

PERMANENT PIPE CULVERTS

SCDOT Designation: SC-M-714 (07/07)

1 Reinforced Concrete Culvert Pipe (RCP)

1.1 Description (RCP)

This section contains specifications for the materials, construction, measurement, and payment for furnishing reinforced concrete culvert pipes (RCP) of the size, shape, type, and dimensions indicated on the plans and installing them to provide drainage structures at places designated on the plans or by the **RCE** in accordance with these specifications and true to the lines and grades shown on the plans or otherwise given by the **RCE**. This work includes the furnishing and installing of necessary tee, wye, elbow, and bend joints, and making connections to existing and/or new structures, including drilling and chipping as is necessary to complete the work.

1.2 Materials (RCP)

Use only materials specified herein for the several items that constitute the finished pipe culvert.

Use only RCP qualified and stamped by **OMR** or a qualified agency on **SCDOT** projects. On occasion, the **OMR** may accept RCP that is not stamped, provided certified tests results are submitted for review for each class and size of RCP to include but is not limited to the results from the three edge bearing test for hairline crack (0.01 inch) and the ultimate strength of RCP. All testing will be in accordance to the latest applicable **SCDOT** and **AASHTO** specifications.

Use circular RCP conforming to the applicable requirements of **AASHTO M 170**, for the specified diameters, shapes, types, and strength classes except for the modifications stated herein and on **SCDOT Standard Drawings**. Provide the **RCE** with certification that pipe meets the requirements of **AASHTO M 170**. When a strength class is not specified, use minimum Class III pipe. Furnish pipe in manufactured lengths from 4 to 12 feet. Make certain circular pipe sizes up through 36 inches in diameter have the standard circular reinforcement conforming to the requirements of **AASHTO M 170**. For elliptical reinforced concrete pipe, use pipe conforming to **AASHTO M 207** except for the modifications stated herein.

Reinforcement for circular pipe sizes 42 inches in diameter or larger may contain any of the reinforcement designs conforming to the requirements of **AASHTO M 170**. When other than circular designs are used, provide a stencil in the top of the shell marked "Top." Place special design reinforcement in position and stabilize by satisfactory means to ensure that it does not shift or rotate during the manufacturing process. When lift holes or lugs are required in pipe, follow OSHA guidelines for handling pipe, and manufacturer guidelines for grouting lift holes after installation.

Install standard **AASHTO M 170** reinforced pipe within minimum and maximum fill heights shown on **SCDOT Standard Drawings**. For classes and sizes of circular, or elliptical pipe with reinforcement designs not shown in **AASHTO M 170**, or **AASHTO M 207**, respectively, have the manufacturer submit to the **OMR** and Roadway Structures Engineer a design that meets or exceeds the loading criteria specified on **SCDOT Standard Drawings** for the design cover height for the project.

Ensure that Portland cement conforms to the requirements of **SCDOT Standard Specifications Subsection 701.2.1**.

The manufacturer may use fly ash and water-granulated blast-furnace slag in accordance with the following requirements:

- A. Fly ash meets **AASHTO M 295** for Type F or C with a maximum Na₂O of 1.5%. Water-granulated blast-furnace slag meets the requirements of **AASHTO M 302**, Grade 100 or better.
- B. Cement may be replaced by fly ash or water-granulated blast-furnace slag in accordance with **AASHTO M 170**.
- C. Fly ash and slag are allowed only from sources listed on the latest edition of **SCDOT Qualified Product Listing 3**. Certified mill test reports are furnished with each shipment to verify compliance requirements.
- D. The manufacturer provides a qualified **OMR** mix design in advance of batching. The submittal indicates the amount of cement removed and the material replacing it.
- E. Storage bins, conveying devices and weighing equipment and procedures to ensure accurate batching provided for each material (fly ash or slag) used.

Ensure that aggregates conform to the quality requirements as specified in **SCDOT Standard Specifications Subsection 701** for aggregates. Gradation of the aggregates is at the option of the manufacturer. When aggregate from marine limestone sources are used, ensure they meet the following additional conditions:

- A. The weighted loss does not exceed 12.0% after being subjected to 5 alterations of the sodium sulfate soundness test according to **AASHTO T 104**.
- B. The abrasion loss does not exceed 45.0% when tested according to **AASHTO T 96**.
- C. A sprinkler is used to ensure saturated aggregate during concrete batching.

Make certain that steel reinforcement conforms to the requirements of **ASTM A 706** Grade 60, **AASHTO M 32**, **AASHTO M 55**, **AASHTO M 221**, or **AASHTO M 225** as applicable. Ensure that steel conforming to **ASTM A 706** comes from a source listed on **SCDOT Qualified Product Listing 60**.

Ensure that Rubber Gasket Joint Material meets the requirements of **AASHTO M 315**. Ensure that Preformed Flexible Joint Sealant meets the requirements of **AASHTO M 198**. Use only those gasket sources that appear on **SCDOT Qualified Product Listing 13**. Obtain qualification by furnishing the **OMR** a certified affidavit with test results made in a recognized laboratory confirming that the material meets **AASHTO M 198** for preformed flexible joint sealant and **AASHTO M 315** for rubber gaskets, along with complete instructions for installation of the material.

When geotextile for drainage filtration is required, follow **SCDOT Supplemental Specifications for Geotextile for Drainage Filtration**.

Make certain water meets the requirements of **SCDOT Standard Specifications Subsection 701.2.11**.

1.3 Construction Requirements (RCP)

1.3.1 Handling and Storage (RCP)

Inspect pipe before it is installed. Check pipe for proper markings and for signs of damage due to fabrication or shipment. Pipe may be rejected due to improper marking, incorrect pipe class, size, or strength. Pipe may also be rejected due to damage which may include, but is not limited to fractures or cracks passing through the wall or extending the entire length of the pipe, spalling, chips, breaks, or honeycombing that would adversely affect the strength or function of the pipe. Damage to the end of the pipe including broken tongues or grooves or ends that are not normal to the walls or centerline of the pipe that prevent satisfactory joint installation may also be cause for rejection. Defective or damaged joint sealant or gaskets may require replacement, but are not cause for rejection of pipe that meets the above requirements.

Handle and store pipe such that no damage occurs to the pipe. Unload the pipe at a site that is relatively flat and level, free of debris, and away from construction traffic. Stack belled pipes using blocking to avoid excess loading on the bells.

1.3.2 Trench for Pipe (RCP)

Lay the pipe in a trench where possible. Excavate trenches to the required grade and to a width sufficient to allow for proper jointing of the pipe and for thorough compaction of the structural backfill material under and around the pipe. Excavate the trench to a width which is 1.5 times the pipe outside diameter plus 12 inches, 1.0 times the pipe outside diameter plus 24 inches, or the width required to safely fit compaction equipment and personnel between the pipe and the trench walls, whichever is greater. When using controlled low strength material (CLSM) backfill, excavate the trench to a minimum width of the outside diameter of the pipe plus 12 inches. Make certain that the trench bottom gives full support to the pipe throughout its length.

Where pipe culverts will be placed in new embankments, first construct the embankments to a height of approximately 1/2 the diameter of the pipe above the top of the designated pipe or to such height as directed by the **RCE**. Construct the embankment for a distance

of not less than 5 times the diameter of the pipe on each side of the pipe location, after which excavate the trench in the embankment as described in this section above.

When excavating for pipe culverts, if rock, hard pan, or other unyielding foundation material is encountered, excavate the hard unyielding material below the elevation of the bottom of the pipe or pipe bell to a minimum depth of 8 inches below the bottom of the pipe.

Follow OSHA safety requirements for trenching. If trench width or wall slopes are changed due to safety requirements, backfill the trench outside of the normal trench dimensions with either embankment material or backfill material described in **Subsection 1.3.6**.

When supports such as trench boxes are used, ensure that support of the pipe and its embedment are maintained throughout the installation. Ensure that sheeting is sufficiently tight to prevent washing out of native soil from behind the trench box. Follow pipe manufacturer's trench box recommendations in order to comply with OSHA safety requirements while preventing loss of support in the bedding and structural backfill when moving trench boxes. Use sloped trench walls or CLSM when either structural backfill or trench box safety requirements cannot be followed.

Do not disturb the installed pipe and its embedment when moving trench boxes. Do not use trench boxes below the top of the pipe zone unless methods, agreed upon in advance with the RCE, are used for maintaining the integrity of the embedment material. As supports are moved, all voids left by the trench walls below the top of the pipe zone must be filled with specified structural backfill described in **Subsection 1.3.6**, compacted per these specifications.

Provide for temporary diversion of water or pumping as may be necessary in order to permit dry installation of the culvert. Keep trenches free from water until any joint sealant material has hardened sufficiently.

1.3.2.1 Foundation for Pipe (RCP)

Unless noted otherwise in the plans or by the **RCE**, support pipe using foundation material that meets the minimum requirements of the roadway embankment.

When a firm foundation is not encountered at the required grade, remove unstable material at least one diameter on each side of the pipe and deep enough to provide appropriate support to the pipe or as specified by the Engineer. Backfill and compact with soil and methods specified for the embankment materials up to the bottom of the bedding. Provide trench suitable to accommodate site conditions and obstructions.

