Supplemental Technical Specification for | September 8, 2009

PERMANENT PIPE CULVERTS

SCDOT Designation: SC-M-714 (08/09)

APPROVED: August 10, 2009
Division Administrator
By: David B. Law
FEDERAL HIGHWAY ADMINISTRATION

1 Reinforced Concrete Pipe Culvert (RCP)

1.1 Description (RCP)

This section contains specifications for the materials, construction, measurement, and payment for furnishing reinforced concrete pipe culverts (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 from a qualified manufacturer as indicated on **SCDOT Qualified Product List 69**. Use only joint sealant specified on **SCDOT Qualified Product List 69** with the pipe supplied.

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 in the plans, use minimum Class III pipe. Furnish pipe in manufactured lengths from 4 to 12 feet.

Make certain circular pipe meet or exceed the reinforcement requirements of **AASHTO M 170**. Install standard **AASHTO M 170** reinforced pipe within minimum and maximum fill heights shown on **SCDOT Standard Drawings**.

If special designed pipe is required (beyond the fill height limits of the **SCDOT Standard Drawings**), have the manufacturer submit to the **OMR** and the appropriate Structures Engineer a design that meets or exceeds the loading criteria specified on **SCDOT Instructional Bulletin 2007-04** for the design cover height for the project and the pipe material chosen.

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 Na_2O 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 is allowed only from sources listed on the latest edition of **SCDOT Qualified Product List 3**. Slag is allowed only from sources listed on the latest edition of **SCDOT Qualified Product List 6**. 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.

Use only circular reinforcement as listed in AASHTO M 170 for standard pipe. Make certain that steel reinforcement conforms to the requirements of **AASHTO M 32**, **AASHTO M 55**, **AASHTO M 221**, or **AASHTO M 225** for wire reinforcement as applicable. Use only steel that conforms with the parameters used in the pipe structural calculations supplied for **SCDOT Standard Drawings**. For custom pipe requiring deformed billet steel, use circular reinforcement that conforms to **ASTM A 706** Grade 60. Ensure that steel conforming to **ASTM A 706** comes from a source listed on **SCDOT Qualified Product List 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 gasket sources that appear on **SCDOT Qualified Product List 69** with the supplied pipe. 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.

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

When lift holes or lugs are required in pipe, follow OSHA guidelines for handling pipe, and manufacturer guidelines for plugging lift holes after installation.

When geotextile for drainage filtration is required, follow **SCDOT Standard Specifications subsection 804.2.11** and **SCDOT Standard Drawings**.

Use tees, wyes, elbows, bends, reducers, and increasers with strength matching or exceeding the strength of the strongest pipe being connected and with the same joint profile of the connecting pipe. Use tees, wyes, elbows, bends, reducers, and increasers with joint profiles that match connected pipe.

For custom pipe, when noncircular (elliptical, shear stirrups, etc.) reinforcement is used,

1. Stabilize reinforcement by satisfactory means to ensure that it does not shift or rotate during the manufacturing process
2. Provide a stencil on the inside and outside shell indicating "CUSTOM PIPE NON CIRCULAR REINFORCEMENT TOP OF PIPE" and a mark "X" indicating exact top of pipe.
3. Provide a stencil on the inside and outside shell indicating designed fill height.
4. Provide to RCE and follow manufacturer guidelines for proper handling and installation instructions. Use installation procedure and materials that meet or exceed the limitations of this specification.

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.

For pipe marked "NON CIRCULAR REINFOCEMENT TOP OF PIPE" follow manufacturer requirements for proper handling of pipe.

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 the greatest of:

1. 1.5 x Pipe OD + 12"
2. Pipe OD + 24"
3. 3 x Pipe OD (only in sections where foundation improvement is required in the plans or by the **RCE**)
4. The width required to safely fit compaction equipment and personnel between the pipe and the trench walls.

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 culvert 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 culvert, 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 to accommodate the required bedding thickness.

Follow OSHA's excavation regulations found in Subpart P of 29 CFR 1926 for safety requirements of trench excavations and protection systems. The Contractor shall employ an onsite Competent Person (as defined by SC OSHA as follows: one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them. In order to be a competent person for the purpose of this standard one must have had specific training in, and be knowledgeable about, soils analysis, the use of protective systems, and the requirements of this standard) during all trenching operations. Provide the RCE with the name and contact information of the responsible Competent Person for each installation. If trench widths or wall slopes are changed due to safety requirements, backfill the trench outside of the vertical trench dimensions with materials meeting the minimum requirements of the embankment (or pipe structural backfill for shallow installations) as described in Subsection 1.3.6. Ensure that the support of the pipe and its embedment are maintained throughout the installation.

If trench boxes (shields, etc.) are required, follow 29 CFR 1926.652, trench box manufacturer, and industry standards for trench installations not exceeding 20 feet. When trench boxes are required for trenches exceeding 20 feet deep, the Contractor shall submit to the RCE designs, plans and supporting calculations for protective systems and shoring equipment sealed by a Professional Engineer who is licensed in South Carolina unless provided in the plans. When trench boxes are moved, the previously placed pipe and structural backfill shall not be disturbed. Move trench box in increments during the installation process to permit placement and compaction of structural backfill

material for the full width of the trench while continuing to follow Subpart P of 29 CFR 1926 OSHA Standards. Voids that are created by movement of the trench box shall be filled and compacted with structural backfill described in Subsection 1.3.6. If necessary to prevent movement, restrain the pipe using methods that do not damage the pipe.

If temporary shoring (sheet pile, timber shoring, mechanically stabilized earth, etc.) is required, the Contractor shall submit to the RCE designs, plans and supporting calculations for protective systems and shoring equipment sealed by a Professional Engineer who is licensed in South Carolina unless provided in the plans. If temporary shoring is to be removed, it shall be pulled out in vertical increments during the installation process to permit placement and compaction of fill material for the full width of the trench while continuing to follow Subpart P of 29 CFR 1926 OSHA Standards. If temporary shoring is to be left in place, provide the resident with location and description of all buried systems for inclusion in as-built plans.

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.

Use the soil boring Standard Penetration Test SPT "N" values and recommendations of **SCDOT Standard Drawings** to determine if additional work is required to prepare an improved foundation. When an improved foundation is required, remove unstable material at least 1 diameter on each side of the pipe. Excavate deep enough to install nonwoven geotextile for drainage filtration and pipe foundation material as indicated on **SCDOT Standard Drawings**. If Type P1 biaxial geogrid is used with the foundation material and geotextile for drainage filtration, the additional foundation undercut may be reduced as indicated on **SCDOT Standard Drawings**. When pipe foundation material is indicated, use the same material that is used for the bedding and pipe structural backfill. Compact the pipe foundation material in accordance with methods used for pipe structural backfill. Provide trench suitable to accommodate site conditions and obstructions.

