

SECTION 302

DRAINAGE STRUCTURES

I. GENERAL

1.1. DESCRIPTION OF WORK

The Contractor shall furnish all labor, supervision, material (except as herein provided), tools, equipment, supplies, and services; and, shall perform all Work necessary for the installation and construction of pipe culverts, endwalls, box culverts, precast concrete and metal arches, storm drains, drop inlets, manholes, spring boxes, junction boxes, and intake boxes and removing and replacing existing structures in accordance with these specifications and in conformity to the lines and grades shown on the Drawings or as designated by the Owner.

1.2. MATERIALS

Materials shall be furnished by the Contractor in accordance with Section 200.

1.3. SUBMITTALS

- A. Submittals shall be made by the Contractor in accordance with the procedures set forth in Section 105 and as described below.
- B. The Contractor shall furnish copies of the manufacturer's specifications and details for cast in place installations indicated on the Drawings, Standard Details, and the VDOT *Road and Bridge Standards*, latest edition, listing specific materials proposed.
- C. Submittal of designs for precast items included on the Drawings will not be required provided fabrication is in accordance with the VDOT *Road and Bridge Standards*, latest edition. Submittal of designs for precast structures on VDOT's approved list will not be required provided the Contractor submits a certification that the item will be fabricated in accordance with the pre-approved design Drawings.
- D. The Contractor shall furnish the Owner with an affidavit stating that products to be installed on this project comply with specification requirements.
- E. The "Acceptance Procedures for Aggregates" shall be in accordance with Section 200.

II. EXECUTION

2.1. PROCEDURES

- A. Trenching, excavation, bedding and backfill operations shall be performed in accordance with the requirements of Section 303. Concrete construction shall conform to the requirements of the VDOT *Road and Bridge Specifications*, Section 404. Reinforcing steel placement shall conform to the requirements of Section 406.

- B. When lift holes are provided in concrete pipe or precast box culverts, the Contractor shall install a lift hole plug, furnished by the manufacturer and double-wrapped in filter cloth, in accordance with the requirements of the VDOT *Road and Bridge Specifications*, Section 232.02(a)1. After pipe installation and prior to backfilling, plugs shall be installed from the exterior of the pipe or box culvert and snugly seated.
- C. Bedding stone depth shall be 6-inches for pipes and structures. Undercut excavation and the replacement of excavated undercut material shall be as specified in Section 303.
- D. Pipe Culverts

Not more than one type of pipe shall be used in any one-pipe line. When field cutting corrugated metal pipe is permitted by the Owner, damaged areas of the protective coating shall be repaired in accordance with the requirements of VDOT *Road and Bridge Specifications*, Section 233.

1. Jacked Method

- a. The Contractor shall submit to the Owner a complete plan and schedule for jacked pipe installation prior to beginning such work. The submission shall include complete details of sheeting, shoring, and bracing for protecting the roadbed plus materials and equipment. The Contractor shall not proceed with pipe installation until the plan has been reviewed and approved by the Owner.
- b. When work is stopped, the heading shall be bulkheaded.
- c. The jacked method shall be by means of tunneling or boring. The jacked tunneling method shall be applicable for installing concrete pipe 30- to 108-inches in diameter and smooth-wall steel pipe 30- to 48-inches in diameter. The jacked boring method shall be applicable for installing concrete pipe 12- to 108-inches in diameter and smooth-wall steel pipe 12 3/4- to 48-inches in diameter.
- d. Pipe shall have a design strength and wall thickness so as to withstand the jacking operation.
- e. Construction shall be performed in such a manner that the ground surface above the pipeline will not settle. Installation of the pipeline shall immediately follow heading or tunneling excavation. Voids occurring behind the pipe during installation shall be filled with hydraulic cement grout, placed under pressure, upon completion of the jacking operation.
- f. Joint sealant material on concrete pipe shall be placed ahead of the jacking frame. At his own expense, the Contractor shall replace or repair, as directed by the Owner, pipe that is damaged during jacking operations. Joints of steel pipe shall be butt welded, watertight, as installation progresses.