1.3.3 Bed for Pipe (RCP)

For bedding material use well-graded sand or gravel meeting the requirements of A-1 (**AASHTO M 145**).

Uniformly graded coarse-grained soils A-3 (**AASHTO M 145**) can be used if provisions are made to evaluate and control possible soil migration into open voids. Completely wrap bedding with geotextile for drainage filtration when uniformly graded materials are used to prevent soil migration.

Ensure that trenches are free of water when placing bedding.

Support the pipe by placing uncompacted bedding material for a depth of 10.0% of the pipe outside diameter or 3 inches (6 inches when placing pipe on rock) whichever is greater. Prepare bedding material at pipe bells and projected hubs if present to prevent excess loading and to provide uniform support in these areas.

Compact bedding material that is outside of the middle third pipe diameter in order to ensure proper support of the pipe. Ensure that bedding material outside the middle third of pipe is compacted to a minimum of 95.0% of the maximum dry density when measured in accordance to **SC-T-29**. Ensure that compaction of bedding material does not cause the pipe to move.

Do not use Controlled low strength material (CLSM), flowable fills or concrete for pipe bedding.

1.3.4 Laying Pipe (RCP)

Begin pipe laying at the downstream end of the culvert with the bell or groove ends and outside laps upstream.

Make certain each section of pipe has a full firm bearing throughout its length, true to line and grade given. Make certain that all supports are uniform (without point loading from irregular backfill) and that bells have been properly accommodated. Remove pipe that settles before final acceptance or which is not in alignment and re-lay without extra compensation.

When concrete elliptical pipe with circular reinforcement or concrete circular pipe with elliptical or quadrant reinforcement is used, install the pipe in such a position that the manufacturer's marks designating the top or bottom of the pipe are not more than 5 degrees from the vertical plane through the longitudinal axis of the pipe.

Before laying the pipe or during the pipe laying operations, construct adequate outfall ditches and inlets free of obstructions in order that proper drainage is provided.

When pipes are connected to drainage structures, install or cut pipe flush with inside face of drainage structure. When pipes are connected to end treatments such as slabs or headwalls, install or cut pipe flush with exposed face of end treatment. When pipe culverts are installed connecting to pipe of different material or connection details, use a standard drainage structure or designed interface as directed by the **RCE**. Where pipe culverts are constructed in conjunction with existing structures, make connections to the satisfaction of the **RCE**.

1.3.5 Joints (RCP)

Use a joint material manufacturer listed on **SCDOT Qualified Product Listing 13** that corresponds with the type of joint specified in the plans or provided by the pipe manufacturer. Submit joint material manufacturer installation recommendations to **RCE** before installation of pipe. Follow joint material manufacturer's recommendations for installation procedure. Follow pipe manufacturer's recommendations for maximum joint opening to meet tightness requirements specified in the plans or contract documents. Order pipe and appropriate joint material from pipe manufacturer. Install pipe using **AASHTO M 198** joints unless specified in the plans, contract documents, or pay items.

1.3.5.1 **AASHTO M 198** Preformed Flexible Joint Sealant

Use a combination of pipe and joint material that meets performance requirements of the **AASHTO M 198**, including the laboratory 10 psi pressure test. Carefully clean all dirt and foreign substances from the jointing surface of the groove end already laid and tongue end of the pipe being added. Allow jointing surfaces to dry completely before application of the joint material. If required by site conditions or manufacturer recommendations, apply an adhesive primer specified by the flexible sealant manufacturer. During cold weather, warm flexible sealant as directed by the manufacturer before application. Remove protective paper from one side of the flexible sealant & apply to the tongue end. Leave protective paper on outside of flexible sealant to protect during pipe alignment. Apply enough flexible sealant to fill the annular joint space with some squeeze out. Align the tongue and groove ends of the pipes before homing (closing) the joint. Remove protective paper from outside surface of flexible sealant. Make sure that the flexible sealant is in contact with the entry taper around the entire circumference with some squeeze out and that the pipe is aligned properly. Seat pipe completely before installing next pipe section.

1.3.5.2 **AASHTO M 315** Rubber Gasket Joint Material

When specified in the plans, use a combination of pipe and joint material that meets performance requirements of the **AASHTO M 315 (ASTM C 443)**, including the laboratory 13 psi pressure test. Carefully clean all dirt and foreign substances from the jointing surface of the groove end already laid and tongue end of the pipe being added. Use lubricant specified by the gasket manufacturer. Lubricate entire inside surface of groove end. Lubricate entire outside surface of the tongue end of the pipe being installed. Pay particular attention to lubricate entire gasket recess. Lubricate all surfaces of the rubber gasket before it is placed on the pipe tongue. Fit the gasket on the tongue recess. Equalize the rubber gasket by running a smooth round object (such as a screwdriver shaft) between the gasket and the pipe. Complete this equalization procedure at least 3 times around the entire length of each gasket (see detail on standard drawing for reinforced concrete pipe). Ensure proper seating of the gasket before proceeding with installation. Align the tongue and groove ends of the pipes before homing (closing) the joint. Make sure that the gasket is in contact with the entry taper around the entire circumference and that the pipe is aligned properly. Seat pipe completely before installing next pipe section.

1.3.5.3 Pressure and Other Joints

Where pressure joints or other types of joints are required in the plans, submit pipe and joint manufacturer's specifications for acceptance by the **RCE** before installation.

1.3.6 Pipe Structural Backfill (RCP)

Advise the **RCE** of the time Pipe Structural Backfill operations are expected to begin. If not properly advised, the **RCE** may require the excavation and reinstallation of the structural backfill material.

For structural backfill material use well-graded sand or gravel meeting the requirements of A-1 (**AASHTO M 145**).

Uniformly graded coarse-grained soils A-3 (**AASHTO M 145**) can be used for backfill if provisions are made to evaluate and control possible migration of fines into open voids. Completely wrap backfill with geotextile for drainage filtration when uniformly graded materials are used to prevent soil migration. If uniformly graded coarse-grained soils A-3 (**AASHTO M 145**) are used for both the bedding and the backfill, wrap the entire bedding and backfill envelope with geotextile for drainage filtration.

Controlled low strength material (CLSM) and controlled density fill are flowable fills that may be used for structural backfill in the haunch area and above. Select a flowable fill mix design that can be excavated. When using CLSM backfill excavate the trench to a width that is a minimum of the outside pipe diameter plus 12 inches but no wider than the outside pipe diameter plus 20 inches. Do not use CLSM when placing perforated pipe. When using CLSM ensure that the pipe is not displaced while using methods that do not damage the pipe.

Ensure that trenches are free of water when placing and compacting structural backfill.

Thoroughly compact the structural backfill material in layers not exceeding 6 inches of compacted material. The first lift must be sufficiently below the spring line such that the material can be worked into the haunch zone of the pipe. Perform compaction by the use of mechanical tampers with the assistance of hand tamps when necessary. Thoroughly compact the structural backfill under the haunches of the pipe and ensure that the backfill soil is in continuous uniform contact with the side and joints of the pipe. Exercise sufficient care to prevent damaging or misaligning the pipe with the compaction equipment.

Install and compact structural backfill on both sides of pipe before adding the next lift of backfill material. Evenly distribute structural backfill on both sides of the pipe for its full length. Ensure that Pipe Structural Backfill process does not cause joint separation or displacement of the installed pipe.

Ensure that the compaction of structural backfill is a minimum of 95.0% of the maximum dry density when measured in accordance with **SC-T-29**. To ensure appropriate compaction, divide the pipe placement into 50-foot lots as directed by the **RCE**.

The **RCE** will test the compaction of each 6-inch lift in each 50-foot lot starting from the pipe bedding up to the minimum cover depth for the pipe. This compaction testing will be

performed on alternating sides of the pipe at random locations within the 50-foot lot to ensure that the material within the pipe embedment zone has been compacted to 95.0% of the maximum dry density for the structural backfill when measured in accordance with **SC-T-29**. For all tests, insert the nuclear gauge probe to its full depth or within 2 to 3 inches of the bottom of the layer being tested, whichever is less. In the event of a non-conforming compaction measurement, recompact the entire 50-foot lot before the compaction is tested again by the **RCE** at the same location and one other location within the 50-foot lot. Continue reworking the structural backfill until all tests indicate conformance with the compaction requirements.

Complete structural backfill installation up to the springline of the pipe. Fill the remainder of the trench pipe embedment zone using material and compaction methods that meet the minimum requirements of the roadway embankment in accordance with **SCDOT Standard Specifications Subsection 203** and that prevent damage to the newly installed pipe. Install this material to the minimum cover elevation above the pipe as indicated on **SCDOT Standard Drawings**. Confirm that backfill material in pipe trench meets or exceeds the embankment compaction requirements before applying final pavement surface.

1.3.7 Cover Height (RCP)

Ensure that the minimum and maximum cover is in accordance with the height of cover tables in the **SCDOT Standard Drawings**.

