SECTION 33 05 13

MANHOLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall furnish and install precast concrete manhole base, sections, adjusting rings, steps, and manhole ring and cover, complete.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 07 91 00, Manhole Preformed Joint Seals.

2. Section 31 23 00, Excavation and Fill.

3. Section 31 23 19, Dewatering.

4. Section 31 23 33, Trenching and Backfilling.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):

a. A48/A48M, Standard Specification for Gray Iron Castings.

b. C150, Standard Specification for Portland Cement.

c. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.

1.04 SUBMITTALS

A. CONTRACTOR shall submit manufacturer's technical descriptions of manhole sections, steps, rings, and covers.

B. CONTRACTOR shall submit repair materials and methods to ENGINEER for review and approval.

C. Material and procedures to be used in structure abandonment shall be approved by ENGINEER.

PART 2 PRODUCTS

2.01 MATERIALS

A. Precast Manhole Sections:

1. Precast reinforced concrete manhole top sections shall be produced using Type II Portland cement, or as approved by ENGINEER, and be fabricated in accordance with ASTM C478.

2. Flexible plastic sealant, RAM-NEK, or equivalent, shall be required for all horizontal mating surfaces between precast top sections and precast slab tops of meter vaults.

3. Manhole sections shall be clearly marked with the information specified for product marking in ASTM C478.

4. Imperfections in the precast concrete manhole base or sections shall be reviewed by ENGINEER prior to repair.

B. Manhole Frames and Covers:

1. Manhole frames and covers shall be three hundred and thirty-eight (338) pounds or greater, twenty-four-inch (24") inside diameter, as manufactured by D & L, Model A-1161 with closed pick hole or approved equal.

2. Frost proof covers if required shall be D & L, Model A-1019 with closed pick hole or approved equal. The ring and cover shall conform to ASTM A48/A48M Class 35B.

3. Watertight frames and covers if required shall be NEENAH R-1915/R-1916 Series (as applicable) or approved equal.

C. Manhole Steps:

1. Manhole steps shall be polypropylene and be cast into the manhole wall at the same time the manhole section is cast.

2. The manhole steps shall be approximately nine (9) inches wide and thirteen (13) inches long and weigh approximately two (2) pounds.

3. The steps shall be located no more than twenty eight (28) inches from the top of the finished manhole nor more than eighteen (18) inches from the floor and be spaced no greater than twelve (12) inches apart.

4. The step shall have a skid-resistant surface and be designed mechanically to prevent sideslip.

D. Joints: All precast concrete joints shall be made with a preformed joint sealer or grout. All joints that are made with the joint sealer shall also be pointed with mortar on the inside of the section.

1. Mortar:

a. Mortar used in jointing precast concrete manhole sections shall be composed of one (1) part Portland cement and not more than three (3) nor less than two (2) parts of fine aggregate. Portland cement shall meet the requirements of ASTM C150, Type II. Hydrated lime or masonry cement shall not be used.

b. Fine aggregate shall consist of well-graded natural sand having clean, hard, durable, uncoated grains, free from organic matter, soft or flaky fragments or other deleterious substances such as calcium chloride. The fine aggregate shall be thoroughly washed and shall be uniformly graded from coarse to fine with a minimum of ninety five percent (95%) passing the #4 sieve and a maximum of seven percent (7%) passing the #100 sieve.

c. All mortar shall be fresh for the WORK at hand. Mortar that has begun to set shall not be used.

2. Joint Seals: Precast concrete manhole section joint seals shall meet the requirements of Section 07 91 00, Manhole Preformed Joint Seals.

PART 3 EXECUTION

3.01 GENERAL

A. The manhole shall be constructed on a properly compacted subgrade and in such a manner that the center of the manhole coincides with the intersection of the projected centerlines of the inlet and discharge pipelines. The surface shall be level to permit proper construction of the riser sections.

B. Changes in size and grade of channels for gravity pipelines shall be made gradually and evenly using concrete made with ASTM C150, Type II Portland cement. The invert channels may be formed directly in the concrete manhole base or may be constructed by laying sewer pipe through the manhole and cutting out the top half (1/2) of the pipe after the concrete has cured and reached design strength. The floor of the manhole outside of the channels shall slope upward from the springline of the pipeline to the wall of the manhole at not less than one (1) inch per foot nor more than two (2) inches per foot.

3.02 INSTALLATION

A. Placement of Precast Concrete Base and Riser Sections:

1. Sections: Set the base and each manhole riser section such that the manhole will be plumb. Use sections of various heights to bring the ring and cover to the proper grade. The last riser section prior to placement of an eccentric cone or flat top shall be the shortest available but in no case greater than twenty four (24) inches in height.

2. Joints: Sections shall be clean and dry. Mortar joints shall not be used when temperature of the air or section will be below thirty five degrees Fahrenheit (35°F) when placing and curing, unless supplemental heat is used to keep the sections warm and mortar from freezing.

a. Using Joint Sealer: The mating surfaces of the two sections to be joined shall be thoroughly cleaned. Apply the joint sealer to the seat of the base or riser section that is already in place. Only one joint is permitted in the sealer. Carefully lower the second precast concrete section onto the first section so that the joint sealer compresses forming a uniform seal. Each succeeding precast section shall be jointed in a similar manner.

b. Using Mortar: The mating surfaces of the two (2) sections to be joined shall be thoroughly cleaned. Apply a one-inch (1") minimum bed of freshly mixed mortar to the joint of the section already in place. The mortar shall be uniform in thickness and cover the entire perimeter of the section. Carefully lower the second precast concrete section onto the first section so that the mortar compresses forming a uniform seal. Tool the mortar for a uniform appearing joint. Each succeeding precast section shall be jointed in a similar manner.

3. Lifting Holes: Fill all lifting holes with mortar.

B. Adjusting Rings, Ring, and Cover Installation:

1. Install ring and cover on one or maximum of two precast concrete adjusting rings.

2. Each adjusting ring shall be a maximum of eight (8) inches high.

3. Adjusting rings shall be placed similar to the precast concrete manhole rings (thoroughly cleaned and placed with mortar or joint sealer).

4. The total allowable height of adjusting rings, ring, and cover shall be one (1) inch less than the manufacturer's shortest precast concrete riser section.

5. Unless otherwise indicated in the DRAWINGS, set the top of the adjusting rings such that no part of the cast iron ring and cover will project above a point one-quarter inch (1/4") below the finish surface of pavement.

C. Pipe Connections:

1. The manhole shall be thoroughly bonded to the barrel of the pipe and all connections with pipe shall be made without projections or voids.

2. All pipes shall have a Hamilton Kent or approved equal waterstop gasket applied around the pipe.

3. The joint between the PVC pipe and manhole wall shall be sealed with a non-shrink grout.

3.03 FIELD QUALITY CONTROL

A. Each manhole shall be watertight from infiltration and exfiltration of water.

B. CONTRACTOR shall inspect and repair all visible leaks and damp spots.

C. When required by ENGINEER, manholes shall be pressure tested by filling with water to the level of the top of the top riser to determine watertightness. There shall be no measurable loss of water in a one-hour (1 hr.) time period.

3.04 ABANDONMENT

A. Manholes to be abandoned in place shall have all pipes entering or exiting the structure plugged with lean concrete or controlled low strength material backfill (Flo-

Fill). For manholes with existing pipes too large to plug with fill, CONTRACTOR shall construct a bulkhead on the inside of the manhole to prevent the fill from entering the pipes.

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

C. Manhole rings and covers, inlet grates and frames, precast flat top or cone sections, or any other salvageable items shall be salvaged, stored, and delivered to such location as prescribed by ENGINEER.

END OF SECTION

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SECTION 33 41 00

REINFORCED CONCRETE PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes construction of reinforced concrete pipe for storm drainage, culverts, and sanitary sewer, including appurtenances normally installed as a part of these systems. Construction may include surface preparation; trench excavation; shoring; dewatering; lay, align and join pipe installation of appurtenances; bedding and backfilling; surface restoration; and other related work.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS, which may be related to this section:

1. Section 31 11 00, Clearing and Grubbing.
2. Section 31 14 13, Topsoil Stripping and Stockpiling.
3. Section 31 23 00, Excavation and Fill.
4. Section 31 23 19, Dewatering.
5. Section 31 23 33, Trenching and Backfilling.

1.03 REFERENCES

A. The following is a list of standards, which may be referenced in this section:

1. ASTM International (ASTM):
    a. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
    b. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
    c. C150, Standard Specification for Portland cement.
    d. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
    e. C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
    f. C443, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

g. C506, Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe.

h. C507, Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.

i. C655, Standard Specification of Reinforced D-Load Culvert, Storm Drain and Sewer Pipe.

j. C827, Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures.

k. C990, Standard Specifications for Joints in Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

l. C1417, Standard Specification for Reinforced Concrete Sewer, Storm Drain and Culvert Pipe for Direct Design.

m. C1479, Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installation.

n. C1619, Standard Specifications for Elastomeric Seals for Joining Concrete Pipe.

o. C1628, Standard Specifications for Joints for Concrete Gravity Flow Sewer Pipe, Using Rubber Gaskets.

2. U.S. Bureau of Reclamation (USBR): M-1, Standard Specifications for Reinforced Concrete Pressure Pipe.

1.04 SUBMITTALS

A. Details of fittings and specials shall be furnished for approval by ENGINEER.

B. Unless otherwise specified, CONTRACTOR shall submit to ENGINEER for approval SHOP DRAWINGS showing the exact dimension of the joints including the permissible tolerances for each size of pipe being furnished and the size, type and locations of gasket materials. Approval of the joint detail DRAWINGS shall not relieve CONTRACTOR of any responsibilities to meet all of the requirements of these SPECIFICATIONS, or of the responsibility for correctness of CONTRACTOR's details.

C. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.

D. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Responsibility for Material:

1. CONTRACTOR shall be responsible for all materials intended for the WORK that are delivered to the construction site and accepted by CONTRACTOR. Payment shall not be made for materials found to be defective or damaged in handling after delivery and acceptance. Defective or damaged materials shall be removed and replaced with acceptable materials at CONTRACTOR's expense.