2. Open Trench Method

- a. The Contactor shall provide, as may be necessary, for the temporary, legal, diversion of stream flow in order to permit the installation of the pipe under dry conditions.
- b. Foundations shall be in accordance with Section 303.
- c. Bedding
 - (i) Bedding material for pipe foundations shall be aggregate No. 57, conforming to the requirements of Section 200 as applicable unless otherwise specified and shown on the Drawings.
 - (ii) Pipe bedding shall be lightly and uniformly compacted and shall be carefully shaped so that the lower section of the pipe exterior is in full contact with the bedding material. Bedding material shall be shaped to accommodate the bell when bell and spigot pipe is used. The depth of bedding material shall be at least 6- inches.
- d. Placing pipe
 - (i) Pipe shall be placed beginning at the downstream end of the pipeline. The lower segment of pipe shall be in contact with the shaped bedding for its entire length. Bell or groove ends of rigid pipe shall be placed facing upstream.
 - (ii) Paved or partially lined pipe shall be placed so that the longitudinal centerline of the paved segment coincides with the flow line.
 - (iii) At intervals not to exceed 100 feet, pipe will be inspected before backfill is placed. Pipe found to be out of alignment, unduly settled, or damaged shall be taken up and reinstalled or replaced. The pipe interior shall be cleaned as the pipe is being installed.
 - (iv) When placing concrete pipe constructed with elliptical reinforcing, the pipe shall be oriented in accordance with the manufacturer's marking of top or bottom.
- e. Joining pipe
 - (i) The method of joining rigid pipe sections shall be such that ends are fully entered and inner surfaces are flush and even.
 - (ii) Joints shall be sealed with any one or combination of the following to form a leak-resistant joint: rubber, preformed plastic, or mastic gaskets; or, cold-applied pipe joint sealer.
 - (iii) Rubber ring gaskets shall be installed to form a flexible, leak-resistant seal.

- (iv) The Contractor shall double wrap each pipe joint with non-woven geotextile fabric strip and attach the fabric to the pipe with a minimum of two (2) non-metallic straps. The width of the fabric strip shall be at least two (2) feet wide and centered over the joint. The fabric shall be laid transversely in the trench of each joint prior to laying pipe and shall be centered over the joint. The inside of all concrete pipes shall be mortared to the spring line of the pipe. When pipes enter structures, the inside of the pipe/structure joint shall be fully mortared.
- (v) Flexible pipe sections shall be aligned and firmly joined by approved coupling bands to form a leak-resistant joint.
- (vi) Permissible construction tolerances between the proposed inverts as shown on the Drawings as the as-built condition:
 - (1) Maximum deviation of any invert from plan grade: $+/-0.05'$.
 - (2) Total deviation of both inverts at each end of a particular line: $+/-0.08'$.
 - (3) Maximum slope deviation $+/- 0.02\%$ between any two points in the line from the plan slope.
 - (4) The strictest of the above shall apply. Any lines not properly installed in compliance with the above shall be removed and reinstalled to the proper alignment and in accordance with all other specification requirements, by the Contractor at no additional expense to the Owner.

f. Structural plate pipe, pipe arches, and arches: Erection shall be in accordance with the manufacturer's assembly diagrams and instruction sheets. Splices in the haunch areas of structural plate pipe arches shall be constructed using the reverse shingle method or the side plates shall be provided without longitudinal seams in the haunch areas. The complete line shall be assembled before backfill is placed. Bolts shall be tightened to a torque of 150 to 250 foot-pounds. If spiraling occurs during installation, bolts shall be loosened and the pipe assembly adjusted to the correct position.

Bolts shall conform to the requirements of ASTM A307 except where high-strength or other special types of bolts are required. Nuts for bolts conforming to the requirements of A307 shall conform to the requirements of ASTM A563 and washers shall conform to the requirements of ASTM F884. Lock washers shall conform to the requirements of ANSI B18.21.1. High strength anchor bolts shall conform to the requirements of AASHTO M314, Grade 55 with the supplemental requirements of S1. Galvanization of steel anchor bolts, nuts, and washers shall conform to the requirements of ASTM A153.

g. Arch substructures: Each side of an arch shall rest in a groove formed into the masonry or on a galvanized angle or channel securely anchored to or embedded

in the substructure. Where the span of the arch is more than 15 feet or the skew angle is more than 20 degrees, a metal bearing surface having a width at least equal to the depth of the corrugation shall be provided.

Metal bearings for arches shall be cold-formed galvanized channel conforming to the requirements of ASTM A 569, at least 3/16 inch in thickness, with the horizontal leg securely anchored to the substructure at points spaced on centers of not more than 24 inches. When the metal bearing is not embedded in a groove in the substructure, one vertical leg shall be punched to allow bolting to the bottom row of plates.

Bolts, washers and nuts shall conform to the requirements of 2.1.D.2.f (above).

h. Backfilling

Backfilling shall be in accordance with Sections 200 and 303.

i. Tunneling operations

The jacked tunneling method shall be applicable for installing concrete pipe 30- to 108-inches in diameter and smooth-wall steel pipe 30- to 48-inches in diameter. Where the Drawings specifically identify tunneling as the means of pipe installation, tunneling shall be performed by the Contractor as follows:

The tunnel shall be excavated in such a manner and to such dimensions that shall permit placing of the proper supports necessary to protect the excavation. The Contractor shall take the proper precautions to avoid excavating earth or rock or shattering rock beyond the limits of excavation necessary for the safe and proper installation of the pipe. Damage from excavating and blasting, either to surface or subsurface structures, shall be repaired or replaced by the Contractor as indicated below at its own expense. Adequate provisions shall be made for the safety and health of the workers required by the work being performed.

