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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 bedding material, placing 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; trenchless installation materials and equipment; pit excavation, dewatering, and placing 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, trench excavation, dewatering, furnishing bedding material, placing 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, and placing 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 bedding material, placing bedding and backfill material, 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, and placing 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.
- c. Includes:** Unit price includes, but is not limited to, furnishing and installing both carrier pipe and casing pipe, trench excavation, dewatering, furnishing bedding material, placing bedding and backfill material, furnishing and installing annular space fill material, casing spacers, 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 with a casing pipe 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 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, and placing backfill material; casing spacers; furnishing and installing annular space fill material; pipe connections; testing; and inspection.
- E. Sanitary Sewer Service Stub:** The portion of the sanitary sewer service from the main to a point 10 feet outside of the right-of-way line or as specified in the contract documents (comply with Figure 4010.201).
 - 1. Measurement:** Each type and size of pipe will be measured in linear feet along the centerline of the pipe from the end of the pipe to the centerline of the sewer main.
 - 2. Payment:** Payment will be made at the unit price per linear foot for each type and size of sanitary 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, testing, and inspection.
- F. Sanitary Sewer Service Relocation:** The portion of an existing sanitary sewer service in a zone of conflict.
 - 1. Measurement:** Each completed relocation will be counted.
 - 2. Payment:** Payment will be made at the unit price for each relocation.
 - 3. Includes:** Unit price includes, but is not limited to, removal of existing pipe, trench excavation, furnishing new pipe and bedding material, placing bedding and backfill material, connection back to existing service, compaction, testing, and inspection.
- G. Sewage Air Release Valve and Pit:**
 - 1. Measurement:** Each completed installation, including valve, accessories, and pit, will be counted.
 - 2. Payment:** Payment will be made at the unit price for each sewage air release valve and pit.
 - 3. Includes:** Unit price includes, but is not limited to, excavation, furnishing bedding material, placing bedding and backfill material, compaction, and testing.
- 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 and placing backfill material.

1.08 MEASUREMENT AND PAYMENT (Continued)**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 backfill.

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 backfill.

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. Coat interior pipe barrel and all joint surfaces with two-component coal-tar epoxy-polyamide black paint or approved equal.
- b. Lining Material: Steel Structures Painting Council (SSPC) Specification No. 16, Table 1.
 - 1) Minimum epoxy resin content 34 to 35% by dry film weight.
 - 2) Minimum sag resistance 40 mils.
 - 3) Minimum solids 80% by volume.
- c. Apply according to lining material manufacturer's recommendations.

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

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

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.

2.01 SANITARY SEWER (Gravity Mains) (Continued)**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 F477.

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. 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.

2.02 SANITARY SEWER FORCE MAINS (Continued)

- 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.
- D. **Tracer Wire:** Comply with Section 5010, 2.05. Tracer wire will be required on all force mains.
- E. **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. **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.

2.04 SANITARY SEWER SERVICES (Continued)

- 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, 2.08.

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 Sewers from Water Mains:** Separate gravity 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, the sewers must be constructed of water main materials meeting the requirements of Section 5010, 2.01. However, provide a linear separation of at least 2 feet.
- B. Separation of Sewer Force Mains from Water Mains:** Separate 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.
- C. Separation of Sewer and Water Main Crossovers:**
1. Vertical separation of sanitary sewers crossing under any water main should be 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, the sewer may be placed not 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 sewer crosses over or less than 18 inches below a water main, locate one full length of sewer pipe of water main material so both joints are as far as possible from the water main. The sewer and water pipes must be adequately supported and have watertight joints. Use a low permeability soil for backfill material within 10 feet of the point of crossing.

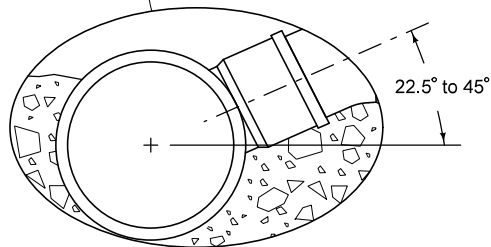
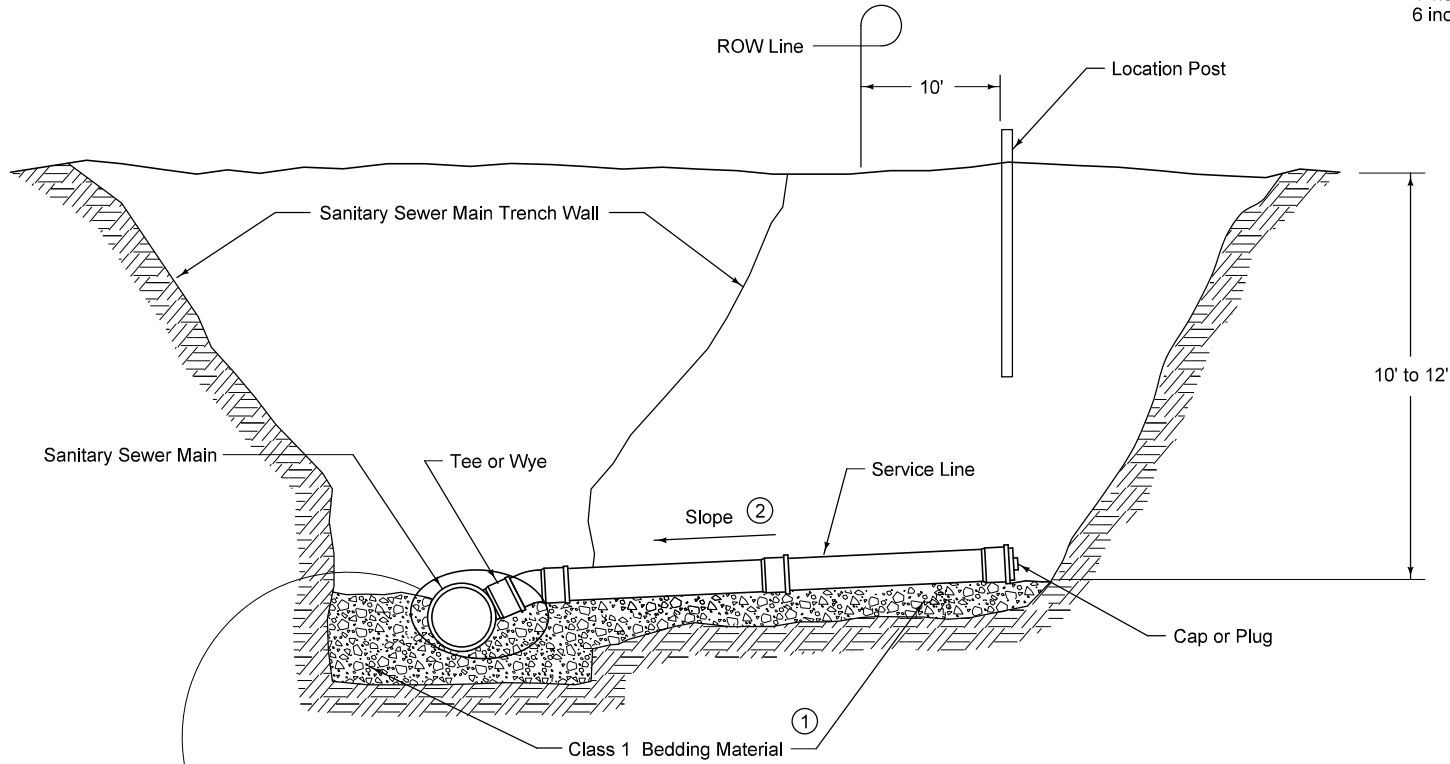
3.13 CLEANING, INSPECTION, AND TESTING

Clean, inspect, and test sanitary sewer per Section 4060.

