

**SECTION 02520****PIPE, STRUCTURAL PLATE PIPE AND PIPE ARCH, AND BOX CULVERTS****02520.01 GENERAL****A. Description**

Pipe culvert and storm drain installation shall include, but not necessarily be limited to, furnishing and installing gravity pipe, fittings, and appurtenances of the size and type shown on the Plans, installed on firm foundation true to line and grade in accordance with the Contract Documents.

**B. Related Work Included Elsewhere**

1. Protection of the environment; Section 01500.
2. Trench excavation, backfill, and compaction; Section 02250.
3. Storm drainage structure installation; Section 02530.

**C. Reference Standards**

1. American Association of State Highway and Transportation Officials (AASHTO)
  - a. AASHTO LRFD Bridge Construction Specifications: Section 27 – Concrete Culverts
  - b. AASHTO LRFD Bridge Construction Specifications: Section 30 – Thermoplastic Pipe AASHTO M170 Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
  - c. AASHTO M 242 Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
  - d. AASHTO M315 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
  - e. AASHTO M330 Polypropylene Pipe 300- 1500-mm (12- to 60-in.) Diameter
  - f. AASHTO R16 Regulatory Information Used in AASHTO Tests
  - g. AASHTO R 82-17 Standard Practice for Pipe Joint Selection for Highway Culvert and Storm Drains
  - h. AASHTO T99 Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

- i. AASHTO T341 Determination of Compression Capacity for profile Wall pipe by Stub Compression Loading
2. American Society for Testing and Materials (ASTM)
  - a. ASTM A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
  - b. ASTM C76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
  - c. ASTM C150 – Standard Specification for Portland Cement
  - d. ASTM C260 – Standard Specification for Air-Entraining Admixtures for ASTM Concrete
  - e. ASTM C361 – Standard Specification for Reinforced Concrete Low- Head Pressure Pipe
  - f. ASTM C443 – Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
  - g. ASTM C655 – Standard Specification of Reinforced D-Load Culvert, Storm Drain and Sewer Pipe.
  - h. ASTM C827 – Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures.
  - i. ASTM C924 – Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
  - j. ASTM C969 – Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
  - k. ASTM C990 – Standard Specifications for Joints in Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
  - l. ASTM C1103 – Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
  - m. ASTM C1417 – Standard Specification for Reinforced Concrete Sewer, Storm Drain and Culvert Pipe for Direct Design
  - n. ASTM C1479 – Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installation

- o. ASTM C1619 – Standard Specifications for Elastomeric Seals for Joining Concrete Pipe
- p. ASTM C1628 – Standard Specifications for Joints for Concrete Gravity Flow Sewer Pipe, Using Rubber Gaskets
- q. ASTM D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
- r. ASTM D3212 – Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seal
- s. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- t. ASTM F1417 – Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines using Low Pressure
- u. ASTM F2487 – Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Corrugated High Density Polyethylene Pipeline.
- v. ASTM F2764 – Standard Specification for 6 to 60 in. [150 to 1500 mm] Polypropylene (PP) Corrugated Double and Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications.
- w. ASTM F2881 – Standard Specification for 12 to 60 in. [300 to 1500 mm] Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications
- x. ASTM F3058 – Standard Practice for Preliminary Field Testing of Thermoplastic Pipe Joints for Gravity Flow (Non-Pressure) Sewer Lines

**D. Quality Assurance**

- 1. Materials
  - a. The Engineer will inspect all materials before and/or after installation to ensure compliance with the Contract Documents. When the specific materials test are called for in the referenced standards and specifications are to be performed in all cases. When additional testing is required, it will be specified in the “Special Provisions”.
  - b. Corrugated polyethylene and polypropylene drainage tubing, pipe, and fittings shall be homogeneous throughout and free from foreign inclusions, cracks, creases, or uneven pigmentation.

- c. Class PS 50 polyvinyl chloride (PVC) pipe, polypropylene pipe (PP) and fittings shall be homogeneous throughout and free from foreign inclusions, cracks, creases, flaws, or other injurious defects. Pipe and fittings shall be as uniform as commercially practical in color, opacity, and other physical properties.
- d. Precast reinforced concrete box sections shall be free from fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint; surface defects indicating honeycombed or open texture; defects that indicate imperfect proportioning, mixing, and molding; or damaged or cracked ends where such damage would prevent making a satisfactory joint.
- e. Reinforced concrete culvert and storm drain pipe and fittings and arch and elliptical pipe shall be free from fractures or cracks that extend through the wall of the pipe or fitting; surface defects indicating honeycombed or open texture; defects that indicate imperfect proportioning, mixing, and molding; damaged or cracked ends where such damage would prevent making a satisfactory joint; or any continuous crack having a surface width of 0.01 inch or more and extending for a length of 12 inches or more.

Materials and finished product testing shall be in accordance with AASHTO M 170 Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe, M 206, or M 207 as detailed in AASHTO T 33, and M330 Standard Specification for Polypropylene Pipe 300- 1500-mm (12- to 60-in.) Diameter, as specified herein. Acceptability of pipe through 54-inch diameter, or with a maximum 54-inch rise, and classes produced in accordance with design tables found in AASHTO M 170, M 206, or M 207, or the modified and special designs permitted therein, shall be determined by results of a three-edge bearing test for a load to produce a 0.01-inch crack. If the load exceeds the requirements before the 0.01-inch crack is reached, the load may be relieved and the pipe accepted for use. For pipe 60-inch diameter, or with a 58-inch rise, and larger, acceptance will be based on materials tests specified in AASHTO M 170, M 206, or M 207.

