STATE OF TENNESSEE

(Rev. 02-06-10)
(Rev. 05-05-10)
(Rev. 12-13-10)
(Rev. 06-12-13)

March 1, 2006

Supplemental Specifications - Section 700

of the

Standard Specifications for Road and Bridge Construction

701.13-Method of Measurement. Add the following as the second paragraph:

Handicap Ramps will be measured by the ft.^{2} (m^2) complete in place as specified by standard drawings. The area shall be obtained by surface measurements. Where standard widths are constructed, the measurements shall not exceed the standard widths shown on the Plans, unless approved in writing by the Engineer.

Subsection 701.14-Basis of Payment. Revise paragraph to include Handicap ramps as follows:

The accepted quantities of Concrete Sidewalk of each thickness, Handicap Ramps, and Concrete Driveway will be paid for at the contract unit price per ft.^{2} (m^2) for the respective items, complete in place. The accepted quantities of Concrete Median Pavement will be paid for at the contract unit price per yd^3. (m^3), complete in place.

Subsection 705.06: Delete the second and third paragraph, and add the following as the second, third, and fourth paragraph. Revise the bulleted section as shown below.

All post holes, dug or drilled, shall be of such size as will permit proper setting of the posts, and allow sufficient room for backfilling and tamping.

When solid rock is encountered while drilling post holes.

- Within 18 in. (460mm) of the ground surface, an oversized or elongated hole shall be drilled 24 in. (610mm) into the rock. The post shall be set at the roadside edge of the hole and the hole should be backfilled with the cutting spoils. If using wooden posts the oversized hole shall be a single hole 23 in. (580mm) in diameter or three overlapping holes 10 in. (250mm) in diameter to a length of 23 inches. For steel posts, the oversized hole shall be a single hole, 20 in. (530mm) in diameter or three overlapping holes 8 in. (203mm) in diameter to a length of 20 inches.
- Below 18 in. (460mm) of the ground surface hole shall be drilled 12 in. (300mm) into the rock or to the specified depth in Plans. The holes shall be 8 in. diameter for steel posts, and 12 in. diameter for wood posts.

- When installing end terminals using tubes, posts 1 and 2 will be installed to full depth or a minimum of 36 in. into the solid rock. The holes around the steel tube shall be backfilled with the cutting spoils.
- See approved shop drawings for additional information concerning post depth, and size of holes.

To validate proper installation of posts, each guardrail contractor/installer doing work for the Department shall have a minimum of 5 line posts and 5 terminal posts per Region per year pulled by the Department for verification of length. The Regional Construction and Materials and Tests offices may select any post for verification, but at a minimum, must select posts from five different runs of rail. If the posts are found to be in accordance with the plans and specifications, they may be re-installed if they were not damaged during the pulling process. If the post length is found to be deficient, the contractor/installer shall be required to remove the entire run of guardrail or end terminal and replace it properly at his expense.

Subsection 705.10: Add to the end of the section

When no contract unit price has been established for drilling or boring in solid rock, for posts, while placing Single Guardrail, payment for each hole shall be made at a rate equal to 2.0 times the contract unit price for Single Guardrail.

While drilling or boring into solid rock for posts placed in conjunction with Guardrail at Bridge Ends, Parapets, Piers, Concrete Endposts, and other similar edifice, payment shall be made at a rate equal to 1.25 times the contract unit price per hole.

When no unit price has been established for drilling or boring into solid rock for End Terminals posts, payment shall be made at a rate equal to 2.0 times the contract unit price for single guardrail per hole.

Unless posts are driven to refusal in solid rock, prior to drilling or boring, no additional payment will be made for drilling or boring for the placement of posts.

Subsection 709.01, Revise entire subsection to the following:

709.01-Description. Riprap shall consist of furnishing and setting or placing, rubble stones, crushed stone, sacked sand-cement, machined riprap, and embedded riprap. Slope Pavement shall consist of the construction of a reinforced concrete mat on prepared slopes. The riprap and slope pavement shall be constructed within reasonably close conformity to the lines, grades, and cross sections, and at the locations indicated on the Plans or as directed by the Engineer, and in conformity with the requirements and provisions of these Specifications.

Subsection 709.02, Revise entire subsection to the following:

709.02-Materials. Materials used in the construction of riprap and slope pavement, in addition to meeting the general requirements of these Specifications, shall conform to the following:

(a) Rubble-stone Riprap shall consist of stone or broken Class "A" or paving concrete meeting the requirements of **Subsection 918.10**. In addition, at least 80% of the stone shall have a minimum dimension of 10 in.(250 mm). The remainder shall be 2 to 4 in.(50 to 100 mm), and shall be approximately rectangular and/or trapezoidal in shape. Broken Class "A" or paving concrete shall be free of steel and wire fabric reinforcement. Sand

for rubble-stone riprap(grouted) shall meet the requirements of **Subsection 903.01** or **903.02**. Cement for rubble-stone riprap(grouted) shall meet the requirements of **Subsection 901.01**.