2. CONTRACTOR shall be responsible for the safe and proper storage of such materials.

B. Pipe Acceptance:

1. In addition to any deficiencies not covered by ASTM C76 for non-pressurized pipe ,ASTM C361 for low head pipe or ASTM C507 for Elliptical Pipe, concrete pipe, which has any of the following visual defects, will not be accepted.

   a. Porous spots on either the inside or the outside surface of a pipe having an area of more than ten (10) square inches and a depth of more than one-half (1/2) inch.

   b. Pipe, which has been patched to repair porous spots, cracks, or other defects, when such patching was not approved by ENGINEER.

   c. Exposure of the reinforcement when such exposure would indicate that the reinforcement is misplaced.

   d. Pipe that has been damaged during shipment or handling even previously approved before shipment.

   e. Concrete pipe, at delivery to the job site, shall have cured and reach the design strength as required by ASTM C76 for non-pressurized pipe, ASTM C316 for low head pipe or ASTM C507 for Elliptical Pipe and be at least five (3) days (seventy-two [72] hours) old.

2. Acceptance of the pipe at point of delivery shall not relieve CONTRACTOR of full responsibility for any defects in materials due to workmanship.

C. Pipe Handling:

1. Pipe and accessories furnished by CONTRACTOR shall be delivered to, unloaded, and distributed at the site by CONTRACTOR. Each pipe shall be unloaded adjacent to or near the intended laying location.

2. Pipe fittings, specials, valves, and appurtenances shall be unloaded and stored in a manner that precludes shock or damage. Such materials shall not be dropped.

3. Pipe shall be handled in a manner intended to prevent damage to the pipe ends or to any coating or lining. Pipe shall not be skidded or rolled against adjacent pipe. Damaged coatings or lining shall be repaired by CONTRACTOR, at CONTRACTOR's expense in accordance with the recommendations of the manufacturer and in a manner satisfactory to ENGINEER. Physical damage to the pipe or accessory shall be repaired by CONTRACTOR at CONTRACTOR's expense, and in a manner satisfactory to ENGINEER.

D. Gasket Storage: All gaskets shall be stored in a cool place, preferably at a temperature of less than seventy degrees Fahrenheit (70°F.), and in no case shall the gaskets be stored in the open, or exposed to the direct rays of the sun.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Precast concrete pipe, which does not conform to ASTM C76 for non-pressurized pipe, ASTM C361 for low head pipe or ASTM C507 for Elliptical Pipe or to any other requirement specified herein, shall not be approved for storm sewer, culvert, or sanitary sewer installations.

B. Allowable ASTM Specifications: All material, manufacturing operations, testing, inspection, and making of concrete pipe shall conform to the requirements of ASTM C76 for non-pressurized pipe, ASTM C361 for low-head pipes or ASTM C507 Elliptical Pipe, latest revision thereof, listed in Article References.

C. Marking:

1. The following shall be clearly marked on both the interior and exterior surface of the pipe:

    a. Appropriate ASTM Specification: ASTM 76, ASTM C361 or ASTM C507

    b. Class and size.

    c. Date of manufacture.

    d. Name or trademark of manufacturer.

D. Diameter of Pipe: The diameter indicated on the DRAWINGS shall mean the inside diameter of the pipe.

E. Wall Thickness and Class of Pipe: The wall thickness and reinforcing steel, if any, shall comply with ASTM C76 for non-pressurized pipe, ASTM C361 for low head pipe or ASTM C507 for Elliptical Pipe and the class of pipe designated on the DRAWINGS. No elliptical reinforcing shall be allowed in any circular pipe. All jacking pipe shall be specifically designed by the pipe manufacturer to withstand all forces that the pipe may be subjected to during the jacking operations.

F. Fittings and Specials: Fittings and specials shall be made up of pipe segments having the same structural qualities as the adjoining pipe and shall have the interior treated the same as the pipe.

G. Lifting Holes: Lifting holes will be allowed for storm sewer pipe provided, however, only two lifting holes per pipe length will be allowed.

H. Cement: Unless otherwise required by ENGINEER, or specified otherwise on the DRAWINGS, Type II Modified Portland Cement complying with the

requirements of ASTM C150 will normally be acceptable in the manufacture of concrete pipe.

I. Joints:

1. The joint design for concrete pipe shall be bell and spigot or tongue and groove. Where rubber gaskets are required or specified, the bell or tongue shall be of confined gasket or single offset spigot configuration to properly contain and seat the rubber gasket. The joint assemblies shall be accurately formed so that when each pipe section is forced together in the trench the assembled pipe shall form a continuous watertight conduit with smooth and uniform interior surface, and shall provide for slight movement of any piece of the pipeline due to expansion, contraction, settlement or lateral displacement. If a gasketed joint is used, the gasket shall be the sole element of the joint providing water tightness. The ends of the pipe shall be in planes at right angles to the longitudinal centerline of the pipe, except where bevel-end pipe is required. The ends shall be furnished to regular smooth surfaces.

2. The jointing material used for concrete pipe storm sewer installations thirty six-inch (36") diameter and greater shall be a rubber gasketed joint. For storm sewers less than thirty six-inch (36") diameter the jointing material may be either a rubber gasket or a flexible plastic sealing compound, unless otherwise specified on the DRAWINGS. Only rubber gasketed joints will be acceptable for concrete pipe sanitary sewer installations. All joints and jointing material shall conform to the following minimum requirements.

a. Rubber Gasketed Joints:

1) Rubber gasket joints for tongue and groove or bell and spigot pipe using a confined gasket joint shall consist of an O-ring rubber gasket or other approved gasket configuration and shall conform to the requirements of ASTM 361, ASTM C443, ASTM C1619, or ASTM C1628 for the pipe designated. Unless otherwise approved by ENGINEER, the standard joint configuration shall be as noted in Subsection 3.04.F.
2) Rubber gasket joints for tongue and groove or bell and spigot pipe using a single offset joint shall consist of a non-circular rubber gasket or other approved gasket configuration and shall conform to the requirements of ASTM C76 or ASTM 361 for the pipe designated. Unless otherwise approved by ENGINEER, the standard joint configuration shall be as noted in Subsection 3.04.F.
3) Gaskets may be natural rubber, isoprene or neoprene conforming to ASTM C1619.

b. Flexible Plastic Joint Sealing Compound: Preformed plastic gaskets conforming to the minimum and application requirements set forth in PART 3 may be used as a joint sealant for storm sewer installations in lieu of rubber gaskets.

1) The flexible plastic gasket shall be in conformance with ASTM C990.
2) The plastic sealing compound shall be packaged in extruded preformed rope-like shape of proper size to completely fill the joint when fully compressed. The material shall be protected in a suitable,

removable, two-piece wrapper so that no wrapper may be removed as the compound is applied to the joint surface without disturbing the other wrapper, which remains attached to the compound for protection. The sealing compound shall be impermeable to water, have immediate bonding strength to the primed concrete surface and shall maintain permanent plasticity, and resistance to water, acids, and alkalis.

c. Mortared Joints: Mortared joints shall only be used in special circumstances and only where specifically authorized by ENGINEER. It is the intent of these SPECIFICATIONS to limit the use of mortared joints to the minimum extent possible except where unusual field conditions require deviation from the jointing material specified.

J. Protective Coatings: Normally, no additional exterior or interior protective coatings shall be required for concrete pipe. However, whenever adverse corrosive conditions warrant additional interior protection, those pipe segments will be noted on the DRAWINGS.

K. Concrete Cutoff Collars: Concrete shall meet the requirements of Section 03 31 00, Structural Concrete.

PART 3 EXECUTION

3.01 GENERAL

A. The pipe and pipe coatings shall be inspected by ENGINEER for damage or defects before being placed in the trench. Damaged or defective pipe shall not be installed.

B. All pipes that do not meet the requirements of PART 2 of this section will be rejected and replaced at CONTRACTOR's expense.

C. CONTRACTOR shall install storm sewer pipe of the type, diameter, load class, wall thickness and protective coating that is shown on the DRAWINGS.

D. Proper equipment, implements, tools and facilities shall be provided and used by CONTRACTOR for safe and convenient installation of the type of pipe being installed.

3.02 SURFACE PREPARATION

A. Within Easement, Cultivated, Landscaped, or Agricultural Area:

1. All vegetation, such as brush, sod, heavy growth of grass or weeds, decayed vegetable matter, rubbish and other unsuitable material within the area of excavation and trench side storage shall be stripped and disposed of in accordance with the requirements of Section 31 11 00, Clearing and Grubbing.

2. Topsoil shall be removed to a depth of eight (8) inches or the full depth of the topsoil, whichever is less. Topsoil shall be removed from the area to be excavated and stockpiled, or, CONTRACTOR may elect to import topsoil to replace that lost during excavation.

B. Within Unpaved Roadway Areas: CONTRACTOR shall strip the cover material from graveled roadways or other developed, but unpaved traffic surfaces to the full depth of the existing surfacing. The surfacing shall be stockpiled to the extent that it is acceptable and useable for restoration purposes.

C. Within Paved Areas:

1. The removal of pavement, sidewalks, driveways, or curb and gutter shall be performed in a neat and workmanlike manner. Concrete pavement, asphalt, sidewalks, driveways, or curb and gutter shall be cut with a power saw to a depth of two (2) inches prior to breaking. The concrete shall be cut vertically in straight lines and avoiding acute angles.

2. Bituminous pavement, sidewalks, driveways, or curb and gutter shall be cut with a power saw, pavement breaker, or other approved method of scoring the mat prior to breaking or excavation. The bituminous mat shall be cut vertically, in straight lines and avoiding acute angles.

3. Any overbreak, separation, or other damage to the existing bituminous or concrete outside the designated cut lines shall be replaced at CONTRACTOR's expense.

4. Excavated paving materials shall be removed from the job site and shall not be used as fill or backfill.

3.03 DEWATERING

A. All pipe trenches and excavation for structures and appurtenances shall be kept free of water during pipe laying and other related work. The method of dewatering shall provide for a dry foundation at the final grades of excavation in accordance with Section 31 23 19, Dewatering. Water shall be disposed of in a manner that does not inconvenience the public or result in a menace to public health. Pipe trenches shall contain enough backfill to prevent pipe flotation before dewatering is discontinued. Dewatering shall continue until such time as it is safe to allow the water to rise in the excavation.

3.04 INSTALLATION

A. General: Precautions shall be taken to prevent foreign material from entering the pipe before or while it is being placed in the line. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe. The open ends of pipe shall be closed with a watertight plug, or with other devices approved by ENGINEER, at times when pipe laying is not in progress.