- f. Corrugated metal culverts, pipe, and pipe arches shall be free from defects due to uneven laps; elliptical shaping; variation from a straight center line; ragged or diagonal sheared edge; loose, unevenly lined or spaced rivets or spot welds; poorly formed rivet heads or lack seams; unfinished ends; illegible brand; lack of rigidity; bruised, scaled, or broken metallic coating; or dents or bends in the metal itself.
- g. All pipe supplied shall meet the minimum joint performance requirements as defined herein and as further defined in the material and joint performance requirements of this specification.

- 1) Watertight Gravity-Flow, Non-Pressure, Drainage-Piping shall be in accordance with ASTM C361, ASTM C443 or ASTM C1628 for RCP, and ASTM D3212 for PP as appropriate per pipe material.
  - 2) Pipe fittings shall be laid so as to form a closed 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, and in a way that they meet or exceed joint performance standards found in ASTM C361, ASTM C443 or ASTM C1628 for RCP, and ASTM D3212 for PP.
2. Delivery, Storage and Handling
- a. All pipe and fittings shall be delivered to the site and unloaded with handling that conforms to the manufacturer's instructions for reasonable care. Pipe shall not be rolled or dragged over gravel or rock during handling. The Contractor shall take necessary precautions to ensure the method used in lifting or placing the pipe does not induce undue stress fatigue in the pipe.
  - b. Responsibility for Material:
    - 1) The CONTRACTOR shall be responsible for all materials intended for the WORK that are delivered to the construction site and accepted by the 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) The CONTRACTOR shall be responsible for the safe and proper storage of such materials.
  - c. Pipe Acceptance:
    - 1) RCP - In addition to any deficiencies not covered by ASTM C76 or ASTM C361 pipe that has any of the following visual defects will not be accepted.
      - a) Pipe, which has been patched to repair porous spots, cracks, or other defects, when such patching was not approved by the ENGINEER.
      - b) Exposure of the reinforcement when such exposure would indicate that the reinforcement is misplaced.
      - c) Pipe that has been damaged during shipment or from handling even if previously approved before shipment.

- d) Concrete pipe, at delivery to the job site, shall have cured and reach the design strength as required by ASTM C76, ASTM C361 and be at least three (3) days (seventy-two [72] hours) old.
- 2) PP – In addition to deficiencies not covered by ASTM F2764, ASTM F2881, or AASHTO M330 pipe that has any of the following visual defects, will not be accepted.
  - a) Pipe with cracks, structural dents, or delamination, when not approved by the ENGINEER.
  - b) Pipe that has been damaged during shipment or from handling even if previously approved before shipment.
  - c) Acceptance of the pipe at point of delivery shall not relieve the CONTRACTOR of full responsibility for any defects in materials due to workmanship.
- d. Pipe Handling:
  - 1) Pipe and accessories furnished by the CONTRACTOR shall be delivered to, unloaded, and distributed at the site by the 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 the CONTRACTOR, at CONTRACTOR's expense, in accordance with the recommendations of the manufacturer and in a manner satisfactory to the ENGINEER. Physical damage to the pipe or accessory shall be repaired by the CONTRACTOR, at CONTRACTOR's expense, and in a manner satisfactory to the ENGINEER.
  - 4) Gasket Storage: All gaskets shall be stored in a cool place, preferably at a temperature 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.
  - 5) Storage Onsite: Storage of Polypropylene Pipe shall conform to manufacturer standards.

3. Piping, Fitting, and Drainage Structure Installation for Polypropylene Pipe
  - a. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of stormwater gravity piping. Location and arrangement of piping layout take design considerations into account. Install piping system as indicated herein and as directed by the product manufacturer, to extent practical. Where specific installation procedure is not indicated, follow product manufacturer's written instructions.
  - b. All products shall be inspected for defects and cracks before being lowered into the trench, piece by piece. Any defective, damaged or unsound pipe, fitting or drainage structure or any product that has had its grade disturbed after laying, shall be taken up and replaced. Open ends shall be protected with a pipe plug to prevent earth or other material from entering the pipe during construction. The interior of the pipe shall be free from dirt, excess water and other foreign materials as the pipe laying progresses and left clean at the completion of the installation.
  - c. Install piping system beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions. Follow product manufacturer's instructions for the use of lubricants, cements, and other special installation requirements.
  - d. Use Manholes or Catch Basins for changes in direction, unless fittings are indicated. Use tap-fittings for branch connections, unless fittings are specified on the drawings.
  - e. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
  - f. For RCP, the CONTRACTOR shall install storm sewer pipe of the type, diameter, load class, and wall thickness that is shown on the DRAWINGS. Installation shall be in accordance with Section 27 of The AASHTO LRFD Bridge Construction Specifications or ASTM C1479.
  - g. For PP, the CONTRACTOR shall install storm sewer pipe of the type, diameter, and joint performance that is shown on the DRAWINGS. Installation shall be in accordance with Section 30 of The AASHTO LRFD Bridge Construction Specifications, ASTM D2321, or manufacture recommendations.
  - h. Proper equipment, implements, tools and facilities shall be provided and used by the CONTRACTOR for safe and convenient installation of the type of pipe being installed.