((b)Sand for sacked sand-cement riprap shall be manufactured or natural sand and shall meet the quality requirements of **Subsection 903.01** or **903.02**. Cement for sacked sand-cement shall meet the requirements of **Subsection 901.01**. Sacks shall be of either cotton or jute, standard grade of cloth, which will hold the sand-cement mixture without leakage during handling and tamping. They shall be strong and shall be sized to hold approximately 1 c.f.(0.03 mm^3).

(c) Reinforced concrete slope pavement shall be composed of Class A concrete meeting the requirements of **Subsection 604.03** and steel reinforcement meeting the requirements of **Subsection 907.01** or **907.03**, whichever is specified. Preformed expansion joint filler shall meet the requirements of **Subsection 905.01**.

(d) Concrete curing materials shall meet the requirements of Section **913**.

(e) Machined Riprap shall be clean shot rock essentially free of sand, dust or organic materials and shall be the size designated for the class specified. The stone shall be uniformly distributed throughout the size range. The thickness of the stone layer shall be that designated for the specified class herein unless otherwise noted on the Plans. Sensitive areas of the project as indicated on project plans, project permits, and/or designated by the Engineer requiring washed and/or clean rock will be provide by the contractor at no additional cost to the project. Washed and/or clean rock must be approved by Engineer prior to placement in environmentally sensitive areas.

When rock or stone is used as riprap, the material when subjected to five alternations of the sodium sulfate soundness test (**AASHTO T 104**), shall not have a weighted percentage of loss of more than 12. The material shall be approved by the Engineer before use.

Subsection 709.08: Second paragraph, **Change** "sawed for a depth of 1 ft." to "1 in."

Subsection 709.09, Revise entire subsection to the following:

709.09-Machined Riprap. The Contractor shall exercise care in the preparation of the riprap subgrade to insure that no reduction in the design waterway occurs. No riprap is to be placed until the final subgrade elevation has been verified by the Engineer. When deemed necessary by the Engineer, the riprap shall be rolled down with metal tracked equipment to provide a more dense stone mass with final contours in reasonable conformance to the plans. Placement of the super-structure shall not proceed until the final elevation of the riprap has been accepted by the Engineer.

Upon completion of the work, visual inspection shall reveal that approximately 50% of the surface area consists of stones no smaller than 1/2 of the maximum size specified.

The material shall be dumped and placed by the use of appropriate power equipment in a manner that will produce a surface uniform in appearance. Hand work may be required to correct irregularities.

The Contractor shall exercise care in the preparation of the site referring to erosion control in accordance with the provisions in Subsection 209 and channel excavation in accordance with the provision of Subsections 203.02(c). When required by project plans, permits, or as directed by

the engineer, embedded riprap in streams, conveyances, diversions, or other sensitive areas shall be properly tamped into the subsurface or otherwise blended into the substrate. Care is to be taken so that water flows over the embedded riprap and that flow is not lost below and/or within the rock. If clean rock is required by the project plans, permit, or directed by the engineer, the rock shall meet the provisions of Subsection 709.02 for clean rock.

Subsection 712.01: Add to the end of paragraph 1.

This work shall include both installing additional devices as necessary in construction work zones.

Subsection 712.04: Remove entire subsection text and replace with the following:

General. At the Pre-construction Conference the Contractor shall designate a responsible person who will be assigned to the project to supervise traffic control.

Signs shall be erected in a workmanlike manner such that all supports are plumb, sign panels generally perpendicular to the travelway and legends horizontal so that they effectively convey the intended message. Advanced warning signs shall not be displayed more than 48 hours before physical construction begins. Signs may be erected up to 1 week before needed, if the sign face is fully covered, in a manner approved by the Engineer. The sheeting of the sign shall be free of any damage that would reduce the reflectivity. The use of overlay plates on signs is prohibited. Signs shall be mounted on stationary or portable supports dependent on the type work being performed. Sign supports shall be driven a minimum of 3.5 ft. (1 m) into soil or 1 ft. (300 mm) into solid rock. Where soil and solid rock are both encountered, the depth of the sign support in the ground shall be:

$d1 + 3.33d2 = 1$, where
$(d1 + 3.5d2 = 42)$
d1 = depth in m (in.) of support in soil
d2 = depth in m (in.) of support in solid rock

Stationary sign supports may be spliced, provided the splice is a minimum of 18 in.(450 mm). In addition, the stubs for the splice shall be driven as required above and shall not extend above 18 in.(450 mm) from ground level. The splice shall be fastened with four bolts, 2 placed at each end of the splice. In general, work being performed at spot locations and of short duration will necessitate the use of portable supports properly weighted for stability.