B. Pipe:

1. Storm sewer pipe shall be installed in accordance with the manufacturer's recommendations for installing the type of pipe used, unless otherwise shown on the DRAWINGS.

2. Pipe lines shall be laid to the grades and alignment shown on the DRAWINGS or staked by ENGINEER. Variation from the prescribed grade and alignment shall not exceed one-tenth (0.10) foot, and the rate of departure from, or return

to, the established grade or alignment shall be not more than one (1) inch in ten (10) feet, unless approved by ENGINEER. No deviation from grade shall cause a depression in the sewer invert that could retain fluids or solids.

3. Pipe with lifting holes shall be installed such that the lifting holes are in the crown of the pipe. All lifting holes shall be properly grouted with cement mortar immediately after the pipe is installed and prior to commencement of backfilling.

4. Pipe with lifting anchors shall be installed such that the lifting anchors are in the crown of the pipe. All lifting anchor recesses in the wall of the pipe at the lifting anchors need not be grouted.

C. Pipe Fittings:

1. Pipe fittings shall be laid so as to form a close concentric joint with the adjoining pipe to avoid sudden offsets of the flow line. Pipe sections shall be joined together in accordance with the manufacturer's recommendations.

2. Pipe fittings and appurtenances shall be carefully lowered into the trench with suitable tools or equipment to prevent damage to the pipe and protective coatings and linings; pipe and accessory materials shall not be dropped or dumped into the trench.

D. Gaskets: No gaskets that show signs of deterioration, such as surface cracking or checking, shall be installed in a pipe joint. The neoprene gaskets used, when the air temperature is ten degrees Fahrenheit (10°F) or lower shall be warmed to temperature of sixty degrees Fahrenheit (60°F) for a period of thirty (30) minutes before being placed on the pipe.

E. Flexible Plastic Joint Sealing Compound:

1. All surfaces of the tongue and groove or bell and spigot shall be primed with an approved priming compound prior to the installation of the sealing compound. The installation of the priming compound and the sealing compound shall be accomplished in strict accordance with the manufacturer's instructions, as to the method of application, quantity of material, the grade of the materials, and the application temperatures.

2. Gaskets installed on both male and female joint surfaces (double gasketing) shall be required for all deflected pipe joints, as well as arch or elliptical pipe joints.

F. Acceptable Joint for Concrete Storm and Sanitary Sewer Installations: Except where a specified type of pipe joint or jointing material is noted on the DRAWINGS, joints and jointing material for concrete sewer installations shall be in conformance with the following table.

Allowable Type of Joints				
Application	**Tongue and Groove with Flexible Plastic Sealing Compound**	**Bell and Spigot (Single Offset) (ASTM 1628 or ASTM C443)**	**Bell and Spigot with USBR M-1 Type R-4 Joint (Confined Gasket) (ASTM C361)**	**Bell and Spigot with USBR M-1 Type R-2 Joint**
1. Non-Pressurized Storm Sewers				
a. Open Cut 36" & larger		X	X	
b. Open Cut 15" to 33"	X	X	X	X
c. Jack or Bored/ Cased			X	X
2. Pressurized Storm Sewers				
a. Open Cut			X	X
b. Jack or Bored/ Cased			X	X
3. Pressurized and Non-Pressurized Sanitary Sewers				
a. Open Cut			X	X
b. Jack or Bored/ Cased			X	X

NOTES:

1) Where more than one type of joint is acceptable, CONTRACTOR may use either type subject to the physical characteristics and manufacturing method of the pipe and approval of ENGINEER.

2) All elliptical pipe or arch pipe shall be double gasketed, or per ASTM C443

3) In addition to the gasket requirements, if the average joint gap in 36-inch diameter pipe or larger pipe exceeds 3/4-inch, the void shall be filled and troweled smooth with an approved non-metallic, non-shrink grout conforming to ASTM C827 or a flexible plastic sealant conforming to ASTM C990 so to provide a smooth interior surface at the joint.

4) For pipe sizes 18-, 24-, 30-, and 36-inch in diameter, the reinforcement in the bell and spigot shall conform to ASTM C76 for the class of pipe specified or to ASTM C361 for a minimum pressure head of 25 feet.

G. Obstructions not shown on the DRAWINGS may be encountered during the progress of the WORK. Should such an obstruction require an alteration to the pipe alignment or grade, ENGINEER will have authority to order a deviation from the DRAWINGS, or ENGINEER may arrange for the removal, relocation, or reconstruction of any structure, which obstructs the pipeline.

H. Joints of precast concrete boxes and precast concrete pipe shall be grouted in accordance with the manufacturer's recommendations or as designated on the DRAWINGS.

3.05 BEDDING AND BACKFILLING

A. Select bedding and backfill material may be required and shall be so shown on the DRAWINGS. Select bedding materials shall conform to the designated gradation requirements in Section 31 23 33, Trenching and Backfilling.

B. Bedding material shall be placed under and around all pipes as shown on the DRAWINGS. Bedding shall be placed in a manner that will minimize separation or change in its uniform gradation. Bedding shall be distributed in six-inch (6") maximum layers over the full width of the trench and simultaneously on both sides of the pipe. Special care shall be taken to ensure full compaction under the haunches and joints of the pipe.

C. Backfill compaction shall not be attained by inundation or jetting, unless approved in writing by ENGINEER. Backfill material shall be uniformly compacted the full depth of the trench.

3.06 CONCRETE CUTOFF COLLARS

A. Concrete cutoff collars shall be placed around pipes as shown on the DRAWINGS or as directed by the ENGINEER.

3.07 SURFACE RESTORATION

A. All streets, alleys, driveways, sidewalks, curbs or other surfaces broken, cut or damaged by CONTRACTOR shall be replaced in kind or as shown on the DRAWINGS.

3.08 CLEAN UP

A. All rubbish, unused materials, and other non-native materials shall be removed from the job site. All excess excavation shall be disposed of as specified, and the right-of-way shall be left in a state of order and cleanliness.

END OF SECTION

SECTION 33 41 01

HIGH-DENSITY POLYETHYLENE PIPE (HDPE)

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes construction of high-density polyethylene pipe for storm drainage culverts including appurtenances normally installed as a part of these systems. Construction may include surface preparation, trench excavation, shoring, dewatering, lay, align, and join pipe, installation of appurtenances, bedding and backfilling, surface restoration, and other related work.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS, which may be related to this section:

1. Section 31 11 00, Clearing and Grubbing.
2. Section 31 14 13, Topsoil Stripping and Stockpiling.
3. Section 31 23 00, Excavation and Fill.
4. Section 31 23 19, Dewatering.
5. Section 31 23 33, Trenching and Backfilling.

1.03 REFERENCES

A. The following is a list of standards, which may be referenced in this section.

1. American Association of State Highway and Transportation Officials (AASHTO):
    a. M252, Standard Specification for Corrugated Polyethylene Drainage Tubing.
    b. M294, Standard Specification for Corrugated Polyethylene Pipe.
    c. Section 18, Soil Thermoplastic Pipe Interaction Systems.
2. ASTM International (ASTM):
    a. D638, Standard Test Method for Tensile Properties of Plastic.
    b. D1056, Specification for Flexible Cellular Materials - Sponge and Expanded Rubber.
    c. D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

d. D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

e. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Material.

f. D4976, Specification for Polyethylene Plastics Molding and Extrusion Materials.

g. F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

h. F667, Standard Specification for Large Diameter Corrugated Polyethylene Tubing and Fittings.

i. F894, Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

j. F2306, Standard Specification for 12 to 60 in. Annular Corrugated Profile-Wall Polyethylene Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.

k. F2562, Specifications for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage.

l. F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and fittings.

3. Plastic Pipe Institute (PPI):

a. Handbook of Polyethylene Pipe.

b. TR-33, Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe.

1.04 SUBMITTALS

A. Details of fittings and specials shall be furnished for approval by ENGINEER.

B. Unless otherwise specified, CONTRACTOR shall submit to ENGINEER for approval SHOP DRAWINGS showing the exact dimension of the joints including the permissible tolerances for each size of pipe being furnished and the size, type and locations of gasket materials. Approval of the joint detail DRAWINGS shall not relieve CONTRACTOR of any responsibilities to meet all of the requirements of these SPECIFICATIONS, or of the responsibility for correctness of CONTRACTOR’s details.

C. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

D. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.

1.05 QUALITY ASSURANCE

A. Manufacturer:

1. Experienced in the design, manufacture, and commercial supplying of the specific material for a minimum period of five (5) years.

2. Experienced in the design, manufacture, and commercial supplying of the specific size of pipe for a period of one (1) year.

3. Certify to above minimum experience requirements.

B. All HDPE pipe and fittings shall be from a single manufacturer. All HDPE pipe to be installed may be inspected at the factory for compliance with these SPECIFICATIONS by an independent testing laboratory provided by the OWNER. The CONTRACTOR shall require the manufacturer's cooperation in these inspections. The cost of these plant inspections of all pipe approved, plus the cost of inspection of a reasonable amount of disapproved pipe, will be borne by the OWNER.

C. Inspection of the pipe shall also be made by the ENGINEER or other representatives of the OWNER after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the SPECIFICATION requirements, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Responsibility for Material:

1. Shipping: Material shall be shipped so to not cut, kink, or otherwise damage pipe during transport.

2. CONTRACTOR shall be responsible for all materials intended for the WORK that are delivered to the construction site and accepted by CONTRACTOR. Payment shall not be made for materials found to be defective or damaged in handling after delivery and acceptance. Defective or damaged materials shall be removed and replaced with acceptable materials at CONTRACTOR's expense.

3. CONTRACTOR shall be responsible for the safe and proper storage of such materials.

a. Limit stacking of pipe to a height that will not cause excessive deformation of bottom layers of pipes under anticipated temperature conditions.

b. Where necessary, because of ground conditions, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.

c. Keep pipe shaded from direct sunlight prior to installation in the trench.

B. Pipe Acceptance:

1. In addition to any deficiencies not covered by the applicable ASTM Specifications, pipe, which has any of the following visual defects, will not be accepted.

a. Cracks, bubbles, pinholes, inclusions or occlusions, which, because of their nature, degree, or extent, detrimentally affect the strength and serviceability of the pipe.

C. Pipe Handling:

1. Pipe and accessories furnished by CONTRACTOR shall be delivered to, unloaded, and distributed at the site by CONTRACTOR. Each pipe shall be unloaded adjacent to or near the intended laying location.