If poor material is encountered that was not indicated in the plans, contact the **Preconstruction Regional Production Group Design Manager** for instructions on foundation preparation.

1.3.3 Bed for Pipe (RCP)

For bedding material, use either:

1. Well graded A-1 (**AASHTO M 145**) soils
2. Screenings meeting A-1 (**AASHTO M 145**)

3. Macadam or Marine Limestone Graded aggregate base from **Qualified Product List 2**

4. Uniformly graded, coarse grained A-3 (**AASHTO M 145**) soils (Class 1 wrapped)

5. Uniformly graded angular stone as large as #5 stone (Class 2 wrapped, vibrated)

The same material must be used for bedding and structural backfill unless CLSM is used for structural backfill.

The materials marked as (wrapped) require geotextile wrap to control migration of fines into open voids. In all cases, use a geotextile that prevents the transmission of the smallest soil particles present in both the in-situ soil and the soil used for bedding and structural backfill. Wrap the entire bedding and backfill envelope and provide a minimum overlap of 2 feet at all geotextile splices. For shallow installations, provide a cover of 6 inches of soil between geotextile and hot mix asphalt.

A sample of the pipe bedding material will be taken at the beginning of pipe laying operations to verify the classification of materials used for bedding and pipe structural backfill. After the initial sample is taken, the sampling frequency will be for each 1,000 foot production lot or until the source or classification of the bedding/backfill material changes. These are minimum requirements that may be increased at the RCE's discretion.

Ensure that trenches are free of water when placing bedding.

Support the pipe by placing uncompacted bedding material above the stable foundation material. Use the larger of 6 inches or 10.0% of the nominal pipe outside diameter for the bedding thickness. 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.

Vibrate angular stone in place using a minimum of 2 passes with a vibratory plate tamp in lifts not to exceed 12 inches.

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 custom pipe with noncircular reinforcement is used, install the pipe in such a position that the manufacturer's marks designating the top of the pipe is not more than 5 degrees from the vertical plane through the longitudinal axis of the pipe or manufacturers guidelines, whichever is most vertical.

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 supplied with the pipe and made by a manufacturer listed on **SCDOT Qualified Product List 69** 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. The laboratory test (which may be performed using vertical joints as indicated in AASHTO) is not intended to indicate field performance of the joint, but rather to indicate the proper sealant size to joint detail configuration as well as performance of the joint under ideal laboratory conditions. 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. Apply material in a single strip as specified by pipe manufacturer (typically from within 1 inch of the tongue end to approximately the middle of the tongue on pipe) for up to 48 inch diameter pipe. For pipe larger than 48 inch

diameter, place half of the sealant on the top side of the tongue end and the other half on the bottom side of the groove end of the two pipes being homed. Provide between 1" and 3" overlap of the installed joint sealant by laying the edges of the sealant side by side. Do not twist ends of sealant around each other or stack one end on top of the other. Leave protective paper on outside of flexible sealant to protect during pipe alignment. Apply enough flexible sealant to fill the annular joint space. Align the tongue and groove or bell and spigot ends of the pipes before homing (closing) the joint. Remove any remaining 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 of the pipe. Confirm that the pipe is aligned properly. Seat the 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. The laboratory test is not intended to indicate field performance of the joint, but rather to indicate the proper gasket size to joint detail configuration as well as performance of the joint under ideal laboratory conditions. 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. Follow pipe manufacturer's recommendations for lubrication of joint and/or gasket. 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.

1.3.6 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, use the same material as the pipe bedding **(Subsection 1.3.3)** unless controlled low strength material is used as described below. When materials are used that require geotextile wrap, cover the entire bedding and structural backfill envelope as described in **Subsection 1.3.3.**

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 and does not float 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**.

The **RCE** will establish a compaction pattern for the contractor to follow during pipe backfill operations. The pattern will be in effect for production lots of 500 feet of pipe, until the source or classification of backfill material changes, site weather conditions change such as rain, or the compactive efforts being applied change. The compaction pattern will be established by allowing the contractor to apply a 6 inch lift in a 50 foot section until the material has been compacted to 95.0% of the maximum dry density for the structural backfill when measured in accordance with **SC-T-29**. The number of passes and the watering efforts applied to the material will be recorded and this pattern will be considered the compaction pattern.

For pipe smaller than 36 inches in diameter, the **RCE** will run a minimum of one verification compaction test at the springline of the pipe for each run of pipe between drainage structures or pipe ends. For pipe 36 inches in diameter and larger, a minimum of one test for each 18 inches of the pipe embedment zone height (including one at the pipe springline) for each run of pipe between drainage structures or pipe ends will be performed. This is a minimum frequency and should be increased at the **RCE**'s discretion.

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, the RCE will check the compaction of the previous lift by removing enough material to perform the verification test. If the second test passes, the contractor will continue the compaction efforts of the current layer until the verification test passes. In the event of 2 failing compaction tests within a single run of pipe (between drainage structures or pipe ends), remove the pipe structural backfill, clean trench and set a new compaction pattern at the **RCE**'s discretion.

Vibrate angular stone backfills in place using methods that properly lock the angular stone in place around the pipe and do not damage the pipe, typically 2 passes with a vibratory plate tamp for each 12 inch lift.

Complete structural backfill installation up to the minimum cover elevation above the pipe for typical installations. When installing pipe under pavement and within 3 feet of the subgrade, complete structural backfill installation up to the top of the subgrade. Confirm that structural backfill material in pipe trench meets or exceeds the embankment compaction requirements before applying pavement structure.

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 at each exposed end of pipe. Follow **Pipe End Treatments Special Provision** or **SC-M-719 Pipe End Treatments** and SCDOT Standard Drawings to determine required end treatment.

Unless shown otherwise in the plans, use a minimum end treatment of a straight pipe end with Class B or C riprap and geotextile for erosion control as shown in the **SCDOT Standard Drawings**. When specified in the plans, use end treatments such as pipe beveled end, concrete slab, straight headwall for pipe, pipe end structure, or pipe wingwall and apron system in accordance with **SCDOT Standard Drawings** or plan structure details.

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)

All traffic control necessary to perform the installation and post construction inspections will be provided by the Prime Contractor. No separate payment will be made for this traffic control.