During periods of non-use, warning signs and other devices shall be removed from the work area, covered or otherwise positioned so they do not convey their message to the traveling public and do not present a safety hazard to drivers. If covered, the covering material shall be maintained in a neat and workmanlike manner during its use. The method of covering the sign face shall not deface or damage the sheeting of the sign.

Barricades and other devices that require lighting shall be lighted, as designated by plans details or as directed by the Engineer, with the use of flashing or steady burning lights. The Contractor will be responsible for procuring and bearing the expense of a continuous power source.

Flaggers with proper attire and paddle shall be provided when necessary to safely handle traffic through the construction zone. Flaggers shall be trained and certified in flagging operations by one of the following training programs:

1) American Traffic Safety Services Association (ATSSA)
2) National Safety Council (NSC)
3) Tennessee Transportation Assistance Program (TTAP)
4) Construction industry associations, consultant organizations, and contractor developed flagger training programs will be acceptable if they have an established, written program which meets all *Manual on Uniform Traffic Control Devices* (MUTCD) requirements and Department Policy.

Flaggers will be considered a general requirement of traffic control and no direct payment will be made for such.

When requested by the Project Engineer or the Contractor and approved by the Regional Safety Coordinator or Regional Operations Office, a Tennessee Highway Patrol (THP) Trooper may be provided to enforce motor vehicle laws and otherwise assist in securing the public safety. Requests to provide the THP should be received at least forty-eight (48) hours in advance of the requested time of service. If the THP is scheduled to work and the work is canceled, or the schedule is changed, the contractor is responsible for notifying the THP and the Project Engineer at least two (2) hours prior to the scheduled time of work.

When a THP Trooper is not available, the contractor may provide a Uniformed Police Officer if approved by the Project Engineer and the Regional Safety Coordinator or Regional Operations Office. The Uniformed Police Officer shall maintain a detailed written log of his enforcement activities and shall submit the log to the Engineer for verification each month.

All Uniformed Law Enforcement Officers working on TDOT projects shall have training from a Peace Officer Standards and Training (POST) certified police training academy in the State of Tennessee and an additional 4 hours of FHWA approved work zone training. Record of this training shall be submitted to the Project Engineer.

The Flashing Arrow Board(s) shall be installed at locations shown on the Plans or as directed by the Engineer and shall comply with all requirements of the **"Manual on Uniform Traffic Control Devices for Highways and Streets"(MUTCD)**. The Contractor shall take all necessary precautions to insure that the Flashing Arrow Board(s) perform as described herein. Any Flashing Arrow Board that exhibits any type of malfunction including improper dimming shall be corrected or replaced immediately.

The Flashing Arrow Board shall be capable of displaying the following configurations:

1. Right Arrow - 10 lamps flashing in unison forming an arrow
2. Left Arrow - 10 lamps flashing in unison forming an arrow
3. Double Arrow - 5 lamps in each arrow head and 3 lamps in a common shaft all flashing in unison
4. Four Point Caution - 4 outermost corner lamps flashing in unison

The Flashing Arrow Board(s) shall be used in the single arrow mode for lane closure only and shall be situated and aligned so that the flashing arrow is clearly visible and legible. The

single arrow mode display shall have 10 lamps flashing in unison. The sequential arrow configuration, chevron arrow configuration, and horizontal bar configuration will not be allowed. The flash rate shall not be less than 25 flashes per minute or more than 40 flashes per minute. Minimum lamp "on-time" shall be 50% of the cycle.

The Flashing Arrow Board(s) shall be mounted so as to provide a minimum of 7 ft.(2.1 m) between the bottom of the panel and the roadway.

Portable signs may be used when the duration of the work is less than three (3) days or as allowed by other conditions in the proposal. All portable signs and sign mounting devices utilized in work shall be **NCHRP 350** compliant. When not being used, portable signs must be removed from the clear zone. Turning signs sideways or backwards is explicitly prohibited while the signs are in the clear zone. Portable interim signs shall be mounted a minimum of one (1) foot above the level of the pavement edge and shall be mounted at the height recommended by the manufacturer's crashworthy testing requirements.

All regulatory sign blanks shall be rigid.

The Contractor shall make every effort to eliminate the use of interim signs as soon as the Work allows for the installation of permanent signs.

Existing street name signs shall be maintained at street intersections.

Any sign(s) or portions of a sign(s) that are not applicable to the traffic control plan shall be covered so as not to be visible to traffic or shall be removed from the roadway when not in use.