2. Pipe fittings, specials, valves, and appurtenances shall be unloaded and stored in a manner that precludes shock or damage. Such materials shall not be dropped.

3. Pipe shall be handled to prevent damage to the pipe ends or to any coating or lining. Pipe shall not be skidded or rolled against adjacent pipe. Damaged coatings or lining shall be repaired or replaced by CONTRACTOR, at CONTRACTOR's expense in accordance with the recommendations of the manufacturer and in a manner satisfactory to Engineer. Physical damage to the pipe or accessory shall be repaired or replaced by CONTRACTOR at CONTRACTOR's expense, and in a manner satisfactory to ENGINEER.

D. Gasket Storage: All gaskets shall be stored in a cool place, preferably at a temperature of less than seventy degrees Fahrenheit (70°F.), and in no case shall the gaskets be stored in the open, or exposed to the direct rays of the sun.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: HDPE pipe, which does not conform to ASTM D3350, ASTM D 4976, ASTM F667, ASTM F894, ASTM F2306, or ASTM F2562 or to any other requirement specified herein, shall not be approved for storm sewer, culvert, or sanitary sewer installations.

B. Allowable Pipe diameters for this specification shall be between eighteen (18) inches to thirty-six (36) inches unless approved by ENGINEER and OWNER.

C. Allowable ASTM Specifications: All material, manufacturing operations, testing, inspection, and making of HDPE pipe shall conform to the requirements of the appropriate allowable ASTM Standard Specifications, latest revision thereof, listed in Article References.

D. Marking:

1. The following shall be clearly marked on both the interior and exterior surface of the pipe:

a. Class and size.

b. Date of manufacture.

c. Name or trademark of manufacturer.

d. Deflection angle for bends.

E. Diameter of Pipe: The diameter indicated on the DRAWINGS shall mean the inside diameter of the pipe.

F. Wall Thickness and Class of Pipe:

1. The wall thickness shall comply with the appropriate ASTM Specification and the class of pipe designated on the DRAWINGS.

2. HDPE pipe and fittings shall have a smooth interior and corrugated exterior. 18-inch through 36-inch pipe shall meet the requirements of AASHTO M294 Type S. The pipe shall have a full circular cross-section with annular corrugations. Pipe shall be produced to constant internal diameters.

3. Pipe and fittings shall be made of high-density, high-molecular weight polyethylene material meeting the requirements of cell classification 324420C or higher in accordance with ASTM D3350. Clean rework material generated by the manufacturer's own production may be used so long as the pipe or fittings produced meet all the requirements of this SPECIFICATION.

G. Fittings and Specials:

1. Elbows and fittings shall be mitered from pipe sections welded together on the interior and exterior at all junctions.

2. The pipe sections forming the miters shall be cut to fit with no gap.

3. Tolerances on the angle of all elbows shall be plus or minus 1 degree.

4. The standard turning radius of elbows shall be 1.5 times the inside diameter. Special turning radii shall be used for special applications.

5. Elbows shall conform to the following requirements:

Angle of Elbow (Degrees)	**Number of Miters**
0 to 45	1
45 to 90	2

6. Elbows shall be designed to prevent joint rupture resulting from dynamic forces or application of a test pressure of 25 psi.

H. Joints:

1. Watertight joints shall be accomplished by rubber gasket, in accordance with ASTM D3212.

2. Gaskets shall be closed-cell synthetic, expanded rubber meeting the requirements of ASTM D1056, Grade 2A2 or made of polyisoprene meeting ASTM F477. Gaskets shall be installed on the connection by the pipe manufacturer.

3. Lubricant shall have no detrimental effect on the gasket of on the pipe.

4. Integral bell and spigot gasketed joints shall be designed so that when assembled, the elastomeric gasket, contained in a machined groove on the pipe spigot, is compressed radially in the pipe bell to form a positive seal. The joint shall be designed to avoid displacement of the gasket when installed in accordance with the manufacturer's recommendations.

PART 3 EXECUTION

3.01 GENERAL

A. The pipe and pipe coatings shall be inspected by ENGINEER for damage or defects before being placed in the trench. Damaged or defective pipe shall not be installed.

B. All pipes, which do not meet the requirements of PART 2 of this section, will be rejected and replaced at CONTRACTOR's expense.

C. CONTRACTOR shall install storm sewer pipe of the type, diameter, load class, wall thickness, and protective coating that is shown on the DRAWINGS.

D. Proper equipment, implements, tools, and facilities shall be provided and used by CONTRACTOR for safe and convenient installation of the type of pipe being installed.

3.02 SURFACE PREPARATION

A. Within Easement, Cultivated, Landscaped, or Agricultural Area:

1. All vegetation, such as brush, sod, heavy growth of grass or weeds, decayed vegetable matter, rubbish and other unsuitable material within the area of excavation and trench side storage shall be stripped and disposed of in accordance with the requirements of Section 31 11 00, Clearing and Grubbing.

2. Topsoil shall be removed to a depth of eight (8) inches or the full depth of the topsoil, whichever is less. Topsoil shall be removed from the area to be excavated and stockpiled, or, CONTRACTOR may elect to import topsoil to replace that lost during excavation.

B. Within Unpaved Roadway Areas: CONTRACTOR shall strip the cover material from graveled roadways or other developed, but unpaved traffic surfaces to the full depth of the existing surfacing. The surfacing shall be stockpiled to the extent that it is acceptable and useable for restoration purposes.

C. Within Paved Areas:

1. The removal of pavement, sidewalks, driveways, or curb and gutter shall be performed in a neat and workmanlike manner. Concrete pavement, asphalt, sidewalks, driveways, or curb and gutter shall be cut with a power saw to a depth of two (2) inches prior to breaking. The concrete shall be cut vertically in straight lines and avoiding acute angles.

2. Bituminous pavement, sidewalks, driveways, or curb and gutter shall be cut with a power saw, pavement breaker, or other approved method of scoring the mat prior to breaking or excavation. The bituminous mat shall be cut vertically, in straight lines and avoiding acute angles.

3. Any overbreak, separation, or other damage to the existing bituminous or concrete outside the designated cut lines shall be replaced at CONTRACTOR's expense.

4. Excavated paving materials shall be removed from the job site and shall not be used as fill or backfill.

3.03 DEWATERING

A. All pipe trenches and excavation for structures and appurtenances shall be kept free of water during pipe laying and other related work. The method of dewatering shall provide for a dry foundation at the final grades of excavation in accordance with Section 31 23 19, Dewatering. Water shall be disposed of in a manner that does not inconvenience the public or result in a menace to public health. Pipe trenches shall contain enough backfill to prevent pipe flotation before dewatering is discontinued. Dewatering shall continue until such time as it is safe to allow the water to rise in the excavation.

3.04 INSTALLATION

A. General: Precautions shall be taken to prevent foreign material from entering the pipe before or while it is being placed in the line. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe. The open ends of pipe shall be closed with a watertight plug, or with other devices approved by ENGINEER, at times when pipe laying is not in progress.

B. Pipe:

1. Pipe shall be installed in accordance with the manufacturer's recommendations for installing the type of pipe used, unless otherwise shown on the DRAWINGS.

2. Pipelines shall be laid to the grades and alignment shown on the DRAWINGS or staked by ENGINEER. Variation from the prescribed grade and alignment shall not exceed one-tenth (0.10) foot, and the rate of departure from, or return to, the established grade or alignment shall be not more than one (1) inch in ten (10) feet, unless approved by ENGINEER. No deviation from grade shall cause a depression in the sewer invert that could retain fluids or solids. Any pipe which is not in true alignment or which shows undue settlement after laying shall be taken up and re-laid at CONTRACTOR'S expense.

3. Lift or roll pipe to protect coating. Do not drag over gravel or rock. Avoid striking rocks or hard objects when lowering into trench.

    a. Pipe on which coatings have been damaged may be rejected at the site of the Work regardless of previous approvals.

C. Pipe Fittings:

1. Pipe fittings shall be laid so as to form a close concentric joint with the adjoining pipe to avoid sudden offsets of the flowline. Pipe sections shall be joined together in accordance with the manufacturer's recommendations.

2. Pipe fittings and appurtenances shall be carefully lowered into the trench with suitable tools or equipment to prevent damage to the pipe and protective coatings and linings; pipe and accessory materials shall not be dropped or dumped into the trench.

D. Gaskets: No gaskets that show signs of deterioration, such as surface cracking or checking, shall be installed in a pipe joint. The neoprene gaskets used, when the air temperature is ten degrees Fahrenheit (10°F) or lower shall be warmed to temperature of sixty degrees Fahrenheit (60°F) for a period of thirty (30) minutes before being placed on the pipe.

E. Obstructions not shown on the DRAWINGS may be encountered during the progress of the WORK. Should such an obstruction require an alteration to the pipe alignment or grade, ENGINEER will have authority to order a deviation from the DRAWINGS, or ENGINEER may arrange for the removal, relocation, or reconstruction of any structure which obstructs the pipeline.

3.05 BEDDING AND BACKFILL FILLING

A. Select bedding and backfill material may be required and shall be so shown on the DRAWINGS. Select bedding materials shall conform to the designated gradation requirements in Section 31 23 33, Trenching and Backfilling.

B. Bedding material shall be placed under and around all pipes as shown on the DRAWINGS. Bedding shall be placed in a manner that will minimize separation or change in its uniform gradation. Bedding shall be distributed in six-inch (6") maximum layers over the full width of the trench and simultaneously on both sides of the pipe. Special care shall be taken to ensure full compaction under the haunches and joints of the pipe.

C. Backfill compaction shall not be attained by inundation or jetting, unless approved in writing by ENGINEER. Backfill material shall be uniformly compacted the full depth of the trench.

3.06 CONCRETE CUTOFF COLLARS

A. Concrete shall meet the requirements of Section 03 31 00, Structural Concrete.

3.07 FIELD TESTING

A. Acceptance Tests for Gravity and Low-Pressure Pipelines:

1. Alignment:

    a. Sewer shall be inspected by flashing a light between manholes or by physical passage where space permits.

    b. Contractor shall clean pipe of joint sealant, other dirt, and debris prior to inspection.

    c. Determine from Illumination or Physical Inspection:

        1) Presence of any misaligned, displaced, or broken pipe.
        2) Presence of visible infiltration or other defects.

