APRONS

- A. Install pipe aprons where specified in the contract documents. Use the same installation methods as used on the pipe to which the apron is being attached. Dewater area as necessary to prevent installing the apron in water or on saturated soil or bedding. Do not allow water to rise around the apron prior to backfilling the area.
- B. Install apron footings where specified in the contract documents. Construct according to [Section 6010](#) and the contract documents. Dewater area as necessary to prevent installing the apron footing in water or on saturated soil or bedding. Do not allow water to rise around the apron footing prior to backfilling the area.

3.06 APRONS (Continued)

- C. Anchor the last three concrete pipe sections and the apron together with two pipe connections per joint. Comply with [Iowa DOT Standard Road Plan DR-121](#).
- D. Attach corrugated metal aprons to the pipe with a manufacturer's approved bolt, weld, or clamp to fasten directly to the pipe.
- E. Install apron guard where specified in the contract documents. Construct according to [Figure 4030.224](#) or [4030.225](#). Repair any damage to the galvanized coating that occurs due to storage, handling, or installation.

3.07 TOLERANCES

The following tolerances apply to utilities installed by open trench construction. For trenchless construction, comply with [Section 3020](#).

- A. Do not allow horizontal and vertical alignment to vary from design line and grade at any structure by more than 1% of the inside diameter of the pipe or 1/4 inch, whichever is larger.
- B. Do not allow the horizontal alignment of the pipe to vary from design line at any point along the pipe by more than 1% of the inside diameter of the pipe.
- C. Low spots holding water exceeding the following depths for each pipe size will be considered unacceptable and must be removed and reinstalled to proper grade.

Pipe Diameter	Maximum Low Spot Depth
8"	1/2"
10"	1/2"
12"	3/4"
15"	3/4"
18" and Larger	5% of Pipe Diameter*

* Measured to the nearest 1/2"

3.08 CONFLICTS

- A. Horizontal Separation of Gravity Storm Sewers from Water Mains:** Separate storm sewers and water mains by at least 10 feet measured edge to edge unless it is impossible to do so. When not possible to maintain a 10 feet horizontal separation, maintain a minimum separation of 3 feet and utilize one of the following within 10 feet measured edge to edge:
 1. Construct the water main of ductile iron pipe with gaskets impermeable to hydrocarbons.
 2. Enclose the water main in a watertight casing pipe with evenly spaced annular gap and watertight end seals.
 3. Construct storm sewer pipe of water main materials.
 4. Construct storm sewers of reinforced concrete pipe with gaskets manufactured according to ASTM C 443.
- B. Separation of Storm Sewer Force Mains from Water Mains:** Separate storm sewer force mains and water mains by a horizontal distance of at least 10 feet unless:
 1. The force main is constructed of water main materials meeting a minimum pressure rating of 150 psi and the requirements of [Section 5010, 2.01](#) and
 2. The sewer force main is laid at least 4 linear feet from the water main.

3.08 CONFLICTS (Continued)**C. Vertical Separation of Storm Sewers and Water Main Crossovers:**

1. Vertically separate storm sewers from water mains by at least 18 inches measured between the outside edges of the water main and the storm sewer. Maintain the maximum feasible separation distance in all cases. Ensure the sewer and water pipes are adequately supported. Use a low permeability soil for backfill material within 10 feet of the point of crossing.
2. When impossible to maintain an 18 inch vertical separation when the water main crosses over the storm sewer, maintain a minimum vertical separation of 6 inches and utilize one of the following within 10 feet measured edge-to-edge centered on the crossing:
 - a. Construct the water main of ductile iron pipe with gaskets impermeable to hydrocarbons.
 - b. Enclose the water main in a watertight casing pipe with evenly spaced annular gap and watertight end seals.
 - c. Construct storm sewer pipe of water main materials.
 - d. Construct storm sewers of reinforced concrete pipe with gaskets manufactured according to ASTM C 443.

3.09 STORM SEWER ABANDONMENT**A. Plug:**

1. Prior to placing the sewer plug, the Engineer will verify the sewer line is not in use.
2. Construct sewer plug by completely filling the end of the pipe with concrete. Force concrete into the end of the pipe for a distance of 16 inches, or one-half the pipe diameter, whichever is greater.

B. Fill:

1. Prior to filling the sewer, the Engineer will verify the sewer line is not in use.
2. If specified in the contract documents, fill the line to be abandoned with flowable mortar, foamed cellular concrete, or CLSM (comply with [Section 3010](#)) by gravity flow or pumping.
3. Batching, mixing, and placing may be started when temperature is 34°F and rising. Cease mixing and placing when temperature is 38°F or less and falling.

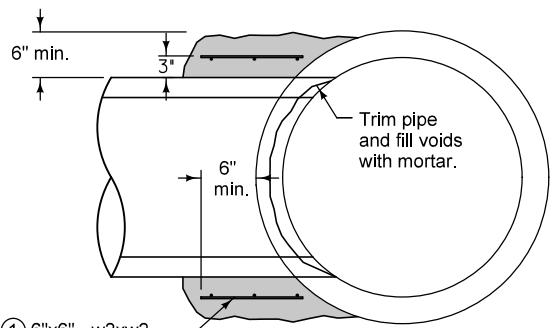
3.10 CONNECTION TO EXISTING MANHOLE OR INTAKE

Comply with [Section 6010, 3.05](#).

3.11 CLEANING, INSPECTION, AND TESTING

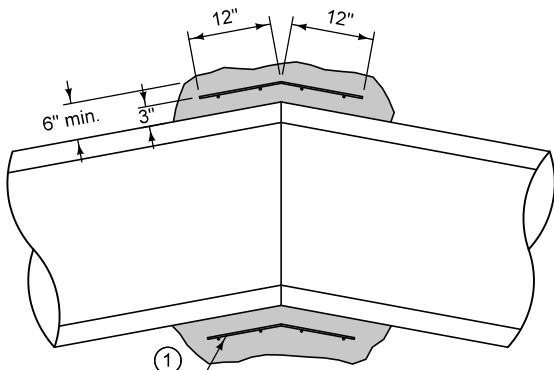
Clean, inspect, and test according to [Section 4060](#).

END OF SECTION



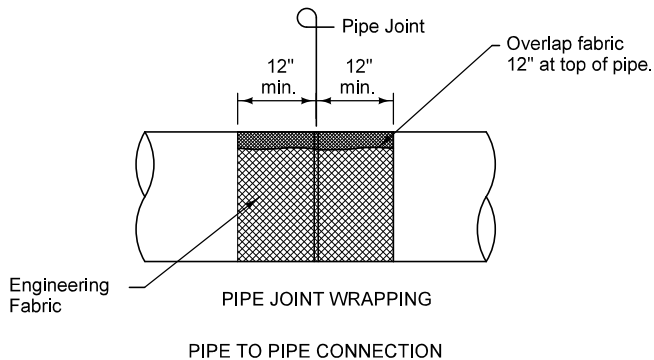
① 6"x6" - w2xw2 (8ga.) Wire Mesh

TYPE PC-1 CONCRETE COLLAR CONNECTION



① 6"x6" - w2xw2 (8ga.) Wire Mesh

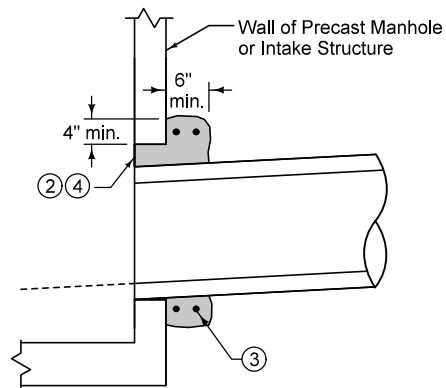
TYPE PC-2 CONCRETE COLLAR CONNECTION



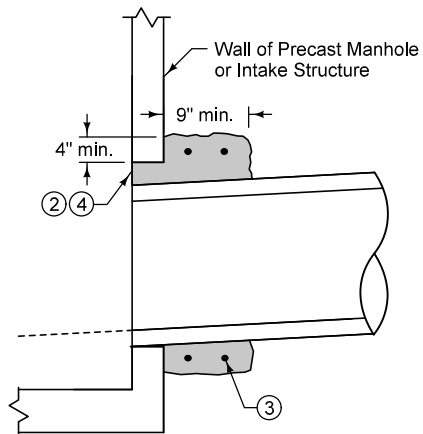
Engineering Fabric

PIPE JOINT WRAPPING

PIPE TO PIPE CONNECTION



CONCRETE COLLAR FOR PIPES 12" AND SMALLER



CONCRETE COLLAR FOR PIPES GREATER THAN 12"

PIPE TO STRUCTURE CONNECTION

- ① Lap ends of wire mesh a minimum of 6 inches.
- ② Concrete collar is required when annular space between the outside of the pipe and the wall of the structure is 2 inches or greater.
- ③ Provide two #4 hoop bars in concrete collar. Lap bars a minimum of 6 inches.
- ④ Trowel concrete flush with inside wall of structure.

SUDAS	IOWADOT	REVISION
		2 04-17-18
FIGURE 4020.211	STANDARD ROAD PLAN	SW-211
		SHEET 1 of 1
<small>REVISIONS: Removed "invert" callout on Pipe to Structure View. Retitled and replaced old Iowa DOT and SUDAS logos with new logos.</small>		
<i>Paul D. Wigand</i> SUDAS DIRECTOR		<i>Brian Smith</i> DESIGN METHODS ENGINEER
STORM SEWER PIPE CONNECTIONS		

PIPE CULVERTS**PART 1 - GENERAL****1.01 SECTION INCLUDES**

- A. Pipe Culverts
- B. Pipe Aprons and Beveled Ends
- C. Footings for Concrete Pipe Aprons
- D. Pipe Apron Guards

1.02 DESCRIPTION OF WORK

Construct pipe culverts, beveled ends, pipe aprons, and associated appurtenances.

1.03 SUBMITTALS

Comply with Division 1 - General Provisions and Covenants.

1.04 SUBSTITUTIONS

Comply with Division 1 - General Provisions and Covenants.

1.05 DELIVERY, STORAGE, AND HANDLING

Comply with Division 1 - General Provisions and Covenants.

1.06 SCHEDULING AND CONFLICTS

Comply with Division 1 - General Provisions and Covenants.

1.07 SPECIAL REQUIREMENTS

None.

1.08 MEASUREMENT AND PAYMENT**A. Pipe Culverts:****1. Trenched:**

- a. **Measurement:** Each type and size of pipe installed in a trench will be measured in linear feet from end of pipe to end of pipe along the centerline of pipe, exclusive of aprons. Lengths of elbows and tees will be included in length of pipe measured.
- b. **Payment:** Payment will be made at the unit price of each type and size of pipe.
- c. **Includes:** Unit price includes, but is not limited to, trench excavation; dewatering; furnishing and installing pipe; furnishing, placing, and compacting bedding and backfill material; connectors; testing; and inspection.

2. Trenchless:

- a. **Measurement:** Each type and size of pipe installed by trenchless methods will be measured in linear feet along the centerline of the casing pipe.
- b. **Payment:** Payment will be made at the unit price for each type and size of pipe.
- c. **Includes:** Unit price includes, but is not limited to, furnishing and installing pipe; trenchless installation materials and equipment; pit excavation, dewatering, and placing and compacting backfill material; pipe connections; testing; and inspection.

1.08 MEASUREMENT AND PAYMENT (Continued)**B. Pipe Aprons:**

1. **Measurement:** Each type and size of pipe apron will be counted.
2. **Payment:** Payment will be made at the unit price for each type and size of pipe apron.
3. **Includes:** Unit price includes, but is not limited to, trench excavation; dewatering; furnishing and installing the apron; furnishing, placing, and compacting bedding and backfill material; connectors; and other appurtenances.

C. Footings for Concrete Pipe Aprons:

1. **Measurement:** Each type and size of footing installed on a concrete pipe apron will be counted.
2. **Payment:** Payment will be made at the unit price for each type and size of footing.
3. **Includes:** Unit price includes, but is not limited to, excavation; dewatering; reinforcing steel; concrete; furnishing, placing and compacting bedding and backfill material.

D. Pipe Apron Guards:

1. **Measurement:** Each type and size of pipe apron guard will be counted.
2. **Payment:** Payment will be made at the unit price for each type and size of pipe apron guard.
3. **Includes:** Unit price includes, but is not limited to, furnishing and installing the apron guard and repairing any damage to the apron from the installation process.

PART 2 - PRODUCTS**2.01 PIPE CULVERTS**

- A. Roadway Pipe Culverts:** All storm sewer pipe materials specified for use in right-of-way in [Section 4020](#) may be used within right-of-way as a roadway pipe culvert.
- B. Entrance Pipe Culverts:** The following pipe culvert types described in [Section 4020](#) may be used within right-of-way as entrance pipe culverts:
1. Reinforced Concrete Pipe (RCP).
 2. Reinforced Concrete Arch Pipe (RCAP).
 3. Reinforced Concrete Elliptical Pipe (RCEP).
 4. Reinforced Concrete Low Head Pressure Pipe (RCPP).
 5. Corrugated Metal Pipe (CMP).
 6. Spiral Rib Pipe.
 7. Coated Corrugated Metal Pipe.
 8. Corrugated Metal Arch Pipe.
- C. Structural Plate Culverts:** Structural plate culverts may be used in the right-of-way as roadway or entrance pipe culverts.
1. Use a galvanized steel structural plate complying with AASHTO M 167.
 2. Use bolts and nuts complying with ASTM A 449 and galvanized per ASTM A 153, Class C.
 3. Assemble the structure according to the manufacturer's recommendations. Tighten the bolts using an applied torque of between 100 and 300 foot-pounds.
 4. Install the structure according to the contract documents, the manufacturer's recommendations, and AASHTO Standard Specifications for Highway Bridges, Division II, Section 26.
 5. Conform the gage of the structure to [Iowa DOT Standard Road Plan DR-104](#) or as specified in the contract documents.
- D. Aluminum Structural Plate Culverts:** Aluminum structural plate culverts may be used in the right-of-way as roadway or entrance pipe culverts.
1. Comply with AASHTO M 219.
 2. Use a corrugation profile of 9 inches by 2 1/2 inches.
 3. Use aluminum complying with ASTM B 209.
 4. Use a minimum thickness of 0.100 inch. Gage of structure complying with manufacturer's requirements.
 5. Use bolts and nuts meeting ASTM A 307 or ASTM A 449 and galvanize per ASTM A 153.

2.01 PIPE CULVERTS (Continued)

6. Assemble the structure according to the manufacturer's recommendations. Tighten the bolts using an applied torque of between 100 and 300 foot-pounds.
7. Install the structure according to the contract documents, the manufacturer's recommendations, and AASHTO Standard Specifications for Highway Bridges, Division II, Section 26.
8. Meet or exceed the AASHTO Standard Specifications for Highway Bridges, Division I, Section 12.8 for HS 20 loading.

2.02 PIPE APRONS

Comply with the requirements of [Section 4020, 2.01](#) and [Section 4030, 2.01](#) for the pipe material of which the apron is constructed. Supply concrete pipe aprons according to [Figure 4030.222](#) and [Figure 4030.223](#). Supply CMP pipe aprons according to [Figure 4030.225](#).

2.03 APRON FOOTINGS

Comply with the requirements of [Figure 4030.221](#) and [Section 6010](#) for reinforcing steel and structural concrete used in apron footings.

2.04 APRON GUARD

Use smooth or deformed steel bars, ASTM A 615, Grade 40 or merchant quality, in the construction of the apron guard. Hot dip galvanize the apron guard according to ASTM A 123.

PART 3 - EXECUTION**3.01 PIPE CULVERT INSTALLATION****A. Trenched:**

1. Install pipe in a trench per [Section 4020](#).
2. For culvert pipe installed in embankment, pipe may be installed at the Contractor's option per the contract documents and the following Iowa DOT Specifications sections:
 - a. Reinforced Concrete Pipe (circular, arched, and elliptical): [Section 2416](#).
 - b. Corrugated Metal and Corrugated Plastic Pipe: [Section 2417](#).
 - c. Structural Plate Culverts: [Section 2420](#).