No pipe shall be placed until the foundation is in a condition satisfactory to the Owner. Tunnel dimensions shown on the Drawings are minimum dimensions. Any excess excavation and subsequent backfill, concrete or grout fill shall be at the Contractor's expense. The pipe shall be laid in the tunnel true to line and grade. If required by the Drawings or if required for safety, suitable steel or timber sheeting, shoring, and bracing shall be used to support the sides and roof of the excavation. Supports may be left in place provided they clear the encasement or carrier pipe. No separate payment shall be made for supports left in place. Installation of the pipeline shall immediately follow tunneling excavation.

If indicated or specified, the entire void between the outside of the pipe and the tunnel walls or the inside face of the tunnel lining shall be grouted in accordance with ASTM C 476 unless the permanent sheeting, bottom, sides, and roof of the tunnel are in a condition satisfactory to the Owner. The minimum thickness of grout backfill shall be maintained throughout. Grout required for backfill in

excess of the excavation tolerances specified herein shall be at the Contractor's expense.

Any pipe damaged during construction operations shall be repaired or removed and replaced by the Contractor at his expense.

If corrugated galvanized metal pipe is used, joints may be made by field bolting or by connecting bands, whichever is feasible. When reinforced concrete pipe 24-inches and larger in diameter with tongue-and-groove joints is used for the encasement pipe, the interior joints for the full circumference shall be sealed, packed with mortar, and finished smooth and even with the adjacent section of pipe.

E. Precast Drainage Structures

1. Concrete shall have a design strength at 28 days of at least 4,000 psi and an air content of 6 +/- 2 %. The design of the concrete mixture and the method of casting, curing, handling, and erecting shall be subject to review by the Owner. Precast units may be shipped after reaching 85 % of the design strength as determined by control cylinders tested in accordance with the requirements of *VDOT Road and Bridge Specifications*, Section 404. Units shall retain their structural integrity during shipment and shall be subject to inspection at the job site
2. Precast units located adjacent to cast-in-place concrete items, such as flumes, ditches, and gutters, shall be connected to the adjacent unit by means of No.4 smooth steel dowels spaced on approximately 12-inch centers throughout the contact length and extending at least 4-inches into both the precast unit and the cast-in-place item. If holes to receive the dowels are provided in the precast unit, they shall be not more than 5/8-inch in diameter. Other methods of providing the connection, such as keyed joints, shall be approved by the Owner prior to fabrication.
3. The chamber section shall be installed in the plumb position. The throat and top sections shall have positive restraints, such as adjacent concrete, pavement, or soil on all sides to prevent displacement and shall have a positive interlock, such as dowels, with the chamber section. The throat and top sections shall be installed to conform to the normal slope of the finished grade, and may be canted up to a maximum grade of 10 %. The chamber may be built up a maximum of 12-inches at any point to provide for complete and uniform bearing of the throat and top sections on the chamber flat slab top or other approved top section. The built up section shall be constructed using whole concrete spacer units where feasible, and partial and whole sections of concrete block or brick with high strength grout and mortar. High strength grout shall be used to provide the final grade adjustment and uniform bearing. The width of the built up section shall match the wall thickness of the chamber section. The concrete block and brick shall be thoroughly bonded with mortar and the inside and outside of the built-up section shall be plastered with mortar except that the concrete spacer unit shall not be plastered.

4. Precast Arches

Protection against corrosion

- a. The concrete cover of reinforcement shall be at least 1½- inches.
- b. In corrosive or marine environments or other severe exposure conditions, reinforcement shall be epoxy coated in accordance with the requirements of Section 200, and as shown on the Drawings.
- c. Exposed reinforcing bars, inserts, and plates intended for bonding with future extensions shall be protected from corrosion as directed by the Owner.
- d. Reinforcement shall be designed and detailed in consideration of fabrication and construction tolerances so that the minimum required cover and proper positioning of reinforcement shall be maintained.
- e. Sufficient anchorage shall be provided at the terminus of lines of precast units. Anchorage may consist of a cast-in-place end section at least 3-feet in length with a headwall or collar around the precast unit(s) provided adequate connection can be made between the collar and units.
- f. Joints between units shall be sealed by preformed plastic or mastic gaskets or grout. When preformed gaskets are used, they shall be of a type listed on the VDOT's approved products list.
- g. Pipe openings will not be allowed in the precast arch but may be provided through the wingwalls. When required, openings shall conform to the requirements of Section 200.

5. Precast Box Culverts

a. Protection against corrosion

The following minimum concrete cover shall be provided for reinforcement:

- (i) For boxes with more than 2-feet of fill over the top slab: 1 1/2-inches. For boxes with less than 2 feet of fill over the top slab: top reinforcement of top slab: 2 1/2-inches; bottom reinforcement of top slab: 2-inches; all other reinforcement 1 1/2-inches.
- (ii) The minimum cover for reinforcement may be reduced by not more than ½ inch, provided the reinforcement having reduced cover is epoxy coated or the concrete surfaces adjacent to the reinforcement are coated in accordance with VDOT *Road and Bridge Specifications*, Section 416.
- (iii) Reinforcing steel for box culverts used in 0- to 2-foot fills, used in corrosive or marine environments or used in other severe exposure

conditions shall be epoxy coated. When epoxy coated reinforcing steel is required due to these conditions, the minimum cover specified shall not be reduced.