END OF SECTION

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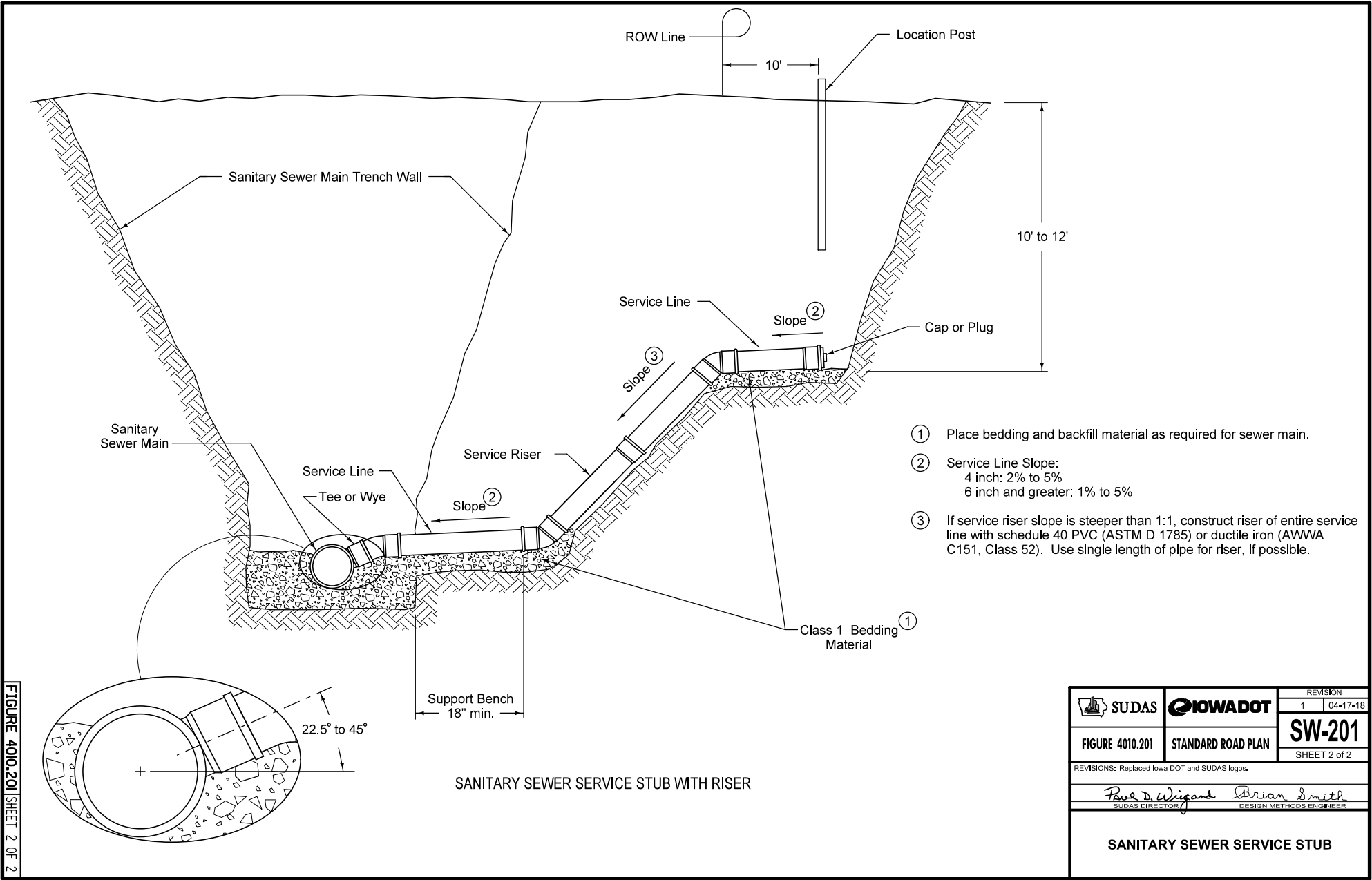
- ① Place bedding and backfill material as required for sewer main.
- ② Service Line Slope:
4 inch: 2% to 5%
6 inch and greater: 1% to 5%



SANITARY SEWER SERVICE STUB

FIGURE 4010.201 SHEET 1 OF 2

| | | |
|---|--------------------|--|
| SUDAS | IOWADOT | REVISION |
| | | 1 04-17-18 |
| FIGURE 4010.201 | STANDARD ROAD PLAN | SW-201 |
| | | SHEET 1 of 2 |
| REVISIONS: Replaced Iowa DOT and SUDAS logos. | | |
| <i>Bud D. Wigand</i> <small>SUDAS DIRECTOR</small> | | <i>Brian Smith</i> <small>DESIGN METHODS ENGINEER</small> |
| SANITARY SEWER SERVICE STUB | | |

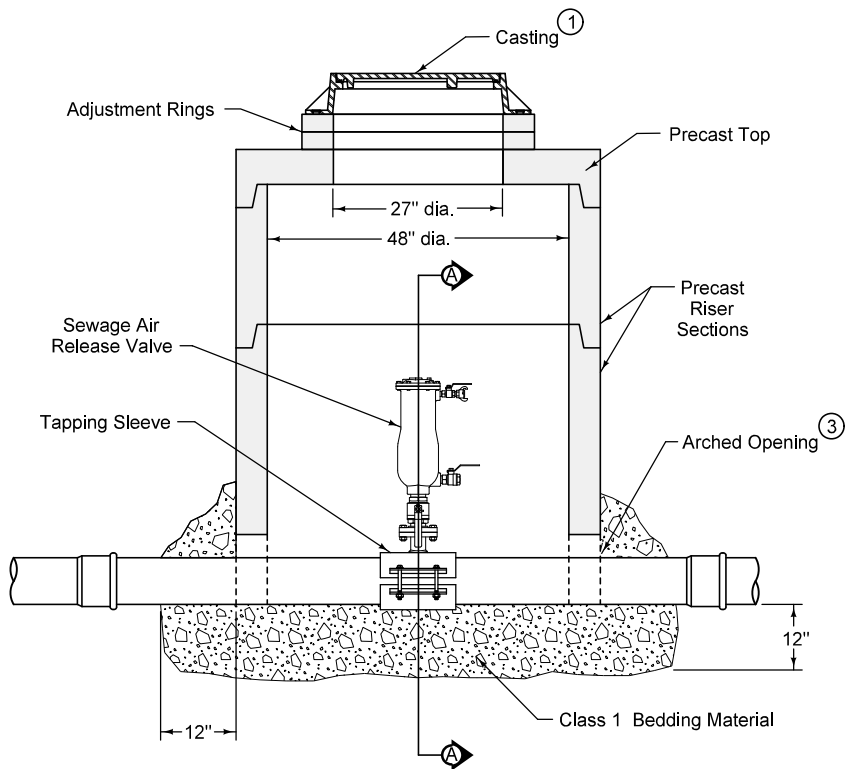


- ① Place bedding and backfill material as required for sewer main.
- ② Service Line Slope:
4 inch: 2% to 5%
6 inch and greater: 1% to 5%
- ③ If service riser slope is steeper than 1:1, construct riser of entire service line with schedule 40 PVC (ASTM D 1785) or ductile iron (AWWA C151, Class 52). Use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

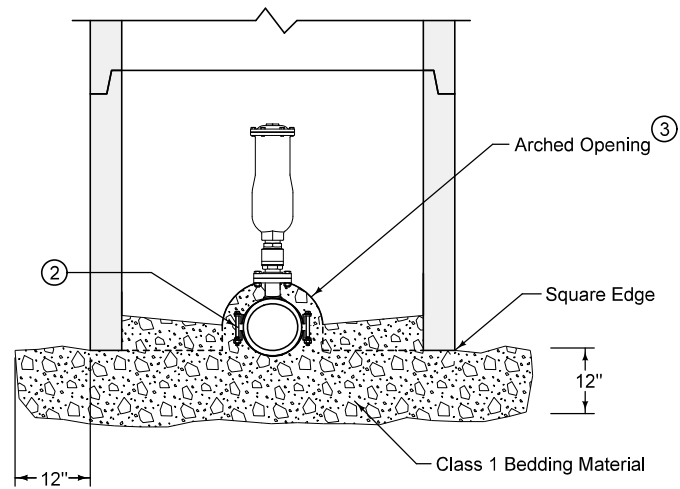
SANITARY SEWER SERVICE STUB WITH RISER

FIGURE 4010.201 SHEET 2 OF 2

| | | |
|--|--------------------|--|
| SUDAS | IOWADOT | REVISION |
| | | 1 04-17-18 |
| FIGURE 4010.201 | STANDARD ROAD PLAN | SW-201 |
| | | SHEET 2 of 2 |
| <small>REVISIONS: Replaced Iowa DOT and SUDAS logos.</small> | | |
| <i>Paul D. Wigand</i> <small>SUDAS DIRECTOR</small> | | <i>Brian Smith</i> <small>DESIGN METHODS ENGINEER</small> |
| SANITARY SEWER SERVICE STUB | | |