The Contractor shall not remove any existing signs and supports without prior approval from the Engineer. All existing signs and supports that are to be removed shall be stored and protected if this material will be required later in the work.

Interim guide, warning, or regulatory signs required to direct traffic shall be furnished, installed, reused, and maintained by the Contractor in accordance with the **MUTCD**. The bottom of all interim signs shall be mounted at least seven (7 ft.) feet above the level of the pavement edge when the signs are used for long-term stationary operations as defined by Section 6G.02 of the **MUTCD**.

Existing guide and exit directional signs on the Project shall be maintained until conditions require a change in location or legend content. When change is required, the signs shall be in accordance with the Traffic Control Plan. When an existing guide and exit directional signs sign is in conflict with work to be performed, the Contractor shall remove the conflicting sign and reset it in a new, non-conflicting location that has been approved by the engineer.

When it is not possible to utilize existing signs, either in place or relocated, the Contractor shall furnish, erect, maintain, modify, relocate, and remove new interim guide and exit directional signs in accordance with the Plans or as directed by the engineer.

The installation of new permanent guide and exit directional signs and the permanent modification or resetting of existing guide and exit directional signs, when included in the contract, shall be accomplished as soon as practical to minimize the use of interim guide and exit directional signs.

Worker Visibility and Safety. All workers within the right-of-way of a project who are exposed to either vehicular traffic or to construction equipment in the work area shall wear high-visibility safety apparel. High-visibility apparel shall be considered personal protective clothing that meets performance Class 2 or Class 3 of the ANSI/ISEA 107-2004 publication. Class 3 apparel shall be required for night work.

Portable Barrier Rail. All portable barrier rail will be placed as far away from the travel lanes as possible while serving the intended purpose. All portable barrier rail will be moved or removed as directed by the engineer. There shall be no additional payment for removing barrier that is no longer required.

Lane Closures. The length of a lane closure should be held to the minimum length required to accomplish the Work. The advanced warning signs for the project should not overlap with the advanced warning signs for lane shifts, lane closures, etc.

Drums shall be used in all transition tapers for lane closures on multi-lane roads

Night Work Lighting. When night work is required by Contract documents or plans, the Contractor shall supply sufficient lighting according to the following Specification.

The following information regarding the lighting plan must be submitted to the project supervisor:

- Descriptions and sketches of the layout of lighting devices including spacing, luminary height, lateral placement and anticipated illuminance provided.
- Photometric & physical specifications of all lighting equipment.
- Detailed description of all lighting to be used on construction equipment.
- Methods to be employed to reduce glare.
- Contractor's frequency and procedure for checking illumination levels.

In addition to their standard protective equipment, the following information regarding construction personnel and equipment shall be followed as a minimum:

1. Traffic Control Persons, all equipment operators and all other workers shall wear high-visibility apparel that meets performance Class 2 or Class 3 of the ANSI/ISEA 107-2004 publication. Class 3 apparel shall be required for night work.
2. They shall also have a minimum of 12 in^2 of reflective material added to their hard hats which is visible from all sides.
3. Traffic Control Persons must also be equipped with a flashlight complete with semi -transparent red cone.
4. All traffic control persons shall be equipped with radios or cell phones so that they have communication with each other.
5. All workers shall receive specific training on night work operations.
6. All vehicles in the work area must operate rotating or flashing incandescent amber lights visible in 360 degrees around the vehicle.
7. All work vehicles including trucks must have red and white reflective tape applied to all sides such that it defines the outline of the vehicle.

The following equipment will be outfitted with non glare balloon style lights or equivalent. The lights will be required on each piece of equipment in operation.

Equipment Type	Illuminance Requirement
Paver, Milling Machine, Material Transfer Devices	1- 4000 watt assembly or 2 - 2000 watts assemblies
Grader, Roller, Rumble Strip	1 – 400 watt assembly

Machine, Shoulder Machine	
Paint truck	1- 400 watt assembly or nonglare 300 watt floodlight assembly
Guardrail driver, stationary Operation	1- 4000 watt assembly or 2 - 2000 watts assemblies or equipment light plant
Trail Vehicle	1-4000 watt assembly or 2 - 2000 watts assemblies

(A trail vehicle will be required to follow the last piece of equipment in a mobile operation(i.e. finish roller, pavement marking, etc.) depicting the beginning of the working area. In addition, portable lighting of at least 400 watts shall be available for the density testing inspector. The illuminance requirement for other vehicles not listed will be determined by the Engineer. A 400 watt metal halide lamp or equal approved by the Engineer may be substituted for a 2000 or 400 watt balloon light assembly.)