1.3.8 Construction Loads (RCP)

Fill height requirements may dictate that more fill is required during construction than for final design. In all cases, install backfill to the minimum construction fill height specified in the **SCDOT Standard Drawings** before driving heavy equipment over pipe. Maintain this minimum cover until heavy equipment usage is discontinued so that damage does not occur to the pipe. Install and remove backfill required due to the construction loading on the pipe at no expense to **SCDOT**. Repair all damage or displacement at no expense to **SCDOT**.

1.3.9 Structures and End Treatments (RCP)

When not included in the plans, follow **SCDOT Standard Drawings** for connections of pipe to drainage structures, manholes, end treatments, or other buried structures.

Construct end treatment (minimum Class B riprap, pipe end structure, concrete slab, wingwall/apron system, etc.) as indicated in the plans or **SCDOT Standard Drawings**.

When scour issues are observed on site, construct a cast in place concrete cut-off wall a minimum of two feet below the scour depth to protect the end treatment and pipe or as directed by the **RCE**.

1.3.10 Installation Inspection (RCP)

Visually inspect 100% of pipe for fractures, cracks, spalling, chips, and breaks during all phases of the installation process. Inspect joints, including tongues and grooves. Chipped pipe ends that prevent the full bond between joint sealant/gasket and both pipes may only be installed in drainage structures at the ends of pipe runs where they will be grouted over. Inspect installed joints for missing, damaged, or improperly installed joint sealant or gasket.

The **RCE** will inspect 100% of pipe under the pavement, and a minimum of 10.0% (random sampling) of each remaining pipe type on the project to ensure proper jointing, clear flow, and that line, grade, and deformations (if applicable) do not exceed allowable limits. The **RCE** will perform these inspections with a combination of either:

- A. Video Camera (condition, jointing, & obstructions) & Laser Profiler/Deflectometer (line, grade & shape)
- B. Video Camera (condition, jointing, & obstructions) & Direct Measurement (line & grade) & either 9-Fin Mandrel (shape) for pipes 48-inch diameter and smaller or Direct Measurement (shape) for pipes larger than 48-inch diameter.

These inspections will be performed and submitted by a **SCDOT certified Earthwork, Drainage, & Base Technician**. Inspections of completed pipe installations will be performed after the embankment is in place and all non-asphalt bases and/or subgrades have been completed for at least 30 days.

For inspections performed on behalf of the **RCE**, submit a report of the inspection results, including a copy of all video taken from each video camera inspection, pipe location identification, equipment used for inspection, inspector name, deviation from design grade (expressed in inches), deviation from line (expressed in inches), deflection (expressed in inches and % of pipe diameter where applicable), and any inspector field notes.

When improper installation or damage is noted in any prior inspection (visual, compaction, installation, etc.) of the pipe, repair the pipe installation to the satisfaction of the **RCE**. The **RCE** may perform additional inspections until confidence is restored that the remaining pipe has been installed in accordance with these specifications and is performing satisfactorily.

For concrete pipe, when signs of distress, such as differential movement, efflorescence, spalling, rust stains or cracks wider than 0.01 inch are present in the pipe, prepare a report for submittal to the **RCE**. This report must address: structural integrity, environmental conditions, design service life of the pipe, and recommended remediation. The **RCE** must accept both the remediation report and recommended repair procedure. At a minimum, seal cracks having widths equal to or greater than 0.01 inch and considered to be detrimental by the **RCE** in accordance with manufacturer's instructions. Replace pipes having cracks greater than 0.1 inch determined to be beyond satisfactory structural repair. Repair or replace pipes having displacement across the crack. Repair or replace pipes exhibiting spalls or delaminations.

1.3.11 Installing Pipe Culvert Under Existing Pavement (RCP)

On projects where the original approach pavement structure is being retained, lay the pipe culvert as herein specified. Repair the portion of the pavement structure removed due to the excavation of the trench using the same type of materials used in the original construction. The **RCE** may accept the use of other materials as deemed appropriate. Perform the work to the satisfaction of the **RCE**. Include the cost of the materials and the labor involved in the unit bid price for the culvert pipe.

1.3.12 Placing Pipe Under Railroads and Other Transportation Facilities (RCP)

When the plans include the installation of pipe under railroads or other transportation facilities not under the jurisdiction of the Department, unless otherwise provided, install the pipe using such methods, materials, and procedures required by the owner. There is no extra compensation for this change in methods, materials, and procedures. This requirement does not apply to the installation under roadways.

1.3.13 Cleaning Out Pipe (RCP)

Thoroughly clean out the entire length of newly installed pipe culverts. No additional payment will be made for the cleaning out of newly installed pipe culverts.

1.4 Measurement (RCP)

The quantity for the items Culvert Pipe, of the size, kind, class, thickness or type specified is measured in linear feet of the net length of culvert pipe complete in place and accepted.

The quantity of pipe culvert is measured for payment by the length of the centerline of each pipe run, in linear feet (LF), complete and in place. The length is obtained by adding the centerline length of each run of pipe between Drainage Structures and End Treatments.

The quantity for the items pipe culvert tees, wyes, elbows, bends, reducers, and increasers of the size, kind, class, thickness or type specified is measured by each item.

The quantity for the items pipe culvert beveled ends, flared ends, pipe end structures, wingwall/apron system, and drainage structures is measured by each unit, complete in place and accepted. Do not include the length of beveled ends, flared ends, pipe end structures, wingwall/apron system, or drainage structures in the linear feet of culvert pipe when measured as provided herein.

The quantity for the excavation of unyielding, unstable, or otherwise unsuitable material necessary to obtain a satisfactory foundation for pipe culverts as specified in **Subsection 1.3.2**, is measured as provided in **SCDOT Standard Specifications Subsection 203.5**. Dispose of the unstable material in the manner outlined in **SCDOT Standard Specifications Subsection 203.2.1.5**.

No measurement will be made for the removal of existing pipe culverts that will be replaced by new culverts. No measurement will be made for pipe inspection.

1.5 Payment (RCP)

Culvert pipe and end treatments, measured as provided in **Subsection 1.4**, are paid for at the contract unit price for the respective items, which price and payment is compensation for furnishing all material, labor, equipment, tools including hauling and placing all pipe sections and materials, excavation, bedding, and pipe structural backfill new or existing trench (both structural and embankment backfill in this region), removal of existing pipe to be replaced, constructing pipe joints, removal of old end treatments, cleaning out pipe, disposal of surplus materials, all visual inspection, and all incidentals necessary to complete the work.

The quantities for the items pipe culvert tees, wyes, elbows, bends, reducers, and increasers measured as provided in **Subsection 1.4**, are paid for by the difference in fabrication, handling, and installation cost between the item and the equivalent length of the largest diameter pipe being connected.

The excavation of unyielding or unstable material, measured as provided in **Subsection 1.4**, is paid for at the contract unit price for Unclassified Excavation in accordance with **SCDOT Standard Specifications Subsection 203.6**.

All work associated with the excavation, removal and disposal of existing pipe culverts that will be replaced by a new structure will be paid for in the pay item of the new structure.

Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.

Pay items are listed in **Subsection 5**.

1.6 Referenced Documents (RCP)

SCDOT Standard Specifications for Highway Construction

SCDOT Supplemental Technical Specifications:

SC-T-29

SCDOT Supplemental Specifications:

SCDOT Supplemental Specifications for Geotextile for Drainage Filtration

SCDOT Qualified Product Listings:

Qualified Product Listing 1
Qualified Product Listing 3
Qualified Product Listing 13
Qualified Product Listing 60

AASHTO Standard Specifications for Transportation Materials & Methods of Sampling and Testing:

AASHTO M 32
AASHTO M 55
AASHTO M 145
AASHTO M 170
AASHTO M 198
AASHTO M 207
AASHTO M 221
AASHTO M 225
AASHTO M 295
AASHTO M 302
AASHTO M 315
AASHTO T 96
AASHTO T 104

ASTM Standard Specifications:

ASTM A 706
ASTM C 443

2 Corrugated Aluminum Alloy & Spiral Ribbed Aluminum Pipe (CAAP&SRAP)

2.1 Description (CAAP&SRAP)

This section contains specifications for the materials, construction, measurement, and payment for furnishing corrugated aluminum alloy pipes (CAAP) and pipe arches and spiral ribbed aluminum pipe (SRAP) of the size, shape, type, and dimensions indicated on the plans and installing them to provide drainage structures at places designated on the plans or by the **RCE** in accordance with these specifications and true to the lines and grades shown on the plans or otherwise given by the **RCE**. This work includes the furnishing and installing of necessary tee, wye, elbow and bend joints, and making connections to existing and/or new structures, including drilling and chipping as is necessary to complete the work.

2.2 Materials (CAAP&SRAP)

Use only materials specified herein for the several items that constitute the finished pipe culvert.

Provide corrugated aluminum alloy pipe, pipe-arch, and spiral ribbed aluminum pipe conforming to **AASHTO M 196**. Provide the **RCE** certification that the pipe meets the requirements of **AASHTO M 196**. Ensure that the thickness of the pipe is in accordance with the plans.