B. Trenchless: For trenchless installations, comply with [Section 3020](#).

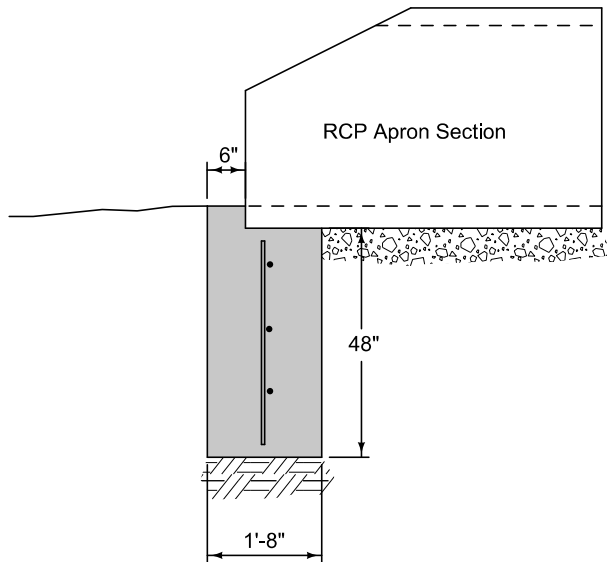
3.02 APRONS

- A. Install pipe aprons where specified in the contract documents. Use the same installation methods as used on the pipe to which the apron is being attached. Dewater area as necessary to prevent installing the apron in water or on saturated soil or bedding. Do not allow water to rise around the apron prior to backfilling the area.
- B. Install apron footings where specified. Construct per [Section 6010](#) and the contract documents. Dewater area as necessary to prevent installing the apron footing in water or on saturated soil or bedding. Do not allow water to rise around the apron footing prior to backfilling the area.
- C. Anchor the last three concrete pipe sections and the apron together with two pipe connections per joint. Comply with [Iowa DOT Standard Road Plan DR-121](#).
- D. Attach corrugated metal aprons to the culvert pipe with a manufacturer's approved bolt, weld, or clamp to fasten directly to the culvert.
- E. Install apron guard where specified. Construct according to [Figure 4030.224](#) or [4030.225](#). Repair any damage to the galvanized coating that occurs due to storage, handling, or installation.

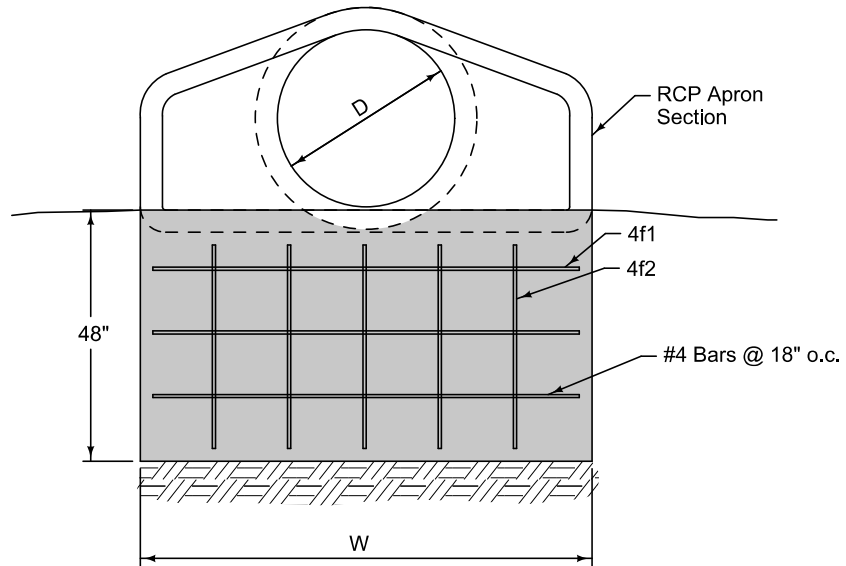
3.03 CLEANING, INSPECTION, AND TESTING

Clean, inspect, and test culverts per [Section 4060](#).

END OF SECTION



TYPICAL SECTION




ELEVATION

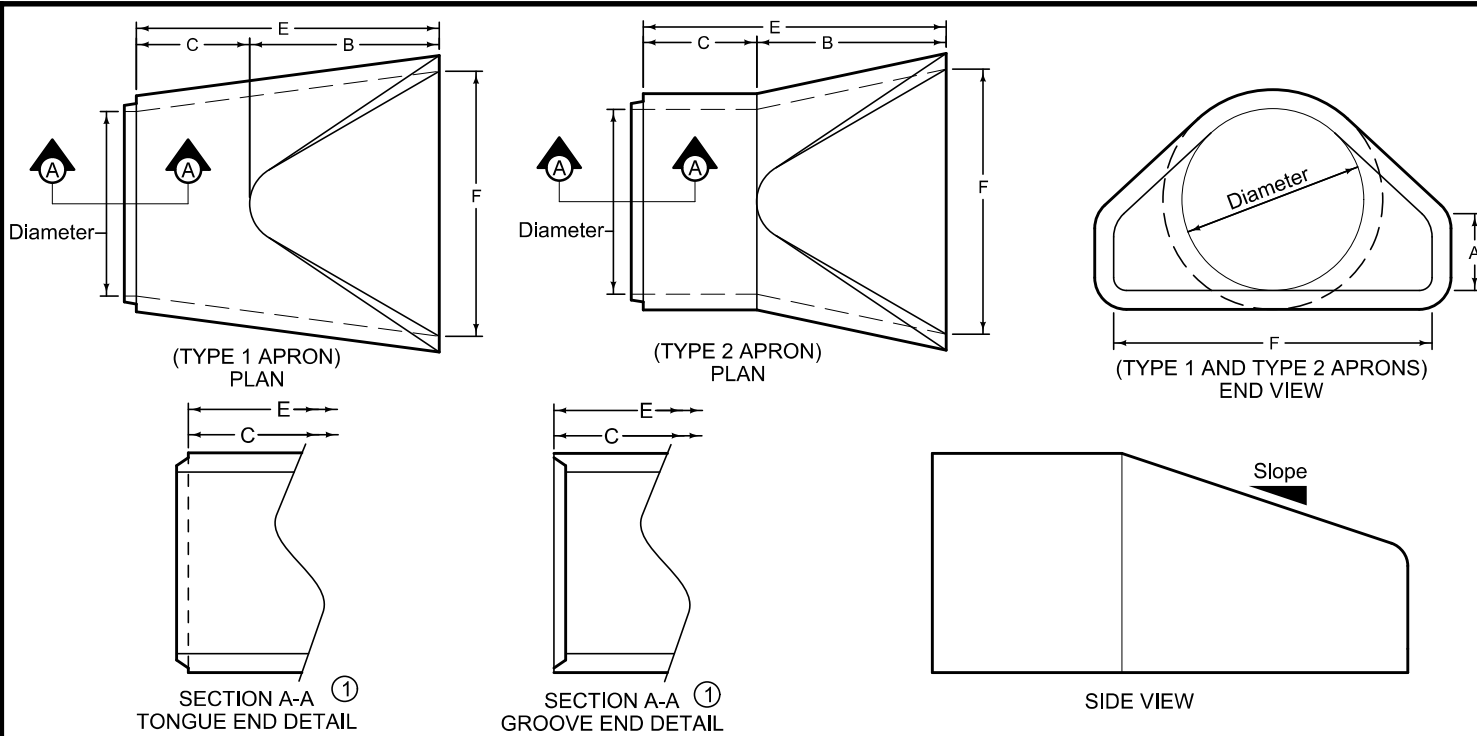
REINFORCING BAR LIST

D	W	Mark	Size	Length	Count
12"	2'-4"	4f1	4	2'-0"	3
		4f2	4	3'-8"	2
15"	2'-10 1/2"	4f1	4	2'-6 1/2"	3
		4f2	4	3'-8"	2
18"	3'-5"	4f1	4	3'-1"	3
		4f2	4	3'-8"	3
24"	4'-6"	4f1	4	4'-2"	3
		4f2	4	3'-8"	3
30"	5'-7"	4f1	4	5'-3"	3
		4f2	4	3'-8"	4
36"	6'-8"	4f1	4	6'-4"	3
		4f2	4	3'-8"	5
42"	7'-3"	4f1	4	6'-11"	3
		4f2	4	3'-8"	5

D	W	Mark	Size	Length	Count
48"	7'-10"	4f1	4	7'-6"	3
		4f2	4	3'-8"	6
54"	8'-5"	4f1	4	8'-1"	3
		4f2	4	3'-8"	6
60"	8'-11"	4f1	4	8'-7"	3
		4f2	4	3'-8"	6
66"	8'-11"	4f1	4	8'-7"	3
		4f2	4	3'-8"	6
72"	10'-0"	4f1	4	9'-8"	3
		4f2	4	3'-8"	7
78"	10'-7"	4f1	4	10'-3"	3
		4f2	4	3'-8"	7
84"	11'-1"	4f1	4	10'-9"	3
		4f2	4	3'-8"	8

FIGURE 4030.221 SHEET 1 OF 1

	REVISION 1 10-21-14
	SUDAS 4030.221
	SHEET 1 of 1
SUDAS Standard Specifications	
RCP APRON SECTION FOOTING	




Dimension 'E' shown is the minimum and is considered the design length. Adjust for any difference between the actual length of concrete apron installed and the length indicated below for the length of concrete culvert pipe furnished.

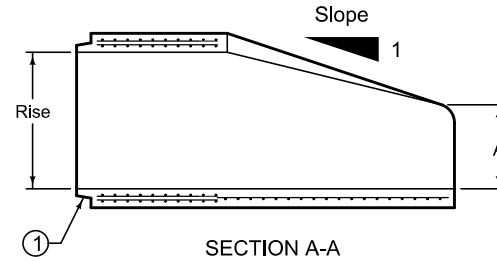
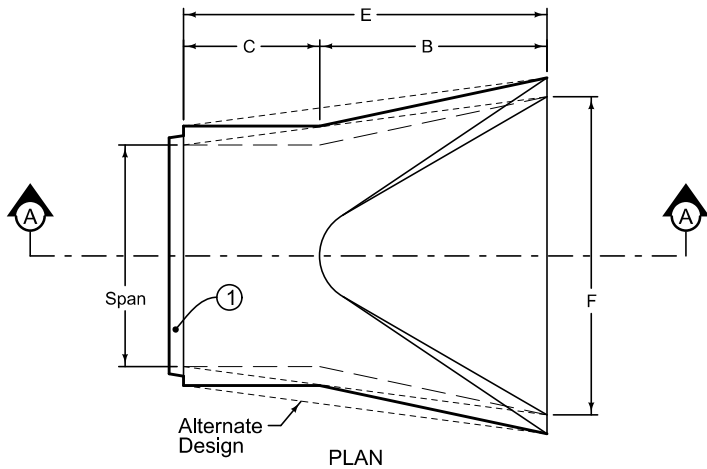
① Tongue end used on inlet end section. Groove end used on outlet end section.

TYPE 1 APRONS						
DIAM.	SLOPE	A	B	MINIMUM		F
				C	E	
12"	2.4:1	4"	2'-0"	4'- $\frac{7}{8}$ "	6'- $\frac{7}{8}$ "	2'-0"
15"	2.4:1	6"	2'-3"	3'-10"	6'-1"	2'-6"
18"	2.3:1	9"	2'-3"	3'-10"	6'-1"	3'-0"
21"	2.4:1	9"	3'-0"	3'-1 $\frac{1}{2}$ "	6'-1 $\frac{1}{2}$ "	3'-5"
24"	2.5:1	9 $\frac{1}{2}$ "	3'-7 $\frac{1}{2}$ "	2'-6"	6'-1 $\frac{1}{2}$ "	4'-0"
27"	2.5:1	10 $\frac{1}{2}$ "	4'-1"	2'-0"	6'-1 $\frac{1}{2}$ "	4'-4"
30"	2.5:1	12"	4'-6"	1'-7 $\frac{3}{4}$ "	6'-1 $\frac{3}{4}$ "	5'-0"
36"	2.5:1	15"	5'-3"	2'-9"	8'-0"	6'-0"
42"	2.5:1	21"	5'-3"	2'-9"	8'-0"	6'-6"
48"	2.5:1	24"	6'-0"	2'-0"	8'-0"	7'-0"
54"	1.8:1	27"	5'-0"	3'-0"	8'-0"	7'-6"
60"	1.6:1	29 $\frac{1}{2}$ "	5'-0"	3'-0"	8'-0"	8'-0"
66"	1.7:1	30"	6'-0"	2'-3"	8'-3"	8'-0"
72"	1.6:1	30"	6'-6"	1'-9"	8'-3"	9'-0"
78"	1.8:1	36"	7'-6"	1'-9"	9'-3"	9'-6"
84"	1.3:1	29 $\frac{1}{2}$ "	6'-9"	2'-6 $\frac{1}{2}$ "	9'-3 $\frac{1}{2}$ "	10'-0"

TYPE 2 APRONS						
DIAM.	SLOPE	A	B	MINIMUM		F
				C	E	
12"	2.4:1	4"	2'-0"	4'- $\frac{7}{8}$ "	6'- $\frac{7}{8}$ "	2'-0"
15"	2.4:1	6"	2'-3"	3'-10"	6'-1"	2'-6"
18"	2.3:1	9"	2'-3"	3'-10"	6'-1"	3'-0"
21"	2.4:1	9"	3'-0"	3'-1 $\frac{1}{2}$ "	6'-1 $\frac{1}{2}$ "	3'-5"
24"	2.5:1	9 $\frac{1}{2}$ "	3'-7 $\frac{1}{2}$ "	2'-6"	6'-1 $\frac{1}{2}$ "	4'-0"
27"	2.5:1	10 $\frac{1}{2}$ "	4'-1"	2'-0"	6'-1 $\frac{1}{2}$ "	4'-4"
30"	2.5:1	12"	4'-6"	1'-7 $\frac{3}{4}$ "	6'-1 $\frac{3}{4}$ "	5'-0"
36"	2.5:1	15"	5'-3"	2'-9"	8'-0"	6'-0"
42"	2.5:1	21"	5'-3"	2'-9"	8'-0"	6'-6"
48"	2.5:1	24"	6'-0"	2'-0"	8'-0"	7'-0"
54"	1.9:1	24 $\frac{1}{2}$ "	5'-5"	2'-7"	8'-0"	7'-6"
60"	1.4:1	24 $\frac{1}{2}$ "	5'-0"	3'-0"	8'-0"	8'-0"
66"	1.7:1	30"	6'-0"	2'-3"	8'-3"	8'-0"
72"	1.4:1	24"	6'-6"	1'-9"	8'-3"	9'-0"
78"	1.8:1	36"	7'-6"	1'-9"	9'-3"	9'-6"
84"	1.5:1	23 $\frac{1}{2}$ "	7'-6 $\frac{1}{2}$ "	1'-9"	9'-3 $\frac{1}{2}$ "	10'-0"

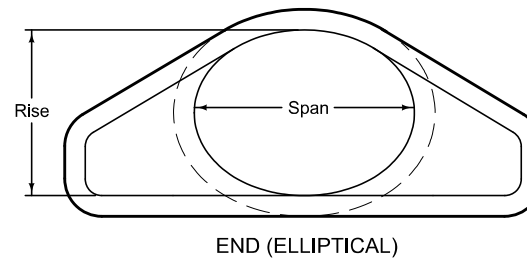
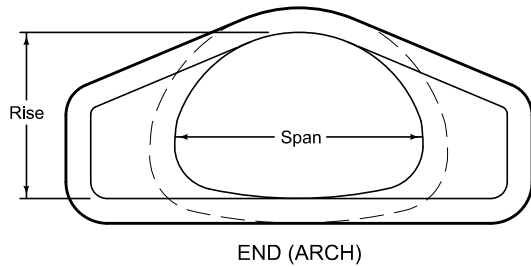
FIGURE 4030.222 SHEET 1 OF 1

	REVISION New 10-18-16
	4030.222
	SHEET 1 of 1
SUDAS Standard Specifications	
CIRCULAR CONCRETE APRONS	



Dimension 'E' shown is the minimum and is considered the design length. Adjust for any difference between the actual length of concrete apron installed and the length indicated below for the length of concrete culvert pipe furnished.

① Tongue end used on inlet end section. Groove end used on outlet end section.