- b. The type of sealant used in joints between units shall be from the VDOT approved list of preformed plastic or mastic gaskets.

Where double or greater lines of precast units are used, a buffer zone of 3- to 6-inches between lines shall be provided. This buffer zone shall be backfilled with porous backfill conforming to the requirements of *VDOT Road and Bridge Specifications*, Section 204.

The porous backfill shall be drained by a 3-inch diameter weep hole, formed by non-rigid tubing, located at the top of the bottom haunch, centered in the outlet end section and at approximately 50-foot intervals along the length of the box. Weep holes shall be covered with a 3-foot square section of filter barrier cloth firmly attached to the outside of the box. A 3-foot width of filter barrier cloth shall also be centered over the buffer zone for the entire length of the structure after placement of the porous backfill material. Filter barrier cloth shall conform to the requirements of Section 200.

Forming weep holes and furnishing and placing of the filter barrier cloth shall be included in the price bid per linear foot for the Precast Box Culvert.

- c. At the terminus of precast units, sufficient anchorage shall be provided. This anchorage may consist of a cast-in-place end section at least 3-feet in length with a headwall and curtain wall or a collar cast-in-place around the units provided adequate connection can be made between the collar and units.

When the ends of precast units are skewed, the end section shall be cast monolithically. The skew may be provided by forming, saw cutting, or other methods approved by the Owner. Regardless of the method used, the variation in the precast unit from the exact skew shall be not greater than 1 1/2-inches at any point.

- d. Pipe openings shall conform to the requirements of Section 200.

F. Drop Inlets, Manholes, Spring Boxes, Intake Boxes, and End Walls

1. Masonry construction shall not be initiated when the air temperature is below 40° F in the shade.
2. The foundation shall be explored below the bottom of the excavation to determine the type and condition of the foundation. Foundation exploration shall extend to a depth equal to ½ inch per foot of fill height or 8-inches, whichever is greater. The Contractor shall report the findings of the foundation exploration to the Owner for approval prior to placing the structure.
3. Where unsuitable foundation is encountered at the established grade, as determined by the Owner, such material shall be removed and replaced.

4. Backfill for areas where unsuitable material has been removed shall be placed and compacted in accordance with the requirements of Sections 200 and 303.
5. Bedding material shall be placed in accordance with the Standard Drawings and shall be #57 stone, unless the field installation conditions and the Owner allow aggregate No. 25 or 26. Bedding material shall conform to the requirements of Section 200.
6. Bedding shall be uniformly compacted. The depth of bedding material shall be as specified in the Contract Documents.
7. Brick and concrete block masonry shall be placed so that each unit will be thoroughly bonded with mortar. Joints shall be full-mortar joints not more than ½-inch in width. Where brick masonry is used, headers and stretchers shall be arranged to bond the mass fully. Every seventh course shall be placed entirely with headers. Inside joints shall be neatly pointed, and the outside of such walls shall be plastered with mortar as they are placed.
8. Iron fittings entering the masonry shall be placed as the work is built up, thoroughly bonded, and accurately spaced and aligned.
9. Inlet and outlet pipe connections shall conform to the same requirements as the pipe to which they connect and shall be of the same size and kind. Pipe sections shall be flush on the inside of the structure wall and shall project outside sufficiently for proper connection with the next pipe section. Masonry shall fit neatly and tightly around the pipe.
10. Immediately following finishing operations, hydraulic cement concrete shall be cured and protected in accordance with Section 502.
11. Backfilling shall be performed in accordance with the requirements of Section 303.
12. When grade adjustment of existing structures is specified, frames, covers, and gratings shall be removed and the walls shall be reconstructed as required. Cleaned frames shall be reset at the required elevation.

G. Post Installation Inspection of Storm Sewer Pipes and Culverts

In addition to the visual inspection if performed by the Owner during the initial installation of storm sewer pipes and pipe culverts, a post installation visual/video camera inspection shall be conducted by the Contractor in accordance with the requirements of this specification and VDOT VTM 123 on all pipes identified on the Drawings as storm sewer pipe and a selected number of pipe culverts. For the purposes of this Section all pipe installations not identified on the Drawings as storm sewer pipe are considered pipe culverts. Post installation Inspections shall be performed on straight line and radial installations.