Use sheet that has been marked and conforms to **AASHTO M 197**. Use permanent sheet markings which identify the name or trademark of sheet manufacturer; alloy and temper; specified thickness or gage; date of manufacture by a six-digit number indicating in order the year, month, and day of the month; and designation number **AASHTO M 197**.

Use a permanent sheet marking method to mark pipe with pipe fabrication information. Mark fabricated pipe with name or trademark of pipe fabricator, date of fabrication of pipe by a six-digit number indicating in order the year, month, and day of the month, designation number **AASHTO M 196**. Align identifying markings with the direction of corrugation and spaced in accordance with **ASTM B 666**.

Mark fittings with the manufacturer's identification symbol and specification designation **AASHTO M 196**.

When geotextile for drainage filtration is required, follow **SCDOT Supplemental Specifications for Geotextile for Drainage Filtration**.

2.3 Construction Requirements (CAAP&SRAP)

2.3.1 Handling and Storage (CAAP&SRAP)

Inspect pipe before it is installed. Check pipe for proper markings and for signs of damage due to fabrication or shipment. Pipe may be rejected due to improper marking, incorrect pipe gage, corrugation, size, or strength. Pipe may also be rejected due to damage which may include, but is not limited to dents, tears, gaps, or deformations that would adversely affect the strength or function of the pipe. Damage to the end of the pipe including open seams (particularly at rerolled ends) or ends not normal to the walls or centerline of the pipe that prevent satisfactory joint installation may also be rejected. Defective or damaged gaskets may require replacement, but are not cause for rejection of pipe that meets the above requirements.

Handle and store pipe such that no damage occurs to the pipe. Unload the pipe at a site that is relatively flat and level, free of debris, and away from construction traffic. Ensure that fittings and other components are lifted and moved safely using appropriate unloading and handling equipment.

2.3.2 Trench for Pipe (CAAP&SRAP)

Lay the pipe in a trench where possible. Excavate trenches to the required grade and to a width sufficient to allow for proper jointing of the pipe and for thorough compaction of the structural backfill material under and around the pipe. Excavate the trench to a width which is 1.5 times the pipe outside diameter plus 12 inches, 1.0 times the pipe outside diameter plus 24 inches, or the width required to safely fit compaction equipment and personnel between the pipe and the trench walls, whichever is greater. When using controlled low strength material (CLSM) backfill, excavate the trench to a minimum width of the outside diameter of the pipe plus 12 inches. Make certain that the trench bottom gives full support to the pipe throughout its length.

Where pipe culverts will be placed in new embankments, first construct the embankments to a height of approximately 1/2 the diameter of the pipe above the top of the designated pipe or to such height as directed by the **RCE**. Construct the embankment for a distance of not less than 5 times the diameter of the pipe on each side of the pipe location, after which excavate the trench in the embankment as described in this section above.

When excavating for pipe culverts, if rock, hard pan, or other unyielding foundation material is encountered, excavate the hard unyielding material below the elevation of the bottom of the pipe or pipe bell to a minimum depth of 8 inches below the bottom of the pipe.

Follow OSHA safety requirements for trenching. If trench width or wall slopes are changed due to safety requirements, backfill the trench outside of the normal trench dimensions with either embankment material or backfill material described in **Subsection 2.3.6**.

When supports such as trench boxes are used, ensure that support of the pipe and its embedment are maintained throughout the installation. Ensure that sheeting is sufficiently tight to prevent washing out of native soil from behind the trench box. Follow pipe manufacturer's trench box recommendations in order to comply with OSHA safety requirements while preventing loss of support in the bedding and structural backfill when moving trench boxes. Use sloped trench walls or CLSM when either structural backfill or trench box safety requirements cannot be followed.

Do not disturb the installed pipe and its embedment when moving trench boxes. Do not use trench boxes below the top of the pipe zone unless methods, agreed upon in advance with the RCE, are used for maintaining the integrity of the embedment material. As supports are moved, all voids left by the trench walls below the top of the pipe zone must be filled with specified structural backfill described in **Subsection 2.3.6**, compacted per these specifications.

Provide for temporary diversion of water or pumping as may be necessary in order to permit dry installation of the culvert. Keep trenches free from water until any joint sealant material has hardened sufficiently.

2.3.2.1 Foundation for Pipe (CAAP&SRAP)

Unless noted otherwise in the plans or by the **RCE**, support pipe using foundation material that meets the minimum requirements of the roadway embankment.

When a firm foundation is not encountered at the required grade, remove unstable material at least 1 diameter on each side of the pipe and deep enough to provide appropriate support to the pipe or as specified by the **RCE**. Backfill and compact with soil and methods specified for the embankment materials up to the bottom of the bedding. Provide trench suitable to accommodate site conditions and obstructions.

2.3.3 Bed for Pipe (CAAP&SRAP)

For bedding material, use well-graded sand or gravel meeting the requirements of A-1 (**AASHTO M 145**).

Uniformly graded coarse-grained soils A-3 (**AASHTO M 145**) can be used if provisions are made to evaluate and control possible soil migration into open voids. Completely wrap bedding with geotextile for drainage filtration when uniformly graded materials are used to prevent soil migration.

Ensure that trenches are free of water when placing bedding.

Support the pipe by placing uncompacted bedding material for a depth of 10.0% of the pipe outside diameter or 3 inches (6 inches when placing pipe on rock) whichever is greater. Prepare bedding material at pipe joints and projected hubs if present to prevent excess loading and to provide uniform support in these areas.

Compact bedding material that is outside of the middle third pipe diameter in order to ensure proper support of the pipe. Ensure that bedding material outside the middle third of pipe is compacted to a minimum of 95.0% of the maximum dry density when measured in accordance to **SC-T-29**. Ensure that compaction of bedding material does not cause the pipe to move.

Do not use controlled low strength material (CLSM), flowable fills or concrete for pipe bedding.

2.3.4 Laying Pipe (CAAP&SRAP)

Begin pipe laying at the downstream end of the culvert.

Make certain each section of pipe has a full firm bearing throughout its length, true to line and grade given. Make certain that all supports are uniform (without point loading from irregular backfill) and that joints have been properly accommodated. Remove pipe that settles before final acceptance or which is not in alignment and re-lay without extra compensation.

Prior to being lowered into the trench, closely examine corrugated metal pipe sections and fit so that they will form a true line of pipe when in place. Do not use sections that do not fit together properly.

Place distorted circular metal pipes with the major axis vertical. If rods, struts, or other means are used to maintain pipe distortion, do not remove them before the completion of the embankment unless otherwise permitted by the **RCE**.

Before laying the pipe or during the pipe laying operations, construct adequate outfall ditches and inlets free of obstructions in order that proper drainage is provided.

When pipes are connected to drainage structures, install or cut pipe flush with inside face of drainage structure. When pipes are connected to end treatments such as slabs or headwalls, install or cut pipe flush with exposed face of end treatment. When pipe culverts are installed connecting to pipe of different material or connection details, use a standard drainage structure or designed interface as directed by the **RCE**. Where pipe culverts are constructed in conjunction with existing structures, make connections to the satisfaction of the **RCE**.

2.3.5 Joints (CAAP&SRAP)

For CAAP & SRAP, submit joint material manufacturer installation recommendations to **RCE** before installation of pipe. Follow joint material manufacturer's recommendations

for installation procedure. Follow pipe manufacturer's recommendations for maximum joint opening to meet tightness requirements specified in the plans or contract documents. Order pipe and appropriate joint material from pipe manufacturer.

ASTM D 1056 Joints (CAAP&SRAP)

For CAAP and SRAP, rerolled pipe ends with annular corrugations are allowed. Use fully corrugated aluminum coupling bands with welded angle brackets that conform to the requirements of **AASHTO M 196** article 9 unless specified otherwise in the plans. Use minimum 1/2 inch diameter galvanized **ASTM A 307** bolts and nuts to connect all size coupling bands and follow minimum quantity requirements shown on **SCDOT Standard Drawings**. Use closed cell expanded rubber strip or sleeve gaskets conforming to **ASTM D 1056**.

Manufacturer must certify that the pipe, coupling band, and gasket combination meets the laboratory 10 psi pressure test. Make certain that the strip or sleeve gaskets are at least as wide as the coupling band (12 inches minimum) and approximately 3/8 inch thick minimum. Rubber O-ring gaskets are not allowed since they are not visible from the inside of the pipe after installation.

Carefully clean pipe ends to remove all debris that could hinder proper sealing of the pipe and gasket. Liberally lubricate gaskets and outside pipe surfaces in contact with the gasket using a lubricant specified by the gasket manufacturer. Lubricate the inside surfaces of the coupling band, check for proper position, and adjust if required to match corrugations. If necessary, fold gasket over itself to allow placement of joining pipe, then unfold over newly placed pipe. Snap the gasket several times to allow for final seating. Confirm that the separation between pipe ends is less than one corrugation of the coupling band and that no foreign matter is present between the gasket and the pipe/coupling band surfaces. Pull coupling band ends together using a long bolt if needed to start the band lap. Make sure that coupling band corrugations align with corrugations of pipe. When helical corrugations are used, if necessary, rotate coupling band to align with previously installed pipe or rotate newly installed pipe to align with coupling band. Insert final bolts and tighten to snug tight conditions (approximately 25-30 ft-lb of torque) or manufacturer recommendations. Tap the band with a rubber mallet during tightening to ensure uniform seating of the gasket. Ensure that band corrugations are fully seated into corrugations of both pipes before proceeding to next pipe connection.