4. Jointing
  - a. Joints shall be constructed as described herein and in accordance with manufacturer's installation instructions.
  - b. All Bell-and-Spigot pipe joints shall be thoroughly cleaned prior to joining.
  - c. Protective gasket wrap must be removed just prior to joint insertion to reduce the risk of introduction of foreign materials.
  - d. Joints with gaskets not pre-installed by the manufacturer must be clean and free of foreign materials prior to gasket installation.
  - e. Joint lubricant, supplied by the manufacturer, shall be applied to the interior of bell and the leading edge of the gasket on spigot prior to assembly.
  - f. Joints shall be assembled by inserting the spigot into the bell to prevent foreign materials from being trapped in the joint connection.
  - g. After initial assembly of the joint, CONTRACTOR shall verify line and grade of pipe. Prior to backfill and after final check of line and grade, the CONTRACTOR shall verify the joint is fully inserted and properly sealed

5. Polypropylene Pipe Bends

- a. All pipe bends shall conform to manufacturer specifications.

6. Field Tests

- a. General

The work shall be inspected and tested as specified in this Section.

After installation, storm drains and culverts will be inspected by the Engineer for compliance with these Specifications. Inspections will be conducted at least 30 days after the section of pipeline being inspected has been backfilled in accordance with Section 02250.03

- b. Visual Inspection

All equipment necessary for the inspection will be furnished by the County, however, the Contractor shall provide assistance as may be required to enable the County to perform the inspection.

The Engineer will inspect all pipe and culverts for alignment, grade, and condition. The inspection may be conducted by crawling or walking through the pipeline, using remote operated equipment, or using mirrors to reflect light through the pipeline.



- 1) If a mirror test is used, the pipe alignment will be acceptable if it is sufficiently true and straight to allow passage of the reflected light with an image of a “full moon”.
  - 2) The pipeline shall be installed on a continuous grade so it does not pond or trap water anywhere along the line.
  - 3) The pipeline shall not contain excessive amounts of debris, silt, earth, gravel, rock, or other foreign material.
  - 4) Any pipe not properly installed shall be taken up and relaid without additional compensation.
  - 5) Check each flexible pipe (PE, PVC, PP, Corrugated Steel and Aluminum) for rips, tears, joint separations, soil migration through the joint, cracks, localized bucking, bulges, settlement and alignment.
- c. Manual Inspection
- 1) For all culverts 48” in diameter and greater, manual inspection shall occur by entry into the culvert.
- d. Television Inspection (CCTV)
- 1) A closed circuit television (CCTV) inspection shall be conducted prior to new storm drain pipeline acceptance. The Inspection shall document and verify the following: The overall condition of the host pipeline, Line and Grade, Cleanliness, Joints, Cracks, and any other observed damage to the inside of the pipe.
  - 2) The inspection will be used to evaluate issues that may affect long term performance of the system. Evaluations on installed pipe shall be conducted per the AASHTO LRFD Bridge Construction Specification, Section 27 (RCP) and Section 30 (PP).
  - 3) The inspection shall occur no sooner than 30-days after backfill reaches subgrade, unless approved by the ENGINEER.
  - 4) The operator shall be trained and competent at operating equipment, taking accurate measurements, and identifying all items required to be noted in the inspection report.
  - 5) Cleaning of the storm drains shall be performed prior to the television inspection.
  - 6) The Contractor shall perform a television inspection (CCTV) on all storm drains between manholes and all storm drain inlet laterals at a

speed no faster than 30 feet per minute using a Camera with high definition resolution, minimum one lux, 10x optical zoom, 10x digital zoom, and a lighting system that is sufficient to clearly illuminate a 60” diameter pipe 10 feet in front of the camera. Pipe runs shall be continuously measured from one pipe end to the other.

- 7) All joints shall be inspected with the camera stopping and rotating around the entire joint. The CCTV camera shall be centered in the pipe, have the ability to pan to a true 90 degrees from the pipe wall and rotate 360 degrees to fully view joints and any observed surface damage.
- 8) Joint separation greater than 0.5-inch, cracking greater than 0.01-inch, deflection over 5%, infiltration, or other noted damage inside the pipe may justify additional inspection, as directed by the ENGINEER.
- 9) The camera’s inspection systems shall be capable of accurately identifying the systems x, y, and z location in the pipe. Pipe length, diameter, location, location of noted items, photos of noted items, and a description of noted items shall all be documented and included in the inspection report. The system shall also have a GPS with sub meter accuracy so all manholes and other surface structures can be located and noted in the final report.
- 10) All data shall be provided digitally and provided in a final report to the OWNER, CONTRACTOR, and ENGINEER.

e. Tests for Deflection

- 1) When visual inspection or inspection by CCTV indicates a potential for excessive deflection, the following test method shall be used.
- 2) Conduct deflection test no sooner than 30 days after completion of final backfill and compaction testing. Clean or flush all lines prior to testing. Perform a deflection test on entire length of installed flexible pipeline upon completion of work adjacent to and over the pipeline, including backfilling, placement of fill, grading, paving, placement of concrete, and any other superimposed loads. Deflection of pipe in the installed pipeline under external loads shall not exceed limits described herein as percent of the average inside diameter of pipe. Use a laser profiler or mandrel to determine if allowable deflection has been exceeded.
- 3) The deflection testing shall be witnessed by the Inspector and shall be conducted by the CONTRACTOR at the CONTRACTOR’S expense. Deflection shall be tested for excessive vertical deflection

using a mandrel approved by the agency. Pass the mandrel through each run of pipe by pulling it by hand. If deflection readings in excess of the allowable deflection of average inside diameter of pipe are obtained, stop and begin test from the opposite direction. The mandrel must meet the Pipe Manufacture's recommendations and the following requirements. Provide a Mandrel that is rigid, nonadjustable, has a minimum of 9 fins, pulling rings at each end, and is engraved with the nominal pipe size and mandrel outside diameter for Plastic Pipe, 5 percent less than the certified-actual pipe diameter for Corrugated Steel and Aluminum, 3 percent less than the certified-actual pipe diameter for Concrete-Lined Corrugated Steel and Ductile Iron Culvert.