For pipe culverts, a minimum of one pipe installation for each size of each material type utilized on the project will be randomly selected by the Owner for inspection, however, in no case will the amount of pipe subject to inspection be less than ten percent of the total contract amount for the size and material type indicated. Where possible, for all installations in which the pipe or

culvert's size, orientation, or location permit deflection to be easily visually identified, (as verified with the Owner) the Contractor may perform visual inspections in lieu of video inspections. If defects as described herein are noted during the inspection, the Owner may require additional pipe installations of that size and/or material be inspected. The Contractor shall coordinate and schedule all post installation inspections so that these are made in the presence of the Owner. The post installation inspection shall be performed no sooner than 30 days after completion of the pipe installation and placement of final cover (except for pavement structure). The Contractor shall issue a report detailing all issues or deficiencies noted during the inspection (including a remediation plan for each deficiency noted where applicable) no later than 5 days after completion of the inspection.

While the intent of this requirement is to perform the post installation inspection prior to paving, project scheduling may dictate that a particular site be paved before the end of the 30 day period. In such cases, a preliminary inspection of the pipe shall be made, prior to paving over it, to insure that the pipe has been properly installed and is performing well. Performing such a preliminary inspection prior to paving will not relieve the Contractor from the requirement to perform the post installation inspection after the 30 day period.

The Contractor's inspection report shall identify and address any of the following items observed during the post installation inspection including identifying any proposed remediation measures the Contractor plans to perform where applicable. Remediation measures may consist of repairing or replacing the defective pipe section(s) or a combination of the two where differing conditions exist within the same run of pipe. Where permitted as an option, remediation methods for the various installation defects shall be proposed by the Contractor, reviewed with the Owner and must have the Owner's approval prior to implementation of the corrective action. Remediation shall be the sole responsibility of the Contractor. Further, if remediation measures are shown to be necessary, any time associated with such measures shall be reflected in the impact to the Contractor's progress schedule (may take the form of a time impact analysis, where required by the scheduling requirements) and will not relieve the Contractor of his responsibilities to finish the work required by the contract within the contract time limits or form the basis for any claim of delay where such remediation measures are determined to be a result of the Contractor's fault, omission or negligence.

Upon completion of any corrective remedial measures, the corrected installations are to be re-inspected prior to final acceptance of the project utilizing the test methods identified in VDOT VTM 123.

The following criteria shall form the basis for inspections for the respective pipe or culvert types listed:

1. Concrete Pipe\Culverts:

- a. **Misalignment:** Vertical and horizontal alignment of the pipe culvert or storm drain pipe barrel shall be checked by sighting along the crown, invert and sides of the pipe, and by checking for sagging, faulting and invert heaving. For the purposes of this provision faulting is defined as differential settlement between joints of the pipe, creating a non-uniform profile of the pipe. The person assigned by the Contractor to perform the inspection should take into account pipe or culvert laid with a designed camber or grade change in accordance with

project or site requirements. Horizontal alignment shall be checked for straightness or smooth curvature. Any issues involving incorrect horizontal and/or vertical alignment shall be noted in the inspection report. If any vertical and/or horizontal misalignment problems are visually noted by the Owner or in the inspection report, a further evaluation shall be conducted by the Owner to determine the impact of the misalignment on the joints and wall of the pipe to ascertain what corrective actions are needed. All corrective actions determined necessary by the Owner that are a result of the Contractor's negligence, omission or fault shall be the sole responsibility of the Contractor to remedy.

- b. **Joints:** Leaking joints may be detected during low flows by visual observation of the joints or checking around the ends of pipes or culverts for evidence of piping or seepage.

Differential movement, cracks, spalling, improper gasket placement, movement or settlement of pipe\culvert sections, and leakage shall be noted by the Contractor in the report. Joint separation greater than one inch shall be remediated by the Contractor at his expense to the satisfaction of the Owner. Evidence of soil migration through the joint will be further evaluated by the Owner to determine the level of corrective action necessary. All corrective actions determined necessary by the Owner that are a result of the Contractor's negligence, omission or fault shall be the sole responsibility of the Contractor to remedy.

- c. **Cracks:** Longitudinal cracks with a width less than one hundredth of an inch (0.01) are considered hairline and minor. They shall be noted in the inspection report; however, no remedial action is necessary.

Longitudinal cracks having a width equal to or greater than one hundredth of an inch (0.01 but equal to or less than one tenth of an inch (0.1) and determined by the Owner to be detrimental to the structure shall be sealed by a method proposed by the pipe\culvert manufacturer and approved by the Owner. Pipes or culverts having longitudinal cracks with widths greater than one tenth of an inch (0.1) and determined to be beyond the limits of a satisfactory structural repair shall be replaced by the Contractor at his expense to the satisfaction of the Owner.

Pipes or culverts having displacement across the crack greater than 0.1 inch but less than 0.3 inch shall be remediated. Remediation methods shall be in accordance with recommendations of the pipe or culvert manufacturer, be acceptable to and authorized by the Owner before implementation and shall be the sole responsibility of the Contractor. Pipes\culverts having displacement across the crack greater than 0.3 inch shall be replaced by the Contractor at his expense to the satisfaction of the Owner.

Transverse cracks will be evaluated using the same criteria as indicated above for longitudinal cracks.