2.3.6 Pipe Structural Backfill (CAAP&SRAP)

Advise the **RCE** of the time Pipe Structural Backfill operations are expected to begin. If not properly advised, the **RCE** may require the excavation and reinstallation of the structural backfill material.

For structural backfill material use well-graded sand or gravel meeting the requirements of A-1 (**AASHTO M 145**).

Uniformly graded coarse-grained soils A-3 (**AASHTO M 145**) can be used for backfill if provisions are made to evaluate and control possible migration of fines into open voids. Completely wrap backfill with geotextile for drainage filtration when uniformly graded materials are used to prevent soil migration. If uniformly graded coarse-grained soils A-3 (**AASHTO M 145**) are used for both the bedding and the backfill, wrap the entire bedding and backfill envelope with geotextile for drainage filtration.

Controlled low strength material (CLSM) and controlled density fill are flowable fills which may be used for structural backfill in the haunch area and above. Select a flowable fill mix design that can be excavated. When using CLSM backfill excavate the trench to a width that is a minimum of the outside pipe diameter plus 12 inches but no wider than the outside pipe diameter plus 20 inches. Do not use CLSM when placing perforated pipe. When using CLSM ensure that the pipe is not displaced while using methods that do not damage the pipe.

Ensure that trenches are free of water when placing and compacting structural backfill.

Thoroughly compact the structural backfill material layers not exceeding 6 inches of compacted material. The first lift must be sufficiently below the spring line such that the material can be worked into the haunch zone of the pipe. Perform compaction by the use of mechanical tampers with the assistance of hand tamps when necessary. Thoroughly compact the structural backfill under the haunches of the pipe and ensure that the backfill soil is in continuous uniform contact with the side and joints of the pipe. Exercise sufficient care to prevent damaging or misaligning the pipe with the compaction equipment.

Install and compact structural backfill on both sides of pipe before adding the next lift of backfill material. Evenly distribute structural backfill on both sides of the pipe for its full length. Ensure that Pipe Structural Backfill process does not cause joint separation or displacement of the installed pipe.

Ensure that the compaction of structural backfill is a minimum of 95.0% of the maximum dry density when measured in accordance with **SC-T-29**. To ensure appropriate compaction, divide the pipe placement into 50-foot lots as directed by the **RCE**.

The **RCE** will test the compaction of each 6-inch lift in each 50-foot lot starting from the pipe bedding up to the minimum cover depth for the pipe. This compaction testing will be performed on alternating sides of the pipe at random locations within the 50-foot lot to ensure that the material within the pipe embedment zone has been compacted to 95.0% of the maximum dry density for the structural backfill when measured in accordance with **SC-T-29**. For all tests, insert the nuclear gauge probe to its full depth or within 2 to 3 inches of the bottom of the layer being tested, whichever is less. In the event of a non-conforming compaction measurement, recompact the entire 50-foot lot before the compaction is tested again by the **RCE** at the same location and one other location within the 50-foot lot. Continue reworking the structural backfill until all tests indicate conformance with the compaction requirements.

Complete structural backfill installation up to the minimum cover elevation above the pipe or to the top of the trench when the top of the pipe is within 3 feet of the finished grade.

Confirm that structural backfill material in pipe trench meets or exceeds the embankment compaction requirements before applying final pavement surface.

2.3.7 Cover Height (CAAP&SRAP)

Ensure that the minimum and maximum cover is in accordance with the height of cover tables in the **SCDOT Standard Drawings**.

2.3.8 Construction Loads (CAAP&SRAP)

Fill height requirements may dictate that more fill is required during construction than for final design. In all cases, install backfill to the minimum construction fill height specified in the **SCDOT Standard Drawings** before driving heavy equipment over pipe. Maintain this minimum cover until heavy equipment usage is discontinued so that damage does not occur to the pipe. Install and remove backfill required due to the construction loading on the pipe at no expense to **SCDOT**. Repair all damage or displacement at no expense to **SCDOT**.

2.3.9 Structures and End Treatments (CAAP&SRAP)

When not included in the plans, follow **SCDOT Standard Drawings** for connections of pipe to drainage structures, manholes, end treatments, or other buried structures.

Construct end treatment (minimum Class B riprap, pipe end structure, concrete slab, wingwall/apron system, etc.) as indicated in the plans or **SCDOT Standard Drawings**.

When scour issues are observed on site, construct a cast in place concrete cut-off wall a minimum of two feet below the scour depth to protect the end treatment and pipe or as directed by the **RCE**.

2.3.10 Installation Inspection (CAAP&SRAP)

Visually inspect 100% of pipe for dents, tears, gaps, deformations, or open seams at any location in the pipe during all phases of the installation process. Inspect joints for missing, damaged, or improperly installed gaskets and fully tightened and properly located coupling bands.

The **RCE** will inspect 100% of pipe under the pavement, and a minimum of 10.0% (random sampling) of each remaining pipe type on the project to ensure proper jointing, clear flow, and that line, grade, and deformations (if applicable) do not exceed allowable limits. The **RCE** will perform these inspections with a combination of either:

- A. Video Camera (condition, jointing, & obstructions) & Laser Profiler/Deflectometer (line, grade & shape)
- B. Video Camera (condition, jointing, & obstructions) & Direct Measurement (line & grade) & either 9-Fin Mandrel (shape) for pipes 48-inch diameter and smaller or Direct Measurement (shape) for pipes larger than 48-inch diameter.

These inspections will be performed and submitted by a **SCDOT certified Earthwork, Drainage, & Base Technician**. Inspections of completed pipe installations will be performed after the embankment is in place and all non-asphalt bases and/or subgrades have been completed for at least 30 days..

For inspections performed on behalf of the **RCE**, submit a report of the inspection results, including a copy of all video taken from each video camera inspection, pipe location identification, equipment used for inspection, inspector name, deviation from design grade (expressed in inches), deviation from line (expressed in inches), deflection (expressed in inches and % of pipe diameter where applicable), and any inspector field notes.

When improper installation or damage is noted in any prior inspection (visual, compaction, installation, etc.) of the pipe, repair the pipe installation to the satisfaction of the **RCE**. The **RCE** may perform additional inspections until confidence is restored that the remaining pipe has been installed in accordance with these specifications and is performing satisfactorily.

For aluminum pipe, when pipe distress such as cracking, wall damage (dents, bulges, creases, cracks and tears) and deflection or poorly shaped cross-section are present in the pipe, prepare a report for submittal to the **RCE**. This report must address: structural integrity, environmental conditions, design service life of the pipe, and recommended remediation. Upon acceptance of the report by the **RCE**, and at a minimum, implement the following: Replace, repair or remediate locations as recommended in the report or by the **RCE**. Replace locations where the measured deflection is greater than 5.0% of the nominal inside diameter of the pipe, or where directed by the **RCE**.

2.3.11 Installing Pipe Culvert Under Existing Pavement (CAAP&SRAP)

On projects where the original approach pavement structure is being retained, lay the pipe culvert as herein specified. Repair the portion of the pavement structure removed due to the excavation of the trench using the same type of materials used in the original construction. The **RCE** may accept the use of other materials as deemed appropriate. Perform the work to the satisfaction of the **RCE**. Include the cost of the materials and the labor involved in the unit bid price for the culvert pipe.

2.3.12 Placing Pipe Under Railroads and Other Transportation Facilities (CAAP&SRAP)

When the plans include the installation of pipe under railroads or other transportation facilities not under the jurisdiction of the Department, unless otherwise provided, install the pipe using such methods, materials, and procedures required by the owner. There is no extra compensation for this change in methods, materials, and procedures. This requirement does not apply to the installation under roadways.

2.3.13 Cleaning Out Pipe (CAAP&SRAP)

Thoroughly clean out the entire length of newly installed pipe culverts. No additional payment will be made for the cleaning out of newly installed pipe culverts.

2.4 Measurement (CAAP&SRAP)

The quantity for the items Culvert Pipe, of the size, kind, class, thickness or type specified is measured in linear feet of the net length of culvert pipe complete in place and accepted.

The quantity of pipe culvert is measured for payment by the length of the centerline of each pipe run, in linear feet (LF), complete and in place. The length is obtained by adding the centerline length of each run of pipe between drainage structures and end treatments.

The quantity for the items pipe culvert tees, wyes, elbows, bends, reducers, and increasers of the size, kind, class, thickness or type specified is measured by each item.

The quantity for the items pipe culvert beveled ends, flared ends, pipe end structures, wingwall/apron system, and drainage structures is measured by each unit, complete in place and accepted. Do not include the length of beveled ends, flared ends, pipe end structures, wingwall/apron system, or drainage structures in the linear feet of culvert pipe when measured as provided herein.