The mandrel must be 5 percent less than the certified-actual pipe diameter. The mandrel shall be sized so as to provide a diameter of at least 95% of the allowable minimum inside diameter. Elbow and wye type fittings should not have a mandrel pulled through them. Plastic pipe is to be checked for deflection with tolerances of 5% and below as acceptable, and 5%-7.5% requiring further evaluation for any potential repair/replacement needs.

- 4) Pipe 36" or larger may be direct measured provided the appropriate safety equipment and certifications are use and held by the inspectors.
- 5) Laser profiling equipment may be used instead of pulling mandrels. All laser profiled results are subject to verification by mandrel or direct measurement.

f. Measuring Cracks and Open Joints

- 1) For RCP, joints separated by more than 0.5-inch and cracks wider than 0.01-inch shall be accurately measured and noted in the inspection report. RCP is to be checked for cracks. 0.01" and below is hairline/minor, 0.01" – 0.10" is to be evaluated for any repair/replacement needs. If camera optics and on board measuring device is not capable of accurately measuring down to 0.01" then the system shall not be used, unless approved by the ENGINEER.
- 2) For PP, joints separated by more than the manufacturers' allowable tolerance shall be accurately measured and noted in the inspection report and repaired by the CONTRACTOR as directed by the manufacturer. If camera optics and on board measuring device is not capable of accurately measuring down to 0.01" then the system shall not be used, unless approved by the ENGINEER.

- 3) Pipes 36" and larger may have joints and cracks directly measured using a tape measure for joints gaps and crack lengths, and a feeler gauge for crack widths. Photos of damage should be taken, with locations of each measurement located relative to the pipe ends.

**g. Post-Installation Inspection Report**

- 1) The deflection results and final post installation inspection report must include: [a copy of all video taken, ]pipe location identification, equipment used for inspection, inspector name, deviation from design, grade, deviation from line, deflection and deformation of flexible pipe, inspector notes, condition of joints, condition of pipe wall (e.g. distress, cracking, wall damage dents, bulges, creases, tears, holes, etc.).

**h. Tests for Leakage**

- 1) When visual inspection or inspection by CCTV indicates a potential for leakage through cracks, at joints rated to be watertight, or if the ENGINEER requires testing; one of the following test methods shall be used to field verify the systems leakage performance.
- 2) Corrugated Polypropylene (PP) Pipe Leakage Tests
  - a) Lines shall be tested by exfiltration tests, as appropriate.
  - b) When leakage exceeds the maximum amount specified, satisfactory correction, as approved by the Engineer, shall be made and retesting accomplished.
  - c) Infiltration and exfiltration testing shall conform to ASTM F2487. Prior to exfiltration tests, the pipe shall be completely backfilled. Visible leaks encountered during CCTV or other operations shall be corrected regardless of leakage test results. When leakage exceeds the maximum amount specified, satisfactory correction, as approved by the Engineer, shall be made and retesting accomplished.
  - d) In lieu of infiltration/exfiltration testing, joint isolation testing of each joint may be performed in accordance with ASTM F3058.

**E. Submittals**

**1. Shop Drawings**

Shop drawings shall be submitted as specified in the "General Provisions" for the various types of pipe and culverts specified in Section 02520.02. The shop drawings

shall include: product information, material strength "type" or "class", joint type, and storage, handling, and installation recommendations or erection diagrams for structural plate pipes and pipe arches.

The following shall be submitted by the Contractor.

- a. Product data for the following:
    - 1) Pipe and fittings
    - 2) Product Specifications
    - 3) Installation Procedures
  - b. Products submitted as approved equal must be submitted at least two (2) weeks prior to project bid opening and must be approved by project engineer. Submittal for approved equal product must contain a signed letter from an executive officer of the manufacturer stating product is equivalent to all applicable requirements of this specification.
  - c. Details of fittings and specials shall be furnished for approval by ENGINEER. 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.
  - d. At the request of the ENGINEER, the CONTRACTOR shall cooperate in obtaining and providing samples of all specified materials.
  - e. At the request of the ENGINEER, the CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.
2. Certificates of Compliance

Certificates of compliance shall be submitted in accordance with the "General Provisions" for pipe, culverts, and bituminous sealer for concrete pipe specified in Section 02520.02. The certificate shall state that the item furnished has been manufactured in accordance with, and meets the requirements of, the standard referenced.

**02520.02 MATERIALS**

**A. Materials Furnished by the County**

The County will not furnish any materials for drain pipe, structural plate pipe or pipe arch, or box culvert installation.

**B. Contractor's Options**

None.