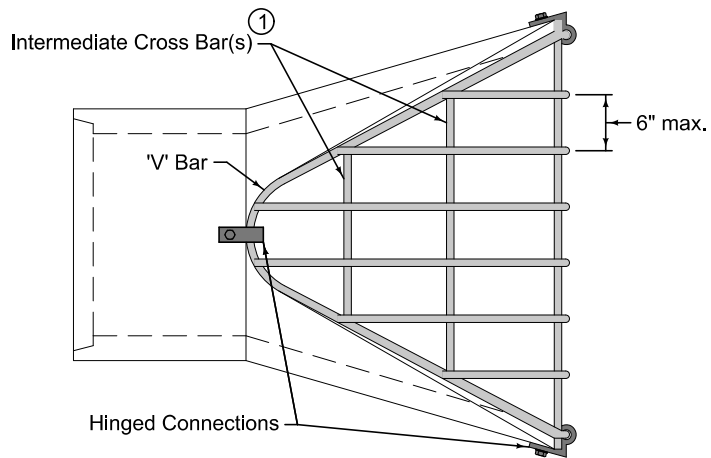
EQUIVALENT DIAMETER Inches	SLOPE	APPROXIMATE DIMENSIONS Inches				
		A	B	C	E	F
18	3:1	7	27	45	72	36
24	3:1	8 $\frac{1}{2}$	39	33	72	48
30	3:1	9 $\frac{1}{2}$	50	46	96	60
36	3:1	11 $\frac{3}{8}$	60	36	96	72
42	3:1	15 $\frac{3}{16}$	60	36	96	78
48	3:1	21	60	36	96	84
54	3:1	25 $\frac{1}{2}$	60	36	96	90
60	3:1	31	60	36	96	96
72	2:1	31	60	39	99	120
84	2:1	21 $\frac{3}{2}$	83	19	102	144

ARCH PIPE

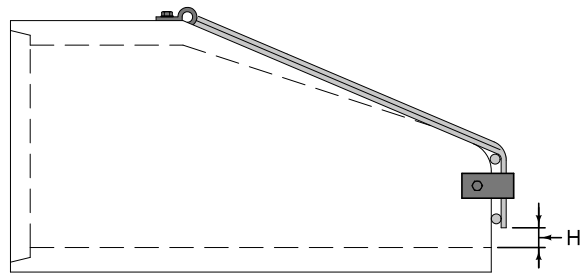
EQUIVALENT DIAMETER Inches	SLOPE	APPROXIMATE DIMENSIONS Inches				
		A	B	C	E	F
18	3:1	7 $\frac{1}{2}$	27	45	72	36
24	3:1	8 $\frac{3}{2}$	39	33	72	48
30	3:1	9 $\frac{1}{2}$	54	18	72	60
36	2.5 to 1	11 $\frac{1}{8}$	60	24	84	72
42	2.5 to 1	15 $\frac{3}{2}$	60	36	96	78
48	2.5 to 1	21	60	36	96	84
54	2.5 to 1	25 $\frac{1}{2}$	60	36	96	90
60	2.5 to 1	30	60	36	96	96
72	2.5 to 1	36	63	33	96	108
90	1.6 to 1	36 $\frac{1}{2}$	58	38	96	113

ELLIPTICAL PIPE

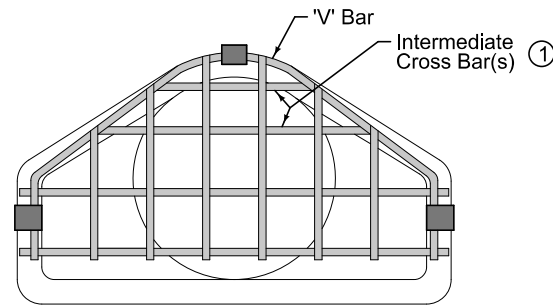
 SUDAS	REVISION
	New 10-18-16
4030.223	
SHEET 1 of 1	
SUDAS Standard Specifications	
ARCH AND ELLIPTICAL CONCRETE PIPE APRONS	



PLAN



PROFILE



FRONT


Provide guard dimensions to fit with type of apron provided. Ensure 'V' Bar completely rests on apron.

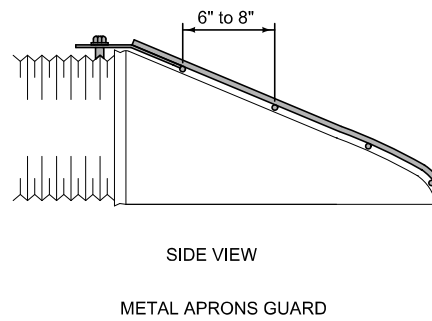
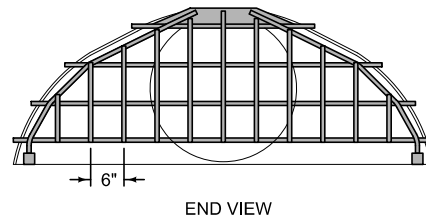
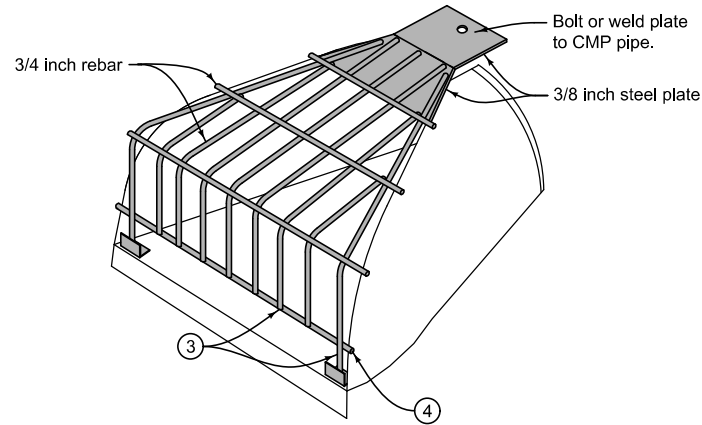
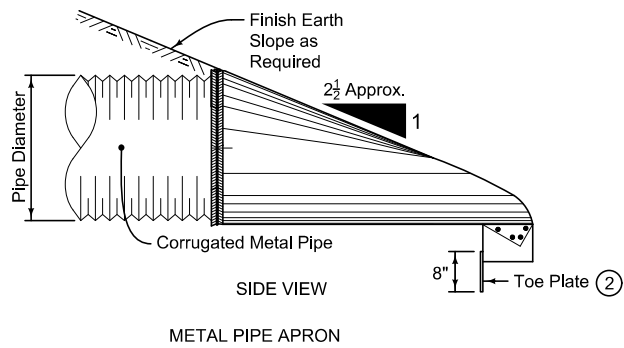
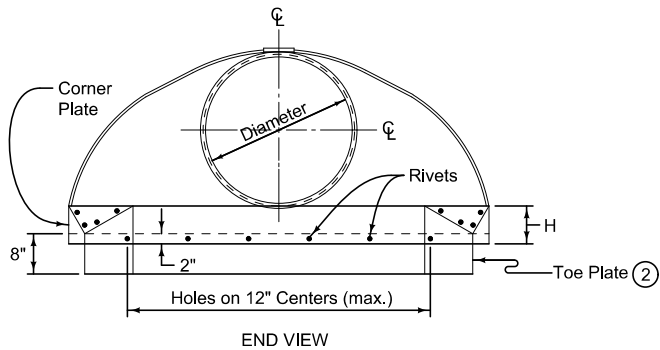
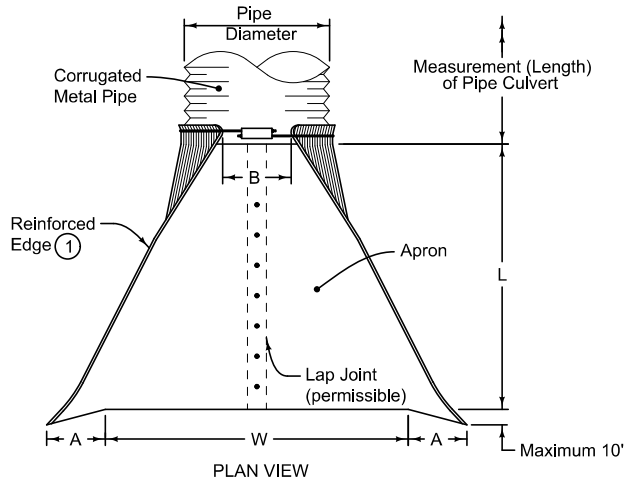
- ① All guards must include at least one intermediate cross bar. If pipe diameter, or equivalent diameter, is 60 inches or greater, use two intermediate cross bars equally spaced.

ROUND		ARCH		ELLIPTICAL	
PIPE SIZE	H	EQUIVALENT DIAMETER	H	EQUIVALENT DIAMETER	H
12"	2½"	18" to 24"	4"	18"	3"
15"	3"	30" to 36"	5"	24"	4"
18" - 24"	4"	42" to 54"	6"	30" to 36"	5"
27" - 36"	5"	60" to 72"	7"	42" to 54"	6"
42" - 54"	6"			60"	7"
60" - 72"	7"				
78" - 90"	8"				

BAR SIZES				
	PIPE SIZE (DIA. or EQUIV.)	HOLE DIA. REQ'D.	BOLT DIA.	BAR SIZE
ROUND	12" - 24"	¾"	⅝"	¾"
	27" - 48"	7/8"	¾"	1"
	54" - 90"	1 1/8"	1"	1 1/4"
ARCH	up to 24" eq.	¾"	⅝"	¾"
	30" to 48"	7/8"	¾"	1"
	54" to 72"	1 1/8"	1"	1 1/4"
ELLIPTICAL	up to 24" eq.	¾"	⅝"	¾"
	30" to 48"	7/8"	¾"	1"
	54" to 60"	1 1/8"	1"	1 1/4"

BOLT LENGTH = PIPE WALL THICKNESS + 2½"

	REVISION
	New 10-18-16
	4030.224
SHEET 1 of 1	
SUDAS Standard Specifications	
CONCRETE PIPE APRON GUARD	



- ① On sizes 60 inches and larger, supplement the reinforced edge with a galvanized stiffener angle attached with bolts.
- ② Install a galvanized toe plate (of the same gage metal as apron) on all aprons 24 inch diameter and larger.
- ③ Hold inside bars up 3 inches off bottom of apron. Extend outside bars to bottom of apron and attach to 2 inch by 2 inch by 1/4 inch steel angle.
- ④ When specified, extend bottom cross bar through apron.

DIMENSIONS					
PIPE DIAM.	A (±1")	B MAX.	H (±1")	L (±1 1/2")	W (±2")
6"	4 1/2"	1"	3"	8 3/4"	12"
8"	5 7/8"	3"	4"	14 1/4"	16"
10"	7 1/2"	6"	6"	21"	24"
12"	4 3/4"	6"	6"	21"	24"
15"	6"	8"	6"	26"	30"
18"	7"	9"	6"	31"	36"
21"	8 1/2"	11"	6"	36"	42"
24"	9 1/2"	12"	6"	42"	48"
30"	12"	15"	7 1/2"	52 1/2"	60"
36"	14"	18"	9"	63"	72"
42"	16"	21"	10 1/2"	73 1/2"	84"
48"	18"	27"	12"	84"	90"
54"	18"	30"	12"	84"	102"
60"	18"	33"	12"	87"	114"
66"	18"	36"	12"	87"	120"
72"	18"	39"	12"	87"	126"
78"	18"	42"	12"	87"	132"
84"	18"	45"	12"	87"	138"
90"	24"	37"	11"	87"	144"
96"	25"	35"	12"	87"	150"

REVISION

New 10-18-16

4030.225

SHEET 1 of 1

SUDAS Standard Specifications

METAL PIPE APRONS
AND APRON GUARDS

SUBDRAINS AND FOOTING DRAIN COLLECTORS**PART 1 - GENERAL****1.01 SECTION INCLUDES**

- A. Subdrains
- B. Subdrain Cleanouts and Outlets
- C. Footing Drain Collectors
- D. Storm Sewer Service and Connections

1.02 DESCRIPTION OF WORK

- A. Construct subdrains, subdrain cleanouts and outlets, and footing drain collectors.
- B. Construct storm sewer service and connections.

1.03 SUBMITTALS

Comply with Division 1 - General Provisions and Covenants.

1.04 SUBSTITUTIONS

Comply with Division 1 - General Provisions and Covenants.

1.05 DELIVERY, STORAGE, AND HANDLING

Comply with Division 1 - General Provisions and Covenants.

1.06 SCHEDULING AND CONFLICTS

Comply with Division 1 - General Provisions and Covenants.

1.07 SPECIAL REQUIREMENTS

None.

1.08 MEASUREMENT AND PAYMENT**A. Subdrains:**

1. **Measurement:** Each type and size of pipe installed will be measured in linear feet from end of pipe to end of pipe along the centerline of pipe, exclusive of outlets. Lengths of elbows and tees will be included in length of pipe measured.
2. **Payment:** Payment will be made at the unit price of each type and size of pipe.
3. **Includes:** Unit price includes, but is not limited to, trench excavation, furnishing and placing bedding and backfill material, engineering fabric (when specified), connectors, and elbows and tees.

1.08 MEASUREMENT AND PAYMENT (Continued)**B. Footing Drain Collectors:**

1. **Measurement:** Each type and size of pipe will be measured in linear feet along centerline of pipe from end of pipe to end of pipe.
2. **Payment:** Payment will be made at the unit price for each type and size of pipe.
3. **Includes:** Unit price includes, but is not limited to, trench excavation, pipe, wyes, tap, fittings, and furnishing and placing bedding and backfill material.

C. Subdrain or Footing Drain Cleanouts:

1. **Subdrain Cleanouts:**
 - a. **Measurement:** Each type and size of subdrain cleanout will be counted.
 - b. **Payment:** Payment for each cleanout will be made at the unit price for each type and size of subdrain cleanout.
 - c. **Includes:** Unit price includes, but is not limited to, trench excavation; furnishing cleanout and lid; and furnishing, placing, and compacting bedding and backfill material.
2. **Footing Drain Cleanouts:**
 - a. **Measurement:** Each type and size of footing drain cleanout will be counted.
 - b. **Payment:** Payment for each cleanout will be made at the unit price for each type and size of footing drain cleanout.
 - c. **Includes:** Unit price includes, but is not limited to, trench excavation; furnishing cleanout and lid; and furnishing, placing, and compacting bedding and backfill material.

D. Subdrain or Footing Drain Outlets and Connections:

1. **Subdrain Outlets and Connections:**
 - a. **Measurement:** Each type and size of outlet or connection to a structure will be counted.
 - b. **Payment:** Payment for each outlet or connection to a structure will be made at the unit price for each type and size installed.
 - c. **Includes:** Unit price includes, but is not limited to, pipe, non-shrink grout, coupling bands, and rodent guards for pipes 6 inches or smaller.
2. **Footing Drain Outlets and Connections:**
 - a. **Measurement:** Each type and size of outlet or connection to a structure will be counted.
 - b. **Payment:** Payment for each outlet or connection to a structure will be made at the unit price for each type and size installed.
 - c. **Includes:** Unit price includes, but is not limited to, pipe, non-shrink grout, coupling bands, and rodent guards for pipes 6 inches or smaller.

E. Storm Sewer Service Stub: The storm sewer service stub is the portion of the storm sewer service from the footing drain collector or storm sewer to a point 10 feet outside of the right-of-way or as specified in the contract documents.

1. **Measurement:** Each type and size of pipe will be measured in linear feet along centerline of pipe from the centerline of storm sewer or footing drain collector to 10 feet outside of the right-of-way.
2. **Payment:** Payment will be made at the unit price per linear foot for each type and size of storm sewer service stub.
3. **Includes:** Unit price includes, but is not limited to, trench excavation, furnishing bedding material, placing bedding and backfill material, tap, fittings, and plugs.

PART 2 - PRODUCTS**2.01 FOOTING DRAIN COLLECTORS****A. Polyvinyl Chloride Pipe and Fittings (Solid Wall PVC):**

1. Comply with ASTM D 3034, minimum thickness SDR 35, 46 psi minimum pipe stiffness.
2. Use PVC plastic conforming to ASTM D 1784, Cell Classification 12454.
3. Integral bell and spigot type rubber gasket joint complying with ASTM D 3212 and ASTM F 477.

B. Corrugated Polyvinyl Chloride Pipe and Fittings (Corrugated PVC):

1. Use corrugated exterior, smooth interior, PVC.
2. Comply with ASTM F 949, minimum pipe stiffness, 46 psi.
3. Use PVC plastic complying with ASTM D 1784, Cell Classification 12454.
4. Integral bell and spigot type rubber gasket joint complying with ASTM D 3212 and ASTM F 477.

C. High Density Polyethylene Pipe and Fittings (HDPE):

1. AASHTO M 252 or M 294, Type S corrugated exterior and smooth interior.
2. Integral bell and spigot joints with O-ring rubber gasket meeting ASTM F 477.