The quantity for the excavation of unyielding, unstable, or otherwise unsuitable material necessary to obtain a satisfactory foundation for pipe culverts as specified in **Subsection 2.3.2**, is measured as provided in **SCDOT Standard Specifications Subsection 203.5**. Dispose of the unstable material in the manner outlined in **SCDOT Standard Specifications Subsection 203.2.1.5**.

No measurement will be made for the removal of existing pipe culverts that will be replaced by new culverts. No measurement will be made for pipe inspection.

2.5 Payment (CAAP&SRAP)

Culvert pipe and end treatments measured as provided in **Subsection 2.4**, are paid for at the contract unit price for the respective items, which price and payment is compensation for furnishing all material, labor, equipment, tools including hauling and placing all pipe sections and materials, excavation, bedding, and pipe structural backfill new or existing trench, removal of existing pipe to be replaced, constructing pipe joints, removal of old end treatments, cleaning out pipe, disposal of surplus materials, all visual inspection, and all incidentals necessary to complete the work.

The quantities for the items pipe culvert tees, wyes, elbows, bends, reducers, and increasers measured as provided in **Subsection 2.4**, are paid for by the difference in fabrication, handling, and installation cost between the item and the equivalent length of the largest diameter pipe being connected.

The excavation of unyielding or unstable material, measured as provided in **Subsection 2.4**, is paid for at the contract unit price for Unclassified Excavation in accordance with **SCDOT Standard Specifications Subsection 203.6**.

All work associated with the excavation, removal and disposal of existing pipe culverts that will be replaced by a new structure will be paid for in the pay item of the new structure.

Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.

Pay items are listed in **Subsection 5**.

2.6 Referenced Documents (CAAP&SRAP)

SCDOT Standard Specifications for Highway Construction

SCDOT Supplemental Technical Specifications:

SC-T-29

SCDOT Supplemental Specifications:

SCDOT Supplemental Specifications for Geotextile for Drainage Filtration

AASHTO Standard Specifications for Transportation Materials & Methods of Sampling and Testing:

AASHTO M 145

AASHTO M 196

AASHTO M 197

ASTM Standard Specifications:

ASTM A 307

ASTM B 666

ASTM D 1056

3 Corrugated High Density Polyethylene Culvert Pipe (HDPE)

3.1 Description (HDPE)

This section contains specifications for the materials, construction, measurement, and payment for furnishing corrugated high density polyethylene culvert pipe (HDPE) of the size, shape, type, and dimensions indicated on the plans and installing them to provide drainage structures at places designated on the plans or by the **RCE** in accordance with these specifications and true to the lines and grades shown on the plans or otherwise given by the **RCE**. This work includes the furnishing and installing of necessary tee, wye, elbow, and bend joints, and making connections to existing and/or new structures, including drilling and chipping as is necessary to complete the work.

3.2 Materials (HDPE)

Provide corrugated high density polyethylene culvert pipe conforming to the requirements of **AASHTO M 294**, Type S, as required.

For **AASHTO M 294**, Type S pipe, provide pipe with an outer corrugated high density pipe wall and a smooth inner liner. Use only **AASHTO M 294**, Type S pipe in permanent applications.

Use only materials from sources complying with the **SCDOT Qualified Product Listing Policy 30** and appearing on the **SCDOT Qualified Product Listing 30**.

Have manufacturer furnish with each shipment of materials a certification showing brand name, the shipping date and to whom it is shipped, and the quantity and size of pipe represented. Ensure that the certificate contains a statement that the material meets the **SCDOT** specifications and is essentially the same as that qualified by the Department. Ensure that the shipped pipe is plainly marked with the manufacturer's name, trademark, nominal size, specification designation **AASHTO M 294**, Type S, plant designation code, the date of manufacture or an appropriate code, and certification stamp from PPI or NTPEP. Ensure that the shipped fittings are plainly marked with the manufacturer's identification symbol and specification designation **AASHTO M 294**, Type S. Furnish a materials safety data sheet and installation instructions with each shipment. Ensure that all HDPE pipe is certified by the **PPI** or **AASHTO NTPEP** third party certification programs.

When geotextile for drainage filtration is required, follow **SCDOT Supplemental Specifications for Geotextile for Drainage Filtration**.

3.3 Construction Requirements (HDPE)

3.3.1 Handling and Storage (HDPE)

Inspect pipe before it is installed. Check pipe for proper markings and for signs of damage due to fabrication or shipment. Pipe may be rejected due to improper marking, incorrect pipe type, size, or strength. Pipe may also be rejected due to damage which may include, but is not limited to cuts, gouges, delaminations, bulges, flat areas, bubbles, dents, tears, breaks, gaps, missing or malformed corrugations, or deformations that would adversely affect the strength or function of the pipe. Damage to the end of the pipe including damage to bell or spigot, or ends that are not normal to the walls or centerline of the pipe that prevent satisfactory joint installation may also be rejected. Defective or damaged gaskets may require replacement, but are not cause for rejection of pipe that meets the above requirements.

Handle and store pipe such that no damage occurs to the pipe. Unload the pipe at a site that is relatively flat and level, free of debris, and away from construction traffic.

3.3.2 Trench for Pipe (HDPE)

Lay the pipe in a trench where possible. Excavate trenches to the required grade and to a width sufficient to allow for proper jointing of the pipe and for thorough compaction of the structural backfill material under and around the pipe. Excavate the trench to a width

which is 1.5 times the pipe outside diameter plus 12 inches, 1.0 times the pipe outside diameter plus 24 inches, or the width required to safely fit compaction equipment and personnel between the pipe and the trench walls, whichever is greater. When using controlled low strength material (CLSM) backfill, excavate the trench to a minimum width of the outside diameter of the pipe plus 12 inches. Make certain that the trench bottom gives full support to the pipe throughout its length.

Where pipe culverts will be placed in new embankments, first construct the embankments to a height of approximately 1/2 the diameter of the pipe above the top of the designated pipe or to such height as directed by the **RCE**. Construct the embankment for a distance of not less than 5 times the diameter of the pipe on each side of the pipe location, after which excavate the trench in the embankment as described in this section above.

When excavating for pipe culverts, if rock, hard pan, or other unyielding foundation material is encountered, excavate the hard unyielding material below the elevation of the bottom of the pipe or pipe bell to a minimum depth of 8 inches below the bottom of the pipe.

Follow OSHA safety requirements for trenching. If trench width or wall slopes are changed due to safety requirements, backfill the trench outside of the normal trench dimensions with either embankment material or backfill material described in **Subsection 1.3.6**.

When supports such as trench boxes are used, ensure that support of the pipe and its embedment are maintained throughout the installation. Ensure that sheeting is sufficiently tight to prevent washing out of native soil from behind the trench box. Follow pipe manufacturer's trench box recommendations to comply with OSHA safety requirements while preventing loss of support in the bedding and structural backfill when moving trench boxes. Use sloped trench walls or CLSM when either structural backfill or trench box safety requirements cannot be followed.

Do not disturb the installed pipe and its embedment when moving trench boxes. Do not use trench boxes below the top of the pipe zone unless methods, agreed upon in advance with the **RCE**, are used for maintaining the integrity of the embedment material. As supports are moved, all voids left by the trench walls below the top of the pipe zone must be filled with specified structural backfill described in **Subsection 3.3.6**, compacted per these specifications.

Provide for temporary diversion of water or pumping as may be necessary in order to permit dry installation of the culvert. Keep trenches free from water until any joint sealant material has hardened sufficiently.

3.3.2.1 Foundation for Pipe (HDPE)

Unless noted otherwise in the plans or by the **RCE**, support pipe using foundation material that meets the minimum requirements of the roadway embankment.

When a firm foundation is not encountered at the required grade, remove unstable material at least 1 diameter on each side of the pipe and deep enough to provide

appropriate support to the pipe or as specified by the **RCE**. Backfill and compact with soil and methods specified for the embankment materials up to the bottom of the bedding. Provide trench suitable to accommodate site conditions and obstructions.

3.3.3 Bed for Pipe (HDPE)

For bedding material use well-graded sand or gravel meeting the requirements of A-1 (**AASHTO M 145**).

Uniformly graded coarse-grained soils A-3 (**AASHTO M 145**) can be used if provisions are made to evaluate and control possible soil migration into open voids. Completely wrap bedding with geotextile for drainage filtration when uniformly graded materials are used to prevent soil migration.

Ensure that trenches are free of water when placing bedding.

Support the pipe by placing uncompacted bedding material for a depth of 10.0% of the pipe outside diameter or 3 inches (6 inches when placing pipe on rock) whichever is greater. Prepare bedding material at pipe joints and projected hubs if present to prevent excess loading and to provide uniform support in these areas.

Compact bedding material that is outside of the middle third pipe diameter to ensure proper support of the pipe. Ensure that bedding material outside the middle third of pipe is compacted to a minimum of 95.0% of the maximum dry density when measured in accordance to **SC-T-29**. Ensure that compaction of bedding material does not cause the pipe to move.

Do not use controlled low strength material (CLSM), flowable fills or concrete for pipe bedding.

3.3.4 Laying Pipe (HDPE)

Begin pipe laying at the downstream end of the culvert with the bell or groove ends and outside laps upstream.