TYPICAL SECTION

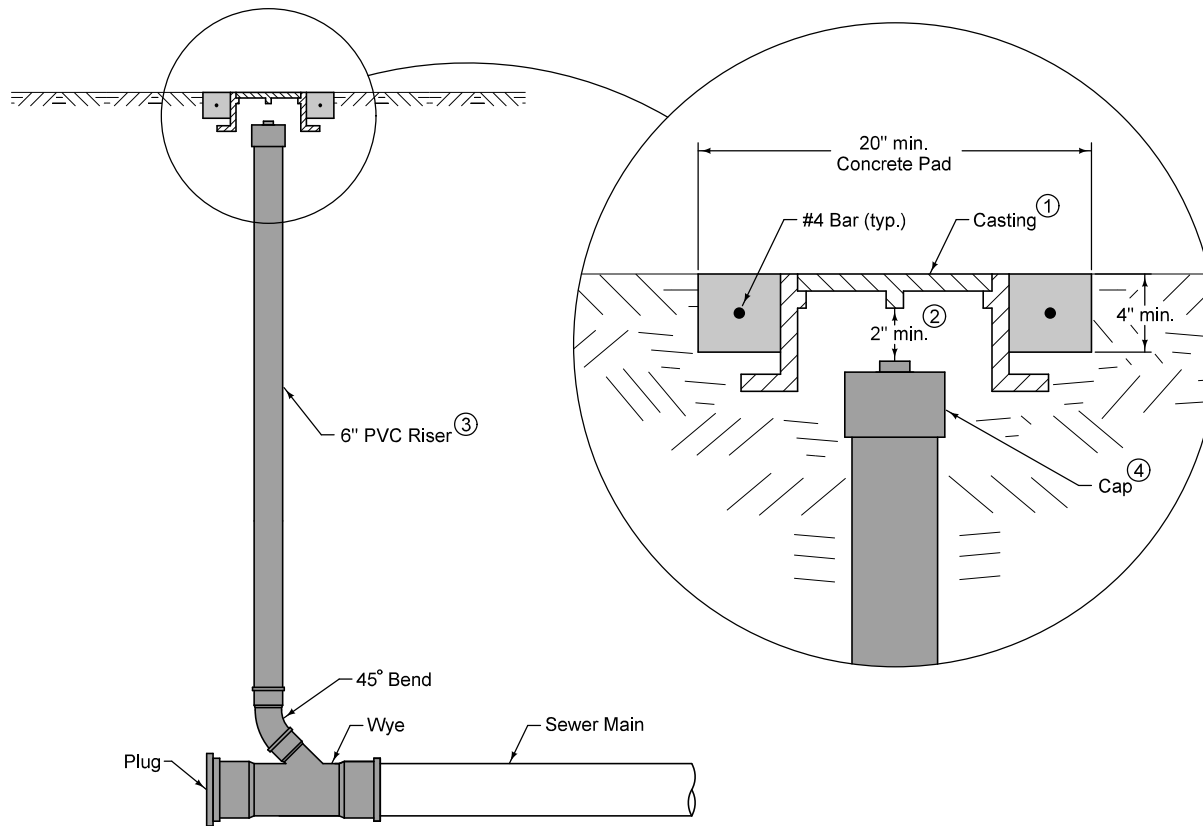


SECTION A-A

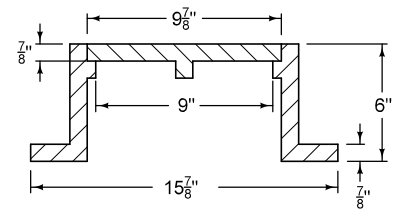
- ① SW-601 Type A or SW-602 Type G casting.
- ② Place bedding material to springline of pipe.
- ③ Prevent riser from bearing on pipe by providing an arched opening with a diameter up to 6 inches larger than pipe diameter.

FIGURE 4010.202 SHEET 1 OF 1

| | | |
|--|--------------------|--|
| SUDAS | IOWADOT | REVISION |
| | | 1 04-17-18 |
| FIGURE 4010.202 | STANDARD ROAD PLAN | SW-202 |
| | | SHEET 1 of 1 |
| <small>REVISIONS: Replaced Iowa DOT and SUDAS logos.</small> | | |
| <i>Paul D. Wigand</i> <small>SUDAS DIRECTOR</small> | | <i>Brian Smith</i> <small>DESIGN METHODS ENGINEER</small> |
| 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



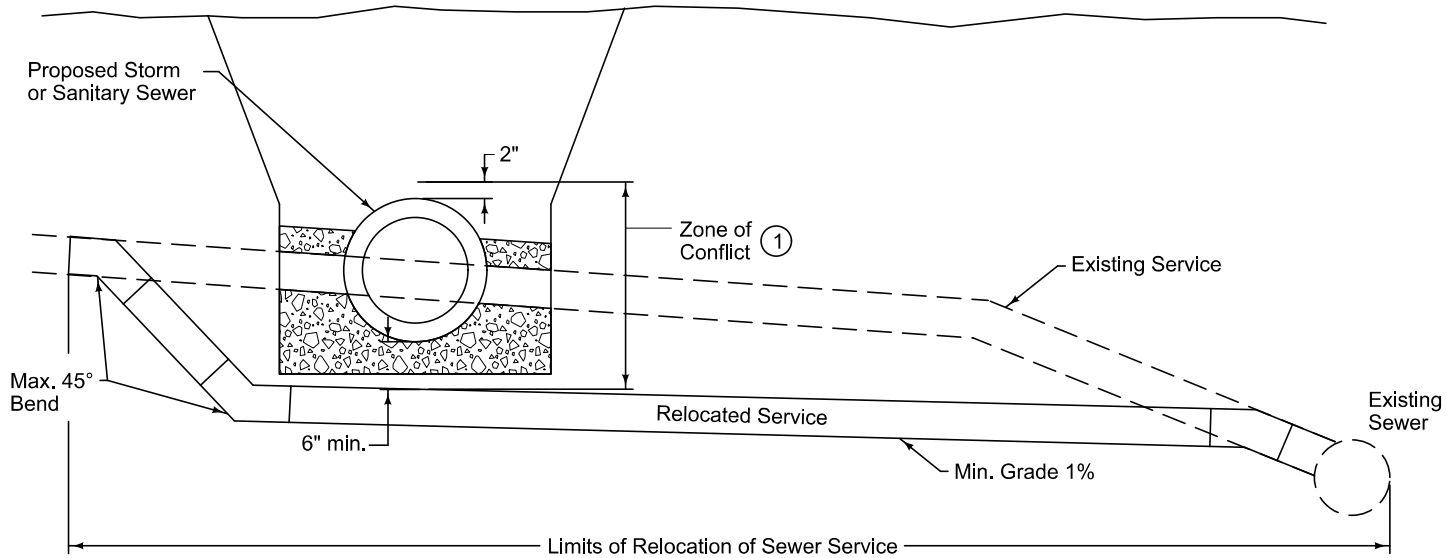
CASTING ①
(Dimensions are nominal)

CLEANOUT

FIGURE 4010.203 SHEET 1 OF 1

| | | |
|--|--------------------|--|
| | | 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> <small>SUDAS DIRECTOR</small> | | <i>Brian Smith</i> <small>DESIGN METHODS ENGINEER</small> |
| 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 bedding material, placing 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, and placing 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 bedding material, placing 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, and placing backfill material; casing spacers; furnishing and installing annular space fill material; pipe connections; testing; and inspection.

C. 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 and placing backfill material.

D. Connection to Existing Manhole or Intake: Comply with Section 6010, 1.08, G.**E. 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 backfill.

1.08 MEASUREMENT AND PAYMENT (Continued)**F. 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 backfill.

G. 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. ASTM D 3350 minimum resin Cell Classification 335420 C.
 - c. Minimum pipe stiffness at 5% deflection according to ASTM D 2412.
 - d. Integral bell and spigot joints with elastomeric seals complying with ASTM F 477.
 - e. Maximum 5% deflection of the average inside diameter by testing after installation according to Section 4060, 3.05.
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.

2.01 STORM SEWERS (Continued)

2. Use of this pipe material requires specific approval by the Engineer.

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 CASING PIPE

Comply with Section 3020, 2.02 for casing pipe requirements.

2.03 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.

2.04 APRON FOOTINGS

Comply with the requirements of Section 6010 for reinforcing steel and structural concrete used in apron footings.

2.05 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 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 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 1/8 inch at the bottom and 5/8 inch at the top.

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.

3.05 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.
- 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.

3.06 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"

3.07 CONFLICTS**A. Horizontal Separation of Gravity Sewers from Water Mains:**

1. Separate gravity storm sewer mains from water mains by a horizontal distance of at least 10 feet unless:
 - The top of a sewer main is at least 18 inches below the bottom of the water main, and
 - 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.
2. 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, the sewers must be constructed of water main materials meeting the requirements of Section 5010, 2.01. However, provide a linear separation of at least 2 feet.

B. Separation of 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.

C. Separation of Sewer and Water Main Crossovers:

1. Vertical separation of storm sewers crossing under any water main should be 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, the sewer may be placed not closer than 6 inches below a water main or 18 inches above a water main. Maintain the maximum feasible separation distance in all cases. The sewer and water pipes must be adequately supported and have watertight joints. Use a low permeability soil for backfill material within 10 feet of the point of crossing.
2. Where the storm sewer crosses over or less than 18 inches below a water main, locate one full length of sewer pipe of water main material or reinforced concrete pipe (RCP) with flexible gasket joints meeting ASTM C 443 so both joints are as far as possible from the water main.

3.08 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.

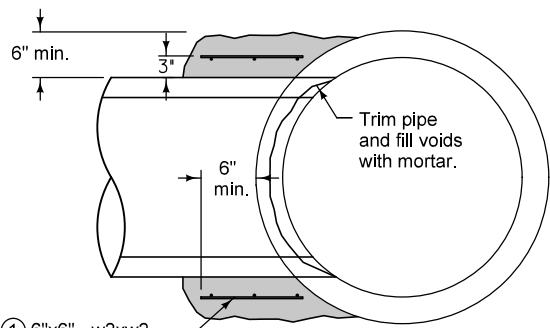
3.09 CONNECTION TO EXISTING MANHOLE OR INTAKE

Comply with Section 6010, 3.05.

3.10 CLEANING, INSPECTION, AND TESTING

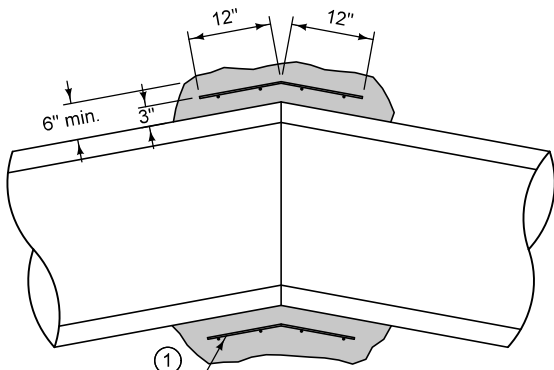
Clean, inspect, and test according to Section 4060.