D. Reinforced Concrete Pipe (RCP): Comply with [Section 4020, 2.01](#).**2.02 TYPE 1 SUBDRAINS (LONGITUDINAL SUBDRAIN)****A. Polyvinyl Chloride Pipe and Fittings (Solid Wall PVC):**

1. Comply with Section 4040, 2.01, A.
2. Slot subdrain pipe according to ASTM F 949 or perforate with four rows of 1/4 inch to 3/8 inch diameter holes along the bottom of the pipe.

B. Corrugated Polyvinyl Chloride Pipe and Fittings (Corrugated PVC):

1. Comply with Section 4040, 2.01, B.
2. Slot subdrain pipe according to ASTM F 949.

C. High Density Polyethylene Pipe and Fittings (HDPE):

1. Comply with Section 4040, 2.01, C.
2. Slot or perforate according to AASHTO M 252, Type SP.

2.02 TYPE 1 SUBDRAINS (LONGITUDINAL SUBDRAIN) (Continued)**D. Corrugated Polyethylene Tubing and Fittings (Corrugated PE):**

1. Comply with AASHTO M 252, Type C, corrugated interior and exterior.
2. Use only fittings supplied or recommended by pipe manufacturer for soil tight service.
3. Slot or perforate according to AASHTO M 252, Type CP.

2.03 TYPE 2 SUBDRAINS (COMBINATION SUBDRAIN/FOOTING DRAIN COLLECTOR)

- A. Use materials complying with Section 4040, 2.01.
- B. Perforate all pipe per the following requirements:
 1. Solid Wall PVC Pipe: Comply with ASTM F 949 or perforate with four rows of 1/4 inch to 3/8 inch diameter holes along the bottom of the pipe.
 2. Corrugated PVC Pipe: Comply with ASTM F 949.
 3. HDPE Pipe: Comply with AASHTO M 252 or M 294, Type CP or Type SP.

2.04 POROUS BACKFILL MATERIAL

- A. **Crushed Stone or Processed Gravel:** Comply with [Iowa DOT Article 4109.02](#), Gradation No. 29 in the Aggregate Gradation Table and the quality requirements of [Iowa DOT Section 4131](#).
- B. **Pea Gravel:** Comply with [Iowa DOT Article 4109.02](#), Gradation No. 20 or No. 21 in the Aggregate Gradation Table and the quality requirements of [Iowa DOT Section 4131](#).

2.05 SUBDRAIN OUTLETS**A. Corrugated Metal Pipe (CMP):**

1. Comply with AASHTO M 36, Type 1.
2. Zinc coating complying with AASHTO M 218.
3. Use a corrugated steel circular section with annular or helical corrugation.
4. Minimum thickness of 0.052 inch.

B. Corrugated HDPE:

1. Comply with Section 4040, 2.01.
2. Pipe to be double-walled.

C. PVC: Comply with Section 4040, 2.01.**D. Coupling Bands:** Match annular or helical corrugations on coupling bands to pipe ends.**E. Rodent Guard:** Mild steel meeting ASTM A 36 with hot-dip galvanized coating applied following welding and fabrication. Comply with [Iowa DOT Materials I.M. 443.01](#) and [Figure 4040.233](#). Required for 4 inch or 6 inch subdrains.

2.06 SUBDRAIN OR FOOTING DRAIN CLEANOUTS**A. Type A-1 or A-2 Cleanouts:**

1. Use solid wall PVC riser pipe and fittings of the same diameter (maximum 8 inch) as the adjacent subdrain or footing drain pipe. Comply with [Figure 4040.232](#).
2. Use a light duty (HS-20 loading) cast iron casting for Type A-1 cleanouts. When a PVC cap is used on top of the cleanout, drive a 1 foot length of reinforcing steel into the ground immediately adjacent to the cleanout to allow future location.

B. Type B Cleanouts: Comply with [Figure 4040.232](#). Use 24 inch diameter riser for subdrain 8 inches or smaller. Use 30 inch diameter riser for 10 inch and 12 inch subdrains.

1. **Reinforced Concrete:** Use Class III RCP complying with [Section 4020, 2.01](#).
2. **Polyvinyl Chloride:**
 - a. Comply with ASTM D 1784, Cell Classification 12454 for PVC plastic.
 - b. Conform to ASTM D 3212 for joints.
 - c. Comply with ASTM F 477 for flexible elastomeric.
3. **Concrete:** Comply with [Section 6010](#) for structural concrete for base and invert shaping.
4. **Castings:** Use a light duty (HS-20 loading) cast iron casting complying with [Section 6010, 2.10](#) or a ductile iron casting meeting ASTM A 536.

2.07 ENGINEERING FABRIC

Use fabric complying with [Iowa DOT Article 4196.01](#).

2.08 STORM SEWER SERVICE STUBS

Use materials complying with Section 4040, 2.01.

PART 3 - EXECUTION**3.01 SUBDRAINS**

- A. Install Type 1 or Type 2 subdrain where specified in the contract documents. Comply with [Figure 4040.231](#).
 - 1. Excavate trench and provide pipe bedding and backfill as shown on the figures. Install engineering fabric if specified in the contract documents.
 - 2. Begin subdrain installation at the outlet and continue upgrade.
 - 3. Lay subdrain pipe to the proper line and grade. Place pipe with the perforations down.
 - 4. If concrete pipe is specified for Type 2 subdrains, wrap exterior of each joint with engineering fabric and do not use joint sealant.
 - 5. Place porous backfill material over installed pipe in layers no more than 6 inches thick. Thoroughly tamp each layer with mechanical tampers.
 - 6. Restore pavement subbase material, shoulder material, or ground above subdrain trench as applicable.
- B. Provide cleanouts where specified in the contract documents. Comply with [Figure 4040.232](#).
- C. Provide outlets where specified in the contract documents.
 - 1. Comply with [Figure 4040.233](#) for outlets to structures.
 - 2. Install a rodent guard on all subdrain outlet pipes 6 inches and smaller.

3.02 FOOTING DRAIN COLLECTORS

- A. Install footing drain collectors according to [Section 3010](#).
- B. If specified, install engineering fabric.
- C. Provide cleanouts and connections where specified in the contract documents.
 - 1. Connect footing drain sewer collectors to storm sewer manhole or intake.
 - 2. Provide fabricated or preformed wye or tee service fitting for each platted lot or building.
- D. Provide manholes, where specified, according to [Section 6010](#).

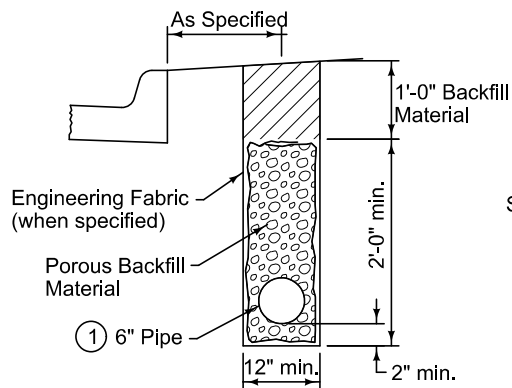
3.03 FOOTING DRAIN SERVICE STUBS

- A. Provide footing drain service stubs at locations specified in the contract documents.
- B. Install wye or tee for each service connection.
 - 1. For new storm sewer and footing drain collector construction, except RCP sewers, install wye or tee fittings according to the manufacturer's requirements.
 - 2. For existing storm sewers, existing footing drain collectors, and all RCP sewers, saw or drill a neat hole in main and install preformed saddle wyes or tees according to the manufacturer's requirements.

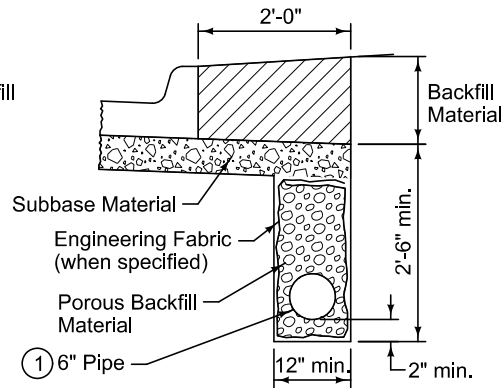
3.03 FOOTING DRAIN SERVICE STUBS (Continued)

- C. Install footing drain service stub to a location 10 feet beyond the right-of-way line or as specified in the contract documents.
 - 1. For undeveloped properties, place a watertight stopper or plug in the end of the storm sewer service.
 - 2. For reconnection of existing service pipe to new sewer service pipe, use a manufactured flexible connection.

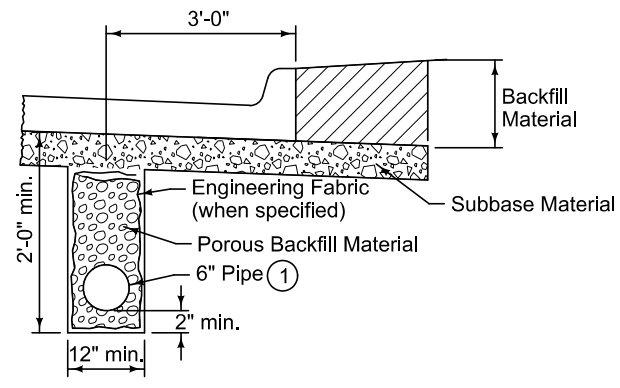
END OF SECTION



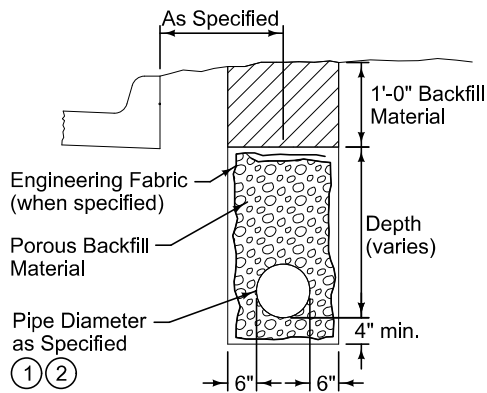
CASE A
TYPE 1



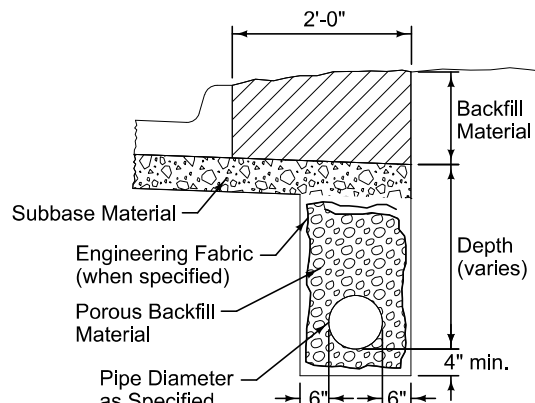
CASE B
TYPE 1



CASE C
TYPE 1




CASE D
TYPE 2

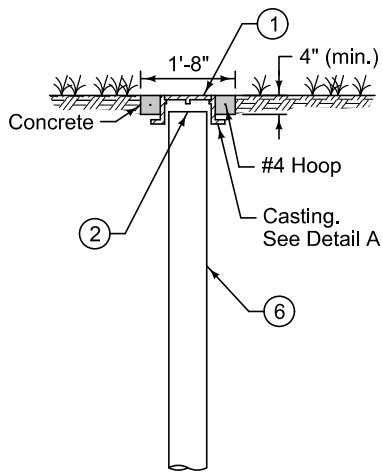


CASE E
TYPE 2

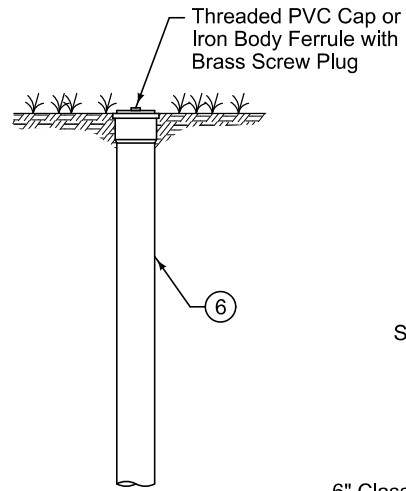
Type 1 installation is for longitudinal subdrain only. Type 2 installation is for combination subdrain/footing drain collectors.

- ① Place perforations down for all installations.
- ② When concrete pipe is specified, wrap pipe joints with engineering fabric. Do not apply joint sealant. Comply with Figure 4020.211

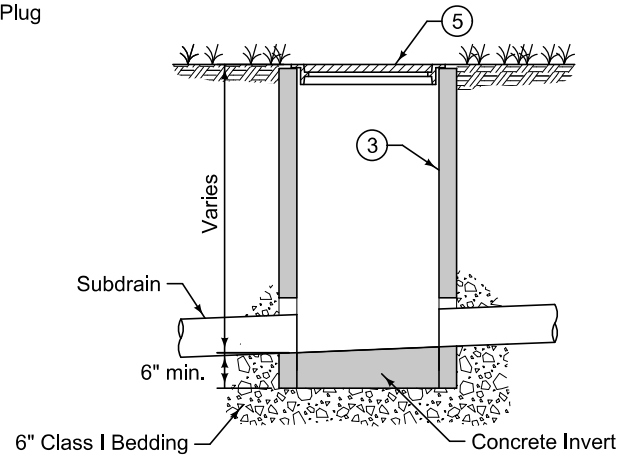
	SUDAS 4040.231	REVISION 1 10-21-14
	SHEET 1 of 1	
SUDAS Standard Specifications		
SUBDRAINS		



TYPE A-1 CLEANOUT



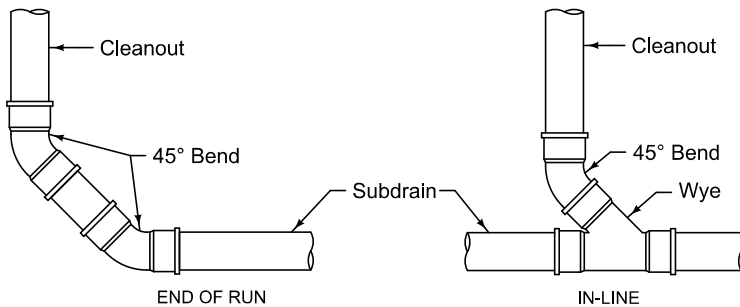
TYPE A-2 CLEANOUT



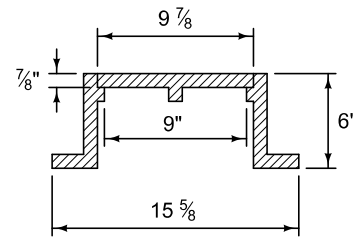
TYPE B CLEANOUT

Use in non-traffic areas.

- ① Light duty casting. Label lid with "Storm" or "Storm C.O."
- ② Do not allow casting to bear on top of riser pipe; provide 2 inch clearance, minimum.
- ③ A manufactured cleanout may be used in lieu of a Type B cleanout, if approved by the Engineer.
- ④ Design is intended for use in conjunction with 8 inch PVC riser pipe. Other sized caps may be used with smaller pipe, as approved by the Engineer.
- ⑤ Provide Type G casting, as required to fit pipe size.
- ⑥ PVC riser pipe; match diameter of subdrain (8 inches maximum).