B. Deflection Testing:

1. Maximum installed deflections of flexible pipe shall be five percent (5%) of mean internal diameter.

2. At the ENGINEER's discretion, CONTRACTOR shall test flexible pipe after backfill has been in place 30 days. Deflection is defined per ASTM D2321.

    a. CONTRACTOR shall provide rigid ball or mandrel deflection testing equipment and labor.

    b. Obtain approval of equipment and acceptance of method proposed for use in testing deflection of the pipe. Test shall be performed without mechanical pulling devices.

    c. Pipe exceeding deflection limits, as defined in ASTM D2321, shall be replaced or re-compacted at CONTRACTOR's expense.

3.08 SURFACE RESTORATION

A. All streets, alleys, driveways, sidewalks, curbs, or other surfaces broken, cut or damaged by CONTRACTOR shall be replaced in kind or as shown on the DRAWINGS.

3.09 CLEAN UP

A. All rubbish, unused materials, and other non-native materials shall be removed from the job site. All excess excavation shall be disposed of as specified, and the right-of-way shall be left in a state of order and cleanliness.

END OF SECTION

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SECTION 33 41 02

SPIRAL RIBBED ALUMINIZED STEEL PIPE (ASP)

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes construction of spiral-ribbed, aluminized steel pipe (ASP), and flared end sections intended for use in storm drainage systems and culverts, including appurtenances normally installed as part of these systems. Construction may include surface preparation, trench excavation, shoring, dewatering, lay, align, and join pipe, installation of appurtenances, bedding, and backfilling, surface restoration, and other related work.

1.02 RELATED SECTIONS

1. Section 31 11 00, Clearing and Grubbing.
2. Section 31 14 13, Topsoil Stripping and Stockpiling.
3. Section 31 23 00, Excavation and Fill.
4. Section 31 23 19, Dewatering.
5. Section 31 23 33, Trenching and Backfilling.

1.03 REFERENCES

A. The following is a list of standards, which may be referenced in this section.

1. American Association of State Highway and Transportation Officials (AASHTO):
    a. M36, Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.
    b. M274, Steel Sheet, Aluminum Coated (Type 2) for Corrugated Steel Pipe.
2. ASTM International (ASTM):
    a. A760, Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
    b. A796, Structural Design of Corrugated Steel Pipe, Pipe-Arches, Arches for Storm and Sanitary Sewers, and Other Buried Applications.
    c. A798, Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications.
    d. A929, Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe.
3. Standard Specification for Highway Bridges:
    a. Section 12 - Soil-Corrugated Metal Structure Interaction Systems.

b. Section 26 - Metal Culverts.

1.04 SUBMITTALS

A. Details of fittings and specials shall be furnished for approval by ENGINEER.

B. Unless otherwise specified, CONTRACTOR shall submit to ENGINEER for approval SHOP DRAWINGS showing the exact dimension of the joints including the permissible tolerances for each size of pipe being furnished and the size, type, and locations of gasket materials and a schedule of pipe lengths (including length of individual pipes by diameter) for the entire project. Approval of the joint detail DRAWINGS shall not relieve CONTRACTOR of any responsibilities to meet all of the requirements of these SPECIFICATIONS, or of the responsibility for correctness of CONTRACTOR's details.

C. CONTRACTOR shall submit to ENGINEER, the name of the pipe and fitting suppliers and a list of materials to be furnished including complete manufacturers specifications and data covering the materials to be furnished and detailed drawings covering the installation.

D. CONTRACTOR shall submit certified test reports that the pipe was manufactured and tested in accordance with the ASTM and AASHTO Standards specified herein.

E. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.

1.05 QUALITY ASSURANCE

A. Manufacturer:

1. Experienced in the design, manufacture, and commercial supplying of the specific material for a minimum period of five (5) years.

2. Experienced in the design, manufacture, and commercial supplying of the specific size of pipe for a period of one (1) year.

3. Certify to above minimum experience requirements.

B. All ASP pipe and fittings shall be from a single manufacturer. All ASP pipe to be installed may be inspected at the factory for compliance with these SPECIFICATIONS by an independent testing laboratory provided by the OWNER. The CONTRACTOR shall require the manufacturer's cooperation in these inspections. The cost of these plant inspections of all pipe approved, plus the cost of inspection of a reasonable amount of disapproved pipe, will be borne by the OWNER.

C. Inspection of the pipe shall also be made by the ENGINEER or other representatives of the OWNER after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the SPECIFICATION requirements, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Responsibility for Material:

1. Shipping: Material shall be shipped so to not bend, dent, or otherwise damage pipe during transport.

2. CONTRACTOR shall be responsible for all materials intended for the WORK that are delivered to the construction site and accepted by CONTRACTOR. Payment shall not be made for materials found to be defective or damaged in handling after delivery and acceptance. Defective or damaged materials shall be removed and replaced with acceptable materials at CONTRACTOR's expense.

3. CONTRACTOR shall be responsible for the safe and proper storage of such materials.

a. Limit stacking of pipe to a height that will not cause excessive deformation of bottom layers of pipes.

b. Where necessary, because of ground conditions, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.

B. Pipe Acceptance:

1. In addition to any deficiencies not covered by the applicable ASTM Specifications, pipe which has any of the visual defects will not be accepted.

a. Dents, punctures, or damage to the coating which, because of the nature, degree, or extent, detrimentally affect the strength and serviceability of the pipe.

C. Pipe Handling:

1. Pipe and accessories furnished by CONTRACTOR shall be delivered to, unloaded, and distributed at the site by CONTRACTOR. Each pipe shall be unloaded adjacent to or near the intended laying location.

2. Pipe fittings, specials, valves, and appurtenances shall be unloaded and stored in a manner that precludes shock or damage. Such materials shall not be dropped.

3. Pipe shall be handled so as to prevent damage to the pipe ends or to any coating or lining. Pipe shall not be skidded or rolled against adjacent pipe. Damaged coatings or lining shall be repaired by CONTRACTOR, at CONTRACTOR's expense in accordance with the recommendations of the manufacturer and in a manner satisfactory to ENGINEER. Physical damage to the pipe or accessory shall be repaired or replaced by CONTRACTOR at CONTRACTOR's expense, and in a manner satisfactory to ENGINEER.

D. Gasket Storage: All gaskets shall be stored in a cool place, preferably at a temperature of less than seventy degrees Fahrenheit (70°F.), and in no case shall the gaskets be stored in the open, or exposed to the direct rays of the sun.

PART 2 PRODUCTS

2.01 MATERIAL

A. General: ASP pipe, which does not conform to the applicable ASTM Standard Specifications, listed in Article References or to any other requirement specified herein shall not be approved for storm sewer, culvert, or sanitary sewer installations.

B. Allowable ASTM Specifications: All material, manufacturing operations, testing, inspection, and making of ASP pipe shall conform to the requirements of the appropriate allowable ASTM Standard Specifications, latest revision thereof, listed in Article References.

C. Marking:

1. The following shall be clearly marked on both the interior and exterior surface of the pipe:

a. Pipe gauge and size.

b. Date of manufacture.

c. Name or trademark of manufacturer.

d. Deflection angle for bends.

D. Diameter of Pipe: The diameter indicated on the DRAWINGS shall mean the inside diameter of the pipe.

E. Wall Thickness and Class of Pipe:

1. Spiral-ribbed aluminized steel pipe shall be manufactured conforming to AASHTO M36.

2. Pipe shall be aluminized Type 2, steel.

3. Metal Sheet for Spiral-ribbed Aluminized Pipe: All metal sheet for pipe fabricated under this SPECIFICATION shall be formed from aluminum-coated sheet conforming to AASHTO M274.

4. Metal Sheet Thickness for Spiral-ribbed aluminized Pipe: Thickness (gauge) specified by AASHTO M36, Section 8, Table 12.

5. Pipe Seam and Ends: Pipe shall be fabricated with helical corrugations having a continuous lock seam extending from end to end of each length of pipe. Each end of each length of pipe shall be re-rolled to an annular corrugation. The re-rolling shall be a minimum of three corrugations.

6. Classification shall be as follows for this SPECIFICATION of spiral-ribbed aluminized pipe:

a. Type IR: This pipe shall have a full circular cross section with a single thickness of smooth sheet, fabricated with helical ribs projecting outward.

b. Type IIR: This pipe shall be a Type IR pipe that has been reformed into a pipe-arch having an approximately flat bottom.

F. Joints:

1. Coupling Bands:

a. Coupling bands shall conform to AASHTO M36 as directed herein and shall allow the use of O-ring gaskets.

b. All coupling bands shall be no less than ten and one-half (10-1/2) inches wide with the minimum width conforming to the appropriate AASHTO designation for the spiral-ribbed aluminized pipe.

c. Steel Sheeting for Coupling Bands: The sheet used in fabricating coupling bands shall conform to the same SPECIFICATION listed herein. The sheet thickness of the coupling bands shall conform to the appropriate AASHTO designation for the corrugated steel pipe.

d. Hardware for Coupling Bands: Bolts and nuts shall conform to AASHTO M36. Coupling bands shall have bar, bolt, and strap connector assemblies per lap.

e. O-Ring Gaskets: Gaskets shall meet or exceed the requirements of AASHTO M198 and be used in conjunction with coupling bands. The use of TC-40 type mastic will be required at the lap joint with O-ring gaskets. The requirement for the use of O-ring gaskets will be noted on the DRAWINGS.

G. Fittings and Specials:

1. Fittings shall be for horizontal and vertical deflections, as specified in the DRAWINGS.

2. Fittings may also be for any accessory such as inlets, manhole structures, and manhole risers, as specified in the DRAWINGS.

3. Fittings shall be at a minimum, manufactured from the same material, thickness, and coating as the pipeline to which they are joined.

H. Concrete Cutoff Collars:

1. Concrete shall meet the requirements of section 03 31 00, Structural Concrete

PART 3 EXECUTION

3.01 GENERAL

A. The pipe and pipe coatings shall be inspected by ENGINEER for damage or defects before being placed in the trench. Damaged or defective pipe shall not be installed.

B. All pipe, which does not meet the requirements of PART 2 of this section, will be rejected and replaced at CONTRACTOR’s expense.

C. CONTRACTOR shall install storm sewer pipe of the type, diameter, load class, wall thickness, and protective coating that is shown on the DRAWINGS.

D. Proper equipment, implements, tools, and facilities shall be provided and used by CONTRACTOR for safe and convenient installation of the type of pipe being installed.