END OF SECTION



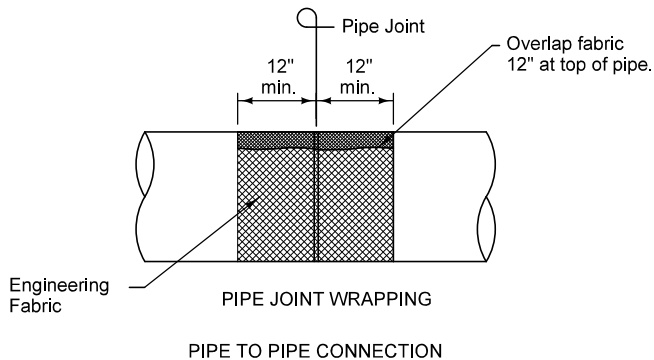
① 6"x6" - w2xw2 (8ga.) Wire Mesh

TYPE PC-1 CONCRETE COLLAR CONNECTION



① 6"x6" - w2xw2 (8ga.) Wire Mesh

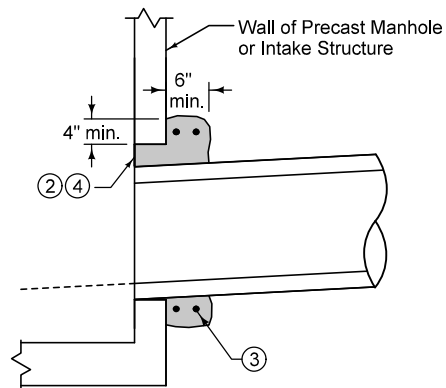
TYPE PC-2 CONCRETE COLLAR CONNECTION



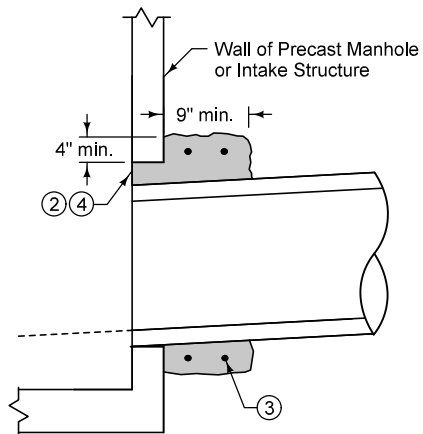
Engineering Fabric

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 bedding material, placing 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 backfill materials; 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 bedding material, placing bedding and backfill material, connectors, and other appurtenances.

C. Footings for Concrete Pipe Aprons:

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

D. Pipe Apron Guards:

1. **Measurement:** Each pipe apron guard will be counted.
2. **Payment:** Payment will be made at the unit price for each pipe apron guard.

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.

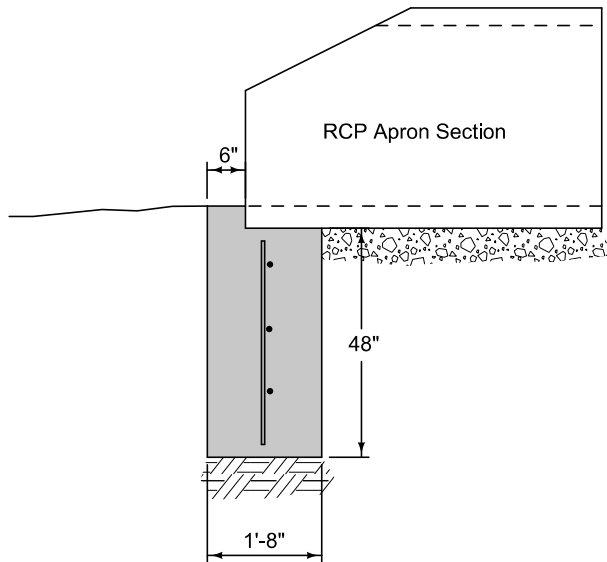
3.02 APRONS

- 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.

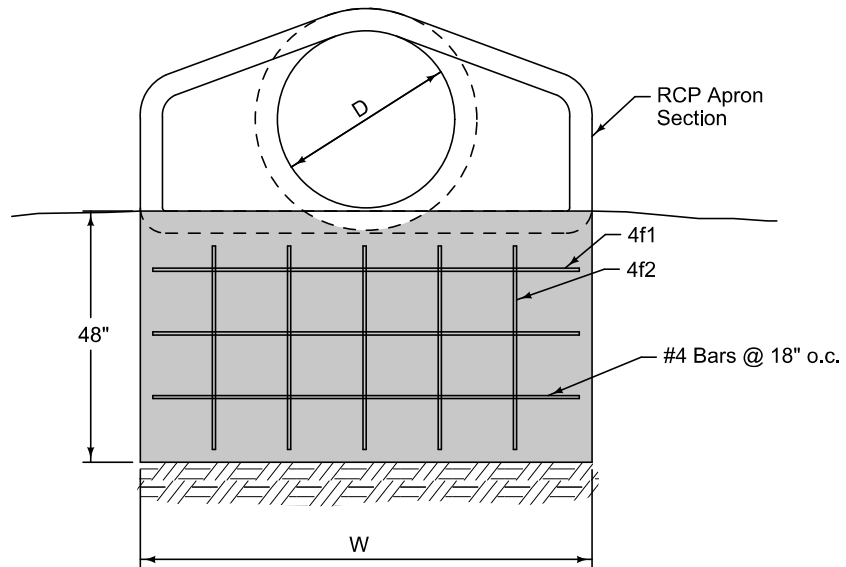
3.03 CLEANING, INSPECTION, AND TESTING

Clean, inspect, and test culverts per Section 4060.

END OF SECTION



TYPICAL SECTION




ELEVATION

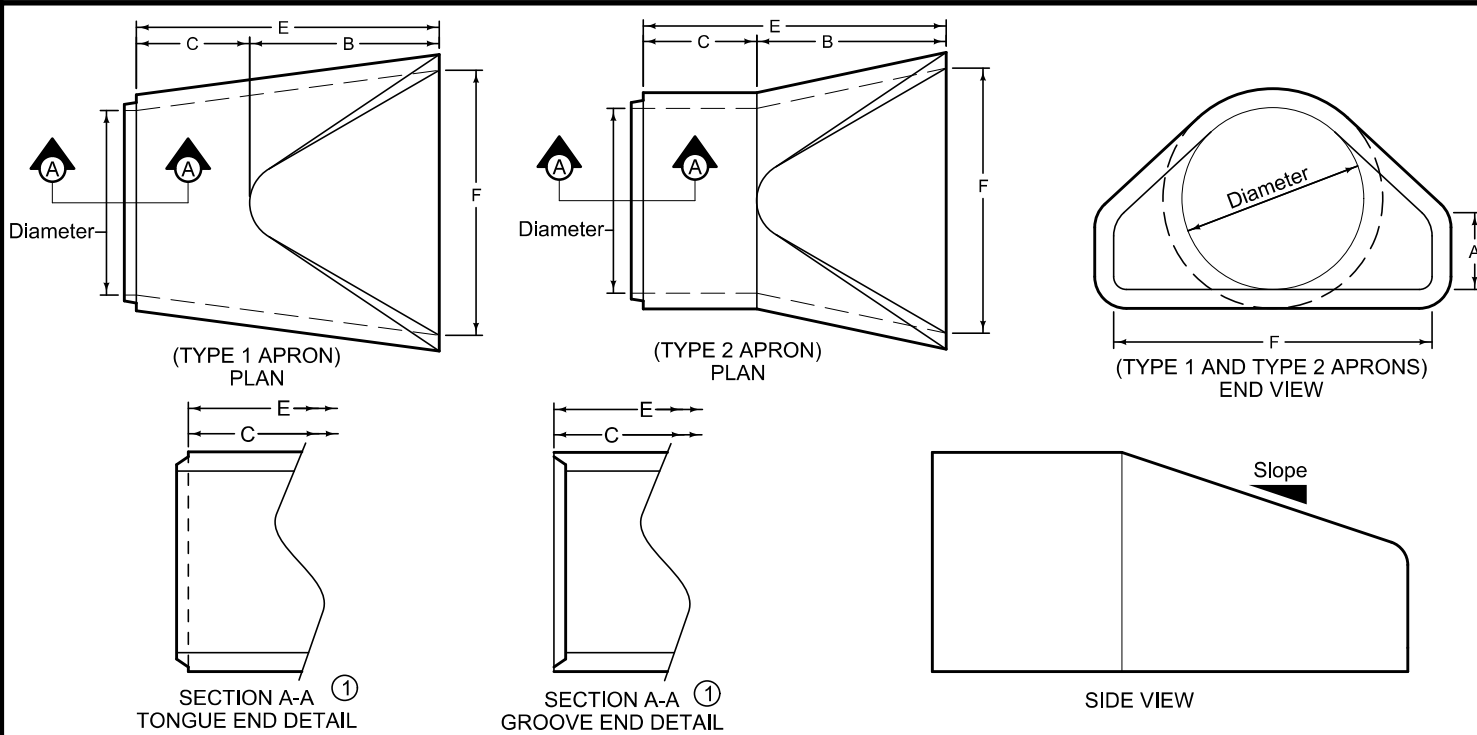
REINFORCING BAR LIST

| 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.