TYPE A CLEANOUT CONNECTIONS

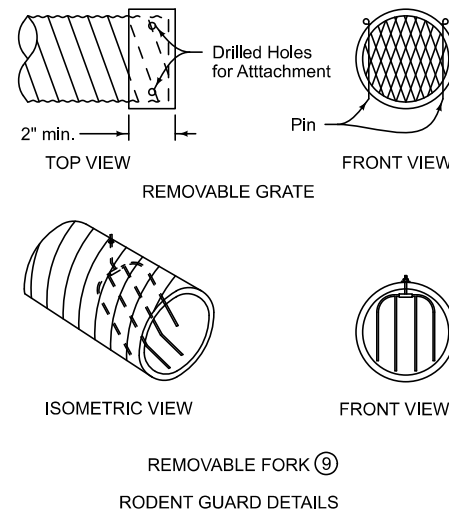
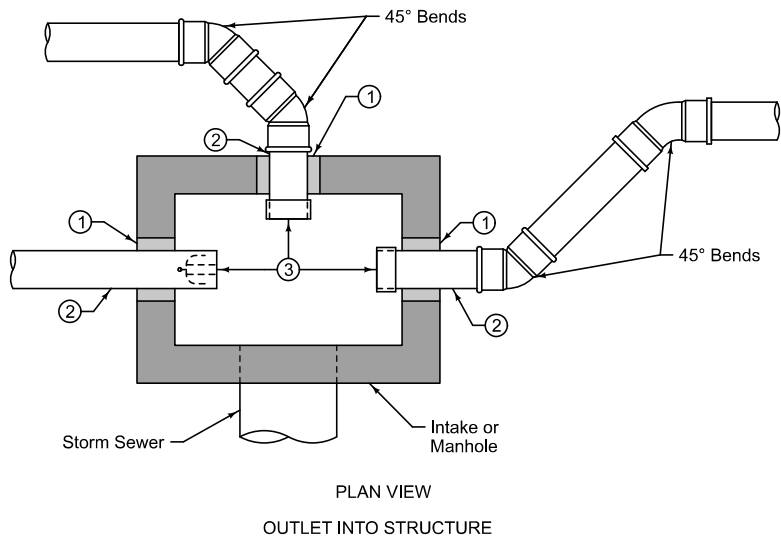


DETAIL A ① ④
(Dimensions are nominal)

	REVISION
	3 2020 Edition
	4040.232
SHEET 1 of 1	

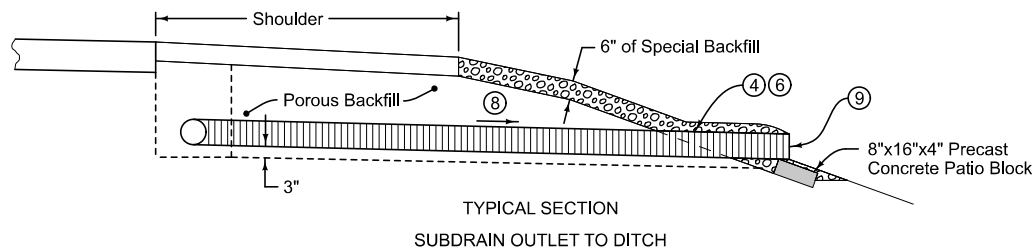
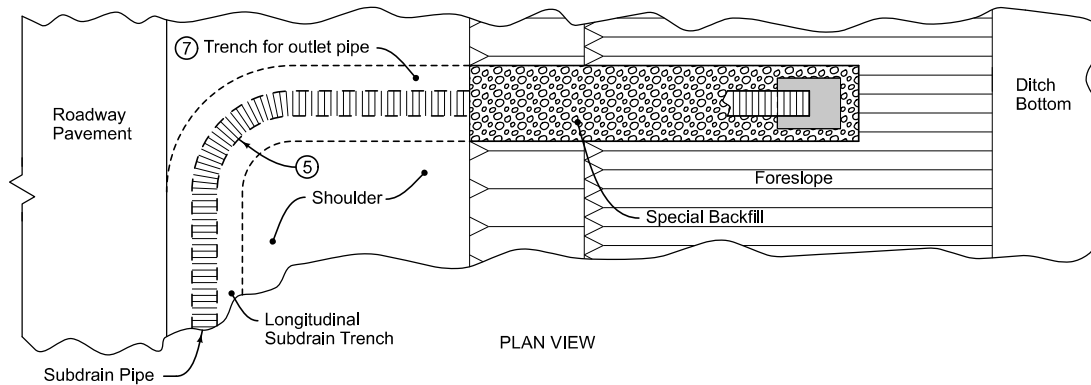
SUDAS Standard Specifications


SUBDRAIN CLEANOUTS



Transverse and backslope subdrains require only single outlets. Install double outlet pipes on all longitudinal subdrain systems, except at the beginning and end of the system. At these locations, install a single outlet pipe.

- ① Fill annular space with non-shrink grout.
- ② Outlets through intake walls to be CMP; corrugated, double-walled HDPE; or PVC.
- ③ Extend outlet pipe into structure as required to install removable rodent guard.
- ④ Construct subdrain outlet to ditch with the same type and size of pipe as used for the subdrain.
- ⑤ Provide a minimum 1 foot radius for all bends or use two 45° fittings
- ⑥ If a CMP outlet is specified in the contract documents, construct the final 10 to 12 feet of the subdrain outlet to ditch with CMP 2 inches larger than the subdrain pipe. Connect pipes with a manufactured coupler or concrete collar.
- ⑦ Provide a minimum trench width of 12 inches for a single outlet and 24 inches for a double outlet.
- ⑧ Provide a 6 inch minimum drop in elevation between longitudinal subdrain and outlet.
- ⑨ For subdrain outlet to ditch, only use fork type rodent guard.



	REVISION 5 2025 Edition 4040.233
	SHEET 1 of 1
	SUDAS Standard Specifications
SUBDRAIN OUTLETS	

PIPE CLEANING AND REHABILITATION**PART 1 - GENERAL****1.01 SECTION INCLUDES**

- A. Pipe Cleaning
- B. Cured-in-place Pipe (CIPP) Main Lining
- C. Cured-in-place Pipe (CIPP) Point Repair
- D. Cured-in-place Pipe (CIPP) Service Repair
- E. Pressure Testing and Grouting of Sewer Joints
- F. Spot Repairs by Pipe Replacement

1.02 DESCRIPTION OF WORK

- A. Pipe Cleaning:
 - 1. Mainline pipe cleaning (not associated with a rehabilitation or pre-inspection) is light sewer cleaning with a hydraulic flusher and includes cleaning the sewer and associated manholes, including drop connections and benches, to remove all deposits settled (DS).
 - 2. Pre-rehabilitation cleaning and inspection is light sewer cleaning with a hydraulic flusher. Does not include root cutting or removal of deposits or protruding service connections.
 - 3. Additional sewer cleaning is heavy sewer cleaning including an unlimited number of passes with high velocity hydro cleaning equipment / hydraulic spinner nozzle, cutting roots, removing deposits of attached encrustation (DAE), and removing deposits of attached grease (DAGS). Does not include lateral cuts.
- B. CIPP lining for mainline, service (lateral) repair, and point repair.
- C. Pressure testing and grouting of sewer joints.
- D. Pipe spot repairs.

1.03 SUBMITTALS

Comply with Division 1 - General Provisions and Covenants, as well as the following:

A. CIPP Rehabilitation:

- 1. **Thickness Design:** Submit design calculations for CIPP wall thickness based upon ASTM F 1216, prepared and signed by a licensed Professional Engineer in the State of Iowa.
- 2. **Resin:** Certificate of compliance with ASTM F 1216 or D 5813.
- 3. **Tube:** Certificate of compliance with ASTM F 1216 or F 2019. If glass fiber reinforcement is used, CIPP strain corrosion testing according to ASTM D 3681.
- 4. **Wet Out and Curing:** Complete description of the manufacturer's recommended wet out procedure and curing method for the type of lining proposed.

1.03 SUBMITTALS (Continued)

5. **Safety Procedures:** Submit documentation of National Institute of Occupational Safety and Health (NIOSH) testing, health hazard evaluation, and recommended safety procedures for CIPP workers and public. The safety plan is to include emission stacks a minimum of 6 feet tall and a method to establish a safe perimeter around manholes/emission stacks a minimum of 15 feet in diameter. Based on active air monitoring, workers must wear suitable Personal Protection Equipment (PPE) when initially opening and entering the transport truck or storage unit holding the liner.

B. Grouting Sewer Joints and Service Connections:

1. **Grout:** Description of chemical grout materials to be used.
2. **Additives:** Description of additives to be used including strengthening agents, shrinkage reducers, dye, viscosity modifiers, gel time modifier, freeze/thaw inhibitor, or others.
3. **Root Inhibitor:** Description of chemical root deterrent.
4. **Procedures:** Manufacturer's published recommendations for storing, mixing, testing, and handling chemical grouts.

C. Installer Information: When requested by the Contracting Authority, submit the following prior to the preconstruction meeting.

1. Installer name.
2. Completed project list for last five years including for each project and year completed, client name/address/contact person/phone number, footages installed by pipe diameter, and number of lateral reinstatements.
3. Detailed installation procedures, including estimated times for each task, lateral reinstatement methods, number of required excavations, and other items unique to each product.
4. Video of installation process, if available.
5. Evidence of properly trained personnel.
6. Related ASTM standards or any nationally recognized standards for product installation.
7. Available equipment list.
8. Detailed procedures for repairing the product in the event of future damage or failure and for tapping future service connections, including and required specialized equipment or training.
9. Videos of two rehabilitated sewer sections showing before and after conditions.
10. Additional information may be required. The submittal of prequalification information in no way implies that the product, manufacturer, or installer will be deemed to be qualified. The Contracting Authority, in its sole discretion, will determine whether a product, manufacturer, or installer does or does not qualify as an approved equal.

1.04 SUBSTITUTIONS

Comply with Division 1 - General Provisions and Covenants, as well as the following:

Provide, as a minimum, the following information for evaluation.

A. Product Information:

1. Product name.
2. Year product first available in the United States.
3. Total footage or number of line segments installed in the United States.
4. Results of all available product testing, including but not limited to leakage, physical properties, pipe stiffness, chemical resistance, strain-corrosion, external loading, flow characteristics, infiltration/inflow reductions, structural capacity, and external hydrostatic loading capacity.
5. Samples of before and after product.
6. Design method.
7. Typical lining thickness for pipe sizes included in the project.

B. Manufacturer Information:

1. Manufacturer name.
2. Years of experience manufacturing the product.
3. Country of manufacture of all product components.
4. Quality control procedures for product manufacture, including inspection requirements, testing procedures, and allowable tolerance levels.
5. Related ASTM standards, or other nationally recognized standards for product manufacturing.

1.05 DELIVERY, STORAGE, AND HANDLING

Comply with Division 1 - General Provisions and Covenants.

1.06 SCHEDULING AND CONFLICTS

Comply with Division 1 - General Provisions and Covenants.

1.07 SPECIAL REQUIREMENTS

- A. Prior to start of work, notify all affected parties 24 hours in advance as to the length of time their service will be blocked.
- B. Unless otherwise specified, the Jurisdiction will provide water at no cost for cleaning and installation of cured-in-place pipe. Utilize an approved double check backflow assembly or open gap.

1.07 SPECIAL REQUIREMENTS (Continued)

- C. Establish a Public Information and Notification Program for contacting each home or business connected to the affected sanitary sewer, informing them of the work to be done and when the sewer will be off-line. The following specific steps are part of the Public Information and Notification Program.
1. Provide written notice to be delivered to each affected home or business describing work, schedule, how the work affects them, and a local telephone number of the Contractor they can call to discuss the project or their problems.
 2. Personally contact each home or business on the day lateral verifications using closed circuit video inspection are to be performed. The homeowner or business will be asked to run water down their drain to verify each lateral. If the homeowner is unavailable, attempt other arrangements (cleanouts) to drain water through the lateral to verify each connection.
 3. Provide written notice and personally contact the home or business the day prior to beginning inversion of the section of sewer to which they are connected.
 4. Personally contact all homes or businesses that cannot be reconnected within the time stated in the written notice.
 5. Furnish and service portable toilets for use by the home or business occupants if so required by any affected served business or homeowner.

1.08 MEASUREMENT AND PAYMENT**A. Pipe Cleaning and Inspection:****1. Mainline Cleaning:**

- a. **Measurement:** Measurement will be made for each diameter range of sewer main cleaned. Diameter ranges: 4 to 12 inch, 15 to 24 inch, and 27 to 30 inch.
- b. **Payment:** Payment will be made at the unit price per linear foot for each diameter of cleaning.
- c. **Includes:** Unit price includes, but is not limited to, sewer cleaning, debris removal and transport, post CCTV inspection for Engineer review, and logging of active service taps (if specified). Unit price also includes disposal and associated costs for all debris removed from sewer.

2. Pre-Rehabilitation Cleaning and Inspection:

- a. **Measurement:** Measurement will be made for each diameter range of sewer main cleaned and inspected prior to rehabilitation. Diameter ranges: 4 to 12 inch, 15 to 24 inch, and 27 to 30 inch.
- b. **Payment:** Payment will be made at the unit price per linear foot for each diameter of pre-lining cleaning and inspection.
- c. **Includes:** Unit price includes, but is not limited to, pre-cleaning CCTV inspection, light sewer cleaning, debris removal and transport, post cleaning CCTV inspection for Engineer review, and identification and logging of active service taps. Unit price also includes disposal and associated costs for all debris removed from sewer.

3. Additional Sewer Cleaning:

- a. **Measurement:** Measurement will be made on an hourly basis for additional sewer cleaning for each diameter range. Hours will start with the initial cleaning work following the Engineer's approval to proceed and will extend until mechanical cleaning ceases. Time for removal, transporting, and disposal of debris is not included. Diameter ranges: 4 to 12 inch, 15 to 24 inch, and 27 to 30 inch.

1.08 MEASUREMENT AND PAYMENT (Continued)

- b. Payment:** Payment will be made at the unit price per hour for additional sewer cleaning.
- c. Includes:** Unit price includes, but is not limited to, heavy sewer cleaning; root cutting; deposit cutting; and post cleaning CCTV inspection for Engineer review.

4. Debris Removal, Transportation, and Disposal:

- a. Measurement:** Measurement will be made on a per ton basis for decanted and pressed debris removed as a part of additional pipe cleaning.
- b. Payment:** Payment will be made at the unit price per ton for additional pipe cleaning based on tickets from an approved landfill site.
- c. Includes:** Unit price includes, but is not limited to, removing, decanting, transporting, disposing, and paying associated costs for all debris removed from sewer as a part of additional cleaning.

B. Remove Protruding Service Connections:

- 1. Measurement:** Each protruding service connection removed will be counted. Quantity will be based on number of protruding service connections identified in the pre-rehabilitation CCTV inspection and removed from the post-rehabilitation CCTV inspection.
- 2. Payment:** Payment will be made at the unit price for each protruding service connection removed.
- 3. Includes:** Unit price includes, but is not limited to, removal of protruding service connections and debris removal.

C. CIPP Lining:**1. CIPP Main Lining:**

- a. Measurement:** Each size of main pipe lining will be measured in linear feet along the centerline of the pipe lining from center of manhole to center of manhole.
- b. Payment:** Payment will be made at the unit price per linear foot for each size of pipe lining.
- c. Includes:** Unit price includes, but is not limited to, furnishing and installing the liner and appurtenances, CCTV inspection immediately prior to lining, bypass pumping unless otherwise specified, sliding foil, post-lining CCTV inspection, and all costs associated with the public information and notification program.

2. Building Sanitary Sewer Service Reinstatement:

- a. Measurement:** Each active sanitary sewer service reinstated, including those reinstated by excavation, will be counted.
- b. Payment:** Payment will be made at the unit price for each active sewer service reinstated.
- c. Includes:** Unit price includes, but is not limited to, reinstating sanitary sewer service connections, removal of debris, and coordination with service owners.

3. CIPP End Seal:

- a. Measurement:** Each size of CIPP end seal installed will be counted.
- b. Payment:** Payment will be made at the unit price for each CIPP end seal installed.
- c. Includes:** Unit price includes, but is not limited to, end seal and installation.

1.08 MEASUREMENT AND PAYMENT (Continued)**D. CIPP Point Repair:**

1. **Measurement:** Each diameter of CIPP point repair will be counted. Repairs in excess of 10 feet in length will be counted as multiple repairs.
2. **Payment:** Payment will be made at the unit price for each diameter of CIPP point repair.
3. **Includes:** Unit price includes, but is not limited to, furnishing and placing point repair liner, bypass pumping unless otherwise specified, sewer cleaning, removal of obstructions, debris removal, pipe preparation, and pre and post repair CCTV inspection.

E. CIPP Service Repair:

1. **CIPP Service Pipe, Connection:**
 - a. **Measurement:** Each size combination of main and service connection diameters repaired will be counted.
 - b. **Payment:** Payment will be made at the unit price for each size combination of CIPP service pipe, connection.
 - c. **Includes:** Unit price includes, but is not limited to, furnishing and placing service connection liner, bypass pumping unless otherwise specified, documentation, and all costs associated with the public information and notification program.
2. **CIPP Service Repair, Partial Pipe:**
 - a. **Measurement:** Each size combination of main and service diameters and specified service length lined will be counted.
 - b. **Payment:** Payment will be made at the unit price for each size combination of CIPP service repair, partial pipe.
 - c. **Includes:** Unit price includes, but is not limited to, furnishing and installing service repair liner, bypass pumping unless otherwise specified, documentation, and all costs associated with the public information and notification program.