Construction Inspection:

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. Verify line and grade in accordance with the frequencies detailed in the Construction Manual. All inspections must be performed by a SCDOT certified Earthwork, Drainage and Base Technician.

When improper installation or damage is noted during the construction inspection of the pipe, repairs must be made to the satisfaction of the RCE. Additional inspections may be performed until confidence is restored that the installation has been performed in accordance with these specifications.

Post Construction Inspection (Acceptance):

The **RCE** will collect survey data for 100% of installed pipe. Survey data will be collected electronically to establish a pipe inventory. Survey data will include latitude, longitude, station, offset, elevation, and coordinates of the flow line for each pipe end. Survey data collected will also include at a minimum pipe diameter, pipe material, and description or survey data for drainage structures and end treatments.

The **RCE** will inspect 100% of pipe under the roadbed, 100% of pipe in a closed drainage system, and a minimum of 10.0% (random locations) of all other locations. These inspections will be performed 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. In cases where the Contractor's accepted CPM Schedule indicates that paving operations will be conducted in less than 30 days, an early inspection may be performed for acceptance. If early inspections are performed

and the paving does not commence as scheduled, an additional inspection may be performed at the **RCE**'s discretion.

When third party surveys and inspections are performed on behalf of the **RCE**, a report will be submitted with the survey and inspection results. This report will include a copy of all video taken from each video camera inspection, pipe location identification, equipment used for inspection, inspector name, inspector field notes, measurements from the pipe inspection (at a minimum to include the following: deviation from design grade, deviation from line, deflection [expressed in inches and % of pipe diameter]), and survey data for all installed pipe.

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 pipe culvert.

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.

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. Pipes must be clean and accessible for inspection and acceptance.

1.3.14 Trench Backfill for Expedited Construction (RCP)

At the RCE's discretion or where otherwise noted, controlled low strength material (CLSM) may be used as structural backfill and to complete trench backfill for pipe installations in order to expedite the re-opening of the roadway to traffic. The decision should be based on traffic volume, safety and public inconvenience.

CLSM, also known as flowable fill, can be placed to a height not to exceed the subgrade elevation. The remaining pavement structure must be installed according to the pavement typical section. Measurements for payment will be made based on the neat line at a trench width (pipe outside diameter + 12") for the pipe type being installed. Any material used beyond these dimensions is considered incidental to the pipe installation. CLSM shall be installed in accordance with manufacturer's recommendations to prevent pipe displacement and uplift during CLSM placement.

When CLSM is specified in the plans or special provisions for completion of the trench backfill, CLSM in the pipe embedment zone will be included in the cost of the pipe, and CLSM above the pipe embedment zone will be paid for at the contract unit price for Controlled Low Strength Material.

When CLSM is specified by the **RCE** during construction, all CLSM used in the trench above the pipe springline will be paid for at the contract unit price for Controlled Low Strength Material.

1.4 Measurement (RCP)

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

Pipe quantities will be the linear measurement from end to end of the pipe through tees, wyes, elbows, bends, reducers, increasers, elbows, and beveled ends, excluding all drainage structures. The length is obtained by adding the centerline length of each run of pipe between Drainage Structures and to the completed end of pipe at End Treatments. Do not include the length of end treatment beyond the pipe in the measurement of the pipe.

If the plans require bevels at the pipe ends, include the length of the beveled end section in the measured length of pipe.

The quantity for the items beveling of smooth wall pipe culvert, pipe culvert tees, wyes, elbows, bends, reducers, and increasers of the size and kind specified is measured by each item.

Measure the quantity for riprap placed around pipe end or end treatment in tons based on the quantity required to complete installation in accordance with the **SCDOT Standard Drawing** and **Instructional Bulletin 2009-2** for the pipe end treatment used.

Measure the quantity for geotextile for erosion control under riprap in square yards based on the quantity required to complete installation in accordance with the **SCDOT Standard Drawing** for the pipe end treatment used.

The quantity for the items pipe culvert flared end section, straight headwalls, concrete slabs, pipe end structures, wingwall and apron system, and drainage structures is measured by each unit, complete in place and accepted.

The quantity of pipe additional foundation work is measured in linear feet along the centerline of the pipe as shown in the **SCDOT Standard Drawings**. Dispose of any unstable material in the manner outlined in **SCDOT Standard Specifications Subsection 203.2.1.5**.

For typical and maximum cover installations shown on **SCDOT Standard Drawings**, no measurement will be made for backfill material shown within the pipe embedment zone, and payment for this material will be included in the cost of the pipe. For shallow and minimum cover installations shown on **SCDOT Standard Drawings**, no measurement will be made for backfill within the pipe trench, and payment for this material will be included in the cost of the pipe.

For installations in cut sections where pipe is deeper than shallow installation, embankment material overfill above the pipe embedment zone will be measured as the volume between the standard trench walls from the top of the pipe embedment zone to the top of the subgrade as shown on the **SCDOT Standard Drawings**.

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)

Pipe culvert 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 of the entire standard trench, bedding, and pipe backfill as described in the measurement section (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, traffic control for all inspections, and all incidentals necessary to complete the work.

All traffic control necessary to perform the installation and post construction inspections will be provided by the Prime Contractor. No separate payment will be made for this traffic control.

Beveling of the pipe end will be included in the unit cost of beveling of pipe culvert as specified in the plans.

Payment for riprap and geotextile for erosion control under riprap as measured in **Subsection 1.4** includes all direct and indirect costs and expenses 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 as each.

The quantity of pipe additional foundation work, measured as provided for in **Subsection 1.4**, is paid for at the contract unit price, which price and payment is compensation for furnishing all material (foundation, extra bedding, extra structural backfill, extra geotextile, etc.), labor (additional trench excavation, compaction, etc.), equipment, tools, hauling, and disposal (of poor material) to complete construction of the pipe foundation, and wider trench as specified in the **SCDOT Standard Drawings**, the plans, or by the **RCE**.

Embankment material overfill in cut sections as described in the measurement section will be paid for as borrow.

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 Qualified Product Lists:

Qualified Product List 1
Qualified Product List 2
Qualified Product List 3
Qualified Product List 60
Qualified Product List 69

SCDOT Instructional Bulletins:
SCDOT Instructional Bulletin 2007-04

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

Websites:
www.osha.gov
www.llr.state.sc.us/labor/osha/
www.concrete-pipe.org
www.precast.org

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. Use pipe supplied with joint sealant material and manufactured at a facility listed on **Qualified Product List 68.**

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 Standard Specifications subsection 804.2.11** and **SCDOT Standard Drawings**.