Make certain each section of pipe has a full firm bearing throughout its length, true to line and grade given. Make certain that all supports are uniform (without point loading from irregular backfill) and that bells have been properly accommodated. Remove pipe that settles before final acceptance or which is not in alignment and re-lay without extra compensation.

Before laying the pipe or during the pipe laying operations, construct adequate outfall ditches and inlets free of obstructions in order that proper drainage is provided.

When pipes are connected to drainage structures, install or cut pipe flush with inside face of drainage structure. When pipes are connected to end treatments such as slabs or headwalls, install or cut pipe flush with exposed face of end treatment. When pipe culverts are installed connecting to pipe of different material of connection details, use a

standard drainage structure or designed interface as directed by the **RCE**. Where pipe culverts are constructed in conjunction with existing structures, make connections to the satisfaction of the **RCE**.

3.3.5 Joints (HDPE)

Submit joint material manufacturer installation recommendations to **RCE** before installation of pipe. Follow joint material manufacturer's recommendations for installation procedure. Follow pipe manufacturer's recommendations for proper joint seating. Follow **ASTM D 2321** for joint installation procedures. Order pipe and appropriate joint material from pipe manufacturer.

3.3.5.1 Standard Joint

Use a bell and spigot type connection with an elastomeric rubber seal meeting **ASTM F477** and meeting the requirements specified in the plan and by the pipe manufacturer. Ship pipe with gasket installed. Certify that the pipe and gasket system meet or exceed the laboratory 10 psi internal pressure test of **ASTM D 3212**. Provide, to the **RCE**, manufacturer's certification that gaskets are manufactured in accordance with the requirements of **ASTM F 477** and do not have any visible cracking when tested according to **ASTM D 1149**. Store bell and spigot type pipe in alternating rows to prevent bell flattening. Cover gaskets with a protective wrap during storage to prevent damage to the gasket. Inspect pipe to ensure that pipe joint components are clean and free from damage or defect before installation. Mark or verify that the pipe ends are marked to indicate the insertion stop position. If pipe bell is manufactured separately from pipe, ensure it is securely installed before proceeding with installation. Lubricate inside and leading edge of bell with a lubricant, specified by the pipe manufacturer, that does not cause damage or deterioration to the gasket material. Use installation methods that do not damage pipe, bell, spigot or gasket. Push the spigot end of the pipe being laid into the bell end of the pipe already installed up to the marked insertion stop point while maintaining true line and grade. Follow manufacturer recommendations on construction devices to use to prevent damage to the pipe. Do not use excessive force that may result in over-assembled joints or dislodged gaskets. If pipe is not fully installed to the marked insertion point, disassemble joints, clean and reinstall joint as described above. Ensure that pipe installed has proper line and grade before installing next pipe section.

3.3.5.2 Field Fabricated Joint

Use field fabricated joints only outside of roadbed and driveways. Splice two field cut pieces of HDPE pipe, using a split coupler band with an elastomeric rubber seal meeting **ASTM F 477**.

Wrap entire joint with a geotextile for drainage filtration to prevent the migration of soils into the pipe or to meet a silt tight designation per **AASHTO M 294**. Geotextile fabric shall extend 12 inches either side of the joint and overlap at least 18 inches. No additional payment will be made for the use and installation of split coupler bands.

3.3.6 Pipe Structural Backfill (HDPE)

Advise the **RCE** of the time Pipe Structural Backfill operations are expected to begin. If not properly advised, the **RCE** may require the excavation and reinstallation of the structural backfill material.

For structural backfill material use well-graded sand or gravel meeting the requirements of A-1 (**AASHTO M 145**).

Uniformly graded coarse-grained soils A-3 (**AASHTO M 145**) can be used for backfill if provisions are made to evaluate and control possible migration of fines into open voids. Completely wrap backfill with geotextile for drainage filtration when uniformly graded materials are used to prevent soil migration. If uniformly graded coarse-grained soils A-3 (**AASHTO M 145**) are used for both the bedding and the backfill, wrap the entire bedding and backfill envelope with geotextile for drainage filtration.

Controlled low strength material (CLSM) and controlled density fill are flowable fills that may be used for structural backfill in the haunch area and above. Select a flowable fill mix design that can be excavated. When using CLSM backfill excavate the trench to a width that is a minimum of the outside pipe diameter plus 12 inches but no wider than the outside pipe diameter plus 20 inches. Do not use CLSM when placing perforated pipe. When using CLSM ensure that the pipe is not displaced while using methods that do not damage the pipe.

Ensure that trenches are free of water when placing and compacting structural backfill.

Thoroughly compact the structural backfill material in layers not exceeding 6 inches of compacted material. The first lift must be sufficiently below the spring line such that the material can be worked into the haunch zone of the pipe. Perform compaction by the use of mechanical tampers with the assistance of hand tamps when necessary. Thoroughly compact the structural backfill under the haunches of the pipe and ensure that the backfill soil is in continuous uniform contact with the side and joints of the pipe. Exercise sufficient care to prevent damaging or misaligning the pipe with the compaction equipment.

Install and compact structural backfill on both sides of pipe before adding the next lift of backfill material. Evenly distribute structural backfill on both sides of the pipe for its full length. Ensure that Pipe Structural Backfill process does not cause joint separation or displacement of the installed pipe.

Ensure that the compaction of structural backfill is a minimum of 95.0% of the maximum dry density when measured in accordance with **SC-T-29**. To ensure appropriate compaction, divide the pipe placement into 50-foot lots as directed by the **RCE**.

The **RCE** will test the compaction of each 6-inch lift in each 50-foot lot starting from the pipe bedding up to the minimum cover depth for the pipe. This compaction testing will be performed on alternating sides of the pipe at random locations within the 50-foot lot to ensure that the material within the pipe embedment zone has been compacted to 95.0% of the maximum dry density for the structural backfill when measured in accordance with **SC-T-29**. For all tests, insert the nuclear gauge probe to its full depth or within 2 to 3 inches of the bottom of the layer being tested, whichever is less. In the event of a non-

conforming compaction measurement, recompact the entire 50-foot lot before the compaction is tested again by the **RCE** at the same location and one other location within the 50-foot lot. Continue reworking the structural backfill until all tests indicate conformance with the compaction requirements.

Complete structural backfill installation up to the minimum cover elevation above the pipe or to the top of the trench when the top of the pipe is within 3 feet of the finished grade. Confirm that structural backfill material in pipe trench meets or exceeds the embankment compaction requirements before applying final pavement surface.

3.3.7 Cover Height (HDPE)

Ensure that the minimum and maximum cover is in accordance with the height of cover tables in the **SCDOT Standard Drawings**.

3.3.8 Construction Loads (HDPE)

Fill height requirements may dictate that more fill is required during construction than for final design. In all cases, install backfill to the minimum construction fill height specified in the **SCDOT Standard Drawings** before driving heavy equipment over pipe. Maintain this minimum cover until heavy equipment usage is discontinued so that damage does not occur to the pipe. Install and remove backfill required due to the construction loading on the pipe at no expense to **SCDOT**. Repair all damage or displacement at no expense to **SCDOT**.

3.3.9 Structures and End Treatments (HDPE)

When not included in the plans, follow **SCDOT Standard Drawings** for connections of pipe to drainage structures, manholes, end treatments, or other buried structures.

Construct end treatment (minimum Class B riprap, pipe end structure, concrete slab, wingwall/apron system, etc.) as indicated in the plans or **SCDOT Standard Drawings**.

When scour issues are observed on site, construct a cast in place concrete cut-off wall a minimum of two feet below the scour depth to protect the end treatment and pipe or as directed by the **RCE**.

3.3.10 Installation Inspection (HDPE)

Visually inspect 100% of pipe for cuts, gouges, delaminations, bulges, flat areas, dents, tears, breaks or gaps during all phases of the installation process. Inspect joints for missing, damaged, or improperly installed gaskets and fully engaged bells and spigots.

The **RCE** will inspect 100% of pipe under the pavement, and a minimum of 10.0% (random sampling) of each remaining pipe type on the project to ensure proper jointing, clear flow, and that line, grade, and deformations (if applicable) do not exceed allowable limits. The **RCE** will perform these inspections with a combination of either:

- A. Video Camera (condition, jointing, & obstructions) & Laser Profiler/Deflectometer (line, grade & shape)
- B. Video Camera (condition, jointing, & obstructions) & Direct Measurement (line & grade) & either 9-Fin Mandrel (shape) for pipes 48-inch diameter and smaller or Direct Measurement (shape) for pipes larger than 48-inch diameter.

These inspections will be performed and submitted by a **SCDOT certified Earthwork, Drainage, & Base Technician**. Inspections of completed pipe installations will be performed after the embankment is in place and all non-asphalt bases and/or subgrades have been completed for at least 30 days.

For inspections performed on behalf of the **RCE**, submit a report of the inspection results, including a copy of all video taken from each video camera inspection, pipe location identification, equipment used for inspection, inspector name, deviation from design grade (expressed in inches), deviation from line (expressed in inches), deflection (expressed in inches and % of pipe diameter where applicable), and any inspector field notes.