**C. Detailed Material Requirements**

1. Pipe, structural plate pipe, and pipe arch and box culverts shall meet the requirements of the referenced standards or specifications:
  - a. Corrugated polyethylene drainage pipe, - AASHTO M 252
  - b. Corrugated polyethylene pipe - AASHTO M 294
  - c. Polyvinyl chloride (PVC) pipe - AASHTO M 278
  - d. Polyvinyl Chloride Profile Wall Pipe (PPWp) – AASHTO M 304
  - e. Precast reinforced concrete box sections for culverts, storm drains, and sewers with less than 2 feet of cover subject to highway loadings - AASHTO M 273
  - f. Precast reinforced concrete box sections for culverts, storm drains, and sewers - AASHTO M 273
  - g. Reinforced concrete pipe - AASHTO M 170, Class 4 and 5
  - h. Reinforced concrete arch culvert - AASHTO M 206
  - i. Reinforced concrete elliptical pipe - AASHTO M 207, Class 4
  - j. Corrugated Polypropylene Drainage Pipe – AASHTO M 330
  - k. Metallic (zinc or aluminum-zinc alloy) coated corrugated steel culverts and underdrains - AASHTO M 36
  - l. Polyethylene (PE) precoated corrugated steel pipe - AASHTO M 245 and M 246
  - m. Corrugated aluminum alloy pipe - AASHTO M 196
  - n. Structural plate for pipe, pipe arches, and arches - AASHTO M 167

- o. Aluminum alloy structural plate for field bolted conduits - AASHTO M 219
- p. Reinforced Concrete Pipe (RCP), watertight, AASHTO M242
- q. Polypropylene (PP) Pipe 12-inch through 60-inch (300 through 1500-mm) pipe shall be watertight, smooth interior and annular exterior corrugated polypropylene (PP) pipe meeting the requirements of ASTM F2764, ASTM F2881 or AASHTO M330 Type S (double-wall) or D (triple-wall, for respective diameters.

Class to be specified in the "Special Provisions" or on the Plans, and the material requirements based on the diameter of the pipe. Where no class of pipe is specified, Class IV pipe shall be furnished.

- 2. Concrete pipe for culverts and storm drains shall be made with tongue and groove jointing and in not less than four-foot lengths. Other types of joints will be considered by the Engineer for use in the work provided the Contractor furnishes evidence satisfactory to the Engineer that the joints are equal or better than those specified.
- 3. Portland cement concrete shall be the Mix Number specified herein, indicated on the Plans, and/or Standard Details, and meet the requirements specified in Section 03310.
- 4. Mortar for pipe joints shall be as specified in Section 04100.02.
- 5. Preformed joint for concrete circular sewer and culvert pipe shall be rubber type gaskets meeting the requirements of AASHTO M198.
- 6. The end section of corrugated metal pipe shall have annular corrugations measuring 2-2/3 inches by 1/2 inch.

### **02520.03 EXECUTION**

#### **A. General**

- 1. Trench excavation, backfill, and compaction, and pipe bedding and haunching shall be as specified in Section 02250.
- 2. When a pipe, structural plate pipe, or pipe arch is to be laid projecting above existing ground on or in fill, the embankment shall be constructed to a height of at least 9 inches above but not more than 3 feet above the top of pipe and then a trench excavated to receive the pipe.
- 3. No pipe shall be laid upon a foundation into which frost has penetrated, nor at any time when there is danger of ice formation or frost penetration at the bottom of the

excavation. In freezing weather, open trench length shall be kept to a minimum and the excavation promptly backfilled after the pipe has been installed.

4. Each pipe shall be bedded on a solid foundation acceptable to the Engineer. Bell holes shall be dug sufficiently large to ensure that joints are properly made and the pipe is firmly bedded for the full length of the barrel.
5. All pipe shall be installed in accordance with the recommendations of the pipe manufacturer and as specified herein. These recommendations shall include maximum trench width, if more restrictive than that shown in the Standard Details; bedding requirements; backfill material and compaction, where applicable.

**B. Corrugated and Non-corrugated Plastic Pipe and Tubing**

1. All corrugated polyethylene drainage tubing and pipe shall be installed with coupled joints. Only couplings and fittings supplied or recommended by the tubing or pipe manufacturer shall be used.
2. PVC pipe shall be installed with one or more of the following joint systems as specified or shown on the Plans:
  - a. Elastomeric gasket joints meeting ASTM D 3212
  - b. Belled ends
  - c. Sleeve-type couplings
  - d. Stop-type couplings
  - e. Solvent cement-type joints

**C. Reinforced Concrete Pipe**

1. All reinforced concrete pipe shall be installed with cemented joints. The pipe shall be installed carefully, hubs up, spigot ends fully entered into the adjacent hub and true to lines and grades given. Before succeeding sections of pipe are installed, the lower half of the hub of the preceding section shall be plastered on the inside with the cement mortar of sufficient thickness to bring the inner surfaces of the abutting pipes flush and even. At the same time, the upper half of the spigot of the succeeding pipe shall be similarly plastered with mortar. After the pipe is installed, the remainder of the joints shall be filled with similar material; and sufficient additional material shall be used to form a bead around the joint. The inside of the joint shall be wiped and finished smooth. The mortar on the outside shall be protected from the air and sun for two (2) days or until the back fill is made around the pipe. The use of 8-foot lengths of pipe handled with a single support through a lay hole through the shell of the pipe will be permitted with an approved lifting device. After installation, the lay hole shall be filled in its entirety with mortar.