All luminaries shall be located and directed in such a way to minimize glare to both motorists and work vehicles. If glare is noted from any travel path, the contractor must adjust the lighting to reduce the glare to an acceptable level to the satisfaction of the Engineer.

The contractor shall replace non-functioning lamps immediately. The luminary aiming shall be checked daily. The luminaries shall be cleaned regularly.

Specification Compliance. The Contractor will be notified for failure to comply with this specification or plans. The safe passage of pedestrians and traffic through and around the temporary traffic control zone, while minimizing confusion and disruption to traffic flow, shall have priority over all other Contractor activities. Continued failure of the Contractor to comply with the requirements of the Traffic Control Standard Specification or Special Provisions will result in non-refundable deductions of monies from the Contract for non-performance of Work that the deficiency is allowed to remain, not as penalty, but as liquidated damages.

Failure of the Contractor to comply with this Specification or take immediate correction actions required within forty-eight (48) hours of written notice shall be reason for the engineer suspending all other work on the Project, except erosion prevention and sediment control and traffic control, applying non-refundable deductions of monies from the Contract at a rate of twenty-five hundred dollars ($2,500) per calendar day per notice and/or withholding payment of monies due to the Contractor for any work on the Project until traffic control deficiencies are corrected. These other actions shall be in addition to the deductions for non-performance of traffic control.

Subsection 712.05: Remove entire subsection text and replace with the following:

Pavement Marking Removal. Conflicting pavement markings must be removed to prevent confusion to vehicle operators. Pavement marking removal shall be accomplished by the Contractor in a manner acceptable to the Engineer.

Final surface pavement markings shall be removed by sand blasting, water blasting, or acceptable grinding methods that will cause the least possible damage to the pavement. Intermediate surface pavement markings shall be removed by sand blasting or water blasting, or other approved methods that will cause the least possible damage to the pavement. The following methods listed below are considered as acceptable for intermediate surface pavement

markings: Sand blasting using air or water, High pressure water, steam or superheated water, or Mechanical devices such as grinders, sanders, scrapers, scarifiers, and wire brushes.

The Contractor at his expense shall repair any damage to the pavement or surface caused by pavement marking removal by methods and materials acceptable to the engineer. The end result of the removal shall not cause a condition that appears to be a line that conflicts with the current markings.

Traffic shifts that are done on the final surface shall be accomplished using interim traffic marking tape unless otherwise specified in the plans.

Removal of an existing pavement marking by painting over with black paint or asphalt will not be an acceptable method.

When the method of removal causes sand or other material to be accumulated on the pavement, the residue shall be removed as the work progresses.

Subsection 712-07 Maintenance. Revise entire subsection to the following:

712.07-Maintenance. The Contractor shall assume full responsibility for the continuous and expeditious maintenance of all signs, barricades, temporary impact attenuators and all other traffic control devices to meet the "acceptable" category as described in *Quality Guidelines for Temporary Traffic control Devices and Features* published by ATSSA. Such maintenance will be considered a part of the original installation cost. Failure to maintain all traffic control devices in such a manner as to provide continuous safety to the public will be cause for suspension of construction operations until proper traffic control is re-established.

Subsection 712.09: Revise the entire subsection to the following:

712.09-Method of Measurement. Signs, including Vertical Panels, erected on suitable supports will be measured by the actual square foot(square meter) installed. No deduction will be made for corner radii.

Drums for channelizing traffic will be measured per each. This number shall be determined by counting the maximum number of drums on a job site and in use at any one time. If a construction project is being stage constructed, the number will be counted for each construction phase and summed up for a grand total for the project.

Barricades will be measured by the linear foot(meter) for the type designated.

Delineators and Temporary Flexible Tubular Delineators will be measured per each.

Warning Lights and Flashing Arrow Boards will be measured per each for the type designated.

Portable Barrier Rail will be measured by the linear foot(meter). Separate measurement will be made for the initial installation of portable barrier rail at each site that the rail is used on the project as indicated on the plans or approved by the Engineer. No separate measurement will be made for removing and resetting portable barrier rail on new alignment at the same site to provide for changes in traffic control required by the different phases of construction. The following conditions apply to measurements of portable barrier rail:

1) The sites on 1 directional roadway of a divided highway will be considered independently of the sites on the other directional roadway and

2) Each bridge for which portable barrier rail is indicated on the plans or approved by the Engineer will be a separate site.
3) Additional relocations of barrier rail that will be relocated due to safety of work zone or traffic, as established in the traffic control plans or as directed by the engineer laterally up to 10 ft., shall be paid at ten percent (10%) of the interconnected portable barrier bid amount unless a separate item is in the proposal.