If special designed pipe is required (beyond the fill height limits of the **SCDOT Standard Drawings**), have the manufacturer submit to the **OMR** and the appropriate Structures Engineer a design that meets or exceeds the loading criteria specified on **SCDOT Instructional Bulletin 2007-04** for the design cover height for the project and the pipe material chosen.

Use tees, wyes, elbows, bends, reducers, and increasers with strength matching or exceeding the strength of the strongest pipe being connected and with the same joint profile of the connecting pipe. Use tees, wyes, elbows, bends, reducers, and increasers with joint profiles that match connected pipe.

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 the greatest of:

1. 1.5 x Pipe OD + 12"
2. Pipe OD + 24"
3. 3 x Pipe OD (only in sections where foundation improvement is required in the plans or by the **RCE**)
4. The width required to safely fit compaction equipment and personnel between the pipe and the trench walls.

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 to accommodate the required bedding thickness.

Follow OSHA's excavation regulations found in Subpart P of 29 CFR 1926 for safety requirements of trench excavations and protection systems. The Contractor shall employ an onsite Competent Person (as defined by SC OSHA as follows: one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them. In order to be a competent person for the purpose of this standard one must have had specific training in, and be knowledgeable about, soils analysis, the use of protective systems, and the requirements of this standard) during all trenching operations. Provide the RCE with the name and contact information of the responsible Competent Person for each installation. If trench widths or wall slopes are changed due to safety requirements, backfill the trench outside of the vertical trench dimensions with materials meeting the minimum requirements of the embankment (or pipe structural backfill for shallow installations) as described in Subsection 2.3.6. Ensure that the support of the pipe and its embedment are maintained throughout the installation.

If trench boxes (shields, etc.) are required, follow 29 CFR 1926.652, trench box manufacturer, and industry standards for trench installations not exceeding 20 feet. When trench boxes are required for trenches exceeding 20 feet deep, the Contractor shall submit to the RCE designs, plans and supporting calculations for protective systems and shoring equipment sealed by a Professional Engineer who is licensed in South Carolina unless provided in the plans. When trench boxes are moved, the previously placed pipe and structural backfill shall not be disturbed. Move trench box in increments during the installation process to permit placement and compaction of structural backfill material for the full width of the trench while continuing to follow Subpart P of 29 CFR 1926 OSHA Standards. Voids that are created by movement of the trench box shall be filled and compacted with structural backfill described in Subsection 2.3.6. If necessary to prevent movement, restrain the pipe using methods that do not damage the pipe.

If temporary shoring (sheet pile, timber shoring, mechanically stabilized earth, etc.) is required, the Contractor shall submit to the RCE designs, plans and supporting calculations for protective systems and shoring equipment sealed by a Professional Engineer who is licensed in South Carolina unless provided in the plans. If temporary shoring is to be removed, it shall be pulled out in vertical increments during the installation process to permit placement and compaction of fill material for the full width of the trench while continuing to follow Subpart P of 29 CFR 1926 OSHA Standards. If temporary shoring is to be left in place, provide the resident with location and description of all buried systems for inclusion in as-built plans.

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.

Use the soil boring Standard Penetration Test SPT "N" values and recommendations of **SCDOT Standard Drawings** to determine if additional work is required to prepare an improved foundation. When an improved foundation is required, remove unstable material at least 1 diameter on each side of the pipe. Excavate deep enough to install nonwoven geotextile for drainage filtration and pipe foundation material as indicated on **SCDOT Standard Drawings**. If Type P1 biaxial geogrid is used with the foundation material and geotextile for drainage filtration, the additional foundation undercut may be reduced as indicated on **SCDOT Standard Drawings**. When pipe foundation material is indicated, use the same material that is used for the bedding and pipe structural backfill. Compact the pipe foundation material in accordance with methods used for pipe structural backfill. Provide trench suitable to accommodate site conditions and obstructions.

If poor material is encountered that was not indicated in the plans, contact the **Preconstruction Regional Production Group Design Manager** for instructions on foundation preparation.

2.3.3 Bed for Pipe (CAAP&SRAP)

For bedding material, use either:

1. Well graded A-1 (**AASHTO M 145**) soils
2. Screenings meeting A-1 (**AASHTO M 145**)
3. Macadam or Marine Limestone Graded aggregate base from **Qualified Product List 2**
4. Uniformly graded, coarse grained A-3 (**AASHTO M 145**) soils (Class 1 wrapped)
5. Uniformly graded angular stone as large as #5 stone (Class 2 wrapped, vibrated)

The same material must be used for bedding and structural backfill unless CLSM is used for structural backfill.

The materials marked as (wrapped) require geotextile wrap to control migration of fines into open voids. In all cases, use a geotextile that prevents the transmission of the smallest soil particles present in both the in-situ soil and the soil used for bedding and structural backfill. Wrap the entire bedding and backfill envelope and provide a minimum overlap of 2 feet at all geotextile splices. For shallow installations, provide a cover of 6 inches of soil between geotextile and hot mix asphalt.

A sample of the pipe bedding material will be taken at the beginning of pipe laying operations to verify the classification of materials used for bedding and pipe structural backfill. After the initial sample is taken, the sampling frequency will be for each 1,000 foot production lot or until the source or classification of the bedding/backfill material changes. These are minimum requirements that may be increased at the RCE's discretion.

Ensure that trenches are free of water when placing bedding.

Support the pipe by placing uncompacted bedding material above the stable foundation material. Use the larger of 6 inches or 10.0% of the nominal pipe outside diameter for the bedding thickness. 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.

Vibrate angular stone in place using a minimum of 2 passes with a vibratory plate tamp in lifts not to exceed 12 inches.

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 either welded angle brackets or bar bolt and strap connections that conform to the requirements of **AASHTO M 196** article 9 unless specified otherwise in the plans. Provide coupling bands and connections that match the configuration used during the joint testing and indicated on **Qualified Product List 68**. 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. Each manufacturer may also elect to test their pipe joints to 13 psi for use in locations where RCP AASHTO M 315 joints are currently specified. Both 10 psi and 13 psi tests are to be conducted in straight alignment with the pipe deflected 5%. The laboratory tests are not intended to indicate field performance of the joint, but rather to indicate the proper sealant size to joint detail configuration as well as performance of the joint under ideal laboratory conditions. 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, use the same material as the pipe bedding **(Subsection 2.3.3)** unless controlled low strength material is used as described below. When materials are used that require geotextile wrap, cover the entire bedding and structural backfill envelope as described in **Subsection 2.3.3.**

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 and does not float 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**.