- d. **Spalls:** Spalling is defined as a localized pop-out of concrete along the wall of

the pipe\culvert generally caused by corrosion of the steel reinforcement or at the edges of longitudinal or circumferential cracks. Spalling may be detected by visual examination of the concrete along the edges of the crack. The person conducting the inspection shall check for possible delamination. If delamination is noted or if a hollow sound is produced when the area is tapped with a device such as a hammer, the pipe\culvert shall be remediated. Remediation methods shall be in accordance with recommendations of the pipe\culvert manufacturer, be acceptable to and authorized by the Owner before proceeding, and shall be the sole responsibility of the Contractor.

- e. **Slabbing:** Any pipe\culvert experiencing slabbing shall be remediated. Slabbing is a structural failure of the pipe\culvert that results from radial or diagonal tension forces in the pipe\culvert. These failures appear as a separation of the concrete from the reinforcing steel near the crown or invert of the pipe\culvert and may span the entire length of a pipe or culvert section (joint to joint). Remediation methods shall be in accordance with recommendations of the pipe or culvert manufacturer, be acceptable to and authorized by the Owner before proceeding, and shall be the sole responsibility of the Contractor. Where slabbing is of such magnitude that, in the opinion of the Owner the integrity or service life of the pipe or culvert is severely compromised, the section(s) of pipe or culvert exhibiting such deficiency shall be replaced at the Contractor's expense to the satisfaction of the Owner.

Remediation efforts and percentage of payment shall apply to the entire section(s) of the deflected pipe or culvert, joint to joint. The cost of the remedial measures (including removal and replacement of the pipe, if necessary) and the re-inspection of the remediated pipe necessitated as a result of the Contractor's negligence, omission or fault shall be the contractual and financial responsibility of the Contractor.

2. Thermoplastic Pipe\Culvert:

- a. **Misalignment:** Vertical and horizontal alignment of the pipe culvert or storm drain pipe barrel(s) shall be checked by sighting along the crown, invert and sides of the pipe, and by checking for sagging, faulting and invert heaving. The person assigned by the Contractor to perform the inspection should take into account pipes\culverts laid with a designed camber or grade change. Horizontal alignment shall be checked for straightness or smooth curvature. Any issues with horizontal and/or vertical alignment shall be noted in the inspection report. If any vertical and/or horizontal misalignment problems are noted in the inspection, a further evaluation will be performed by the Owner to determine the impact of the misalignment on the joints and wall of the pipe\culvert to ascertain what corrective actions are needed. All corrective actions determined necessary by the Owner that are a result of the Contractor's negligence, omission or fault shall be the sole responsibility of the Contractor to remedy.
- b. **Cracks:** Cracks or splits in the interior wall of the pipe shall be remediated. Remediation methods shall be in accordance with recommendations of the pipe manufacturer, be acceptable to and authorized by the Owner before proceeding,

and shall be the sole responsibility of the Contractor

- c. **Joints:** Pipes\culverts showing evidence of crushing at the joints shall be remediated. Differential movement, improper joint sealing, movement or settlement of pipe\culvert sections, and leakage shall be noted in the inspection report. Joint separation of greater than 1 inch shall be remediated. Evidence of soil migration through the joint will be further investigated by the Owner to determine the level of remedial action required by the Contractor. Remediation methods shall be in accordance with recommendations of the pipe manufacturer, be acceptable to and authorized by the Owner before proceeding. All corrective actions determined necessary by the Owner that are a result of the Contractor's negligence, omission or fault shall be the sole responsibility of the Contractor to remedy.
- d. **Buckling, bulging, and racking:** Flat spots or dents at the crown, sides or flow line of the pipe due to racking shall be noted in the inspection report and will be evaluated by the Owner. Areas of wall buckling and bulging shall also be noted in the inspection report and evaluated by the Owner for corrective action if deemed necessary by the Owner. All corrective actions determined necessary by the Owner shall be the sole responsibility of the Contractor.
- e. **Deflection:** Any one of several methods may be used to measure deflection of thermoplastic pipe\culvert (laser profiler, mandrel, direct manual measure, etc.) If the initial inspection indicates the pipe\culvert has deflected more than 5 percent of its original diameter, and if the original inspection was performed using a video camera, then a mandrel test shall also be performed in accordance with VDOT VTM 123. All deflections shall be noted in the inspection report. Deflections of less than 5 percent of the original pipe\culvert's diameter shall not require remediation. If the pipe\culvert is deflected greater than 5 percent of the original diameter, the pipe\culvert shall be replaced by the Contractor at his expense to the satisfaction of the Owner

Remediation efforts and percentage of payment shall apply to the entire section(s) of the deflected pipe or culvert, joint to joint. The cost of the remedial measures (including removal and replacement of the pipe, if necessary) and the re-inspection of the remediated pipe necessitated as a result of the Contractor's negligence, omission or fault shall be the contractual and financial responsibility of the Contractor.