3.02 SURFACE PREPARATION

A. Within Easement, Cultivated, Landscaped, or Agricultural Area:

1. All vegetation, such as brush, sod, heavy growth of grass or weeds, decayed vegetable matter, rubbish, and other unsuitable material within the area of excavation and trench side storage shall be stripped and disposed of in accordance with the requirements of Section 31 11 00, Clearing and Grubbing.

2. Topsoil shall be removed to a depth of eight (8) inches or the full depth of the topsoil, whichever is less. Topsoil shall be removed from the area to be excavated and stockpiled, or, CONTRACTOR may elect to import topsoil to replace that lost during excavation.

B. Within Unpaved Roadway Areas: CONTRACTOR shall strip the cover material from graveled roadways or other developed, but unpaved traffic surfaces to the full depth of the existing surfacing. The surfacing shall be stockpiled to the extent that it is acceptable and useable for restoration purposes.

C. Within Paved Areas:

1. The removal of pavement, sidewalks, driveways, or curb and gutter shall be performed in a neat and workmanlike manner. Concrete pavement, asphalt, sidewalks, driveways, or curb and gutter shall be cut with a power saw to a depth of two (2) inches prior to breaking. The concrete shall be cut vertically in straight lines and avoiding acute angles.

2. Bituminous pavement, sidewalks, driveways, or curb and gutter shall be cut with a power saw, pavement breaker, or other approved method of scoring the mat prior to breaking or excavation. The bituminous mat shall be cut vertically, in straight lines and avoiding acute angles.

3. Any overbreak, separation, or other damage to the existing bituminous or concrete outside the designated cut lines shall be replaced at CONTRACTOR's expense.

4. Excavated paving materials shall be removed from the job site and shall not be used as fill or backfill.

3.03 DEWATERING

A. All pipe trenches and excavation for structures and appurtenances shall be kept free of water during pipe laying and other related work. The method of dewatering shall provide for a dry foundation at the final grades of excavation in accordance with Section 31 23 19, Dewatering. Water shall be disposed of in a manner that does not inconvenience the public or result in a menace to public health. Pipe trenches shall

contain enough backfill to prevent pipe flotation before dewatering is discontinued. Dewatering shall continue until such time as it is safe to allow the water to rise in the excavation.

3.04 INSTALLATION

A. General: Precautions shall be taken to prevent foreign material from entering the pipe before or while it is being placed in the line. During laying operations, no debris, tools, clothing, or other materials shall be placed in the pipe. The open ends of pipe shall be closed with a watertight plug, or with other devices approved by ENGINEER, at times when pipe laying is not in progress.

B. Pipe:

1. Pipe shall be installed in accordance with the manufacturer's recommendations for installing the type of pipe used, unless otherwise shown on the DRAWINGS. Pipelines shall be laid to the grades and alignment shown on the DRAWINGS or staked by ENGINEER. Variation from the prescribed grade and alignment shall not exceed one-tenth (0.10) foot, and the rate of departure from, or return to, the established grade or alignment shall be not more than one (1) inch in ten (10) feet, unless approved by ENGINEER. No deviation from grade shall cause a depression in the sewer invert that could retain fluids or solids. Any pipe which is not in true alignment or which shows undue settlement after laying shall be taken up and re-laid at CONTRACTOR's expense.

2. Lift or roll pipe to protect coating. Do not drag over gravel or rock. Avoid striking rocks or hard objects when lowering into trench.

   a. Pipe on which coatings have been damaged may be rejected at the site of the WORK regardless of previous approvals.

C. Pipe Fittings:

1. Pipe fittings shall be laid so as to form a close concentric joint with the adjoining pipe to avoid sudden offsets of the flow line. Pipe sections shall be joined together in accordance with the manufacturer's recommendations.

2. Join pipe sections with bolted coupling bands of the same material as the pipe in accordance with the manufacturer's recommendations.

3. Pipe fittings and appurtenances shall be carefully lowered into the trench with suitable tools or equipment to prevent damage to the pipe and protective coatings and linings; pipe and accessory materials shall not be dropped or dumped into the trench.

D. Gaskets: No gaskets that show signs of deterioration, such as surface cracking or checking, shall be installed in a pipe joint. The neoprene gaskets used, when the air temperature is ten degrees Fahrenheit (10°F) or lower shall be warmed to temperature of sixty degrees Fahrenheit (60°F) for a period of thirty (30) minutes before being placed on the pipe.

3.05 BEDDING AND BACKFILLING

A. Select bedding and backfill material may be required and shall be so shown on the DRAWINGS. Select bedding materials shall conform to the designated gradation requirements in Section 31 23 33, Trenching and Backfilling.

B. Bedding material shall be placed under and around all pipes as shown on the DRAWINGS. Bedding shall be placed in a manner that will minimize separation or change in its uniform gradation. Bedding shall be distributed in six-inch (6") maximum layers over the full width of the trench and simultaneously on both sides of the pipe. Special care shall be taken to ensure full compaction under the haunches and joints of the pipe.

C. Backfill compaction shall not be attained by inundation or jetting, unless approved in writing by ENGINEER. Backfill material shall be uniformly compacted the full depth of the trench.

3.06 CONCRETE CUTOFF COLLARS

A. Concrete cutoff collars shall be placed around pipes as shown on the DRAWINGS or as directed by the ENGINEER.

3.07 FIELD TESTING

A. Acceptance Tests for Gravity and Low-Pressure Pipelines:

1. Alignment:

a. Sewer shall be inspected by flashing a light between manholes or by physical passage where space permits.

b. CONTRACTOR shall clean pipe of excess mortar, joint sealant, and other dirt and debris prior to inspection.

c. Determine from Illumination or Physical Inspection:

1) Presence of any misaligned, displaced, or broken pipe.
2) Presence of visible infiltration or other defects.

B. Deflection Testing:

1. Maximum installed deflections of flexible pipe shall be five percent (5%) of mean internal diameter.

2. At the ENGINEER’s discretion, CONTRACTOR shall test flexible pipe after backfill has been in place 30 days. Deflection is defined per ASTM D2321.

a. CONTRACTOR shall provide rigid ball or mandrel deflection testing equipment and labor.

b. Obtain approval of equipment and acceptance of method proposed for use in testing deflection of the pipe. Test shall be performed without mechanical pulling devices.

c. Pipe exceeding deflection limits, as defined in ASTM D2321, shall be replaced or re-compacted at CONTRACTOR's expense.

3.08 SURFACE RESTORATION

A. All streets, alleys, driveways, sidewalks, curbs, or other surfaces broken, cut or damaged by CONTRACTOR shall be replaced in kind or as shown on the DRAWINGS.

3.09 CLEAN UP

A. All rubbish, unused materials, and other non-native materials shall be removed from the job site. All excess excavation shall be disposed of as specified, and the right-of-way shall be left in a state of order and cleanliness.

END OF SECTION

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SECTION 33 41 03

POLYVINYL CHLORIDE (PVC) PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes all labor, materials, equipment, and incidentals required and installation of Polyvinyl Chloride (PVC) pipe and fittings, 18-inch diameter to 60-inch diameter intended for use in storm drainage systems including appurtenances normally installed as part of these systems. Construction may include surface preparation, trench excavation shoring, dewatering, lay align and join pipe, installation of appurtenances, bedding and backfilling, surface restoration, and other related work.

1.02 RELATED SECTIONS

1. Section 31 11 00, Clearing and Grubbing.
2. Section 31 14 13, Topsoil Stripping and Stockpiling.
3. Section 31 23 00, Excavation and Fill.
4. Section 31 23 19, Dewatering.
5. Section 31 23 33, Trenching and Backfilling.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO)
    a. M278, Standard Specification for Class PS46 Poly (Vinyl Chloride) (PVC) Pipe
    b. M304, Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
2. ASTM International (ASTM):
    a. D1784, Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds.
    b. D2321, Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
    c. D2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

d. D3212, Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

e. F477, Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

f. F679, Polyvinyl Chloride (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.

g. F794, Polyvinyl Chloride (PVC) Ribbed Gravity Sewer Pipe and Fittings Based On Controlled Inside Diameter.

h. F949, Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings.

i. F1803, Standard Specifications for Poly (Vinyl Chloride) (PVC) Closed Profile Gravity Pipe and Fittings Based on Controlled Inside Diameter.

1.04 SUBMITTALS

A. Details of fittings and specials shall be furnished for approval by ENGINEER.

B. Unless otherwise specified, CONTRACTOR shall submit to ENGINEER for approval SHOP DRAWINGS showing the exact dimension of the joints including the permissible tolerances for each size of pipe being furnished and the size, type and locations of gasket materials and a schedule of pipe lengths (including length of individual pipes by diameter) for the entire project. Approval of the joint detail DRAWINGS shall not relieve CONTRACTOR of any responsibilities to meet all of the requirements of these SPECIFICATIONS, or of the responsibility for correctness of CONTRACTOR's details.

C. CONTRACTOR shall submit to ENGINEER, the name of the pipe and fitting suppliers and a list of materials to be furnished including complete manufacturers specifications and data covering the materials to be furnished and detailed drawings covering the installation.

D. CONTRACTOR shall submit certified test reports that the pipe was manufactured and tested in accordance with the ASTM and AASHTO Standards specified herein.

E. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.

1.05 QUALITY ASSURANCE

A. Manufacturer:

1. Experienced in the design, manufacture, and commercial supplying of the specific material for a minimum period of five (5) years.

2. Experienced in the design, manufacture, and commercial supplying of the specific size of pipe for a period of one (1) year.

3. Certify to above minimum experience requirements.

B. All PVC pipe and fittings shall be from a single manufacturer. All PVC pipe to be installed may be inspected at the factory for compliance with these SPECIFICATIONS by an independent testing laboratory provided by the OWNER. The CONTRACTOR shall require the manufacturer's cooperation in these inspections. The cost of these plant inspections of all pipe approved, plus the cost of inspection of a reasonable amount of disapproved pipe, will be borne by the OWNER.

C. Inspection of the pipe shall also be made by the ENGINEER or other representatives of the OWNER after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Responsibility for Material:

1. Shipping: Material shall be shipped so to not bend, dent or otherwise damage pipe during transport.

2. CONTRACTOR shall be responsible for all materials intended for the WORK that are delivered to the construction site and accepted by CONTRACTOR. Payment shall not be made for materials found to be defective or damaged in handling after delivery and acceptance. Defective or damaged materials shall be removed and replaced with acceptable materials at CONTRACTOR's expense.