The **RCE** will establish a compaction pattern for the contractor to follow during pipe backfill operations. The pattern will be in effect for production lots of 500 feet of pipe, until the source or classification of backfill material changes, site weather conditions change such as rain, or the compactive efforts being applied change. The compaction pattern will be established by allowing the contractor to apply a 6 inch lift in a 50 foot section until the material has been compacted to 95.0% of the maximum dry density for the structural backfill when measured in accordance with **SC-T-29**. The number of passes and the watering efforts applied to the material will be recorded and this pattern will be considered the compaction pattern.

For pipe smaller than 36 inches in diameter, the **RCE** will run a minimum of one verification compaction test at the springline of the pipe for each run of pipe between drainage structures or pipe ends. For pipe 36 inches in diameter and larger, a minimum of one test for each 18 inches of the pipe embedment zone height (including one at the pipe springline) for each run of pipe between drainage structures or pipe ends will be performed. This is a minimum frequency and should be increased at the **RCE**'s discretion.

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, the RCE will check the compaction of the previous lift by removing enough material to perform the verification test. If the second test passes, the contractor will continue the compaction efforts of the current layer until the verification test passes. In the event of 2 failing compaction tests within a single run of pipe (between drainage structures or pipe ends), remove the pipe structural backfill, clean trench and set a new compaction pattern at the **RCE**'s discretion.

Vibrate angular stone backfills in place using methods that properly lock the angular stone in place around the pipe and do not damage the pipe, typically 2 passes with a vibratory plate tamp for each 12 inch lift.

Complete structural backfill installation up to the minimum cover elevation above the pipe for typical installations. When installing pipe under pavement and within 3 feet of the subgrade, complete structural backfill installation up to the top of the subgrade. Confirm that structural backfill material in pipe trench meets or exceeds the embankment compaction requirements before applying pavement structure.

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 at each exposed end of pipe. Follow **Pipe End Treatments Special Provision** or **SC-M-719 Pipe End Treatments** and SCDOT Standard Drawings to determine required end treatment.

Unless shown otherwise in the plans, use a minimum end treatment of a straight pipe end with Class B or C riprap and geotextile for erosion control as shown in the **SCDOT Standard Drawings**. When specified in the plans, use end treatments such as pipe beveled end, concrete slab, straight headwall for pipe, pipe end structure, or pipe wingwall and apron system in accordance with **SCDOT Standard Drawings** or plan structure details.

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)

All traffic control necessary to perform the installation and post construction inspections will be provided by the Prime Contractor. No separate payment will be made for this traffic control.

Construction Inspection:

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. Verify line and grade in accordance with the frequencies detailed in the Construction Manual. All inspections must be performed by a SCDOT certified Earthwork, Drainage and Base Technician.

When improper installation or damage is noted during the construction inspection of the pipe, repairs must be made to the satisfaction of the RCE. Additional inspections may be performed until confidence is restored that the installation has been performed in accordance with these specifications.

Post Construction Inspection (Acceptance):

The **RCE** will collect survey data for 100% of installed pipe. Survey data will be collected electronically to establish a pipe inventory. Survey data will include latitude, longitude, station, offset, elevation, and coordinates of the flow line for each pipe end. Survey data collected will also include at a minimum pipe diameter, pipe material, and description or survey data for drainage structures and end treatments.

The **RCE** will inspect 100% of pipe under the roadbed, 100% of pipe in a closed drainage system, and a minimum of 10.0% (random locations) of all other locations. These inspections will be performed 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. In cases where the Contractor's accepted CPM Schedule indicates that paving operations will be conducted in less than 30 days, an early inspection may be performed for acceptance. If early inspections are performed and the paving does not commence as scheduled, an additional inspection may be performed at the **RCE**'s discretion.

When third party surveys and inspections are performed on behalf of the **RCE**, a report will be submitted with the survey and inspection results. This report will include a copy of all video taken from each video camera inspection, pipe location identification, equipment used for inspection, inspector name, inspector field notes, measurements from the pipe inspection (at a minimum to include the following: deviation from design grade, deviation from line, deflection [expressed in inches and % of pipe diameter]), and survey data for all installed pipe.

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**.

For aluminum 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**.

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 pipe culvert.

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.

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. Pipes must be clean and accessible for inspection and acceptance.

2.3.14 Trench Backfill for Expedited Construction (CAAP&SRAP)

At the RCE's discretion or where otherwise noted, CLSM may be used as structural backfill and to complete trench backfill for pipe installations in order to expedite the re-opening of the roadway to traffic. The decision should be based on traffic volume, safety and public inconvenience.

CLSM can be placed to a height not to exceed the subgrade elevation. The remaining pavement structure must be installed according to the pavement typical section. Measurements for payment will be made based on the neat line at a trench width (pipe outside diameter + 12") for the pipe type being installed. Any material used beyond these dimensions is considered incidental to the pipe installation. CLSM shall be installed in accordance with manufacturer's recommendations to prevent pipe displacement and uplift during CLSM placement.

When CLSM is specified in the plans or special provisions for completion of the trench backfill, CLSM in the pipe embedment zone will be included in the cost of the pipe, and CLSM above the pipe embedment zone will be paid for at the contract unit price for Controlled Low Strength Material.

When CLSM is specified by the **RCE** during construction, all CLSM used in the trench above the pipe springline will be paid for at the contract unit price for Controlled Low Strength Material.

2.4 Measurement (CAAP&SRAP)

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

Pipe quantities will be the linear measurement from end to end of the pipe through tees, wyes, elbows, bends, reducers, increasers, elbows, and beveled ends, excluding all drainage structures. The length is obtained by adding the centerline length of each run of pipe between Drainage Structures and to the completed end of pipe at End Treatments. Do not include the length of end treatment beyond the pipe in the measurement of the pipe.

If the plans require bevels at the pipe ends, include the length of the beveled end section in the measured length of pipe

The quantity for the items beveling of smooth wall pipe culvert, beveling of corrugated wall pipe culvert, pipe culvert tees, wyes, elbows, bends, reducers, and increasers of the size and kind specified is measured by each item.

Measure the quantity for riprap placed around pipe end or end treatment in tons based on the quantity required to complete installation in accordance with the **SCDOT Standard Drawing** and **Instructional Bulletin 2009-2** for the pipe end treatment used.

Measure the quantity for geotextile for erosion control under riprap in square yards based on the quantity required to complete installation in accordance with the **SCDOT Standard Drawing** for the pipe end treatment used.

The quantity for the items pipe culvert flared end section, straight headwalls, concrete slabs, pipe end structures, wingwall and apron system, and drainage structures is measured by each unit, complete in place and accepted.