3. Metal Pipe\Culvert:

- a. **Misalignment:** Vertical and horizontal alignment of the pipe culvert or storm drain pipe barrel shall be checked by sighting along the crown, invert and sides of the pipe\culvert, and by checking for sagging, faulting and invert heaving. The person assigned by the Contractor to perform the inspection should take into account pipe laid with a designed camber or grade change. Horizontal alignment shall be checked for straightness or smooth curvature. Any issues with horizontal and/or vertical alignment shall be noted in the inspection report for evaluation by the Owner. If any vertical and/or horizontal misalignment

problems are noted in the inspection, further evaluation will be conducted by the Owner to determine the impact of the misalignment on the joints and wall of the pipe\culvert to ascertain what corrective actions by the Contractor are needed. All corrective actions determined necessary by the Owner that are a result of the Contractor's negligence, omission or fault shall be the sole responsibility of the Contractor to remedy.

- b. Buckling, bulging, and racking: Flat spots or dents at the crown, sides or flow line of the pipe due to racking shall be noted by the Contractor's inspector in the inspection report and will be evaluated by the Owner for possible remediation by the Contractor. Areas of wall buckling and bulging shall also be noted in the inspection report and evaluated by the Owner for possible remediation by the Contractor. If the Owner determines corrective actions are necessary they shall be in accordance with the pipe\culvert manufacturer's recommendations, be acceptable to and authorized by the Owner prior to implementation and be the sole responsibility of the Contractor.
- c. Joints: Pipes showing evidence of crushing at the joints shall be remediated. Differential movement, improper joint sealing, movement or settlement of pipe sections, and leakage shall be noted in the report. Joint separation of greater than 1.0 inch shall be remediated. Evidence of soil migration through the joint will be further investigated by the Owner to determine the level of remedial action required by the Contractor. All corrective actions determined necessary by the Owner that are a result of the Contractor's negligence, omission or fault shall be the sole responsibility of the Contractor to remedy.
- d. Coating: Areas of the pipe where the original coating has been scratched, scoured or peeled shall be noted in the inspection report and evaluated by the Owner to determine the need for immediate repair. If repairs are required they shall be performed by and at the expense of the Contractor in accordance with the recommendations of the pipe\culvert coating manufacturer.
- e. Deflection: Any one of several methods may be used to measure deflection of metal pipe\culvert (laser profiler, mandrel, direct manual measure, etc.) If the initial inspection indicates the pipe\culvert has deflected more than 5 percent or more of its original diameter, and if the original inspection was performed using a video camera, then a mandrel test shall also be performed in accordance with VDOT VTM 123. All deflections shall be noted in the inspection report. Deflections of less than 5 percent of the original pipe\culvert's diameter shall not require remediation. If the pipe\culvert is deflected greater than 5 percent of the original diameter, the pipe shall be replaced by the Contractor at his expense to the satisfaction of the Owner

Remediation efforts and percentage of payment shall apply to the entire section(s) of the deflected pipe or culvert, joint to joint. The cost of the remedial measures (including removal and replacement of the pipe, if necessary) and the re-inspection of the remediated pipe necessitated as a result of the Contractor's negligence, omission or fault shall be the contractual and financial responsibility of the Contractor.

H. Cleaning

Upon completion, each pipe and structure shall be cleaned of silt, debris, and foreign matter and shall be kept clear of such accumulation until final acceptance.

III. MEASUREMENT FOR PAYMENT

- A. The cost of excavation, backfill, and disposal of surplus material for drop inlets, intake boxes, manholes both new and reconstructed, spring boxes, junction boxes, and base sections of pipe tee units used as drop inlets and manholes shall be included in the bid price for such items. No additional or separate payment will be made. In the event steps or invert shaping are required, the cost thereof shall also be included in the price for such items.
- B. Bedding stone depth shall be 6-inches and shall be considered incidental to the pipe and structures.
- C. Undercut excavation and the replacement of excavated undercut material shall be as specified in Section 303.
- D. Pipe will be measured in linear feet. Pipe will be measured through the fittings from center of the structure to center of structure or to the terminal end. When a partial section is required, the actual length of the partial section will be measured in place. Pipe shall be paid for at the contract unit price per linear foot, complete in place. Payment will include the cost of the following:
 - 1. Backfilling, compacting, and compaction testing
 - 2. Bedding
 - 3. Cleaning prior to acceptance, as required
 - 4. Dewatering
 - 5. Disposal of surplus material
 - 6. Excavation
 - 7. Joint Wrapping & Sealing, including geotextile fabric
 - 8. Main line fittings
 - 9. Pipe anchor blocks
 - 10. Restoration in right-of-way and shoulders and easements (including curb and gutter restoration), unless otherwise specified on the Drawings.
 - 11. Storm sewer and appurtenances
 - 12. Stripping and stockpiling topsoil
 - 13. Temporary seeding and stabilization
 - 14. Temporary sheeting and bracing.
- E. Pipe culverts will be measured and paid in linear feet. Pipe will be measured through the fittings from center of the structure to center of structure or to the terminal end. When a partial section is required, the actual length of the partial section will be measured in place.
- F. Pipe tees and elbows will not be measured separately.
- G. Pipe reducers will be measured and paid in linear feet of pipe for payment at the larger pipe size.