3. CONTRACTOR shall be responsible for the safe and proper storage of such materials.

a. Limit stacking of pipe to a height that will not cause excessive deformation of bottom layers of pipes under anticipated temperature conditions.

b. Where necessary, because of ground conditions, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.

c. Keep Pipe shaded from direct sunlight prior to installation in the trench.

B. Pipe Acceptance:

1. In addition to any deficiencies not covered by the applicable ASTM Specifications, any pipe or fitting which has any of the visual defects will not be accepted.

a. Delaminations, cracks, bubbles, pinholes, inclusions or occlusions, which, because of their nature, degree, or extent, detrimentally affect the strength and serviceability of the pipe.

C. Pipe Handling:

1. Pipe and accessories furnished by CONTRACTOR shall be delivered to, unloaded, and distributed at the site by CONTRACTOR. Each pipe shall be unloaded adjacent to or near the intended laying location.

2. Pipe, fittings, specials, valves and appurtenances shall be unloaded and stored in a manner that precludes shock or damage. Such materials shall not be dropped.

3. Pipe shall be handled so as to prevent damage to the pipe ends or to any coating or lining. Pipe shall not be skidded or rolled against adjacent pipe. Damaged coatings or lining shall be repaired or replaced by CONTRACTOR, at CONTRACTOR's expense in accordance with the recommendations of the manufacturer and in a manner satisfactory to ENGINEER. Physical damage to the pipe or accessory shall be repaired or replaced by CONTRACTOR at CONTRACTOR's expense, and in a manner satisfactory to ENGINEER.

D. Gasket Storage: All gaskets shall be stored in a cool place, preferably at a temperature of less than seventy degrees Fahrenheit (70°F.), and in no case shall the gaskets be stored in the open, or exposed to the direct rays of the sun.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: PVC pipe, which does not conform to the applicable ASTM Standard Specifications, listed in Article References or to any other requirement specified herein shall not be approved for storm sewer, culvert, or sanitary sewer installations.

B. Allowable ASTM Specifications: All material, manufacturing operations, testing, inspection, and making of PVC pipe shall conform to the requirements of the appropriate allowable ASTM Standard Specifications, latest revision thereof, listed in Article References.

C. Marking:

1. Class and size.

2. Date of manufacture.

3. Name or trademark of manufacturer.

4. Deflection angle for bends.

D. Diameter of Pipe: The diameter indicated on the DRAWINGS shall mean the inside diameter of the pipe.

E. Wall Thickness and Class of Pipe:

1. PVC large-diameter plastic gravity sewer pipe and fitting shall conform to ASTM F679 or ASTM F794, with minimum pipe stiffness of 46 psi.

2. The wall thickness shall comply with the appropriate ASTM Specification and the class of pipe designated on the DRAWINGS.

3. PVC pipe and fittings shall have a smooth interior and corrugated exterior. 18-inch through 36-inch pipe shall meet the requirements of AASHTO M294 Type S. The pipe shall have a full circular cross-section with annular corrugations. Pipe shall be produced to constant internal diameters.

4. Pipe and fittings shall be made of high-density, high molecular weight polyethylene material meeting the requirements of cell classification 324420C or higher in accordance with ASTM D3350. Clean rework material generated by the manufacturer's own production may be used so long as the pipe or fittings produced meet all the requirements of this SPECIFICATION.

F. Fittings and Specials:

1. Fittings and specials shall conform to ASTM F679 or ASTM F794, with minimum pipe stiffness of 46 psi.

2. Fittings or specials shall have permanently and plainly marked on the interior of the pipe wall the pipe class and size, date of manufacture, manufacturer's name or trademark, and deflection angle for bends.

G. Joints:

1. Pipe joints shall be airtight and of the bell spigot type with elastomeric gaskets conforming to the requirements of ASTM D3212.

2. Gaskets shall comply in all aspects with physical requirements specified in ASTM F477.

3. Gaskets shall be neoprene or synthetic elastomer. Natural rubber is not acceptable:

4. The gasket shall be the only element depended upon to make the joint flexible and watertight.

5. Lubricant used for assembly shall have no detrimental effect on the gasket or the pipe.

6. Integral bell and spigot gasketed joints shall be designed so that when assembled, the elastomeric gasket, contained in a machined groove on the pipe spigot, is compressed radially in the pipe bell to form a positive seal. The joint shall be designed to avoid displacement of the gasket when installed in accordance with the manufacturer's recommendations.

PART 3 EXECUTION

3.01 GENERAL

A. The pipe and pipe coatings shall be inspected by ENGINEER for damage or defects before being placed in the trench. Damaged or defective pipe shall not be installed.

B. All pipes which do not meet the requirements of PART 2 of this section will be rejected and replaced at CONTRACTOR's expense.

C. CONTRACTOR shall install storm sewer pipe of the type, diameter, load class, wall thickness and protective coating that is shown on the DRAWINGS.

D. Proper equipment, implements, tools and facilities shall be provided and used by CONTRACTOR for safe and convenient installation of the type of pipe being installed.

3.02 SURFACE PREPARATION

A. Within Easement, Cultivated, Landscaped, or Agricultural Area:

1. All vegetation, such as brush, sod, heavy growth of grass or weeds, decayed vegetable matter, rubbish and other unsuitable material within the area of excavation and trenchside storage shall be stripped and disposed of in accordance with the requirements of Section 31 11 00, Clearing and Grubbing.

2. Topsoil shall be removed to a depth of eight (8) inches or the full depth of the topsoil, whichever is less. Topsoil shall be removed from the area to be excavated and stockpiled, or, CONTRACTOR may elect to import topsoil to replace that lost during excavation.

B. Within Unpaved Roadway Areas: CONTRACTOR shall strip the cover material from graveled roadways or other developed, but unpaved traffic surfaces to the full depth of the existing surfacing. The surfacing shall be stockpiled to the extent that it is acceptable and useable for restoration purposes.

C. Within Paved Areas:

1. The removal of pavement, sidewalks, driveways, or curb and gutter shall be performed in a neat and workmanlike manner. Concrete pavement, asphalt, sidewalks, driveways, or curb and gutter shall be cut with a power saw to a depth of two (2) inches prior to breaking. The concrete shall be cut vertically in straight lines and avoiding acute angles.

2. Bituminous pavement, sidewalks, driveways, or curb and gutter shall be cut with a power saw, pavement breaker, or other approved method of scoring the mat prior to breaking or excavation. The bituminous mat shall be cut vertically, in straight lines and avoiding acute angles.

3. Any overbreak, separation, or other damage to the existing bituminous or concrete outside the designated cut lines shall be replaced at CONTRACTOR's expense.

4. Excavated paving materials shall be removed from the job site and shall not be used as fill or backfill.

3.03 DEWATERING

A. All pipe trenches and excavation for structures and appurtenances shall be kept free of water during pipe laying and other related work. The method of dewatering shall provide for a dry foundation at the final grades of excavation in accordance with Section 31 23 19, Dewatering. Water shall be disposed of in a manner that does not inconvenience the public or result in a menace to public health. Pipe trenches shall

contain enough backfill to prevent pipe flotation before dewatering is discontinued. Dewatering shall continue until such time as it is safe to allow the water to rise in the excavation.

3.04 INSTALLATION

A. General: Precautions shall be taken to prevent foreign material from entering the pipe before or while it is being placed in the line. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe. The open ends of pipe shall be closed with a watertight plug, or with other devices approved by ENGINEER, at times when pipe laying is not in progress.

B. Pipe:

1. Pipe shall be installed in accordance with the manufacturer's recommendations for installing the type of pipe used, unless otherwise shown on the DRAWINGS.

2. Pipe lines shall be laid to the grades and alignment shown on the DRAWINGS or staked by ENGINEER. Variation from the prescribed grade and alignment shall not exceed one-tenth (0.10) foot, and the rate of departure from, or return to, the established grade or alignment shall be not more than one (1) inch in ten (10) feet, unless approved by ENGINEER. No deviation from grade shall cause a depression in the sewer invert that could retain fluids or solids. Any pipe which is not in true alignment or which shows undue settlement after laying shall be taken up and re-laid at Contractor's expense.

3. Lift or roll pipe to protect coating. Do not drag over gravel or rock. Avoid striking rocks or hard objects when lowering into trench.

a. Pipe on which coatings have been damaged may be rejected at the site of the WORK regardless of previous approvals.

C. Pipe Fittings:

1. Pipe fittings shall be laid so as to form a close concentric joint with the adjoining pipe to avoid sudden offsets of the flowline. Pipe sections shall be joined together in accordance with the manufacturer's recommendations.

2. Pipe fittings and appurtenances shall be carefully lowered into the trench with suitable tools or equipment to prevent damage to the pipe and protective coatings and linings; pipe and accessory materials shall not be dropped or dumped into the trench.

D. Gaskets: No gaskets that show signs of deterioration, such as surface cracking or checking, shall be installed in a pipe joint. The neoprene gaskets used, when the air temperature is ten degrees Fahrenheit (10°F) or lower shall be warmed to temperature of sixty degrees Fahrenheit) for a period of thirty (30) minutes before being placed on the pipe.

E. Obstructions not shown on the DRAWINGS may be encountered during the progress of the WORK. Should such an obstruction require an alteration to the pipe alignment or grade, ENGINEER will have authority to order a deviation from the DRAWINGS,

or ENGINEER may arrange for the removal, relocation, or reconstruction of any structure which obstructs the pipeline.

3.05 BEDDING AND BACKFILL FILLING

A. Select bedding and backfill material may be required and shall be so shown on the DRAWINGS. Select bedding materials shall conform to the designated gradation requirements in Section 31 23 33, Trenching and Backfilling.

B. Bedding material shall be placed under and around all pipes as shown on the DRAWINGS. Bedding shall be placed in a manner that will minimize separation or change in its uniform gradation. Bedding shall be distributed in six-inch (6") maximum layers over the full width of the trench and simultaneously on both sides of the pipe. Special care shall be taken to ensure full compaction under the haunches and joints of the pipe.

C. Backfill compaction shall not be attained by inundation or jetting, unless approved in writing by ENGINEER. Backfill material shall be uniformly compacted the full depth of the trench.