2. Where indicated on the Plans or directed by the Engineer, pipe shall be encased in a 6-inch jacket of Mix No. 1 Concrete. When required, the Contractor shall furnish cold weather protection for mortar joints and concrete encasements by maintaining a temperature of not less than 40°F for a period of 3 days, or backfill immediately and maintain a temperature of 40°F inside the pipe for a period of 3 days.
3. As an alternate to mortared joints for concrete culvert, storm drain, and sewer pipe, rubber type gaskets, or resilient type material may be used under the prescribed conditions. Care shall be exercised to ensure the proper application of sealer on the underside of all joints.
4. Joints between sections shall be caulked with one or more rings of oakum, jute or hemp. The jointing material shall then be firmly applied into the joint space until flush with the outer rim of the bell or barrel of tongue-and-groove section, after which additional sealer shall be applied to form a bead around the joint.

**D. Watertight Polypropylene (PP) Pipe (corrugated)**

1. General
  - a. 12-inch through 60-inch (300 through 1500 mm) pipe shall be smooth interior and annular exterior corrugated polypropylene (PP) pipe meeting the requirements of ASTM F2764, ASTM F2881 or AASHTO M330 Type S (double-wall) or D (triple-wall), for respective diameters.
  - b. Material for 12- through 60-inch pipe and fitting production shall be an impact modified copolymer meeting the material requirements of ASTM F2764, ASTM F2881 and AASHTO M330, for respective pipe diameters.
  - c. Marking: The following shall be clearly marked on both the interior and exterior surface of the pipe:
    - 1) Appropriate ASTM Specifications: ASTM F2764, ASTM F2881 or AASHTO M330; as appropriate.
    - 2) Class, size, and wall.
    - 3) Date manufactured.
    - 4) Name or trademark of manufacturer.
    - 5) Diameter of Pipe: The diameter indicated on the DRAWINGS shall mean the inside diameter of the pipe.
2. Joint Performance
  - a. Watertight joints shall be bell-and-spigot meeting the watertight requirements of ASTM D3212. Gaskets shall comply with the requirements

of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable wrap to ensure the gasket is free from debris. A joint lubricant supplied by the manufacturer shall be used on the gasket and bell during assembly.

3. Fittings
  - a. Fittings shall conform to ASTM F2764, ASTM F2881 or AASHTO M330, with the exception of meeting the watertight joint performance requirements of ASTM D3212. Gasketed bell & spigot connections shall utilize a spun-on, welded or integral bell and spigot with gaskets meeting ASTM F477.
  - b. Repair couplers may be utilized to connect field-cut pipe.

**E. Corrugated Metal Pipe**

1. When any type of corrugated metal pipe sections are connected on the work, the ends shall be butted together and the sections joined with a standard band, which shall be bolted firmly in place. Pipe sections or fittings shall not be cut with a torch.
2. Spiral corrugated metal pipe sections shall be butted together and joined with an approved metal band.

**F. Pipe Connections**

Where shown on the Plans, pipe connections shall be constructed. These connections shall be for any pipe size, type or alignment and shall be of three basic types.

1. Prefabricated Pipe Connection. This type connection shall be prefabricated by the pipe manufacturer and delivered to the project for installation. It shall include reinforced concrete pipe, polypropylene pipe, corrugated metal pipe, structural plate pipe, pipe arches, and box culverts.
2. Field Pipe Connection. This type shall be fabricated at the site during the installation of the pertinent pipe culverts. It shall include connections of new pipe culverts to existing pipe culverts when specified. A field connection shall include cutting a hole in one pipe, inserting and trimming the connecting pipe and pouring a concrete collar at the connection. In the case of corrugated metal pipes, a welded connection may be substituted for the concrete collar. Backfill may be placed immediately after installing pipe, provided the mortar joints are protected with building paper or other approved material. For polypropylene pipe connections, Standard Details and manufacturer standards shall be used.
3. Connections to Concrete Structures. For polypropylene pipe connections to structures, Standard Details and manufacturer standards shall be used for applications involving various degrees of moisture tightness. The Standard Details reference pipe to structure connections for soil-tight, water-resistant, and watertight

applications (no grout). Watertight connections involve no grout. Refer to Details D-94 and D-109 for options to enhance connection stability and improve moisture seal. Manufacturer literature shall be referenced for determination of specific materials for the degree of moisture tightness required for an application.

**G. End Treatments**

The following requirements apply to all types of pipe culverts except structural plate pipes and structural plate pipe arches:

1. The ends of pipe culverts placed askew shall be cut off flush with the end wall.
2. Endwalls on the inlet ends of pipe, when built to grade and visible from the roadway, shall be constructed parallel to the roadway; askew pipe shall protrude through the endwall.
3. Endwalls on the inlet ends of pipes, when not built to grade and not visible from the roadway, shall be constructed normal to the centerline of the pipe. Embankment slope faces, in case of askew pipes, will not be warped. The area between endwall and normal slope will be filled to 3 inches below top of endwall and the area sloped to drain.
4. Endwalls on the outlet end of pipes, when used, shall be constructed as noted above.