Measurement of Portable Impact Attenuators will be based on the initial installation of each portable impact attenuator. No additional payment will be made for removal, moving and reinstalling impact attenuators at other locations on the project as directed by the Engineer. Payment will be based on the maximum number of portable impact attenuators in place at one time.

Temporary pavement marking line will be measured as described for Painted Pavement Marking Line in **Subsection 716.07** regardless of whether the lines are painted, taped markings or raised pavement markers or a combination of the above as shown on the plans or as required by the Engineer except that Removable Pavement Marking(Line) which will be measured by the linear foot(meter) of installed line.

Unless otherwise specified, no individual measurement will be made of traffic cones, removal of pavement marking or flaggers, as these items will be included in the lump sum item Traffic Control.

THPs shall be compensated by the Department but the contractor will be responsible for notifying the THP and the Project Engineer when work has been canceled within two (2) hours of the schedule of work. When the THP is not notified of work cancellation and the THP elects to monitor/patrol the project for a maximum of two (2) hours, a deduction will be made to monies owed the contractor equaling the THP pay rate for two (2) hours of work.

Uniformed Police Officers shall be provided by the contractor and compensation made by the Department for the invoice price of the work plus 5% not to exceed $50 per hour for the hours present on the project. No compensation will be made for drive time.

Subsection 712.10: Revise the entire subsection to the following:

712.10-Basis of Payment. The lump sum payment for Traffic Control shall include Temporary Workzone Lighting and all equipment, labor, materials and shall included full compensation for furnishing flaggers, traffic cones and removing conflicting and incorrect pavement markings, as required, until project completion.

Payment for Portable Barrier Rail will be by the linear foot (meter) at the contract bid price which shall be full compensation for all materials, installation, maintenance and all incidentals of the work.

Payment for Portable Energy Absorbing Terminals will be made at the contract price per Portable Energy Absorbing terminal, complete in place, with total payment based on the maximum number of portable energy absorbing terminals in place at one time as specified in **Subsection 712.09.**

Payment for Portable Impact Attenuators will be made at the contract price per Portable Impact Attenuator, complete in place, with total payment based on the maximum number of portable impact attenuators in place at one time as specified in **Subsection 712.09.**

Payment for Signs and Vertical Panels measured per square foot(square meter) shall be full compensation for sign panels with proper sheeting and legend, erecting on proper supports, furnishing all mounting hardware, covering when not in use, relocating, handling and maintaining until project completion.

Payment for Flexible Drums shall be measured per each, for the highest number that is IN USE on the project at one time. This shall be designated by making a notation such as "On October 29, 2004, there were 242 Flexible Drums in use. Pay quantity is 242 Each."

This will not apply to phase construction projects. On phase construction projects, each phase would need to be treated as a separate project to arrive at a final pay quantity. The highest number used on Phase I, plus the highest number used on subsequent phases, shall constitute the final pay quantity.

Payment for Barricades measured by the linear foot(meter) complete in place, shall be full compensation for materials, equipment, relocating, handling, maintaining, and all incidentals of the work.

Unless otherwise designated, all signs, barricades, and other traffic control devices covered by this section shall become the property of the Contractor at the completion of the project. The salvage value for these items shall be reflected in the contract unit price bid.

Ten ft.(3 m) lane line/center line and solid barrier line will be paid for as Painted Pavement Marking(Line) in accordance with **Subsection 716.08.**

Payment for Removable Pavement Marking Line,(8 in.(200 mm)) Barrier Line, Channelization Striping or Stop Line, shall include installation, maintenance and removal of the marking line when it is no longer required.

Payment for Uniformed Police Officers shall be full compensation for providing the Officer, official law enforcement vehicle, all necessary equipment, and administrative costs associated therewith.

Subsection 714.02 Revise entire subsection to the following:

714.02-Materials and Submittal Data Requirements. Materials used in this construction shall conform to the requirements of **Section 917** and to the following Sections or Subsections, unless otherwise stipulated:

Material	Section or Subsection
Gray Iron Castings	**908.07**
Portland Cement Concrete, Class	**604**
Steel Bar Reinforcement for Concrete Structures	**907.01**
Welded Steel Wire Fabric	**907.03**
Crushed Stone Grading D	**903.05**
Cement Concrete Curing Materials	**913**
Aluminum Paint	**910.04**
Conduit	**917.05 or 917.07**

Within 30 days after the issuance of the work order, the Contractor shall submit to the Engineer, four (4) collated sets of the manufacturer's descriptive literature and technical data which fully describes the types of lighting equipment he proposes to use. Descriptive literature shall include the manufacturer, models, etc. and be adequate to determine if the equipment or material meets the requirements of the Plans and these specifications. These sets of submittal

data shall include a list of the materials submitted along with descriptive material for, but not limited to, the following items when applicable:

1. Complete photometric data of luminaires as published by the manufacturer with independent testing laboratory results.
2. Computer printouts showing illumination levels throughout each interchange area where high mast luminaires are to be installed.
3. General details of light standards, breakaway bases and bracket arms.
4. Highmast tower details with a set of design computation for each height including access hole, base, anchorage, head frame, and lowering device. Details are to include specification references for materials and location, type, size and extent of welds.
5. Dimension sheets and performance data on all related equipment.