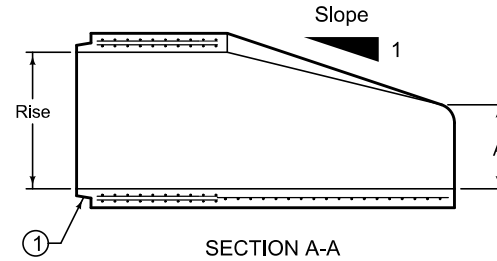
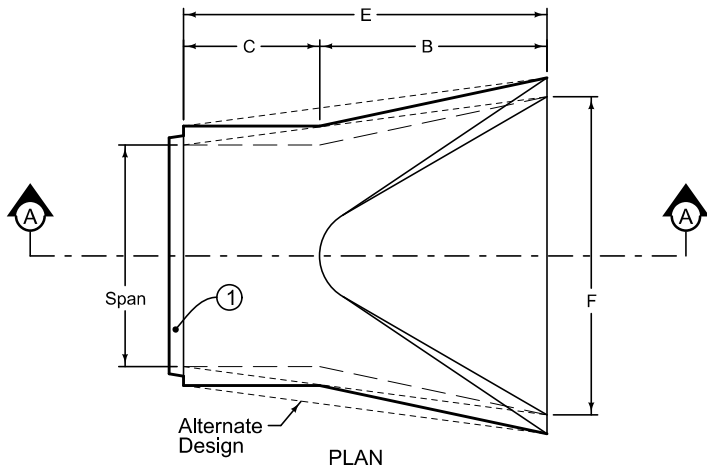
- ① Tongue end used on inlet end section. Groove end used on outlet end section.

| 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" |

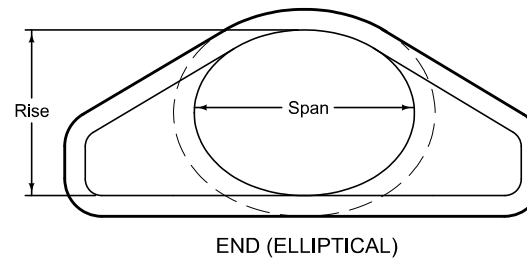
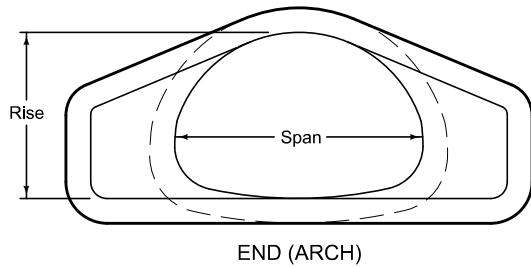
FIGURE 4030.222 SHEET 1 OF 1

| | |
|---|---------------------------------|
|  | REVISION New 10-18-16 |
| | SUDAS 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.



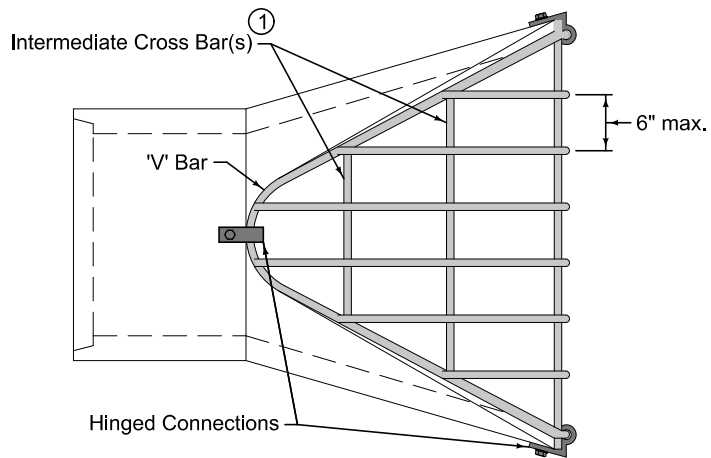
| EQUIVALENT DIAMETER Inches | SLOPE | APPROXIMATE DIMENSIONS Inches | | | | |
|-------------------------------|-------|----------------------------------|----|----|-----|-----|
| | | A | B | C | E | F |
| 18 | 3:1 | 7 | 27 | 45 | 72 | 36 |
| 24 | 3:1 | 8 $\frac{1}{2}$ | 39 | 33 | 72 | 48 |
| 30 | 3:1 | 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

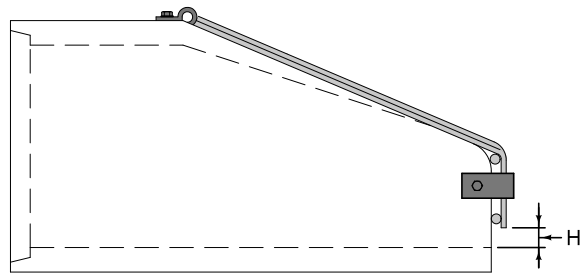
| EQUIVALENT DIAMETER Inches | SLOPE | APPROXIMATE DIMENSIONS Inches | | | | |
|-------------------------------|----------|----------------------------------|----|----|----|-----|
| | | A | B | C | E | F |
| 18 | 3:1 | 7 $\frac{1}{2}$ | 27 | 45 | 72 | 36 |
| 24 | 3:1 | 8 $\frac{3}{2}$ | 39 | 33 | 72 | 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

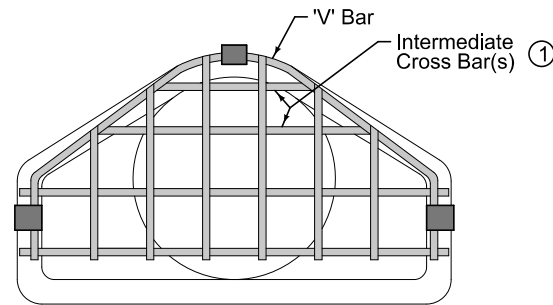
| | |
|--|-----------------|
| | REVISION |
| | New 10-18-16 |
| | 4030.223 |
| SHEET 1 of 1 | |
| SUDAS Standard Specifications | |
| ARCH AND ELLIPTICAL CONCRETE PIPE APRONS | |



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.

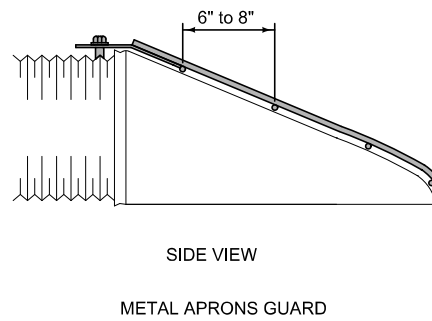
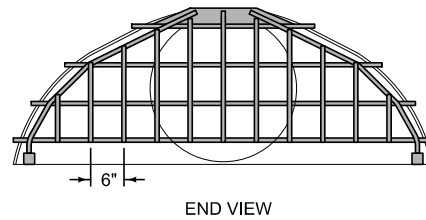
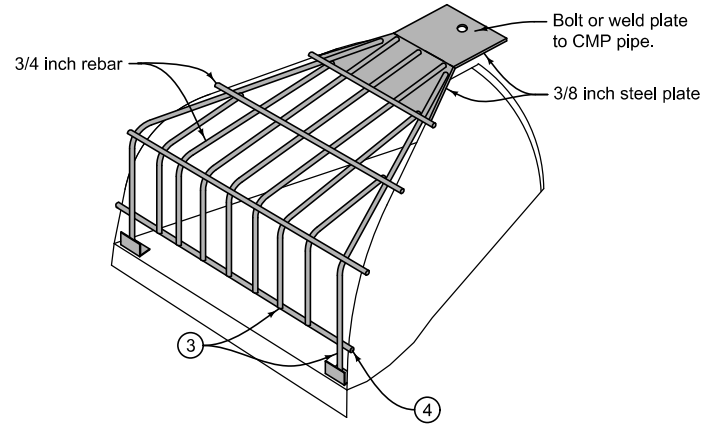
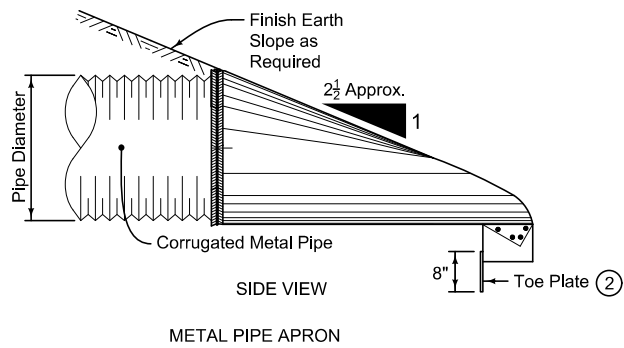
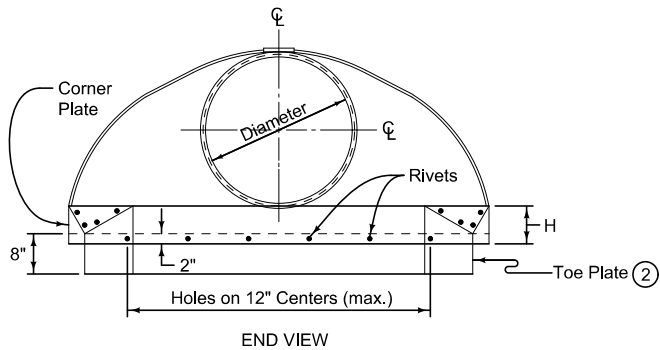
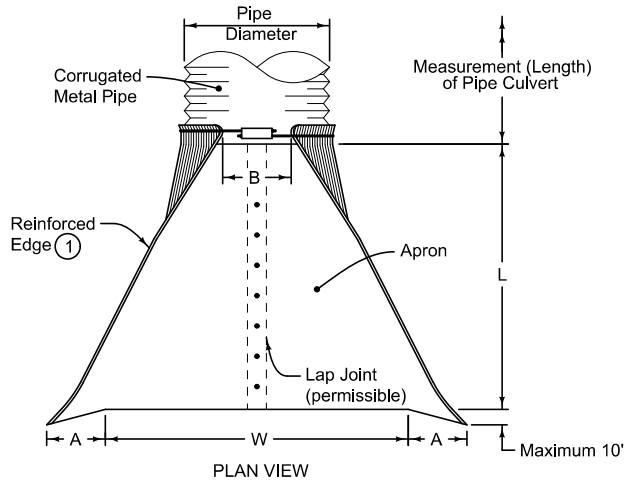
| ROUND | | ARCH | | ELLIPTICAL | |
|-----------|-----|---------------------|----|---------------------|----|
| PIPE SIZE | H | EQUIVALENT DIAMETER | H | EQUIVALENT DIAMETER | H |
| 12" | 2½" | 18" to 24" | 4" | 18" | 3" |
| 15" | 3" | 30" to 36" | 5" | 24" | 4" |
| 18" - 24" | 4" | 42" to 54" | 6" | 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"

| | |
|---|-----------------|
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| | 4030.224 |
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| CONCRETE PIPE APRON GUARD | |

SHEET 1 of 1



- 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" |

FIGURE 4030.225 SHEET 1 OF 1

| | |
|--------------|--------------|
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| 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. **Measurement:** Each type and size of subdrain or footing drain cleanout will be counted.
2. **Payment:** Payment for each cleanout will be made at the unit price for each type and size of subdrain or footing drain cleanout.