When improper installation or damage is noted in any prior inspection (visual, compaction, installation, etc.) of the pipe, repair the pipe installation to the satisfaction of the **RCE**. The **RCE** may perform additional inspections until confidence is restored that the remaining pipe has been installed in accordance with these specifications and is performing satisfactorily.

For HDPE pipe, when installed pipe deflections exceed 5.0% of the inside diameter, prepare a report for submittal to the **RCE**. This report must address: structural integrity, environmental conditions, design service life of the pipe, and recommended remediation. Upon acceptance by the **RCE**, and at a minimum, implement the following: Replace the pipe at locations where the measured deflection exceeds 7.5% of the nominal inside diameter of the pipe. Repair or remediate locations as recommended in the report or by the **RCE**. Replace locations where directed by the **RCE**.

3.3.11 Installing Pipe Culvert Under Existing Pavement (HDPE)

On projects where the original approach pavement structure is being retained, lay the pipe culvert as herein specified. Repair the portion of the pavement structure removed due to the excavation of the trench using the same type of materials used in the original construction. The **RCE** may accept the use of other materials as deemed appropriate. Perform the work to the satisfaction of the **RCE**. Include the cost of the materials and the labor involved in the unit bid price for the culvert pipe.

3.3.12 Placing Pipe Under Railroads and Other Transportation Facilities (HDPE)

When the plans include the installation of pipe under railroads or other transportation facilities not under the jurisdiction of the Department, unless otherwise provided, install the pipe using such methods, materials, and procedures required by the owner. There is no extra compensation for this change in methods, materials, and procedures. This requirement does not apply to the installation under roadways.

3.3.13 Cleaning Out Pipe (HDPE)

Thoroughly clean out the entire length of newly installed pipe culverts. No additional payment will be made for the cleaning out of newly installed pipe culverts.

3.4 Measurement (HDPE)

The quantity for the items Culvert Pipe, of the size, kind, class, thickness or type specified is measured in linear feet of the net length of culvert pipe complete in place and accepted.

The quantity of pipe culvert is measured for payment by the length of the centerline of each pipe run, in linear feet (LF), complete and in place. The length is obtained by adding the centerline length of each run of pipe between Drainage Structures and End Treatments.

The quantity for the items pipe culvert tees, wyes, elbows, bends, reducers, and increasers of the size, kind, class, thickness or type specified is measured by each item.

The quantity for the items pipe culvert beveled ends, flared ends, pipe end structures, wingwall/apron system, and drainage structures is measured by each unit, complete in place and accepted. Do not include the length of beveled ends, flared ends, pipe end structures, wingwall/apron system, or drainage structures in the linear feet of culvert pipe when measured as provided herein.

The quantity for the excavation of unyielding, unstable, or otherwise unsuitable material necessary to obtain a satisfactory foundation for pipe culverts as specified in **Subsection 3.3.2**, is measured as provided in **SCDOT Standard Specifications Subsection 203.5**. Dispose of the unstable material in the manner outlined in **SCDOT Standard Specifications Subsection 203.2.1.5**.

No measurement will be made for the removal of existing pipe culverts that will be replaced by new culverts. No measurement will be made for pipe inspection.

3.5 Payment (HDPE)

Culvert pipe and end treatments measured as provided in **Subsection 3.4**, are paid for at the contract unit price for the respective items, which price and payment is compensation for furnishing all material, labor, equipment, tools including hauling and placing all pipe sections and materials, excavation, bedding, and pipe structural backfill new or existing trench, removal of existing pipe to be replaced, constructing pipe joints, removal of old end treatments, cleaning out pipe, disposal of surplus materials, all visual inspection, and all incidentals necessary to complete the work.

The quantities for the items pipe culvert tees, wyes, elbows, bends, reducers, and increasers measured as provided in **Subsection 1.4**, are paid for by the difference in fabrication, handling, and installation cost between the item and the equivalent length of the largest diameter pipe being connected.

The excavation of unyielding or unstable material, measured as provided in **Subsection 3.4**, is paid for at the contract unit price for Unclassified Excavation in accordance with **SCDOT Standard Specifications Subsection 203.6**.

All work associated with the excavation, removal and disposal of existing pipe culverts that will be replaced by a new structure will be paid for in the pay item of the new structure.

Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.

Pay items are listed in **Subsection 5**.

3.6 Referenced Documents (HDPE)

SCDOT Standard Specifications for Highway Construction

SCDOT Supplemental Technical Specifications:

SC-T-29

SCDOT Supplemental Specifications:

SCDOT Supplemental Specifications for Geotextile for Drainage Filtration

SCDOT Qualified Product Listings:

Qualified Product Listing 30

AASHTO Standard Specifications for Transportation Materials & Methods of Sampling and Testing:

AASHTO M 145

AASHTO M 294

ASTM Standard Specifications:

ASTM D 1149

ASTM D 2321

ASTM D 3212

ASTM F 477

4 Pipe Maintenance (All Existing Pipe)

This section contains specifications for the materials, construction, measurement, and payment of maintenance on existing pipe infrastructure. This work includes cleaning existing pipe to restore hydraulic performance to pipe being retained as well as removal or abandoning of pipe that will not be replaced by a new culvert.

4.1 Cleaning Out of Existing Pipe (All Existing Pipe)

Maintain retained pipe culverts that are clean in the same condition as they existed before beginning work. When specified in the plans, thoroughly clean out the entire length of existing pipe culverts. Remove all debris and settlement that affects the hydraulic performance of the entire pipe, including all debris within two pipe diameters of each end of the pipe.

4.1.1 Measurement of Existing Pipe Cleaning (All Existing Pipe)

The quantity for the cleaning of existing pipe culverts is measured in linear feet for the entire length of the pipe to be cleaned plus four pipe diameters.

4.1.2 Payment of Existing Pipe Cleaning (All Existing Pipe)

Cleaning of existing pipe, as measured in **Subsection 4.1.1**, is paid for at the contract unit price for Cleaning Existing Pipe, which price and payment is full compensation for all work and costs of cleaning, debris removal, transporting, disposing of all obstructions within the pipe that is to be cleaned and within two pipe diameters of each pipe end.

4.2 Removing of Existing Pipe (All Existing Pipe)

Remove existing pipe in accordance with the provisions of **SCDOT Standard Specifications Subsection 202.4.3**. Backfill and compact fill material to the same grade and slope of the area before the pipe was removed.

4.2.1 Measurement of Existing Pipe Removal (All Existing Pipe)

The quantity for the excavation necessary for the removal of existing pipe culverts that are not to be replaced by new culverts is measured in cubic yards as set forth in **SCDOT Standard Specifications Subsection 202.5**.

4.2.2 Payment of Existing Pipe Removal (All Existing Pipe)

The excavation for the removal of existing pipe as measured in **Subsection 4.2.1**, is paid for at the contract unit price for Unclassified Excavation as specified in **SCDOT Standard Specifications Subsection 202.6**, which price and payment is full compensation for all work and costs of removal, transporting, and storing or disposing of existing pipe that is not to be replaced by a new structure and re-installation and compaction of fill material to restore embankment to original grade.

4.3 Abandoning Pipe (All Existing Pipe)

At locations on the plans where existing culvert pipe is to be abandoned, plug the existing pipe using brick and mortar or use the Taylor Made Plastics, Inc. "Pipe Plug" or equal. Fill the entire abandoned pipe with CLSM that meets the strength requirements of the embankment and can be excavated. Place CLSM using a method that produces the smallest air pockets or voids within the abandoned pipe, such as pumping from a single location until the both ends of the pipe are full.

4.3.1 Measurement Pipe Abandoning (All Existing Pipe)

Measurement for pipe abandoning will be paid for as CLSM in accordance with **SCDOT Standard Specifications Subsection 210.5**.

4.3.2 Payment Pipe Abandoning (All Existing Pipe)

Payment for pipe abandoning will be in accordance with **SCDOT Standard Specifications Subsection 210.6**, which price and payment is full compensation for all work and costs of materials, labor, and construction costs to abandon the pipe. No additional pay items will be made for this work regardless of the method chosen.

5 Pay Items

Pay items under this Supplemental Technical Specification include the following:

Item No.	Pay Item	Unit
714XXXX	<i>(size) (kind) Culvert Pipe (class or thickness or type)</i>	LF
714XXXX	<i>(size) (kind) Pipe Culvert Beveled End Section (class or thickness)</i>	EA
714XXXX	<i>(size) (kind) Pipe Culvert Flared End Section (class or thickness)</i>	EA
714XXXX	<i>(size) (kind) Pipe Culvert Tee (class or thickness or type)</i>	EA
714XXXX	<i>(size) (kind) Pipe Culvert Wye (class or thickness or type)</i>	EA
714XXXX	<i>(size) (kind) Pipe Culvert (degree) Bend (class or thickness)</i>	EA
714XXXX	<i>(size) (kind) Reducer (size) to (size) Diameter (class or thickness)</i>	EA
714XXXX	<i>(size) (kind) Increaser (size) to (size) Diameter (class or thickness)</i>	EA
7149999	Cleaning Existing Pipe	LF