The quantity of pipe additional foundation work is measured in linear feet along the centerline of the pipe as shown in the **SCDOT Standard Drawings**. Dispose of any unstable material in the manner outlined in **SCDOT Standard Specifications Subsection 203.2.1.5**.

For typical and maximum cover installations shown on **SCDOT Standard Drawings**, no measurement will be made for backfill material shown within the pipe embedment zone, and payment for this material will be included in the cost of the pipe. For shallow and minimum cover installations shown on **SCDOT Standard Drawings**, no measurement will be made for backfill within the pipe trench, and payment for this material will be included in the cost of the pipe.

For installations in cut sections where pipe is deeper than shallow installation, embankment material overfill above the pipe embedment zone will be measured as the volume between the standard trench walls from the top of the pipe embedment zone to the top of the subgrade as shown on the **SCDOT Standard Drawings**.

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)

Pipe culvert 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 of the entire standard trench, bedding, and pipe structural backfill as described in the measurement section, 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, traffic control for all inspections, and all incidentals necessary to complete the work.

All traffic control necessary to perform the installation and post construction inspections will be provided by the Prime Contractor. No separate payment will be made for this traffic control.

Beveling of the pipe ends will be included in the unit cost of beveling of pipe culvert as specified in the plans.

Payment for riprap and geotextile for erosion control under riprap as measured in **Subsection 2.4** includes all direct and indirect costs and expenses 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 as each.

The quantity of pipe additional foundation work, measured as provided for in **Subsection 2.4**, is paid for at the contract unit price, which price and payment is compensation for furnishing all material (foundation, extra bedding, extra structural backfill, extra geotextile, etc.), labor (additional trench excavation, compaction, etc.), equipment, tools, hauling, and disposal (of poor material) to complete construction of the pipe foundation, and wider trench as specified in the **SCDOT Standard Drawings**, the plans, or by the **RCE**.

Embankment material overfill in cut sections as described in the measurement section will be paid for as borrow.

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 Instructional Bulletins:
SCDOT Instructional Bulletin 2007-04

SCDOT Qualified Product List:

Qualified Product List 2
Qualified Product List 68

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

Websites:
www.osha.gov
www.llr.state.sc.us/labor/osha/

3 Corrugated High Density Polyethylene Pipe Culvert (HDPE)

3.1 Description (HDPE)

This section contains specifications for the materials, construction, measurement, and payment for furnishing corrugated high density polyethylene pipe culvert (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 pipe culvert conforming to the requirements of **AASHTO M 294**, Type S, as required. Use pipe supplied with joint sealant material and manufactured at a facility listed on **Qualified Product List 30.**

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 Policy 30** and appearing on the **SCDOT Qualified Product List 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**, plant designation code, the date of manufacture or an appropriate code, and certification stamp from NTPEP. Ensure that the shipped fittings are plainly marked with the manufacturer's identification symbol and specification designation **AASHTO M 294**. Furnish a materials safety data sheet and installation instructions with each shipment. Ensure that all HDPE pipe is certified by **AASHTO NTPEP** third party certification programs.

When geotextile for drainage filtration is required, follow **SCDOT Standard Specifications subsection 804.2.11** and **SCDOT Standard Drawings**.

If special designed pipe is required (beyond the fill height limits of the **SCDOT Standard Drawings**), have the manufacturer submit to the **OMR** and the appropriate Structures Engineer a design that meets or exceeds the loading criteria specified on **SCDOT Instructional Bulletin 2007-04** for the design cover height for the project and the pipe material chosen.

Use tees, wyes, elbows, bends, reducers, and increasers with strength matching or exceeding the strength of the strongest pipe being connected and with the same joint profile of the connecting pipe. Use tees, wyes, elbows, bends, reducers, and increasers with joint profiles that match connected pipe.

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 the greatest of:

1. 1.5 x Pipe OD + 12"
2. Pipe OD + 24"
3. 3 x Pipe OD (only in sections where foundation improvement is required in the plans or by the **RCE**)
4. The width required to safely fit compaction equipment and personnel between the pipe and the trench walls.

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 to accommodate the required bedding thickness.

Follow OSHA's excavation regulations found in Subpart P of 29 CFR 1926 for safety requirements of trench excavations and protection systems. The Contractor shall employ an onsite Competent Person (as defined by SC OSHA as follows: one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them. In order to be a competent person for the purpose of this standard one must have had specific training in, and be knowledgeable about, soils analysis, the use of protective systems, and the requirements of this standard) during all trenching operations. Provide the RCE with the name and contact information of the responsible Competent Person for each installation. If trench widths or wall slopes are changed due to safety requirements, backfill the trench outside of the vertical trench dimensions with materials meeting the minimum requirements of the embankment (or pipe structural backfill for shallow installations) as described in Subsection 3.3.6. Ensure that the support of the pipe and its embedment are maintained throughout the installation.

If trench boxes (shields, etc.) are required, follow 29 CFR 1926.652, trench box manufacturer, and industry standards for trench installations not exceeding 20 feet. When trench boxes are required for trenches exceeding 20 feet deep, the Contractor shall submit to the RCE designs, plans and supporting calculations for protective systems and shoring equipment sealed by a Professional Engineer who is licensed in South Carolina unless provided in the plans. When trench boxes are moved, the previously placed pipe and structural backfill shall not be disturbed. Move trench box in increments during the installation process to permit placement and compaction of structural backfill material for the full width of the trench while continuing to follow Subpart P of 29 CFR 1926 OSHA Standards. Voids that are created by movement of the trench box shall be filled and compacted with structural backfill described in Subsection 3.3.6. If necessary to prevent movement, restrain the pipe using methods that do not damage the pipe.

If temporary shoring (sheet pile, timber shoring, mechanically stabilized earth, etc.) is required, the Contractor shall submit to the RCE designs, plans and supporting calculations for protective systems and shoring equipment sealed by a Professional Engineer who is licensed in South Carolina unless provided in the plans. If temporary shoring is to be removed, it shall be pulled out in vertical increments during the installation process to permit placement and compaction of fill material for the full width of the trench while continuing to follow Subpart P of 29 CFR 1926 OSHA Standards. If temporary shoring is to be left in place, provide the resident with location and description of all buried systems for inclusion in as-built plans.

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.