- H. Jacked pipe will be measured in linear feet to the nearest 1/10 of a foot. Jacked pipe will be paid at the contract unit price per linear foot for each size pipe installed, complete in place including all work associated with bore pit.
- I. Reinstalled pipe will be measured and paid in linear feet along a line parallel to the flow line. This price shall include excavation involved in removing pipe, hauling, cleaning, relaying, backfilling, necessary cutting for joining to other sections of pipe, furnishing new coupling bands, disposing of surplus excavation, disposing of surplus and damaged materials, and replacing any otherwise usable sections damaged or broken because of the negligence of the Contractor.
- J. End sections will be measured in units of each, complete-in-place.
- K. End walls and arch substructures will be measured per each.
- L. Box culverts will be measured in linear feet along the centerline of the barrel from face of curtain wall to face of curtain wall. This price shall include all work including, but not limited to designing, casting, reinforcing, installing, bedding, waterproofing, sealing joints, anchoring, and providing buffer zones for multiple lines.
- M. Pipe grates will be measured and paid in linear feet or each, complete and in place, as indicated on the Bid form, unless included in another Bid item. This price shall include fabricating, furnishing, galvanizing, and installing.
- N. Drop inlets, yard inlets, catch basins, and intake boxes will be measured as each as complete units, including the frame and grate or cover. Drop inlets, yard inlets, catch basins, and intake boxes will be paid for at the contract unit price per each. Where curb or curb and gutter extend along the drop inlet, the contract unit price for drop inlets shall include that part of the curb or gutter within the limits of the structure.
- O. Base sections of pipe tee units used as drop inlets and manholes will be measured and paid in linear feet horizontally of pipe specified. The riser section and additional costs for the tee shall be included in the price for the drop inlet or manhole.
- P. Manhole (4- or 5-foot diameter) installed complete in place, 0- to 6-foot in depth. Measurements will be made to the nearest foot from the bottom of the frame and cover to the invert out. Payment will be made at the unit price bid for each standard depth manhole (0- to 6-foot) installed and satisfactorily tested, and will include the cost of the following:
 - 1. All appurtenances required for satisfactory operation
 - 2. Bedding
 - 3. Cleaning prior to acceptance, as required
 - 4. Dewatering
 - 5. Excavation, bedding, backfill, and compaction
 - 6. Manhole, complete including frame and cover, benches, invert and troughs
 - 7. Openings and seals
 - 8. Sheeting and shoring
 - 9. Steps, unless otherwise noted

Q. Manhole (4- or 5-foot diameter) Extra Depth, installed complete in place, in excess of 6-feet in depth will be made based on the vertical feet of manhole installed in excess of 6-feet, measured to the nearest foot from 6-feet below the bottom of the frame and cover to the invert out in depth. Payment will be made at the unit price bid for each additional vertical foot of manhole (in excess of 6-feet in depth) installed and satisfactorily tested and will include the cost of the following:

1. All appurtenances required for satisfactory operation
2. Cleaning prior to acceptance, as required
3. Dewatering
4. Excavation, bedding, backfill, and compaction
5. Openings and seals
6. Sheeting and shoring
7. Steps, unless otherwise noted

R. Conflict Manhole, installed complete in place. Measurement will be made as each. Payment will be made at the unit price bid for each conflict manhole installed and satisfactorily tested will include the cost of the following:

1. All appurtenances required for satisfactory operation
2. Bedding
3. Cleaning prior to acceptance, as required
4. Dewatering
5. Ductile iron pipe
6. Excavation, bedding, backfill, and compaction
7. Manhole, complete including benches, inverts and troughs, and frame and cover
8. Openings and seals
9. Sheeting and shoring
10. Steps, unless otherwise noted

S. Concrete spring boxes will be measured and paid as each.

T. Junction boxes will be measured as a complete unit including frame and cover, and paid as each.

U. Reconstructed manholes will be measured and paid as each as a complete unit.

V. Precast arches will be measured and paid in linear feet along the centerline of the invert from face of headwall to face of headwall. This price shall include designing, forming, casting, reinforcing, excavating, wingwalls, installing, waterproofing, sealing joints, anchoring and bedding, and providing buffer zones for multiple lines. The cost for cast-in-place work other than that specified on the Drawings shall be included in the price for precast arches.

W. Post Installation Inspection of Storm Pipes and Culverts shall be measured and paid in linear feet of televised pipe in accordance with Section 811, Television Inspection. The cost of remedial measures (including removal and replacement of the pipe, if necessary) and the re-inspection of the remediated pipe necessitated as a result of the Contractor's negligence, omission or fault shall be the contractual and financial responsibility of the Contractor.

End of Section