D. Subdrain or Footing Drain Outlets and Connections:

1. **Measurement:** Each type and size of outlet or connection to a structure will be counted.
2. **Payment:** Payment for each outlet or connection to a structure will be made at the unit price for each type and size installed.
3. **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.

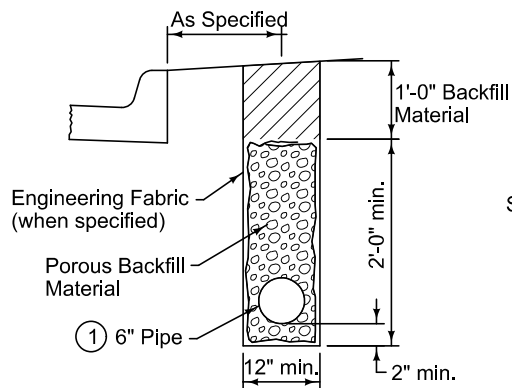
3.03 FOOTING DRAIN SERVICE STUBS

- 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.

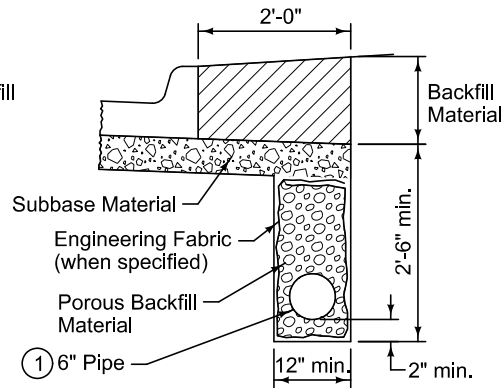
3.03 FOOTING DRAIN SERVICE STUBS (Continued)

- 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.

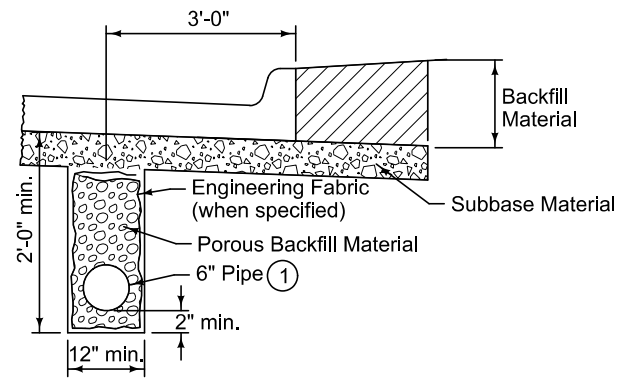
END OF SECTION



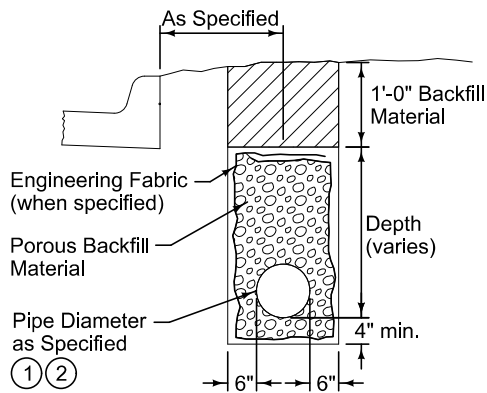
CASE A
TYPE 1



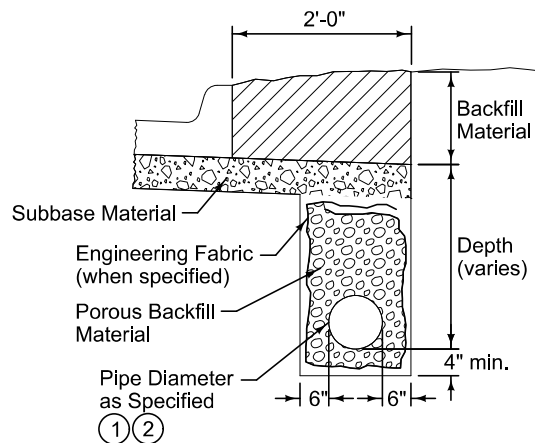
CASE B
TYPE 1



CASE C
TYPE 1




CASE D
TYPE 2

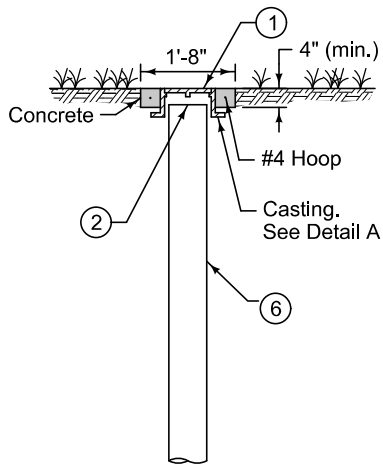


CASE E
TYPE 2

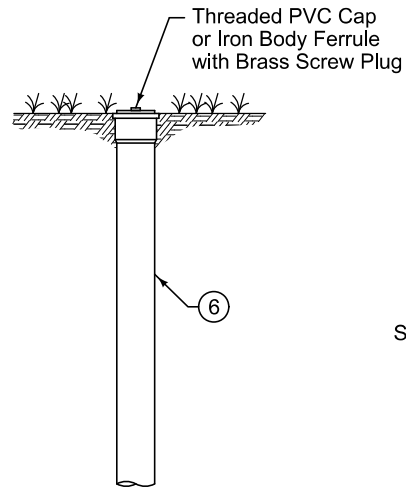
Type 1 installation is for longitudinal subdrain only. Type 2 installation is for combination subdrain/footing drain collectors.

- 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

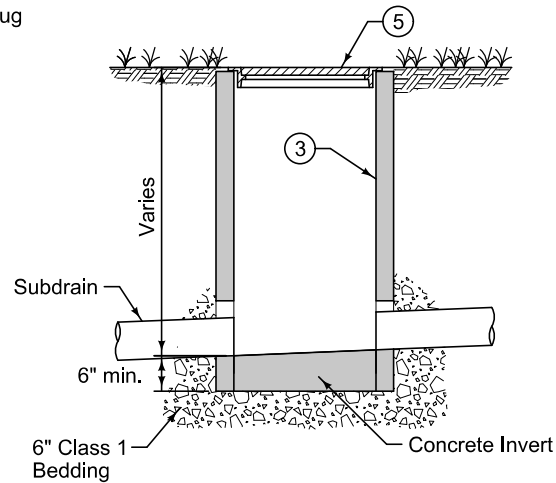
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|  | SUDAS 4040.231 | REVISION 1 10-21-14 |
| | SHEET 1 of 1 | |
| SUDAS Standard Specifications | | |
| SUBDRAINS | | |



TYPE A-1 CLEANOUT

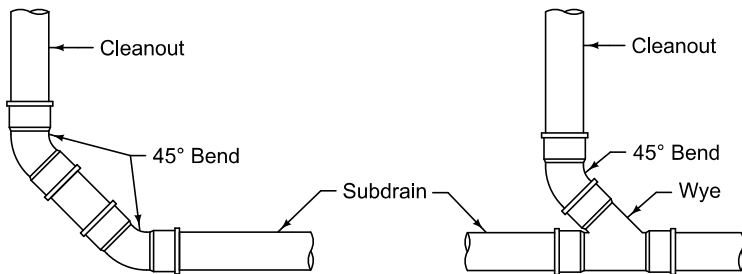


TYPE A-2 CLEANOUT
(Non-traffic areas only)

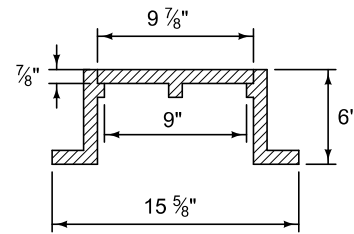


TYPE B CLEANOUT
(Non-traffic areas only)