Use the soil boring Standard Penetration Test SPT "N" values and recommendations of **SCDOT Standard Drawings** to determine if additional work is required to prepare an

improved foundation. When an improved foundation is required, remove unstable material at least 1 diameter on each side of the pipe. Excavate deep enough to install nonwoven geotextile for drainage filtration and pipe foundation material as indicated on **SCDOT Standard Drawings**. If Type P1 biaxial geogrid is used with the foundation material and geotextile for drainage filtration, the additional foundation undercut may be reduced as indicated on **SCDOT Standard Drawings**. When pipe foundation material is indicated, use the same material that is used for the bedding and pipe structural backfill. Compact the pipe foundation material in accordance with methods used for pipe structural backfill. Provide trench suitable to accommodate site conditions and obstructions.

If poor material is encountered that was not indicated in the plans, contact the **Preconstruction Regional Production Group Design Manager** for instructions on foundation preparation.

3.3.3 Bed for Pipe (HDPE)

For bedding material, use either:

1. Well graded A-1 (**AASHTO M 145**) soils
2. Screenings meeting A-1 (**AASHTO M 145**)
3. Macadam or Marine Limestone Graded aggregate base from **Qualified Product List 2**
4. Uniformly graded, coarse grained A-3 (**AASHTO M 145**) soils (Class 1 wrapped)
5. Uniformly graded angular stone as large as #5 stone (Class 2 wrapped, vibrated)

The same material must be used for bedding and structural backfill unless CLSM is used for structural backfill.

The materials marked as (wrapped) require geotextile wrap to control migration of fines into open voids. In all cases, use a geotextile that prevents the transmission of the smallest soil particles present in both the in-situ soil and the soil used for bedding and structural backfill. Wrap the entire bedding and backfill envelope and provide a minimum overlap of 2 feet at all geotextile splices. For shallow installations, provide a cover of 6 inches of soil between geotextile and hot mix asphalt.

A sample of the pipe bedding material will be taken at the beginning of pipe laying operations to verify the classification of materials used for bedding and pipe structural backfill. After the initial sample is taken, the sampling frequency will be for each 1,000 foot production lot or until the source or classification of the bedding/backfill material changes. These are minimum requirements that may be increased at the RCE's discretion.

Ensure that trenches are free of water when placing bedding.

Support the pipe by placing uncompacted bedding material above the stable foundation material. Use the larger of 6 inches or 10.0% of the nominal pipe outside diameter for the bedding thickness. 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.

Vibrate angular stone in place using a minimum of 2 passes with a vibratory plate tamp in lifts not to exceed 12 inches.

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**. Each manufacturer may also elect to test their pipe joints to 13 psi for use in locations where RCP AASHTO M 315 joints are currently specified. Both 10 psi and 13 psi tests are to be conducted in straight alignment with the pipe deflected 5%. The laboratory tests are not intended to indicate field performance of the joint, but rather to indicate the proper sealant size to joint detail configuration as well as performance of the joint under ideal laboratory conditions. 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, use the same material as the pipe bedding **(Subsection 3.3.3)** unless controlled low strength material is used as described below. When materials are

used that require geotextile wrap, cover the entire bedding and structural backfill envelope as described in **subsection 3.3.3**.

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 and does not float 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**.

The **RCE** will establish a compaction pattern for the contractor to follow during pipe backfill operations. The pattern will be in effect for production lots of 500 feet of pipe, until the source or classification of backfill material changes, site weather conditions change such as rain, or the compactive efforts being applied change. The compaction pattern will be established by allowing the contractor to apply a 6 inch lift in a 50 foot section until the material has been compacted to 95.0% of the maximum dry density for the structural backfill when measured in accordance with **SC-T-29**. The number of passes and the watering efforts applied to the material will be recorded and this pattern will be considered the compaction pattern.

For pipe smaller than 36 inches in diameter, the **RCE** will run a minimum of one verification compaction test at the springline of the pipe for each run of pipe between drainage structures or pipe ends. For pipe 36 inches in diameter and larger, a minimum of one test for each 18 inches of the pipe embedment zone height (including one at the pipe springline) for each run of pipe between drainage structures or pipe ends will be performed. This is a minimum frequency and should be increased at the **RCE**'s discretion.

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, the RCE will check the compaction of the previous lift by removing enough material to perform the verification test. If the second test passes, the contractor will continue the compaction efforts of the current layer until the verification test passes. In the event of 2 failing compaction tests within a single run of pipe (between drainage structures or pipe ends), remove the pipe structural backfill, clean trench and set a new compaction pattern at the **RCE**'s discretion.

Vibrate angular stone backfills in place using methods that properly lock the angular stone in place around the pipe and do not damage the pipe, typically 2 passes with a vibratory plate tamp for each 12 inch lift.

Complete structural backfill installation up to the minimum cover elevation above the pipe for typical installations. When installing pipe under pavement and within 3 feet of the subgrade, complete structural backfill installation up to the top of the subgrade. Confirm that structural backfill material in pipe trench meets or exceeds the embankment compaction requirements before applying pavement structure.

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 at each exposed end of pipe. Follow **Pipe End Treatments Special Provision** or **SC-M-719 Pipe End Treatments** and SCDOT Standard Drawings to determine required end treatment.

Unless shown otherwise in the plans, use a minimum end treatment of a straight pipe end with Class B or C riprap and geotextile for erosion control as shown in the **SCDOT Standard Drawings**. When specified in the plans, use end treatments such as pipe beveled end, concrete slab, straight headwall for pipe, pipe end structure, or pipe wingwall and apron system in accordance with **SCDOT Standard Drawings** or plan structure details.

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)

All traffic control necessary to perform the installation and post construction inspections will be provided by the Prime Contractor. No separate payment will be made for this traffic control.

Construction Inspection:

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. Verify line and grade in accordance with the frequencies detailed in the Construction Manual. All inspections must be performed by a SCDOT certified Earthwork, Drainage and Base Technician.

When improper installation or damage is noted during the construction inspection of the pipe, repairs must be made to the satisfaction of the RCE. Additional inspections may be performed until confidence is restored that the installation has been performed in accordance with these specifications.

Post Construction Inspection (Acceptance):

The **RCE** will collect survey data for 100% of installed pipe. Survey data will be collected electronically to establish a pipe inventory. Survey data will include latitude, longitude, station, offset, elevation, and coordinates of the flow line for each pipe end. Survey data collected will also include at a minimum pipe diameter, pipe material, and description or survey data for drainage structures and end treatments.

The **RCE** will inspect 100% of pipe under the roadbed, 100% of pipe in a closed drainage system, and a minimum of 10.0% (random locations) of all other locations. These inspections will be performed 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. In cases where the Contractor's accepted CPM Schedule indicates that paving operations will be conducted in less than 30 days, an early inspection may be performed for acceptance. If early inspections are performed and the paving does not commence as scheduled, an additional inspection may be performed at the **RCE**'s discretion.