The Engineer shall retain one copy and forward one copy to the Regional Materials and Test Division, one copy to the local entity (city or county engineer), and one copy to the Design Division for their review.

The submittal sets shall also include detailed scale drawings of any non-standard or special equipment and of any proposed deviation from the Plans. Any deviation from plans or specifications shall require approval from the Design Division. A letter requesting deviations or alternate materials must be included in the submittal for Design Devision approval. If requested to do so, the Contractor shall submit for approval sample articles of any materials proposed for use. The Department will not be liable for any materials purchased, labor performed, or delay to the work prior to such approval.

In addition to the above, each submittal shall include a notarized letter certifying that all lighting system materials listed in the submittal are in conformance with the Plans and Specifications. The Contractor shall also submit to the Engineer a statement from the Maintaining Agency that the system is acceptable to the Agency.

Subsection 716.02 Delete "Adhesive 918.26" from the table.

Subsection 716.03 Revise entire subsection to the following:

716.03-Thermoplastic Pavement Marking.

(a) General.

The material shall be applied to the pavement by the screed extrusion method or the ribbon dispenser method. The screed extrusion device shall have one side of the shaping die open with the other 3 sides being contained by, or being part of, suitable equipment for heating and controlling the flow of material. Ribbon dispensers shall be heated, suspended above the road surface, and shall apply the material to the width and thickness specified.

The equipment shall be constructed to provide continuous mixing and agitation of the material. Conveying parts of the equipment between the main material reservoir and the shaping die shall be so constructed as to prevent accumulation and clogging. All parts of the equipment which come in contact with the material shall be so constructed as to be easily accessible for cleaning and maintenance. The equipment shall be constructed so that all mixing and conveying parts up to and including the shaping die, maintain the material at the plastic temperature with heat transfer oil or electrical element controlled heat. Direct fire heat transfer will not be allowed.

The equipment shall be so constructed as to insure continuous uniformity in the dimensions of the stripe. The applicator shall provide a method of applying "skip" lines. The use of pans, aprons, or similar appliances which the die overruns will not be permitted under this Specification. The equipment shall be calibrated, and checked periodically by marking over a metal plate. The equipment will be so constructed as to provide for varying widths to produce varying widths of traffic markings.

Glass spheres applied to the surface of the completed stripe shall be applied by an automatic bead dispenser attached to the striping machine in such a manner that the beads are dispensed almost instantaneously upon the installed line. The glass sphere dispenser shall be capable of applying glass spheres to the surface of the completed stripe by a double drop application for initial traffic striping and marking. The bead dispenser for the first bead drop shall be attached to the striping machine in such a manner that the beads are dispensed closely behind with the thermoplastic material. The second bead dispenser bead shall be attached to the striping machine in such a manner that the beads are dispensed immediately after the first bead drop application. Glass spheres dispensers shall be equipped with an automatic cut-off control that is synchronized with the cut-off of the thermoplastic material and applies the glass spheres in a manner such that the spheres appear uniform on the entire traffic stripes and markings surface with, 50 to 60% embedment.

Special kettle(s) shall be provided for melting and heating the thermoplastic material. The kettle(s) must be equipped with automatic thermostatic control devices so that heating can be done by controlled heat transfer rather than by direct flame, so as to provide positive temperature control and prevent over-heating of the material.

Applicators shall be mobile and maneuverable to the extent the straight line can be followed and normal curves can be made in a true arc.

The applicator equipment to be used on roadway installations shall consist of either hand equipment or truck mounted units depending on the type of marking required.

The hand equipment shall have sufficient capacity to hold 150 lbs (70 kgs) of molten material and shall be sufficiently maneuverable to install crosswalks, lane, edge, and center lines, arrows and legends. The truck mounted unit for lane, edge and center lines shall consist of a mobile self contained unit carrying its own material capable of operating at a minimum speed of 5 mph (8 kph) continuously during an 8 hour period while installing striping.

Hand equipment used for stop bars, cross walks, legends, directional arrows and other specialty markings shall use the same thermoplastic formulation as described above with the exception of placing the marking at a minimum thickness of 0.090 in. (3mm) and a single drop of AASHTO M-247-09, Type 1 bead at the rate of 8 to 10 pounds per 100 square feet {3.6 to 4.5 kg per 9.3 m2} of stripe.