- 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

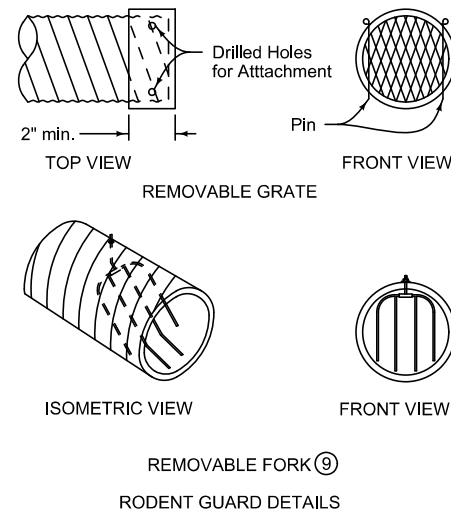
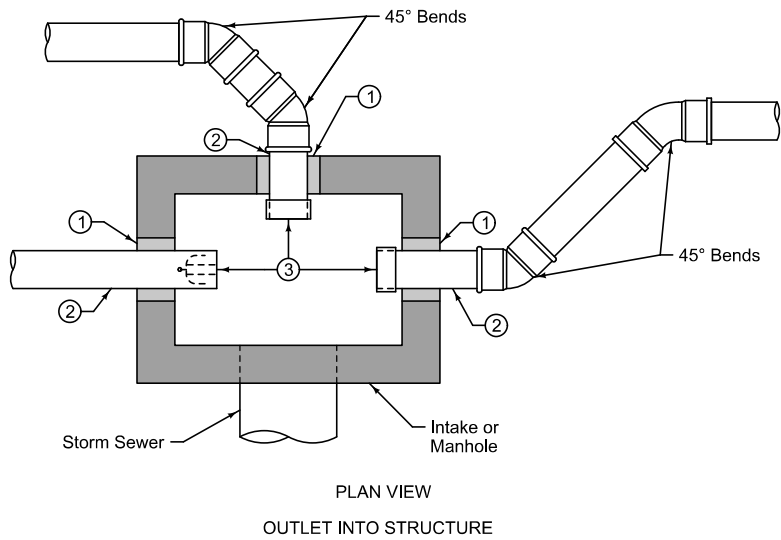


DETAIL A ① ④
(Dimensions are nominal)

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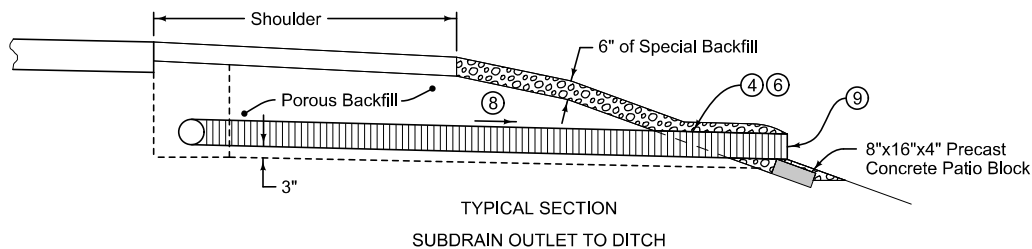
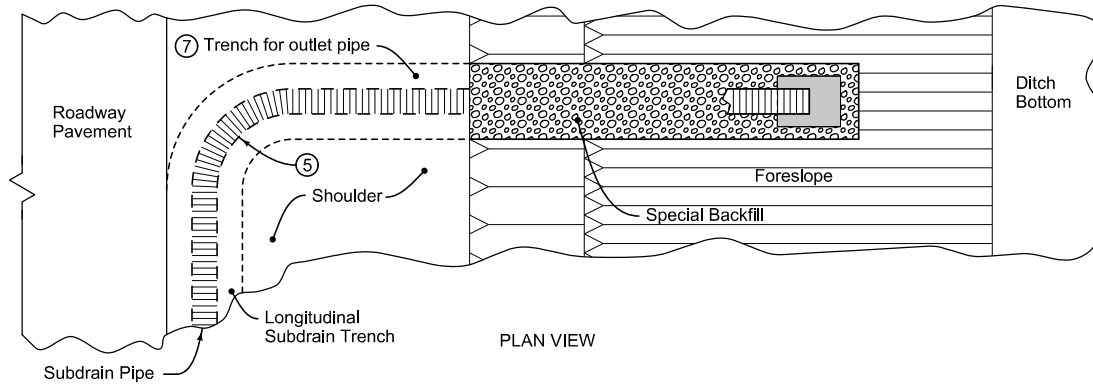
SUDAS Standard Specifications

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 Use only fork type rodent guard for subdrain outlet to ditch.



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| | REVISION 3 10-18-16 |
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| | SHEET 1 of 1 |
| SUDAS Standard Specifications | |
| SUBDRAIN OUTLETS | |

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

- A. Sliplining Pipe
- B. Cured-in-place Pipe Lining
- C. Deformed/Reformed Pipe Lining
- D. Folded/Formed Pipe Lining
- E. Spot Repairs by Pipe Replacement

1.02 DESCRIPTION OF WORK

- A. Pipe Lining:
 - 1. Resin impregnated, cured-in-place.
 - 2. Deformed/reformed polyethylene.
 - 3. Folded/formed polyvinyl chloride.
 - 4. Sliplining.
- B. Pipe spot repairs.

1.03 SUBMITTALS

Comply with Division 1 - General Provisions and Covenants.

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.

1.04 SUBSTITUTIONS (Continued)**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.

C. Installer Information:

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.

1.05 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. Notify the Jurisdiction's water works to use meter and pay for water, if required.
- C. Unless otherwise specified, the Owner will provide water for installation of cured-in-place pipe from a nearby hydrant through a separate valve mounted on the hydrant.
- D. Public Relations Program: 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 Lining:**

- 1. **Measurement:** Each type and size of pipe lining will be measured in linear feet along the centerline of the pipe lining from center of manhole to center of manhole.
- 2. **Payment:** Payment will be made at the unit price per linear foot for each type and size of pipe lining.
- 3. **Includes:** Unit price includes removal of internal obstructions, pipe cleaning, inspection, and all costs associated with the public information and notification program.

B. Building Sanitary Sewer Service Reconnection:

- 1. **Measurement:** Each active existing building sanitary sewer service reconnected to the pipe lining, including the services reconnected by excavating and reconnecting services or by trenchless reconnection methods, will be counted.
- 2. **Payment:** Payment will be made at the unit price for each reconnection.
- 3. **Includes:** Unit price includes, but is not limited to, removal of internal obstructions, pipe cleaning, and all costs associated with the public information and notification program.

1.08 MEASUREMENT AND PAYMENT (Continued)

C. 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, placing backfill material for replacement pipe, and restoring the surface.

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.

PART 2 - PRODUCTS**2.01 POLYETHYLENE AND POLYOLEFIN MANUFACTURED PIPE FOR SLIPLINING****A. Pipe:**

1. Comply with ASTM D 3035, minimum pipe stiffness of 46 psi.
2. Polyethylene complying with ASTM D 1248, Type III, Class C, Category 5, Grade P 34 or ASTM D 3350 Cell Classification PE 335434C.
3. Maximum outside diameter as specified in the contract documents.

B. Joints:

1. Joined into continuous length on job site.
2. Fuse butt joints according to the pipe manufacturer's recommendations with approved equipment and complying with ASTM D 2657.

2.02 POLYVINYL CHLORIDE PIPE (PVC) MANUFACTURED PIPE 12 INCH TO 36 INCH FOR SLIPLINING**A. Pipe:**

1. Comply with ASTM F 949, minimum pipe stiffness, 46 psi.
2. PVC plastic complying with ASTM D 1784, Cell Classification 12454.

B. Joints: Gasketed joints complying with ASTM F 477 and ASTM D 3212.

2.03 POLYVINYL CHLORIDE PIPE (PVC) MANUFACTURED PIPE 21 INCH TO 48 INCH FOR SLIPLINING**A. Pipe:**

1. Comply with ASTM F 1803, minimum pipe stiffness, 46 psi.
2. PVC plastic complying with ASTM D 1784, Cell Classification 12364.

B. Joints: Gasketed joints complying with ASTM F 477 and ASTM D 3212.

2.04 CENTRIFUGALLY CAST FIBERGLASS REINFORCED POLYMER MORTAR PIPE (CCFRPM) 18 INCH TO 48 INCH FOR SLIPLINING.

A. Pipe: Comply with ASTM D 3262.

B. Joints: Gasketed joints complying with ASTM D 4161.

2.05 RESIN-IMPREGNATED TUBE FOR CURED-IN-PLACE PIPE (CIPP) LINING**A. Pipe Lining:**

1. Comply with ASTM F 1216.
2. Use one or more layers of flexible needled felt or equivalent non-woven material.
3. Stretch material to fit irregular pipe and negotiate bends.

2.05 RESIN-IMPREGNATED TUBE FOR CURED-IN-PLACE PIPE (CIPP) LINING (Continued)

4. Outside layer plastic coated with a translucent flexible material. No delamination of plastic coating.
5. Fabricated to a size that when installed tightly fits length without joints.
6. Designed as per Equation X-1, ASTM F 1216.

B. Resin and Catalyst:

1. Unsaturated, styrene-based, thermoset resin and catalyst system or an epoxy resin and hardener that is compatible with the inversion process.
2. Cures in the presence of water with temperature greater than 150°F and less than 180°F.
3. Initial structural properties complying with ASTM F 1216. Also comply with the following table.

Table 4050.01: CIPP Lining Properties

| CIPP Properties | ASTM Test Method | Minimum Value |
|--------------------------------|-------------------------|----------------------|
| Flexural Strength | D 790 | 4,500 psi |
| Flexural Modulus of Elasticity | D 790 | 250,000 psi |

C. 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.

2.06 DEFORMED/REFORMED HIGH DENSITY POLYETHYLENE PIPE LINING (DRP-HDPE)**A. Pipe Lining:**

1. Manufactured in deformed shape from HDPE pipe compound complying with ASTM D 1248, Class C, Category 5 and Grade P 34.
2. Comply with long term hydrostatic strength rating of 1600 psi or more according to ASTM D 2837.
3. Environmental stress crack resistance (ESCR) less than 2,000 hours in 100% solution, Igepal CO-630 at 100°C before failure according to ASTM D 1693, Condition C.
4. Comply with the following table for minimum DRP lining structural standards.