F. Pressure Testing and Grouting of Sewer Joints and Service Connections:

1. **Pressure Testing of Mainline Sewer Joints:**
 - a. **Measurement:** Each mainline sewer joint tested will be counted. Separate measurement will be made for each diameter of sewer main. Visually leaking joints, whether tested or not, will be counted if they are grouted.
 - b. **Payment:** Payment will be made at the unit price for each sewer joint tested.
 - c. **Includes:** Unit price includes, but is not limited to, bypass pumping unless otherwise specified, control testing, and documentation.
2. **Injection Grouting of Mainline Sewer Joints:**
 - a. **Measurement:** Each mainline sewer joint grouted will be counted. Separate measurement will be made for each diameter of sewer main.
 - b. **Payment:** Payment will be made at the unit price for each sewer joint grouted.
 - c. **Includes:** Unit price includes, but is not limited to, bypass pumping unless otherwise specified, material testing, pressure testing after grouting, re-grouting of failed joints, and documentation. Unit price does not include the quantity of chemical grout used.
3. **Pressure Testing of Service Connections:**
 - a. **Measurement:** Each sewer service connection tested will be counted. Separate measurement will be made for service connections on each diameter of sewer main.
 - b. **Payment:** Payment will be made at the unit price for each service connection tested.
 - c. **Includes:** Unit price includes, but is not limited to, bypass pumping unless otherwise specified, and documentation.

1.08 MEASUREMENT AND PAYMENT (Continued)**4. Injection Grouting of Service Connections:**

- a. **Measurement:** Each service connection grouted will be counted. Separate measurement will be made for service connections on each diameter of sewer main.
- b. **Payment:** Payment will be made at the unit price for each service connection grouted.
- c. **Includes:** Unit price includes, but is not limited to, bypass pumping unless otherwise specified, material testing, pressure testing after grouting, and documentation. Unit price does not include the quantity of chemical grout used.

5. Chemical Grout:

- a. **Measurement:** Each gallon of chemical grout used for sealing mainline sewer joints and service connections will be counted.
- b. **Payment:** Payment will be made at the unit price for each gallon of chemical grout used.
- c. **Includes:** Unit price includes, but is not limited to, grout additives; root inhibitor; and supplying, mixing, and measurement of chemical grout.

G. Bypass Pumping

1. **Measurement:** Lump sum item, no measurement will be made.
2. **Payment:** Payment will be made at the lump sum price for bypass pumping.
3. **Includes:** Lump sum price includes, but is not limited to, development and submittal of the bypassing plan, all staffing, equipment, and appurtenances necessary to accomplish the approved bypassing plan, including reserve equipment.

H. Spot Repairs by Pipe Replacement: Both of the following methods will be used for measurement and payment of spot repairs by pipe replacement.**1. Spot Repairs by Count:**

- a. **Measurement:** Each spot repair location will be counted.
- b. **Payment:** Payment will be made at the unit price for each spot repair.
- c. **Includes:** Unit price includes, but is not limited to, uncovering and removing existing pipe and furnishing and placing bedding and backfill material for replacement pipe.

and;

2. Spot Repairs by Linear Foot:

- a. **Measurement:** Each spot repair will be measured in linear feet along the centerline of the replacement pipe.
- b. **Payment:** Payment will be made at the unit price per linear foot of spot repair.
- c. **Includes:** Unit price includes, but is not limited to, furnishing and installing replacement pipe and connections.

I. Pavement Removal and Replacement: Comply with [Section 7040](#).**J. Sod:** Comply with [Section 9020](#).**K. Seeding:** Comply with [Section 9010](#).

PART 2 - PRODUCTS**2.01 CIPP MAIN LINING**

- A. Fabric Tube and Resin:** Comply with ASTM F 1216 for heat cure or ASTM F 2019 and D 5813 for UV light cure.
- B. CIPP Lining Dimensions:**
1. Use nominal internal diameter and length such that CIPP forms to internal circumference and length of original pipe.
 2. Field verify diameter and length.
 3. Use one continuous length without joints.
- C. Structural Requirements:**
1. Design the CIPP liner according to ASTM F 1216.
 2. Unless otherwise specified in the contract documents, assume fully deteriorated conditions and the following properties for design at each location:

Table 4050.01: CIPP Main Lining Design Values

Design Criteria	Value
Factor of safety, N	2.0
Soil modulus, E'_s	1,000 psi
Soil density, ω	120 lb/ft ³
Live load, W_s	H20
Ovality reduction factor, C	As specified for each location
Height of soil above pipe, H	As specified for each location
Height of water above top of pipe, H_w	1/2 depth of cover
Long term flexural strength, σ_L	Use value for 50 year design

3. Set the long term (50 year extrapolated) creep retention factor at 50% of the initial design flexural modulus as determined by ASTM D 790 unless long term test data according to ASTM D 2990 substantiates a different retention factor.
 4. Design for internal pressure or vacuum is not required.
- D. CIPP Lubricant:** Provide a non-toxic, oil based product that has no detrimental effects on the tube or boiler and pump system, will not support the growth of bacteria, and will not adversely affect the fluid to be transported.
- E. CIPP End Seal:**
1. **Hydrophilic Gasket Sleeve:** Provide a seamlessly molded gasket and retaining ring system complying with ASTM F 3240.
 2. **Expansion Band System:**
 - a. Provide a one-piece rubber gasket and a pair of stainless-steel expansion bands in a system manufactured specifically for CIPP end seal applications.
 - b. Provide bands with positive locking mechanism permanently securing the bands in their expanded position after tightening.
 - c. Comply with material requirements of ASTM C 923 for rubber gasket and stainless steel.

2.02 CIPP POINT REPAIR

A. General: Utilize a repair system that complies with the following requirements.

1. Meet or exceed the material requirements of ASTM F 1216 or ASTM F 2019 and ASTM D 5813.
2. Provides a full wrap section sized to create a circular liner equal to the inner diameter of the pipe. Ensure one end of the CIPP point repair sheet overlaps the second end by a minimum of 10% to allow for variation in pipe diameter.
3. Sufficient strength to bridge missing pipe segments and ability to stretch to fit irregular pipe sizes.
4. Uniform thickness and 10% extra resin.
5. Utilizes a thermoset resin system comprised of a base resin and hardener that cure at ambient temperatures.
6. Has a shrinkage value of less than 0.5% when measured according to ISO 2577 or ASTM D 6289.
7. Designed against corrosion and typical chemicals found in domestic sewage.

B. Liner Length: Minimum length as specified in the contract documents. Lengths beyond 10 feet may be completed with multiple liners.

C. Structural Requirements: Design the CIPP point repair according to the structural requirements for CIPP main lining described herein. Assume an ovality of 2% unless otherwise specified in the contract documents.

2.03 CIPP SERVICE REPAIR

A. General: Utilize a repair system that provides the following.

1. Full circumferential CIPP liner inside the main pipe and a tube that extends continuously from the sewer main into the service for the distance specified in the contract documents.
2. Installation of system from within the sewer main without the need for excavation or access through a clean out.
3. The ability to seal a combination of tees and wyes of varying angles.
4. The ability to seal the connection of the service to the mainline in a continuous, tight fitting, watertight pipe within a pipe that eliminates infiltration and root intrusion between the liner and host pipe.

B. Liner Length:

1. **CIPP Service Connection Repair:** Provide service liner with a length of 12 to 24 inches to seal the connection between the main line and the wye or tee.
2. **Partial Service Pipe:** Provide service liner with a length between 12 and 24 inches, as specified in the contract documents, to seal the connection from the main line to the first service pipe joint.
3. **Main Pipe Liner Length:** Provide main pipe liner with a length of 18 inches minimum.

2.03 CIPP SERVICE REPAIR (Continued)**C. Fabric Tube:**

1. Provide a fabric tube consisting of one or more layers of absorbent non-woven felt fabric, felt/fiberglass, or fiberglass complying with the requirements of ASTM F 1216 or ASTM F 2019 and ASTM D 5813.
2. Provide nominal fabric tube wall thickness to the nearest 0.5 mm increment as required by the thickness design. Ensure the wet-out fabric tube has a uniform thickness that, when compressed at installation pressures, meets or exceeds the design thickness after cure.
3. Coat inside (after installation) of fabric tube with an impermeable, flexible membrane that will contain the resin and facilitate vacuum impregnation.
4. Mark the fabric tube with the name of the lining system manufacturer and manufacturing lot or production footage. Ensure print is visible during final CCTV inspection.

D. Resin:

1. Provide a chemical-resistant thermoset (heat or UV light) resin and catalyst system or epoxy resin and catalyst / hardener system that, when cured within the fabric tube, complies with requirements of ASTM F 1216 or ASTM F 2019 and ASTM D 5813.
2. Method of cure may be by heat source, UV light, or ambient temperature.
3. Provide resin to tube ratio as recommended by the manufacturer.

E. Structural Requirements:

1. Design the cured-in-place service liner according to ASTM F 1216 utilizing the following assumptions, unless otherwise specified in the contract documents:

Table 4050.02: CIPP Service Design Values

Design Criteria	Value
Factor of safety	2.0
Soil modulus	1,000 psi
Soil density	120 pcf
Live load	H20
Depth of cover	As specified for each location
Groundwater	1/2 depth of cover
Ovality	2%

2. Set the long term (50 year extrapolated) creep retention factor at 50% of the initial design flexural modulus as determined by ASTM D 790 unless long term test data according to ASTM D 2990 substantiates a different retention factor.

2.03 CIPP SERVICE REPAIR (Continued)

3. Comply with the following minimum structural properties:

Table 4050.03: Minimum Structural Properties for CIPP Service

Property	Test Method	Minimum Value
Flexural modulus of elasticity	ASTM D 790	250,000 psi
Flexural strength	ASTM D 790	4,500 psi

4. Do not consider the bond to the existing pipe in determining the structural performance of the lining system.

2.04 CHEMICAL GROUT

- A. Grout:** Provide a chemical grout (chemical sealing material) complying with ASTM F 2304 or ASTM F 2454.
- B. Additives:** Strengthening agents, shrinkage reducers, dyes, viscosity modifiers, gel time modifiers, and freeze/thaw inhibitors, are allowed at the Contractor's discretion. Provide additives compatible with the chemical grout and complying with chemical grout manufacturer's requirements.
- C. Root Inhibitor:** When specified in the contract documents, provide a root deterrent chemical to control root regrowth. Ensure root inhibitor is compatible with chemical grout and additives and complies with grout manufacturer's requirements.

2.05 SEWER DYE

Provide tracer dye complying with NSF/ANSI 60.

2.06 PIPE REPAIR COUPLINGS FOR SPOT REPAIRS BY PIPE REPLACEMENT

- A. Style:** Full circle, fully lined, bolted.
- B. Length:** As recommended by the manufacturer for pipe diameter; 12 inches, minimum.
- C. Materials and Manufacturer:**
- Shells, armors, side bars, lugs, Turner lifting bars; complying with ASTM A 240, Type 304 stainless steel.
 - MIG welds, fully passivated.
 - Rubber gasket complying with ASTM D 2000, AA415 with full coverage and a grid pattern.
 - Stainless steel armor bonded to gasket to bridge lug area.
- D. Nuts and Bolts:** 1/2 inch or 5/8 inch diameter, complying with ASTM A 240, Type 304 stainless steel, and Teflon coated threads.

2.07 SEWER MAIN PIPE (FOR SPOT REPAIRS)

- A. Comply with [Section 4010](#).
- B. Use materials for pipe replacement as specified in the contract documents or approved by the Engineer.

PART 3 - EXECUTION**3.01 SEWER CLEANING AND INSPECTION****A. General:**

1. Provide equipment specifically designed and constructed for sewer cleaning and inspection.
2. Use sewer cleaning equipment manufacturer's recommended size tools for various pipe sizes.
3. Utilize equipment recommended by the manufacturer to protect the manhole and pipe during cleaning and inspection operations.
4. Perform all cleaning and removal operations under CCTV observation to monitor the progress of the work and to monitor the sewer line for damage. Continue until the condition of the host pipe meets the requirements of the liner manufacturer.
5. Flush all debris to downstream manhole. Screen, collect, and remove debris from sewer.
6. Dispose of all sanitary sewer debris and material at a location directed by the Owner. If specified in the contract documents, pay for all disposal fees.

B. Pre-Cleaning Inspection:

1. Complete CCTV inspection of sewer prior to initiating cleaning.
2. Inspect each pipe segment between manholes or access points in a single, continuous run where possible.
3. If line is impassable due to debris or obstructions, reverse setup and inspect from opposite manhole or access point.

C. Sewer Pipe Cleaning:

1. Perform light cleaning with hydraulic flusher or high velocity cleaning equipment to remove loose debris.
2. Complete up to three passes in an attempt to remove all debris from line.
3. If the light cleaning fails to leave the sewer line in a condition ready for lining, contact Engineer for authorization to proceed with additional sewer cleaning.

D. Additional Sewer Cleaning:

1. Notify Engineer prior to performing heavy cleaning as required to remove obstructions, grease, rock, sticks, deposits attached grease (DAGS), deposits attached encrustation (DAE), and roots, so the sewer is ready for lining. This item does not include cutting/grinding protruding service lines.
2. Utilize bucket machines with Teflon or equivalent covers, rotating nozzles, saws or cutters, or high velocity hydro-cleaning equipment.
3. Keep all the debris removed during additional cleaning separate from debris removed during light cleaning. Prior to removal, decant and press debris onsite. Discharge decanted water into a sanitary sewer prior to obtaining the tonnage of the material removed from the sewer..

3.01 SEWER CLEANING AND INSPECTION (Continued)

4. Notify Engineer prior to use of mechanical/hydraulic spinner nozzle, chain flail, or other devices that may damage pipe or service connections.
5. If deposits and obstructions cannot be removed by tools normally used in the sewer cleaning industry, notify the Engineer immediately
6. Maintain a log of time spent performing additional pipe cleaning on each line segment.

E. Remove Protruding Service Connection:

1. Grind or cut services that protrude more than 1/2 inch into the sewer main as approved by the Engineer.
2. Utilize a remote grinding/cutting device specifically designed to remove concrete, vitrified clay, PVC, and other types of pipe materials.
3. Notify the Engineer if ductile iron, steel, cast iron, or other non-typical service materials are encountered to review the ability and risks of removing the protruding services.
4. Grind or cut protruding service flush to the main sewer pipe without scouring or damaging the main sewer or service connection.
5. Notify the Engineer immediately if the sewer main or service pipe are not structurally sound.

F. Post-Cleaning CCTV Inspection: Complete inspection according to Section 4060 and the following.

1. Complete CCTV inspection of sewer upon completion of all sewer cleaning, obstruction removal, and protruding service removal activities.
2. Identify active and inactive service connections by the following:
 - a. Observe each service connection and identify active connections by active sewage flow or evidence of recent sewage flow.
 - b. If the status of the connection is inconclusive, run water down adjacent services to verify the location of each service.
 - c. Dye test connections if necessary to verify active status.
 - b. Accurately measure and log the location and clockwise position of all active service connections.

G. Groundwater: If significant groundwater infiltration is present, which could result in resin loss, resin contamination, reduction in CIPP thickness, or inadequate curing, notify the Engineer prior to installing CIPP liner.**H. Inspection Reporting:**

1. Provide a copy of the pre-cleaning and post-cleaning video inspections. Include on-screen continuous footage, pipe diameter, direction of viewing, manhole number, and street location reference in the recording. Affix labels to the recording media to include the name of the project, the date, and the location of the inspection.
2. Provide a written report of the inspections. Include true to scale drawings of all sewer defects and observation locations. Reference the time stamp on each line item entry on the written report.

3.02 BYPASSING SEWAGE

- A. Submit a bypassing plan to the Engineer for review.
- B. When sewer line flows exceed the values in Table 4050.04, or the depth recommended by the manufacturer of the sewer rehabilitation practice being implemented, reduce flows to acceptable levels.
 1. Plug the line at a point upstream of pipe to be rehabilitated if bypassing is required.
 2. Pump flow to a downstream point or adjacent system as directed by the Engineer.
 - a. Provide pump and bypass lines of adequate capacity to handle all flows.
 - b. Provide adequate reserve pumps on-site for emergency use and for storm flows.
- C. Rehabilitation and inspection work may be completed without bypassing in certain situations including low flow conditions, adequate upstream storage, use of a flow-through packer, or other situations approved by the Engineer. If proposed work will be completed without bypassing, have equipment and plan of action available to implement bypass pumping in the event the work is delayed or sewage levels in the upstream line are in danger of causing backups.