**H. Structural Plate Pipes and Pipe Arches**

This paragraph is intended to describe structural plate pipes and pipe arches, which structures differ from pipe culverts hereinbefore mentioned, in that they are usually of greater size and are composed of curved plates usually bolted together in the field. The plates must be shop fabricated to required dimensions and having all required holes and be shipped complete with proper markings and including all necessary connection devices, such as bolts, nuts, washers, etc. Culvert structures with beveled or skewed ends shall be detailed by the producer and the detailed drawings submitted to the Engineer. An erection diagram shall be submitted to the Engineer for all structural plate pipes and pipe arches. No fabrication shall be performed until shop drawings are reviewed and approved by the Engineer.

1. Plates

Plates shall consist of structural units of galvanized corrugated metal. Single plates shall be furnished in standard sizes to permit structure length increments of 2 feet. (Plates have approximately a 2-inch lip beyond each end crest, which results in the actual length of a given structure being approximately 4 inches longer than the nominal length, except when skewed or beveled).

2. Gages

The gages for plates will be specified in the Contract Documents for each location. The plate configurations shall have radii and curvature in accordance with

AASHTO requirements. When bottom plates are specified to be thicker than top and side plates, the thicker plates for circular pipes shall cover at least 25% of periphery of the circle. For pipe arches, the thicker plates shall include corner plates as well as bottom plates.

3. Erection

The plates at longitudinal and circumferential seams shall be connected by bolts. Joints shall be staggered so that not more than three plates come together at any one point. Each plate shall be curved to one or more circular arcs.

- a. Plates shall be formed to provide lap joints. The boltholes shall be punched so that all plates having like dimensions, curvature, and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross sectional dimensions of the finished structure shall be as indicated on the Plans or as specified.
- b. Unless otherwise specified, bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be staggered in rows 2 inches apart, with one row in the valley and one in the crest of the corrugations. Boltholes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 12 inches. The minimum distance from center of hole to edge of the plate shall be not less than one and three quarter times the diameter of the bolt. The diameter of the boltholes in the longitudinal seams shall not exceed the diameter of the bolt by more than 1/8 inch.
- c. Plates for forming skewed or sloped ends shall be cut so as to give the angle of skew or slope specified. Burned edges shall be free from oxide and burrs, shall present a workmanlike finish. Legible identification numerals shall be placed on each plate to designate its proper position in the finished structure.
- d. The method of erection will vary with the size of the structure. The structural plates shall be assembled in accordance with the recommendations of the manufacturer and/or reviewed and accepted detailed shop drawings. The structures may be partially assembled and then placed on the prepared foundations. If the structures are to be preassembled other than at the job site, the materials and construction procedure shall be in strict accordance with the specification requirements contained herein. Whenever two or more sections of the structure are to be assembled at the job site, care shall be exercised to ensure proper matching and aligning of joints. Where such procedure is allowed, the length of the assembly shall not exceed that which permits lifting, moving, and depositing of the section without any bending or distortion or stress being induced therein.

**4. Foundation Preparation**

- a. Excavation and bedding shall be in accordance with Section 02520.03, Article A. It is very important that templates be set at convenient intervals and the foundation screeded to be coincidental with the exact shape of the bottom plates. Screeding shall be done immediately prior to erection.
- b. In some cases, the prepared foundation must be cambered to allow for possible settlement of underlying strata supporting the foundation because the part of the structure under the deepest fill will deflect greater than under the slopes. Therefore, before preparing any foundation, the Contractor is responsible for conferring with the Engineer to ascertain anticipated need for camber, as well as the amount thereof.

**5. Bolting**

All bolting and tightening of nuts shall be done with impact wrenches. Each nut and bolt shall be tightened to a minimum of 100 foot-pounds and not to exceed a maximum of 200 foot-pounds of torque. The impact wrenches shall be equipped with a device to assure that the number of foot-pounds of torque applied is between these minimum and maximum limits.

- a. The plates composing the bottom of the structures may be bolted together in positions outside of the permanent one. In this case, the bottom sections may be bolted in lengths as limited above and placed on the prepared foundation. Plates composing sides and tops shall then be erected and bolted. In any event, all plates (bottom, etc.) must be in their proper positions. Bolts shall be placed in all holes, unless otherwise specified.
- b. Where washers are specified or required, they shall be placed under the nuts. In preliminary assembly, the bolts shall first be scattered or distributed over the section being assembled and holes made to align by shifting the plates; and the nuts shall not be drawn tight until the section is assembled and ready for placing. For bottom plates, the nuts may be inside the structure, if necessary. After placing and before backfilling or coating, all nuts shall be finally tightened and tested to assure compliance with torque requirements.

**6. Backfilling**

- a. Backfilling shall be as specified in Section 02250.03 with additional precaution that backfills are elevated uniformly along each side of the structure. For structures without headwalls, backfill shall be commenced in the center of the structure. If the structure includes headwalls or spandrel walls, backfilling operation may commence at one wall and extend toward the opposite side, care being taken in all cases to bring embankment or sections thereof up evenly on each side to a height of not less than 18 inches above top of the structural plate pipe structure.

- b. No trucks or construction equipment shall be allowed to pass over any part of a structural plate pipe structure until the backfill has been completed and tamped up to a height of not less than 18 inches above the structure. In all cases, the fill material shall be thoroughly but not excessively tamped.