Table 4050.02: DRP-HDPE Lining Properties

| FIPP Properties | ASTM Test Method | Minimum Value |
|--------------------------------|-------------------------|----------------------|
| Flexural Strength | D 790 | 3,300 psi |
| Flexural Modulus of Elasticity | D 790 | 136,000 psi |
| Tensile Strength | D 638 | 3,200 psi |

**2.06 DEFORMED/REFORMED HIGH DENSITY POLYETHYLENE PIPE LINING (DRP-HDPE)
(Continued)****B. DRP Lining Dimensions:**

1. Nominal internal diameter and length of existing pipe as specified in the contract documents.
2. Field verify diameter and length.
3. Outside diameter fabricated to fit tightly.
4. Use one continuous length without joints between manholes.
5. Minimum SDR wall thickness as specified in the contract documents.

2.07 FOLDED/FORMED POLYVINYL CHLORIDE PIPE LINING (FFP-PVC)**A. Pipe Lining:**

1. Manufacture in deformed shape complying with ASTM D 1784, Cell Classification 12454
B. Compounds with different cell classifications because one or more properties are superior to those specified are acceptable.
2. Performance requirements complying with ASTM D 3034.
3. Comply with the following table for FFP lining structural properties.

Table 4050.03: FFP-PVC Lining Properties

| FIPP Properties | ASTM Test Method | Minimum Value |
|-------------------------------|-------------------------|----------------------|
| Tensile Modulus of Elasticity | D 638 | 350,000 psi |
| Tensile Strength | D 638 | 6,000 psi |

B. FFP Lining Dimensions:

1. Nominal internal diameter and length of existing pipe as specified in the contract documents.
2. Field verify diameter and length prior to manufacturing.
3. Use one continuous length without joints between manholes.
4. Outside diameter fabricated to fit tightly.
5. Minimum SDR wall thickness as specified in the contract documents and complying with ASTM F 1216.

2.08 PIPE REPAIR COUPLINGS FOR SPOT REPAIRS BY PIPE REPLACEMENT**A. Style:** Full circle, fully lined, bolted.**B. Length:** 12 inches, minimum.

2.08 PIPE REPAIR COUPLINGS FOR SPOT REPAIRS BY PIPE REPLACEMENT (Continued)**C. Materials and Manufacturer:**

1. Shells, armors, side bars, lugs, Turner lifting bars, bolts and nuts; complying with ASTM A 240, Type 304 stainless steel.
2. MIG welds, fully passivated.
3. Rubber gasket complying with ASTM D 2000, AA415 with full coverage and a grid pattern.
4. Stainless steel armor bonded to gasket to bridge lug area.

D. Nuts and Bolts: 1/2 inch or 5/8 inch, Teflon coated threads.**2.09 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 EXAMINATION****A. Cleaning:**

1. Clean and remove soil, grit, debris, and obstructions according to Section 4060 prior to video inspection and/or insertion of pipe lining.
2. Do not flush debris to downstream sections.
3. Deposit removed material at an approved site.

B. Video Inspection:

1. Furnish the Jurisdiction with a recording of sewers: 1) before the lining process and while the flow is being bypassed; and 2) after the lining process and service reconnections have been completed.
2. Provide an on-screen numerical display of the camera location, indexed from the starting manhole, in feet.

C. Service and Obstruction Location:

1. Coordinate and cooperate with the Engineer for service and obstruction location.
2. Locate the active sewer services by one of following:
 - a. Use video inspection to observe service locations, breaks, obstructions, and structural failures.
 - b. Insert a sounding device through the service, noting its location on the ground surface.
 - c. Dye testing.

3.02 BYPASSING SEWAGE

- A. Submit a bypassing plan to the Engineer for review.
- B. Plug the line at a point upstream of pipe to be rehabilitated if bypassing is required.
- C. Pump flow to a downstream point or adjacent system as directed by the Engineer.
 1. Provide pump and bypass lines of adequate capacity to handle all flows.
 2. Provide adequate reserve pumps on-site for emergency use and for storm flows.

3.03 OBSTRUCTIONS

- A. Remove all obstructions.
- B. If an obstruction is encountered that cannot be removed by equipment operating within the pipe, excavate and remove the obstruction upon approval of the Engineer.
- C. Place backfill, compact, and restore the surface according to the contract documents.

3.04 TEMPORARY SEWER SERVICE

If full normal sewer service is not re-established within the times stated, provide temporary facilities or hotel accommodations for affected residents and businesses.

3.05 SLIPLINING**A. Excavation:**

1. For sliplining insertions, excavate at or near one structure and work from the existing manhole at the other end of the section to be pulled.
2. Insertion Pit:
 - a. For sliplining with segmented pipe (one pipe section at a time), construct the insertion pit as required to accommodate the length of individual pipe sections.
 - b. For sliplining with pipe that is to be welded together above ground and pulled into the sewer, dig a pit length 12 times the inside pipe diameter and slope the pit end back to the ground surface at a rate of 2.5 (horizontal) to 1.0 (vertical).

B. Test Head:

1. Pull the pulling head with one short section of sliplining pipe through the sewer before inserting the pipe to test for taps or obstructions protruding too far into the sewer.
2. Attach cables to both ends of the test head to allow for removal if an obstruction is encountered.

C. Installation: Push segmented pipe into the host pipe according to the manufacturer's recommendations, or pull in a continuously welded pipe according to ASTM F 585.**D. Service Reconnection:**

1. Allow the sliplining pipe to recover according to the manufacturer's recommendations.
2. Do not leave the sanitary service unconnected for more than 24 hours.
3. Complete reconnections involving excavation of service lines according to the local plumbing codes.
4. Reconnect excavated service connections according to the local plumbing code, except that the annular space between the host pipe and the sliplining pipe is to be filled with grout.

E. Grouting:

1. Before trimming the ends of the pipe and sealing, allow for the pipe to recover its original length according to the manufacturer's recommendations. Recovery time is at least equal to the time required to pull the pipe into place.
2. Fill the space between the sliplining pipe and the host pipe with CLSM complying with Section 3010, 2.05 or other material approved by the Engineer. Pump filler in from the lower end of the sliplining pipe.

3.06 RESIN IMPREGNATED CIPP LINING

- A. Install according to the manufacturer's recommendations for this lining process and ASTM F 1216 unless otherwise specified.
- B. Use a resin impregnated tube, hydraulically inverted in place with an approved lubricant, and cured-in-place according to ASTM F 1216, Section 7.
- C. Make the tube continuous between manholes. The tube may span several manhole reaches as allowed by the equipment, properties of the CIPP, and the size and condition of the sewer.

3.06 RESIN IMPREGNATED CIPP LINING (Continued)

- D. Ensure the tube is free of uncured spots, lifts (spots cured away from the sewer), and delaminations. Remove and replace deficient sections.
- E. Service Reconnections:
 - 1. Do not leave sanitary service unconnected for more than 24 hours.
 - 2. Complete reconnections involving excavation of service lines according to the local plumbing code.

3.07 DRP-HDPE OR FFP-PVC LINING INSTALLATION

Install according to the manufacturer's recommendations for particular lining material and process, unless otherwise specified.

A. Lining Installation:

- 1. Designate location where insertion is to begin, subject to the Engineer's approval.
- 2. Transport lining to the site in one continuous length on spools compatible with the manufacturer's designated process.
- 3. Heat lining material at the job site as necessary for insertion. Pull lining into the sewer with appropriate pulling heads, cables, and heat distribution equipment.
- 4. Ensure lining is continuous between manholes as allowed by the tensile properties of lining and the size and condition of the sewer.
- 5. Connect fully inserted lining to the heat source distribution equipment.
- 6. Round and expand by uniformly distributed heat, steam, and pressure and by mechanical devices.
- 7. After lining has been expanded to a tight fit, cool gradually under pressure until the process is complete.
- 8. Provide a continuous pipe lining, without joints, over the entire length of pipe.
- 9. Ensure the lining is free of all material defects, pits, pinholes, cracks, crazing, folds, or unrounded sections.
- 10. Repair all defects at no additional cost to the Jurisdiction.

B. Service Reconnections:

- 1. Do not leave sanitary service unconnected for more than 24 hours.
- 2. Complete reconnections involving excavation of service lines according to the local plumbing code.

3.08 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.
- 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.

3.09 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 video tapes, CDs, or DVDs to 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 VISUAL INSPECTION

- A. Check each section of sanitary sewer, storm sewer, or pipe culvert by lamping.
- B. Light should be visible through section of pipe lamped.
- C. Visually inspect each run of pipe.
- D. Repair or replace defective pipe or joints, or remove and relay pipe not meeting alignment tolerances, as directed by the Engineer.

3.03 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.

3.03 VIDEO INSPECTION (Continued)**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.

3.04 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.

3.04 SANITARY SEWER LEAKAGE TESTING (Continued)**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.

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 |

3.04 SANITARY SEWER LEAKAGE TESTING (Continued)

- 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.

D. Sanitary Sewer Vacuum Testing:**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.

3.05 DEFLECTION TESTING

- A. Perform deflection tests on all flexible sanitary sewer mains, excluding ductile iron pipe. Also perform deflection tests on all HDPE 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.
- E. Remove and replace pipe exceeding deflection limits.
- F. Handle and divert existing flows during deflection testing.

3.06 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

3.06 FORCE MAIN TESTING (Continued)

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