Table 4050.04: Maximum Depth of Flow During Inspection, Testing, and Rehabilitation

Main Diameter	CCTV Inspection	Joint Testing/Sealing
6" to 10"	20% of pipe diameter	25% of pipe diameter
12" to 24"	25% of pipe diameter	30% of pipe diameter
27" and up	30% of pipe diameter	35% of pipe diameter

3.03 CIPP MAIN LINING**A. General:**

1. Clean, prepare, and inspect the repair point according to Section 4050, 3.01
2. Install liner according to the manufacturer's published recommendations, ASTM F 1216, and ASTM F 2019.

B. Resin Impregnation:

1. Vacuum impregnate tube with resin (wet-out) at manufacturer's plant under quality controlled conditions or on-site in mobile wet-out unit.
2. Fill all voids in the tube material, adding 5% to 10% excess resin to allow for migration of resin into the voids and cracks.

C. Insertion:**1. General:**

- a. Perform pre-lining video inspection immediately prior to insertion of the wet-out tube.
- b. Insert the wet-out tube through an existing manhole or approved access.
- c. Ensure the tube is continuous between manholes with no joints. A single tube may span several manhole reaches as allowed by the equipment, properties of the CIPP, and time limits imposed by sewage flows to the host pipe.
- d. Insertion of CIPP indicates acceptance of the host pipe conditions and the suitability of the liner inserted into the host pipe. Repair any failure of CIPP liner due to inadequate cleaning, groundwater infiltration, or defects in the liner system at no additional cost to the Contracting Authority.

3.03 CIPP MAIN LINING (Continued)**2. Inverted Heat-Cured Liner:**

- a. Prior to installation of the liner, place a temperature sensor on the bottom of the host pipe to monitor the temperature of the outside of the liner during the curing process. Place sensor at the termination point or location most distant from the heat source.
- b. Insert the wet-out tube into the inversion device or standpipe with the impermeable plastic liner on the outside of the tube.
- c. Turn back the end of the liner to form a cuff and secure the cuff to the inversion device or standpipe.
- d. Apply air pressure or hydrostatic head as required to invert the tube into the host pipe with the impermeable liner on the inside of the pipe.
- e. Apply lubricant directly to the tube or pour lubricant into the standpipe during the inversion process to reduce friction.
- f. Maintain and adjust pressure as necessary to invert the tube from the point of insertion to the point of termination and to hold the tube tight against the wall, producing dimples at service connections.

3. Pull-In UV Light Cured Liner:

- a. If CIPP manufacturer recommends the use of a sliding foil for the existing pipe conditions, provide sliding foil which covers the lower third to lower half of the pipe circumference. Pull sliding foil into place.
- b. Fold the wet-out liner in half and pull into place through an existing manhole. Monitor pulling speed and tension to avoid exceeding the manufacturer's recommendations.
- c. Pull 1 to 2 feet of excess liner into the termination manhole.
- d. If the product is sensitive to elongation, measure the overall elongation of the tube after pull-in. Ensure the elongation of the tube is less than 2% of the overall length of the segment specified by the manufacturer.
- e. Expand the resin-impregnated tube as necessary to hold the tube tight against the wall, producing dimples at service connections.
- f. Perform CCTV inspection of the inflated liner prior to initiating cure. Confirm alignment and fit prior to initiating cure. Make corrections as necessary to provide a finished liner free of wrinkles and defects.

D. Curing:**1. Heat Cured:**

- a. Maintain consistent pressure, as recommended by the liner manufacturer, until curing is complete. Increase pressures to compensate for external ground water, if present.
- b. Cure liner using circulating heated water or steam. Ensure the temperature is sufficient to affect a cure in all sections of the pipe.
- c. Monitor and log the temperature from the sensor placed between the impregnated tube and the host pipe.
- d. Initial cure will occur during heat up and is achieved when exposed portions of the new pipe appear to be hard and sound and the temperature sensor indicates the liner has reached the temperature necessary to effect a cure in the resin.
- e. After initial cure is reached, raise the temperature to post-cure temperatures and hold for a period of time as recommended by the resin manufacturer.
- f. Cool the new pipe to a temperature of 100°F for water cure and 113°F for steam cure before relieving the internal pressure within the section.

2. UV Light Cured:

- a. Automatically record the time, rate of travel of the ultraviolet assembly, pressures, and amount of lamps in operation for each CIPP segment as documentation of correct curing of the fabric tube.
- b. Maintain consistent pressure, as recommended by the liner manufacturer, until curing is complete.

3.03 CIPP MAIN LINING (Continued)

- c. Draw the multi-lamp ultraviolet curing assembly through the pipe at a consistent, predetermined, speed that allows for cross-linking/polymerization of the CIPP resin.
- d. Adjust air pressure during curing as necessary to hold liner tight to the wall. Maintain pressure by adjustment of the outlet valve.
- e. Remove the temporary internal calibration hose installed by the manufacturer after curing is complete.

E. CIPP End Seal Installation:

1. **Hydrophilic Gasket Sleeve:** Install sleeve according to ASTM F 3240, sleeve manufacturer's published recommendations, and the following:
 - a. Do not install sleeve in host pipe more than 24 hours prior to CIPP lining.
 - b. Clean the first 6 inches of the main pipe to remove debris and visible grease deposits.
 - c. Install metal retaining clip at the leading edge of the sleeve. The metal clip may be held in place with adhesive tape if desired.
 - d. Install the sleeve in the main pipe so the leading edge is no more than 6 inches inside the end of the main pipe as measured from the manhole wall.
 - e. If the main pipe has a diameter of 18 inches or larger, utilize anchor screws to hold the sleeve in place.
2. **Expansion Band System:** Install system according to manufacturer's published recommendations and the following:
 - a. After installation of the CIPP liner, trim the end of the liner squarely a distance of 2 to 6 inches from the inside face of the manhole.
 - b. Clean the exposed face of the main pipe to remove debris and loose resin.
 - c. Slide the rubber gasket into the pipe, centering it over the end of the liner. Ensure one expansion band will seat against the liner and the other will seat against the main pipe.
 - d. Expand the expansion bands using a hydraulic expansion tool approved by the band manufacturer.

F. Service Reinstatement:

1. Do not leave sanitary service blocked for more than 24 hours.
2. Reinstatement active service lines from within the main with a CCTV camera and remote cutting tool. Do not reinstatement inactive service connections.
3. Machine the opening to full size of the service connection opening area. Ensure the bottom of the liner opening and service line are flush.
4. Ensure the opening does not have pipe fragments or CIPP fragments that may obstruct flow or snag debris.
5. In the event that service reinstatement results in a liner opening greater than 100% of the service connection opening, or damage to the service connection occurs, install a CIPP service repair to cover the over-cut service connection at no additional cost to the Contracting Authority.
6. If service connection cannot be reinstated remotely and requires excavation complete according to the local plumbing code at no additional cost to Contracting Authority.

3.03 CIPP MAIN LINING (Continued)

G. Inspection: Complete inspection according to Section 4060 and the following.

1. Perform CCTV video inspection of completed CIPP lining, including observance of reinstated service connections. Provide copy of video inspection to Jurisdiction.
2. Ensure the tube is free of dry spots, lifts (spots cured away from the sewer), and delaminations. Remove and replace deficient sections.
3. If the CIPP does not fit tight against the original pipe at its termination point, seal the space between the pipes by filling with a resin mixture or hydrophilic seal compatible with the CIPP.

3.04 CIPP POINT REPAIR

A. Preparation: Clean, prepare, and inspect the repair point according to Section 4050, 3.01.

B. Bypass Pumping: Develop a plan for flow diversion or stoppage. Review with Engineer prior to initiating repair.

C. Installation:

1. Bypass mainline flow according to the submitted bypass plan.
2. Install CIPP point repair according to system manufacturer's published recommendations.
3. Wet-out the liner with the entire volume of resin recommended by the manufacturer.
4. Load the wet-out liner onto the packer and secure in place. Ensure the ends of the packer extend beyond the ends of the liner.
5. Pull the packer into position within the pipe. Verify position with CCTV observation.
6. Apply air pressure to the packer to expand the CIPP point repair liner against the host pipe.
7. Maintain consistent pressure for the duration of the curing period.

D. Inspection: Complete inspection according to Section 4060 and the following.

1. Perform CCTV video inspection of completed CIPP point repair. Provide copy of video inspection to Jurisdiction.
2. Ensure the tube is free of foreign inclusions, dry spots, pinholes, wrinkles greater than 2% of the pipe diameter, and delamination. Remove and replace deficient sections.

3.05 CIPP SERVICE REPAIR

A. Preparation:

1. Prior to installation of the system, clean and prepare the interior of the host and service pipe in according to the manufacturer's written instructions.
2. Remove all debris and obstructions.

3.05 CIPP SERVICE REPAIR (Continued)

3. Perform a post cleaning CCTV inspection in preparation for installation of the lining system.
4. If any obstructions, joint misalignments, broken or collapsed pipe, or other conditions are identified that will prohibit proper installation of the system, notify the Engineer immediately.

B. Installation:

1. Install CIPP service repair according to system manufacturer's published recommendations and to the length specified in the contract documents.
2. Bypass main line flow according to the submitted bypass plan. Coordinate installation with service owner to prevent service line flows.
3. Wet-out the entire liner, including lateral and mainline portions, using vacuum impregnation.
4. Load the lining system inside or on a pressure apparatus and move into position in the mainline pipe at the service connection.
5. Align and verify the position of liner and service line via CCTV prior to initiating installation.
6. Apply air pressure to invert or expand the resin impregnated CIPP into the lateral pipe and push the main-line portion of the system against the main pipe. Maintain pressure until the curing process is complete.
7. Apply heat or UV light as required by the manufacturer to properly cure the liner.
8. If liner is heat cured, follow manufacturer's recommendations for cool-down before relieving pressure.
9. If liner is ambient cured, maintain pressure according to the manufacturer's recommendations before relieving pressure.
10. Remove frayed ends of the system.

C. Inspection and Documentation: Complete inspection according to Section 4060 and the following.

1. Provide Jurisdiction with video documentation of pre-installation conditions and post-installation conditions showing the repair.
2. Ensure the finished CIPP service repair is free of any leakage and visual defects including foreign inclusions, dry spots, lifts, pinholes, major wrinkles, and delamination. Repair any defects that could affect the structural integrity of the system or allow leaks.
3. Maintain a written log of installation conditions according to system manufacturer's recommendations. At a minimum, include time of wet out, time and location of insertion, time of inflation, bladder pressure requirements, required cure time, actual cure time, and cool down duration.
4. Submit documentation of results for CIPP liner material to Jurisdiction.

3.06 PRESSURE TESTING AND GROUTING OF SEWER JOINTS**A. General:**

1. Clean, prepare, and inspect the repair point according to Section 4050, 3.01
2. Complete sewer joint and service connection testing and grouting according to the grout supplier and equipment manufacturer's published recommendations, ASTM F 2304, and ASTM F 2454.

B. Equipment:

1. **Joint Testing Device:** Provide a joint testing device (packer), with means for introducing air under pressure into the void area created by the expanded ends of the packer against the host pipe and a means of continuously measuring, viewing, and recording the static pressure of the test medium and grout within the void area only. Provide packer constructed in a manner to allow a limited amount of sewage to flow through at all times.
2. **Service Connection Testing Device:** Provide a service connection testing device with inflatable mainline end elements and a service line grouting plug that creates a void area extending beyond the main connection. Use a service line grouting plug sized to match the diameter of the service being grouted with an effective sealing length of at least 18 inches, unless otherwise specified in the contract documents.
3. **Pumping Equipment:**
 - a. Provide positive displacement metering grout pump and hose delivery system capable of supplying a mixed volume of grout at a minimum of 3 gallons per minute and 30 gallons of uninterrupted flow within 10 minutes.
 - b. Ensure pump system has sufficient discharge pressure (in excess of system pressure losses and groundwater) to deliver grout volume to fill void space within the gel set time of the chemical grout.
4. **Grout Tanks:** When using non-soluble additives, ensure grout tanks have mechanical mixing devices to keep additives in suspension.
5. **Measuring Equipment:** Provide means of measuring and recording the volume of mixed grout pumped for each grouted joint or service connection.

C. Control Tests:

1. Prior to beginning testing and grouting, perform a demonstration test in an above ground 8 inch nominal diameter test cylinder suitable to contain the full length of the packer and sustain the void test pressure. For service line testing, provide an 8 inch test cylinder with 6 inch service tee to receive the lateral bladder.
2. Equip the test cylinder with a pressure gauge to monitor internal pressure and a release valve to exercise a controlled release of pressurized air from the void area to test the packer under both sound and leaking conditions.
 - a. With the void release valve closed, inflate the packer and air test the void at 7 to 10 psi. Ensure the observed void pressure at the test cylinder pressure gauge is within $\pm 1/2$ psi of the test monitoring equipment.
 - b. Crack open the release valve to simulate a small leak. Ensure the pressure drop of the cylinder gauge is within $\pm 1/2$ psi of the test monitoring equipment.

3.06 PRESSURE TESTING AND GROUTING OF SEWER JOINTS (Continued)

2. After entering each pipeline segment, but prior to commencement of joint testing, position the packer on a section of sound and clean sewer between two consecutive pipe joints and perform a pressure test. Pressurize packer to between 7 and 10 psi and hold for a period of 15 seconds with a pressure drop of less than 1.0 psi. Deflate packer and ensure that void pressure monitoring equipment drops $\pm 1/2$ psi of initial reading.
3. If any of the control tests are unsuccessful, clean equipment of excess grout or make necessary repairs and retest.

D. Sewer Main Joint Pressure Testing:

1. Test joints at a target pressure equal to $1/2$ psi per vertical foot of pipe depth plus 2 psi (not exceeding 10 psi).
2. Position the packer within the pipe so the packer straddles the pipe joint to be tested. Verify location via CCTV monitoring.
3. Expand the packer ends to isolate the joint from the remainder of the pipe and to create a void area between the pipe joint and testing device.
4. Pump air into void space until the pressure reaches the required test pressure.
5. Stop the flow of air into the void space and observe the void pressure for 15 seconds.
6. If the pressure is maintained with a drop of less than 1 psi, the joint will be considered as having passed the test.
7. If the pressure drops more than 1 psi during the test period, the joint will be considered as having failed and sealing will be required.
8. Deflate packer and verify the void pressure monitor drops to within $\pm 1/2$ psi of 0 psi. Clean equipment if pressure fails to return to 0 psi.

E. Service Line Pressure Testing:

1. Test service lines at a target pressure equal to $1/2$ psi per vertical foot of pipe depth plus 2 psi (not exceeding 10 psi).
2. Position the testing device within the line segment to straddle the service connection. Verify location via CCTV.
3. Align the service bladder with the service connection.
4. Apply air pressure to invert or inflate the bladder from the mainline assembly into the service pipe.
5. Expand the packer ends to isolate the section of the service connection to be tested.
6. Introduce air into the void area until a pressure equal to or up to 10% greater than the required test pressure is observed.
7. Stop the flow of air into the void space and observe the void pressure for 15 seconds.
8. If the pressure is maintained, with a pressure drop of less than 2 psi, the connection will be considered as having passed the test.

3.06 PRESSURE TESTING AND GROUTING OF SEWER JOINTS (Continued)

9. If the pressure drops more than 2 psi during the test period, the connection will be considered as having failed and sealing will be required.
10. Deflate packer and bladder and verify the void pressure monitor drops to within $\pm 1/2$ psi of 0 psi. Clean equipment if pressure fails to return to 0 psi.

F. Sewer Main Joint Sealing by Injection Grouting: Perform joint sealing according to ASTM F 2304, equipment manufacturer, grout supplier, and the following:

1. Position packer over the faulty joint and expand packer ends, isolating the joint with a tight seal.
2. Pump two-part chemical sealant material into the ratio specified by the grout supplier.
3. Continue to pump grout, in stages if necessary, until "refusal" is achieved.
 - a. Refusal indicates the grout has flowed throughout the void, into the surrounding soil, forming a cohesive seal stopping further flow of grout.
 - b. Under pumping conditions, void pressure will slowly rise as grout is forced into the surrounding soil and begins to set. When void pressure spikes an additional 8 psi or more in a short pumping period of 1 to 5 seconds, the point of refusal is achieved.
 - c. If a quantity of grout equal to 1/2 gallon per inch diameter of pipe size is pumped without reaching the point of refusal, staging may be required. Staging is accomplished by repetitive cycles of pumping and curing until refusal is achieved. Notify Engineer for approval before staging is attempted.
 - d. If joint cannot be sealed by staging, abandon sealing operations at that joint and notify Engineer.
4. Upon reaching refusal, stop grout pumps and allow grout to cure for 30 to 40 seconds.
5. Deflate packer to break away the ring of gel formed in the void and move at least one packer length away from the joint in either direction.
6. Ensure pressure gauge reads zero pressure $\pm 1/2$ psi. If gauge does not return to zero clean equipment.
7. Reposition packer over joint and retest at a pressure equal to the initial test pressure.
8. If joint fails pressure test, repeat grouting and pressure testing procedure until the joint is sealed or Engineer determines grout consumption is too high and continued attempts to seal joint are abandoned.
9. Remove residual sealing materials that extend into the pipe or restrict the flow. Ensure sealed joint surfaces are left flush with existing pipe surface. Remove residual grout material from manhole; do not allow grout to be flushed down the sewer.