When third party surveys and inspections are performed on behalf of the **RCE**, a report will be submitted with the survey and inspection results. This report will include a copy of all video taken from each video camera inspection, pipe location identification, equipment used for inspection, inspector name, inspector field notes, measurements from the pipe inspection (at a minimum to include the following: deviation from design grade, deviation from line, deflection [expressed in inches and % of pipe diameter]), and survey data for all installed pipe.

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 pipe culvert.

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.

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. Pipes must be clean and accessible for inspection and acceptance.

3.3.14 Trench Backfill for Expedited Construction (HDPE)

At the RCE's discretion or where otherwise noted, CLSM may be used as structural backfill and to complete trench backfill for pipe installations in order to expedite the re-opening of the roadway to traffic. The decision should be based on traffic volume, safety and public inconvenience.

CLSM can be placed to a height not to exceed the subgrade elevation. The remaining pavement structure must be installed according to the pavement typical section. Measurements for payment will be made based on the neat line at a trench width (pipe outside diameter + 12") for the pipe type being installed. Any material used beyond these dimensions is considered incidental to the pipe installation. CLSM shall be installed in accordance with manufacturer's recommendations to prevent pipe displacement and uplift during CLSM placement.

When CLSM is specified in the plans or special provisions for completion of the trench backfill, CLSM in the pipe embedment zone will be included in the cost of the pipe, and CLSM above the pipe embedment zone will be paid for at the contract unit price for Controlled Low Strength Material.

When CLSM is specified by the **RCE** during construction, all CLSM used in the trench above the pipe springline will be paid for at the contract unit price for Controlled Low Strength Material.

3.4 Measurement (HDPE)

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

Pipe quantities will be the linear measurement from end to end of the pipe through tees, wyes, elbows, bends, reducers, increasers, elbows, and beveled ends, excluding all drainage structures. The length is obtained by adding the centerline length of each run of pipe between Drainage Structures and to the completed end of pipe at End Treatments. Do not include the length of end treatment beyond the pipe in the measurement of the pipe.

If the plans require bevels at the pipe ends, include the length of the beveled end section in the measured length of pipe.

The quantity for the items beveling of smooth wall pipe culvert, pipe culvert tees, wyes, elbows, bends, reducers, and increasers of the size and kind specified is measured by each item.

Measure the quantity for riprap placed around pipe end or end treatment in tons based on the quantity required to complete installation in accordance with the **SCDOT Standard Drawing** and **Instructional Bulletin 2009-2** for the pipe end treatment used.

Measure the quantity for geotextile for erosion control under riprap in square yards based on the quantity required to complete installation in accordance with the **SCDOT Standard Drawing** for the pipe end treatment used.

The quantity for the items pipe culvert flared end section, straight headwalls, concrete slabs, pipe end structures, wingwall and apron system, and drainage structures is measured by each unit, complete in place and accepted.

The quantity of pipe additional foundation work is measured in linear feet along the centerline of the pipe as shown in the **SCDOT Standard Drawings**. Dispose of any unstable material in the manner outlined in **SCDOT Standard Specifications Subsection 203.2.1.5**.

For typical and maximum cover installations shown on **SCDOT Standard Drawings**, no measurement will be made for backfill material shown within the pipe embedment zone, and payment for this material will be included in the cost of the pipe. For shallow and minimum cover installations shown on **SCDOT Standard Drawings**, no measurement will be made for backfill within the pipe trench, and payment for this material will be included in the cost of the pipe.

For installations in cut sections where pipe is deeper than shallow installation, embankment material overfill above the pipe embedment zone will be measured as the volume between the standard trench walls from the top of the pipe embedment zone to the top of the subgrade as shown on the **SCDOT Standard Drawings**.

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)

Pipe culvert 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 of the entire standard trench, bedding, and pipe structural backfill as described in the measurement section, 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, traffic control for all inspections, and all incidentals necessary to complete the work.

All traffic control necessary to perform the installation and post construction inspections will be provided by the Prime Contractor. No separate payment will be made for this traffic control.

Beveling of the pipe ends will be included in the unit cost of beveling of pipe culvert as specified in the plans.

Payment for riprap and geotextile for erosion control under riprap as measured in **Subsection 3.4** includes all direct and indirect costs and expenses necessary to complete the work.

The quantities for the items pipe culvert tees, wyes, elbows, bends, reducers, and increasers measured as provided in **Subsection 3.4**, are paid for as each.

The quantity of pipe additional foundation work, measured as provided for in **Subsection 3.4**, is paid for at the contract unit price, which price and payment is compensation for furnishing all material (foundation, extra bedding, extra structural backfill, extra geotextile, etc.), labor (additional trench excavation, compaction, etc.), equipment, tools, hauling, and disposal (of poor material) to complete construction of the pipe foundation, and wider trench as specified in the **SCDOT Standard Drawings**, the plans, or by the **RCE**.

Embankment material overfill in cut sections as described in the measurement section will be paid for as borrow.

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 Qualified Product Lists:

Qualified Product List 2
Qualified Product List 30

SCDOT Instructional Bulletins:
SCDOT Instructional Bulletin 2007-04

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

Websites:
www.osha.gov
www.llr.state.sc.us/labor/osha/
www.plasticpipe.org
www.ntpep.org

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 pipe culvert 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	*(size) Smooth Wall Pipe Culvert*	LF
714XXXX	*(size) Corrugated Wall Pipe Culvert*	LF
714XXXX	*(size)* RC Pipe Culvert (RCP) - *(class)*	LF
714XXXX	*(size)* RC Pipe Culvert (RCP) - *(class)* AASHTO M315	LF
714XXXX	*(size)* Corr. Alum. Alloy Pipe Culvert (CAAP) - *(gage)*	LF
714XXXX	*(size)* Spiral Rib. Alum. Pipe Culvert (SRAP) - *(gage)*	LF
714XXXX	*(size)* Corr. Polyethylene Pipe Culvert (HDPE) – Type S	LF
714XXXX	*(size) (kind)* Pipe Culvert Flared End Section *(class or thickness)*	EA
714XXXX	*(size) (kind)* Pipe Culvert Tee	EA
714XXXX	*(size) (kind)* Pipe Culvert Wye	EA
714XXXX	*(size) (kind)* Pipe Culvert *(degree)* Bend	EA
714XXXX	*(size) (kind)* Increaser *(size)* to *(size)* Diameter	EA
7149999	Cleaning Existing Pipe	LF