3.06 CONCRETE CUTOFF COLLARS

A. Concrete shall meet the requirements of Section 03 31 00, Structural Concrete.

3.07 FIELD TESTING

A. Acceptance Tests for Gravity and Low-Pressure Pipelines:

1. Alignment:

a. Sewer shall be inspected by flashing a light between manholes or by physical passage where space permits.

b. Contractor shall clean pipe of, joint sealant, and other dirt and debris prior to inspection.

c. Determine from Illumination or Physical Inspection:

1) Presence of any misaligned, displaced, or broken pipe.
2) Presence of visible infiltration or other defects.

B. Deflection Testing:

1. Maximum installed deflections of flexible pipe shall be five percent (5%) of mean internal diameter.

2. At the ENGINEER’s discretion, CONTRACTOR shall test flexible pipe after backfill has been in place 30 days. Deflection is defined per ASTM D2321.

a. CONTRACTOR shall provide rigid ball or mandrel deflection testing equipment and labor.

b. Obtain approval of equipment and acceptance of method proposed for use in testing deflection of the pipe. Test shall be performed without mechanical pulling devices.

c. Pipe exceeding deflection limits, as defined in ASTM D2321, shall be replaced or re-compacted at CONTRACTOR's expense.

3.08 SURFACE RESTORATION

A. All streets, alleys, driveways, sidewalks, curbs or other surfaces broken, cut or damaged by CONTRACTOR shall be replaced in kind or as shown on the DRAWINGS.

3.09 CLEAN UP

A. All rubbish, unused materials, and other non-native materials shall be removed from the job site. All excess excavation shall be disposed of as specified, and the right-of-way shall be left in a state of order and cleanliness.

END OF SECTION

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SECTION 33 46 00

SUBDRAINAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall furnish all labor, tools, and equipment and perform all Work necessary for, or incidental to, the supply and installation of pipe underdrains as shown in the DRAWINGS and specified herein. This WORK includes trenching, placement of a geotextile fabric, rock, HDPE pipe, PVC pipe, and clean-outs to drain water from structure foundations. The WORK shall be coordinated with the work of all other trades and activities on the PROJECT.

B. CONTRACTOR shall furnish and install all supplementary and miscellaneous items, appurtenances and devices incidental to or necessary for a complete installation.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 23 19, Dewatering.

2. Section 31 23 33, Trenching and Backfilling.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):

a. M252, Standard Specification for Corrugated Polyethylene Drainage Pipe.

b. M294, Standard Specification for Corrugated Polyethylene Pipe, 300-mm to 1500-mm Diameter.

2. ASTM International (ASTM):

a. C33, Standard Specification for Concrete Aggregates.

b. D737, Standard Test Method for Air Permeability of Textile Fabrics.

c. D1784, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

d. D3034, Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

e. D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

f. D3776, Standard Test Method for Mass per Unit Area (Weight) of Fabric.

g. D3786, Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method.

h. D3887, Standard Specification for Tolerances for Knitted Fabrics

i. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

j. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

k. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

l. D4751, Standard Test Method for Determining the Apparent Opening Size of a Geotextile.

m. D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

n. D6241, Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products using a 50-mm Probe

o. D6707, Standard Specification for Circular-Knit Geotextile for Use in Subsurface Drainage Applications

p. F405, Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings.

q. F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.04 SUBMITTALS

A. Submittals shall include as a minimum the following:

1. Geotextile fabric.

2. Rock gradation results.

3. Polyethylene pipe and fittings (including slot perforation pattern).

4. PVC pipe and fittings (including perforation pattern).

5. Meter vault sections and lid (where required for clean-outs).

1.05 DELIVERY, STORAGE, AND HANDLING

A. Geotextile: During shipment and storage, the rolls of fabric shall be protected against deterioration from the sun, mud, dirt, dust, and other deleterious conditions at all times.

B. Keep Pipe shaded from direct sunlight prior to installation in the trench.

PART 2 PRODUCTS

2.01 GEOTEXTILE FABRIC

A. The fabric shall have complete resistance to deterioration from ambient temperatures, acid, and alkaline conditions, and shall be indestructible to microorganisms and insects. The material shall be resistant to short-term (until placement) deterioration by ultraviolet light or protected until placement, as recommended by the manufacturer, such that no deterioration occurs.

B. Fibers used in the manufacture of geotextiles, and the threads used in joining geotextiles by sewing, shall consist of long chain synthetic polymers composed of at least eighty five percent (85%) by weight polyolefins, polyesters, or polyamides. They shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including selvedges.

C. The property values shown below are not design values, but represent the minimum accepted physical characteristics of the geotextile required. The number represents a value to be confirmed by the manufacturer. These values represent minimum average roll values (for example, any roll tested shall meet or exceed the minimum values in the table).

Property	Value	Test Method
Grab Strength	120 lbs.	ASTM D4632
Grab Tensile Elongation	55%	ASTM D4632
Burst Strength	225 psi	ASTM D3786
Puncture Resistance	65 lbs.	ASTM D4833
Trapezoid Tear Strength	50 lbs.	ASTM D4533
Apparent Opening Size	70, U.S. Standard Sieve	ASTM D4751
Permittivity	1.7 $sec.^{-1}$	ASTM D4491
Water Flow Rate	140 $gal./min./ft.^2$	ASTM D4491

D. Geotextile fabric for pipe underdrains shall be Mirafi 140N or equivalent.

2.02 DRAIN SLEEVE

Property	Value	Test Method
Weight	3.5 – 3.9 $oz./yd^2$.	ASTM D3776
Thickness	0.040 in.	
Burst Strength (min)	120 psi	ASTM D3887
Puncture Resistance (min)	180 lbs.	ASTM D6241
Air Permeability	700 $ft.^3/ft.^2/min.$	ASTM D737
Apparent Opening Size	30, U.S. Standard Sieve	ASTM D4751

Property	Value	Test Method
Permittivity (min)	2.4 $sec.^{-1}$	ASTM D4491
Water Flow Rate	300 $gal/min/ft.^2$ (2" Constant Head)	ASTM D4491

2.03 ROCK BEDDING

A. Unless otherwise shown in the DRAWINGS, rock shall consist of dense, clean, uniformly graded material with a maximum size of two (2) inches and less than five percent (5%) passing the three-eighths inch (3/8") sieve. Coarse concrete aggregate meeting the requirements of ASTM C33 No. 4 may be used.

2.04 HDPE PIPE AND FITTINGS

A. ADS Heavy Duty Pipe meeting ASTM F405 with slotted or circular perforations providing a minimum inlet area as required by AASHTO M252 or AASTO M294 Class 2 perforations.. The slotted perforation pattern shall be in accordance with AASHTO M252 or AASHTO M294 Class 2 perforations providing a flow rate for six-inch (6") diameter pipe of ninety four hundredths (0.94) GPM at a one-foot (1') pressure head. The pipe is available in ten-foot (10') joints, one hundred (100), and one thousand five hundred (1,500) linear foot rolls. The pipe shall include a factory-installed drain sleeve that meets the requirements of ASTM D6707 (ADS Drain-Sleeve or approved equal).

B. HDPE pipe and fittings shall be made in accordance with ASTM F405.

C. HDPE pipe shall be Type S or approved equal.

2.05 PVC PIPE AND FITTINGS

A. Specifications and Dimensions:

1. PVC pipe and fittings shall be made in accordance with ASTM D1784.

2. The pipe shall be designed, manufactured, tested, inspected and marked in accordance with the provisions of this SPECIFICATION and ASTM D3034. The minimum wall thickness shall be SDR 35.

3. Nominal pipe lengths of pipe shall be twenty (20) feet, with shorter lengths provided as required by DRAWINGS, alignment, and grade.

B. Joint Type:

1. Pipe joints shall be made using an integral bell with an elastomeric gasket push-on type joint. The joint shall comply with the requirements of ASTM D3212.

2. Gaskets shall meet the requirements of ASTM F477.

3. Solvent-cement joints are strictly prohibited.

C. Perforations:

1. PVC piping shown on the DRAWINGS to be perforated shall be perforated to the pattern shown on the DRAWINGS. If no pattern is shown on the DRAWINGS, four (4) one-quarter inch (1/4") diameter holes shall be provided at six-inch (6") centers at the quarter points of the pipe. No perforation shall be made within six (6) inches from either end of the pipe.

2. Laterals, drain lines away from the structure, and the top ten (10) feet of cleanout risers shall have a solid wall.

2.06 METER VAULT

A. The precast concrete meter vault sections and lid shall be to the dimensions shown on the DRAWINGS. The vault shall be furnished by Amcor or equivalent. The lid shall be blank and not be labeled “water.”

PART 3 EXECUTION

3.01 TRENCHING

A. The underdrain shall be trenched into the native soil a maximum of six (6) inches if so shown on the DRAWINGS to the grades shown on the DRAWINGS. The trenches shall slope uniformly at the grade shown on the DRAWINGS.

3.02 GEOTEXTILE FABRIC

A. All perforated pipe shall be wrapped with geotextile fabric.

B. Perforated pipe in cleanout risers shall be wrapped in geotextile fabric. Suitable means shall be found to seal the seam and maintain the position of the fabric during backfilling.

C. Care shall be taken not to tear any geotextile fabric during backfilling.

3.03 ROCK

A. Rock shall be placed on the geotextile fabric to the depth shown prior to placement of the underdrain pipe. After the pipe is in place, rock shall be placed along and over the top of the pipe in a manner that shall not damage the pipe.

3.04 HDPE PIPE AND FITTINGS

A. The pipe shall be installed in accordance with the manufacturer’s written instructions, a copy of which shall be maintained on site during pipe installation.

3.05 PVC PIPE AND FITTINGS

A. General: When laying PVC pipe out on a curve, the joints may be deflected up to seventy five percent (75%) of the maximum value permitted by the manufacturer of the pipe. Tighter curves shall be made by either using shorter lengths of pipe or by using manufactured bends.

B. Perforated Pipe: Perforated pipe shall be placed in the rock bedding as shown on the DRAWINGS.

C. Solid Pipe: Solid PVC pipe shall be placed on six (6) inches of sand bedding, unless the native soil is capable of providing uniform support as approved by ENGINEER or shown on the DRAWINGS.

3.06 CLEAN-OUTS

A. The clean-out risers shall be protected from damage during the backfilling operations.

B. The ring and cap shall be secured in place with a reinforced concrete collar as shown on the DRAWINGS.

END OF SECTION