G. Service Connection Sealing by Injection Grouting: Perform service sealing according to ASTM F 2454, equipment manufacturer, grout supplier, and the following requirements.

1. Pump two-part chemical sealant material at the ratio specified by the grout supplier.
2. Continue to pump grout, in stages if necessary, until refusal is achieved.
 - a. Under initial pumping conditions, the void pressure will slowly rise to a range of approximately 2 to 4 psi.
 - b. Continue pumping until there is a sudden increase to over 8 psi in a few seconds, indicating refusal.

3.06 PRESSURE TESTING AND GROUTING OF SEWER JOINTS (Continued)

- c. If a quantity of grout equal to 1 gallon per foot of service line bladder plus 3 gallons is pumped without reaching the point of refusal, staging may be required.
 - d. Stage grouting by pumping additional grout equivalent to 1 gallon plus 0.25 gallons per foot of bladder, waiting 1 full minute and retesting. Do not exceed two stages unless approved by Engineer
3. Upon reaching refusal, stop grout pumps and allow grout to cure for 1 full minute.
 4. Deflate service packer, re-inflate, and repeat service line pressure testing.
 5. If the service connection test fails, repeat injection grouting and pressure testing procedures until service is sealed or Engineer determines grout consumption is too high and continued attempts to seal service are abandoned.
 6. Confirm flow after sealing of each service. If a grout blockage exists, immediately clear the service of the blockage.
 7. A thin film of residual grout inside the service, which does not significantly impede flow, is a normal result of sealing and is not considered a blockage.

H. Inspection and Reporting: Comply with ASTM F 2304 Section 12.9 as noted below.

1. **Inspection:** Complete inspection according to Section 4060 and the following.
 - a. Perform CCTV observation and recording of initial pressure testing, sealing operations (if required), and final pressure testing (if required) for each joint or service.
 - b. Perform final CCTV video inspection of sewer main rehabilitated by injection grouting after all grouting work is completed. Provide copy of video to the Jurisdiction.
2. **Reporting:** Upon completion of each pipe segment, submit a report showing the following information for each joint and service connection tested, grouted or both.
 - a. Identification of sewer pipe section tested.
 - b. Type of pipe material, diameter, and depth of pipe to surface at manholes.
 - c. Length of pipe sections between joints.
 - d. Test pressure used before and after sealing and duration of test.
 - e. Location of each joint or service connection tested and any joints or service connections not tested with and explanation for not testing.
 - f. Pass/fail results for each joint or service connection tested.
 - g. Volume of grout material used on each joint or service connection.
 - h. Grout mix record of the batches mixed including amount of grout and catalyst, additives, temperature of the grout solution in the tanks, and gel set time used.

3.07 SPOT REPAIRS BY PIPE REPLACEMENT

- A. Excavate trench according to [Section 3010](#).
- B. Remove existing pipe to the extent required and disconnect affected sewer services.
- C. Install replacement pipe of the same nominal size as the existing pipe.
 1. Use the materials as specified in the contract documents that comply with [Section 4010](#).
 2. Place bedding material according to [Section 3010](#).

3.07 SPOT REPAIRS BY PIPE REPLACEMENT (Continued)

- D. Install pipe repair coupling.
 - 1. Cut pipes to length required allowing no more than a 1/2 inch gap between butted pipe ends at coupling location. Cut pipes perpendicular to centerline.
 - 2. Clean the outside surface of the existing and replacement pipes as required to provide a positive seal with the pipe repair coupling.
 - 3. Wrap coupling around pipes, centered on butt joint, and tighten bolts according to manufacturer's recommendations.
- E. Reconnect sewer services.
- F. Place backfill in trench according to [Section 3010](#).

3.08 CLEANUP AND CLOSEOUT

- A. Verify that the services are reconnected and fully operable, with at least 90% of original capacity.
- B. Submit initial and final recordings in a digital format and on a device approved by the Engineer.
- C. Remove all equipment and debris.

END OF SECTION

CLEANING, INSPECTION, AND TESTING OF SEWERS**PART 1 - GENERAL****1.01 SECTION INCLUDES**

- A. Cleaning, Inspecting, and Testing Sanitary Sewers
- B. Cleaning, Inspecting, and Testing Storm Sewers
- C. Cleaning and Inspecting Pipe Culverts
- D. Cleaning and Inspecting Rehabilitated Pipes

1.02 DESCRIPTION OF WORK

- A. Clean, inspect, and test sanitary sewer gravity mains, sanitary sewer force mains, and sanitary sewer service stubs.
- B. Clean, inspect, and test storm sewers.
- C. Clean and inspect pipe culverts.
- D. Clean, inspect, and test rehabilitated pipe.

1.03 SUBMITTALS

Comply with Division 1 - General Provisions and Covenants.

1.04 SUBSTITUTIONS

Comply with Division 1 - General Provisions and Covenants.

1.05 DELIVERY, STORAGE, AND HANDLING

Comply with Division 1 - General Provisions and Covenants.

1.06 SCHEDULING

Comply with Division 1 - General Provisions and Covenants, as well as the following:

- A. Notify Engineer at least 24 hours prior to performing testing.
- B. The Engineer must be present to review testing procedures and to record results.

1.07 SPECIAL REQUIREMENTS

None.

1.08 MEASUREMENT AND PAYMENT

Cleaning, inspecting, and testing sanitary sewers, storm sewers, pipe culverts, and rehabilitated pipes (including video inspection) are incidental to other project costs and will not be paid for separately.

PART 2 - PRODUCTS**2.01 TESTING EQUIPMENT**

- A. General:** Comply with applicable sections of ASTM and other applicable industry standards and codes.
- B. Video Inspection:**
1. Camera:
 - a. High-resolution color with adjustable iris focus.
 - b. Pan and tilt capabilities.
 - c. Integral lighting suitable to provide proper illumination and a clear video image of the entire periphery of the pipe.
 - d. Capable of operating in 100% humidity conditions.
 - e. Produce a high quality video image.
 2. Provide closed-circuit video inspection equipment capable of displaying on-screen footage of distance measured to within 1% of actual distance.
 3. Record the inspection in color in the recording media specified by the Engineer. Forward the recording to the Engineer.

PART 3 - EXECUTION**3.01 CLEANING**

- A. Clean all sanitary sewers, storm sewers, and pipe culverts prior to testing by flushing with high pressure water and removing debris by vacuum extraction, and by removing sheeting, bracing, shoring, forms, soil sediment, concrete, or other debris.
- B. Do not discharge soil sediment or debris to drainage channels, existing storm sewers, or existing sanitary sewers.

3.02 VIDEO INSPECTION**A. General:**

1. Unless otherwise specified in the contract documents, conduct video inspection of all new and rehabilitated sanitary and storm sewers after all backfill and compaction operations are completed, but prior to paving.
2. Notify the Engineer the day prior to inspection so the Engineer may be present during the inspection.
3. Notify the Engineer of the extent of noncompliance with the low spot depth tolerances in [Section 4010](#) for sanitary sewers and [Section 4020](#) for storm sewers.
4. Re-inspect sewers after any corrective action has been completed.

B. Inspection Procedure:

1. Prior to video inspection, run sufficient water through the pipe to saturate potential low spots so they may be detected during inspection.
2. Inspect each pipe segment between manholes or access points in a single, continuous run. Progress through the entire project in a uniform direction.
3. Inspect all lateral connections and other observations at right angles utilizing the pan and tilt capabilities of the camera.
4. Center the video camera in the pipe during the inspection.
5. Do not exceed 30 feet of inspection per minute.

C. Inspection Reporting:

1. Provide a copy of the video inspection including on-screen continuous footage, pipe diameter, direction of viewing, and manhole and street location references in the recording. Affix labels to the recording media to include the name of the project, the date, and the location of the inspection.
2. Provide a written report of the inspection. In the report, include true-to-scale drawings of all sewer defects and observation locations. Reference the time stamp on each line item entry on the written report.

3.03 SANITARY SEWER LEAKAGE TESTING

Perform one or more of the following tests on new sanitary sewer gravity mains and sanitary sewer service stubs. Conduct tests only if service lines to any private properties are plugged and not active. Test sanitary sewer manholes separately as specified in [Section 6030](#).

A. Sanitary Sewer Infiltration Testing:

1. Use only where ground water is more than 2 feet above top of pipe at highest point in section being tested.
2. Provide documented verification of ground water elevations for no less than 24 hours before measurement of infiltration.
3. Measure infiltration in sanitary sewer with a V-notch weir in a downstream manhole.
4. The maximum allowable infiltration for new sanitary sewers, including manholes, is 200 gallons per inch of diameter per mile of pipe per day.

B. Sanitary Sewer Exfiltration Testing:

1. **General:** Use an exfiltration test when ground water level is less than 2 feet above top of pipe at highest point in section being tested. Sectionalize the test section so the internal pressure in the pipe does not exceed 5 feet of water.
2. **Test Procedures:**
 - a. Install a watertight plug in the inlet of the upstream and downstream manhole of sewer section being tested.
 - b. Fill the sewer and upstream manhole with potable water until the water elevation in the upstream manhole is 2 feet higher than outside top of pipe in section being tested or 2 feet above existing ground water level, whichever is highest elevation.
 - c. Allow the water level to stabilize for 30 minutes, then refill the upstream manhole with water to the original level and begin the test.
 - d. Measure the amount of water lost in the upstream manhole in 1 hour. Use that amount to determine exfiltration in a 24 hour period.
3. **Exfiltration Rate:** The following table may be used to determine exfiltration in gallons per 24 hours by measuring the loss that occurs in 1 hour. The table is applicable only for 48 inch diameter manholes.

The maximum allowable exfiltration for new sanitary sewer, including manholes, is 200 gallons per inch of diameter per mile of pipe per day.

Table 4060.01: Loss in Gallons per 24 Hours for Drop in Water Level per Hour in 48 Inch Diameter Manhole (table may be interpolated to the nearest 1/4" drop)

Drop	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"
	0	188	376	564	752	940	1128	1316	1504	1692

For manholes larger than 48 inch diameter use the following formula:

$$G = 0.0816(H)(D^2)$$

Where:

G = loss in gallons.

D = diameter of manhole in inches.

H = water level drop in manhole in inches.

3.03 SANITARY SEWER LEAKAGE TESTING (Continued)**C. Sanitary Sewer Low Pressure Air Testing:****1. General:**

- a. A low pressure air test may be used in lieu of an exfiltration test except as noted.
- b. Air test is not recommended when ground water elevation is 2 feet or greater above the top of the pipe, and cannot be used when ground water is greater than 6 feet above the top of the pipe.
- c. Use extreme care and follow safety precautions during testing operations. No one is allowed in manholes during testing.

2. Test Procedures:

- a. Clean entire line of all debris. Flush or wet line to produce consistent results.
- b. Plug all inlets and outlets to resist the test pressure. Special attention must be given to stoppers and laterals.
- c. Determine the test duration for the section being tested from the following table. This table ignores pipe length and uses the factor $0.472 \times d$, with "d" being in inches. Pressure holding time is based on average holding pressure of 3.0 psi or drop from 3.5 psi to 2.5 psi.

Table 4060.02: Test Duration

Size Pipe (inches)	Test Period Duration (minutes)
8	4.0
10	5.0
12	6.0
15	7.0
18	8.5
21	10.0
24	11.5
27	13.0
30	14.0
36	17.0
42	20.0
48	23.0
54	25.5
60	28.5

- d. Add air to the line segment being tested until the internal air pressure of the sewer line is raised to approximately 4.0 psi greater than the average back pressure of any ground water that may be over the top of the pipe. Pressure in the sewer should not exceed 5.0 psi. Allow at least 2 minutes for air pressure to stabilize.
- e. When pressure has stabilized and is at or above the starting test pressure of 3.5 psi, commence the test. Record the drop in pressure for the test period. The test may be discontinued when the prescribed test time has been completed, even though 1.0 psi drop has not occurred.
- f. If the ground water level at the time of testing is above the pipe invert, add 0.43 psi of air per foot of water above the invert to the test air pressure range of 2.5 psi to 3.5 psi stated above.
- g. If the pressure drop exceeds 1.0 psi during the test period, the test will be considered to have failed. Repair and retest the line.

3.03 SANITARY SEWER LEAKAGE TESTING (Continued)**D. Sanitary Sewer Vacuum Testing:** Comply with ASTM C 1244.**1. General:**

- a. Vacuum testing may be used in lieu of other specified test methods.
- b. Use extreme care and follow safety precautions during testing operations. Keep personnel out of and away from manholes during testing.
- c. Where practical, clean the pipe prior to testing and wet the pipe surface. Isolate the test segment as necessary, including closing service connections.

2. Test Procedures:

- a. Determine the test time for the size of pipe being tested using the following table.

Table 4060.03: Minimum Test Time

Nominal Pipe Size (inches)	Time (Minutes/100 feet of pipe)
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0

- b. Test time is the time required for vacuum to drop from 3.5 to 2.5 psi.
- c. Use a vacuum pump with the capacity to evacuate the sewer test section in time equal or less than that shown in Table 4060.03 for the size of pipe being tested.
- d. Evacuate air until the internal air pressure of the sewer line is lowered by approximately 4.0 psi. Allow the air pressure to stabilize.
- e. When the air pressure is stabilized near the starting test vacuum of 3.5 psi, commence the test by allowing gage pressure to drop to 3.5 psi, then commence time recording. Record the drop in vacuum for the test period.
- f. If the drop in vacuum is 1.0 psi or less during the test period, the test will be considered successfully passed.
- g. If the drop in vacuum is greater than 1.0 psi during the test period, inspect, evaluate, repair, and retest.

3.04 DEFLECTION TESTING

- A. Perform deflection tests on all flexible sanitary sewer mains, excluding ductile iron pipe. Also perform deflection tests on all flexible storm sewer or culvert pipe 12 inches in diameter or greater.
- B. Perform deflection tests after backfill has been in place at least 30 calendar days and before paving activity takes place, or as per appropriate sections of these specifications.
- C. Pull 9 arm deflection mandrel, complying with applicable ASTM Standards, through sewer by hand.
- D. Ensure pipe deflection does not exceed 5% of average inside diameter as established by ASTM Standards.

3.04 DEFLECTION TESTING (Continued)

- E. Remove and replace pipe exceeding deflection limits.
- F. Handle and divert existing flows during deflection testing.

3.05 FORCE MAIN TESTING

- A. Provide test pumps, test plugs, pipe, and gages. Make necessary piping connections.
- B. Fill the force main with potable water and flush before testing to remove entrapped air. Other water sources may be used if approved by the Engineer.
- C. Insert taps as required to remove air. Plug taps after the completion of tests.
- D. Use a test pressure of 1.5 times the working pressure at the lowest point along the test section, but not less than 50 psi.
- E. Pressurize the test section and allow it to stabilize prior to beginning the leakage test.
- F. Maintain pressure to within 5 psi of the test pressure by pumping in potable water as required.
- G. Leakage is the quantity of water that must be supplied into the test section to maintain pressure within 5 psi of the specified test pressure during a 2 hour test period.
- H. The maximum allowable leakage is determined by the following formula:

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

Where:

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

The following table assumes an average test pressure (P) of 50 psi and length of pipe (S) of 1,000 feet.

Table 4060.04: Maximum Allowable Leakage Rate

Pipe Diameter (inches)	Allowable Leakage Rate (gallons/hour/1,000 feet of pipe)
4	0.19
6	0.29
8	0.38
10	0.48
12	0.57
14	0.67
16	0.76

- I. Examine exposed pipe and fittings during testing. Repair all visible leaks.
- J. If the test indicates leakage greater than allowed, locate, repair, or replace damaged or defective pipe, and repeat tests until the requirements are met.

END OF SECTION