7. **Strutting**

Where specified, structural plate pipe structures shall be strutted with timber posts. In such cases, the table for strutting will be shown on the Plans. If no strutting table is shown, it shall be the Contractor's responsibility to prepare a suggested table of strutting sizes and spacings which is subject to approval by the Engineer before strutting begins. The strutting shall be done in combination with the use of approved jacks so the structure's rise is changed by the proper amount. When strutting is specified, it shall be uniform from end to end. Struts shall be left in place until backfills are completed, unless their removal is otherwise permitted by the Engineer. All removal of struts shall be done by the contractor, and the Contractor shall receive and dispose of all removed materials.

8. **Concreting**

When specified on the Plans or in the "Special Provisions", the invert of structural plate pipe or pipe arch shall be paved using Mix No. 2 concrete. The dimensions of the invert paving will be detailed on the Plans.

The concrete shall be cured in accordance with the requirements of Section 03300.03 using burlap. Cold weather protection shall be performed in accordance with the requirements of Section 03300.03.

9. **Multi-cell Installations**

Where batteries or multi-cell installations of structural plate pipe structures are specified, the foregoing provisions shall be used with extra requirements as follows:

- a. In backfilling, backfills between cells shall be elevated equally on each side of each cell.
- b. Individual cells may be erected for their full length before beginning another cell, or the entire structure may be erected in sections so that the total length of the total structure is completed at approximately the same time.
- c. Structural plate pipe structures shall have at their termini cutoff walls, endwalls, headwalls, or slope protection. The details and type of end protection shall be as shown on the Plans, and construction shall be in accordance with the pertinent item.

10. **End Treatment**

- a. Ends of structural plate pipe arches shall be shop fabricated on a bevel to fit and be flush with the slope and alignment of the surface through which they protrude, except that where an endwall or masonry slope protection is specified the ends of the structural plates shall then be shop fabricated to fit that construction. Beveled ends shall not be used on skews of 70° or less angle (between center line of stream and center line of road). The ends of all structural plate pipes and pipe arches which require an end treatment (endwall or slope protection) shall contain hook bolts for anchorage into the concrete.
- b. Endwalls for structural plate pipes and pipe arches, unless otherwise specified, shall be constructed parallel to the alignment of the edge of the adjacent road shoulder.

**I. Box Culverts**

1. The precast reinforced concrete box sections shall be produced with male and female ends. The ends shall be of such design and the ends of the box sections so formed that when the sections are laid together they will make a continuous line of box sections with a smooth interior free of appreciable irregularities in the flow line.
2. Box section shall be installed with mortared joints, bituminous sealer, rubber type gaskets, or resilient type material. The inner surfaces of the abutting sections shall be flush and even. Mortared joints shall be protected from the air, sun, and freezing, and bituminous sealer protected from cold temperatures as specified in Section 02520.03, Article B.

**J. Connections to Existing Structures**

1. Holes for installing new pipes in existing structures shall be carefully cored, drilled, or cut in such a manner to minimize damage to the structure. Any damage to the existing structure shall be promptly repaired to the satisfaction of the Engineer or the structure replaced. Reinforcing steel in precast manholes and inlets shall be cut only to the extent necessary to accommodate the new pipe.
2. The new pipe shall be roughly centered in the hole and the pipe end set flush with the inside wall. The entire space between the pipe and the wall shall be filled with brick and mortar so as to make it watertight.
3. For polypropylene pipe, use only non-shrink grout per Section 03600. Refer to Section 02520.03.F for polypropylene connections to structures.

**02520.04 METHOD OF MEASUREMENT**

**A. Pipe and Box Culverts**

The number of linear feet of pipe and box culverts installed will be determined by measurement of pipe, pipe arch, or box culvert installed in place, completed and accepted, which measurement will be along the centerline of the conduit from end to end of each completed pipeline without deduction for manholes, structures, or fittings.

**B. Structural Plate Pipe Structures**

Structural plate pipe structures will be measured in linear feet as follows: measure top length and bottom length. The average of these two lengths will be the pay length for each pipe in the structure. Such lengths of all pipes will be totaled to obtain the total pay length.

**C. Portland Cement Concrete**

Measurement for furnishing and installing concrete for encasements will be made in cubic yards of concrete placed to the limits indicated in the Standard Details or as directed.

**02520.05 BASIS OF PAYMENT**

**A. General**

1. Payments will be made at the unit and/or lump sum prices bid. The prices bid shall include furnishing all labor, tools, equipment, and materials necessary to complete the work as shown, and specified in strict accordance with the Contract Documents, and accepted by the Engineer.
2. The prices bid for furnishing and installing pipe, structural plate pipe and pipe arch, and box culverts shall include the following:
  - a. Trench excavation, backfill, compaction, and incidental items as specified in Section 02250.
  - b. Furnishing and installing granular pipe bedding materials as shown on the Standard Details and as required elsewhere in the Contract Documents.
3. Payment will be made for contingent items when ordered by the Engineer. Payment will be as specified in Sections 02951, 02952, 02953, 02954, 02955, 02956, and 02957.

**B. Pipe, Structural Plate Pipe and Pipe Arch, and Box Culverts**

Payment for furnishing and installing pipe, structural plate pipe and pipe arch structures, and box culverts will be made per linear foot for the particular type of completed conduit specified



**PIPE, STRUCTURAL PLATE PIPE AND  
PIPE ARCH, AND BOX CULVERTS**

**02520-25 of 25**

on the Plans or as directed by the Engineer. The price bid shall include all galvanizing, invert paving, connecting to existing structures, cut-in pipe connections, and bends.

END OF SECTION