As an alternate, the Contractor may apply preformed thermoplastic marking material for stop bars, cross walks, legends or directional arrows. The preformed thermoplastic material shall have a minimum thickness of 0.090 in. (3 mm) and fused to the pavement by the heat of a torch.

(b) Application.

The pavement temperature shall be a minimum of 50° F (10° C) and rising before application begins. Application shall be suspended at any time the pavement temperature

falls below 50° F (10° C). All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign matter before application of the striping.

To insure optimum adhesion of thermoplastic applied on all Portland cement concrete pavements, the Contractor shall apply a binder-sealer material as recommended by the thermoplastic manufacturer. To insure optimum adhesion, the thermoplastic material shall be installed in a melted state at a temperature of 400 to 450° F (205 to 230° C). The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line of compatible material. Such new material shall bond itself to the old line in such a manner that no splitting or separation takes place.

Longitudinal lines shall be off-set at least 2 in. (50 mm) from longitudinal joints of Portland Cement Concrete pavements.

Unless specified on the plans, a minimum average film thickness of 0.100 in. (2.54 mm) for lane and edge lines shall be maintained on all markings. This is to be computed on the basis of the amount of material used each day. The film thickness shall be uniform in appearance throughout its application. The glass sphere top coating must be applied by means of a pressure type spray gun designed specifically for this purpose, and which will embed the spheres into the line surface to at least one-half their diameter.

Placement of Drop on Glass Beads AASHTO M-247-09, Type 1 and AASHTO M-247-09, Type 4 shall each be placed on the thermoplastic stripe at a rate of 8 to 10 pounds per 100 square feet {3.6 to 4.5 kg per 9.3 m2} of stripe.

The AASHTO M-247-09, Type 4 glass beads shall be placed immediately after the first bead drop application of AASHTO M-247-09, Type 1 beads.

"Regardless of the application methods and procedures, or pavement types, the Contractor will be responsible for replacing any and all pavement markings that fail to comply with these specifications or fail to adhere to the pavement for one year after installation at the Contractor's own expense."

Contractor's Responsibility for Notification.

Notify the Engineer prior to the placement of the thermoplastic materials. Furnish the Engineer with the manufacturer's name and batch numbers of the thermoplastic materials and glass spheres to be used. Ensure that the approved batch numbers appear on the thermoplastic materials and glass spheres packages.

When thermoplastic is used on the final surface, the Contractor shall have the option of using reflectorized paint installed to permanent standards at the end of each day's work and then installing the permanent marking after the paving operation is completed. Short, unmarked sections will not be allowed.

Protection of Newly Applied Traffic Stripes and Markings.

Do not allow traffic onto or permit vehicles to cross newly applied pavement markings until they are sufficiently dry. Remove and replace any portion of the pavement markings damaged by passing traffic or from any other cause, at no additional cost to the Department.

Subsection 716.04 Replace the first paragraph with the following:

716.04-Raised Reflective Pavement Markers. Markers shall be bonded to the pavement with an epoxy listed on the Departments QPL and approved by the marker manufacturer or a hot bituminous adhesive conforming to the requirements as described below. Markers manufactured with a self adhesive backing will not be allowed. Markers shall be spaced as shown on the plans but shall not be installed over joints in rigid type pavements.

Subsection 716.06: Replace with the following

The application of preformed plastic pavement markings shall be made on clean dry surfaces free of dirt and foreign matter. The pavement temperature shall be 60° F (15° C) or over. Should plastic require activators for the adhesive or various special coatings for different pavement surfaces, the bidder shall include the cost of the activator or special coatings in the unit price of plastic bid upon.

The vendor will furnish with each package of reflectorized pavement marking materials complete instructions and/or specifications for the application of pavement marking materials to pavement surface. The reflectorized pavement marking materials are to be installed according to the vendor's specifications. Any adhesion used in the installation shall be as specified by the manufacturer. An adhesion-promoting primer shall be required when recommended by the pavement marking manufacturer.

Guides to mark the lateral location of pavement markings shall be established as shown on the plans or as directed by the Engineer. The Contractor shall establish the pavement marking guides and the Engineer will verify the location of the guides. Markings shall be placed in proper alignment with the guides. The deviation rate in alignment shall not exceed 1 inch per 200 feet of roadway. The maximum deviation shall not exceed 2 inches nor shall any deviation be abrupt.

Markings placed that are not in alignment or sequence, as shown on the plans or as stated in this specification, shall be removed and replaced by the Contractor at the Contractor's expense. Removal shall be in accordance with **Subsection 712.05,** Pavement Marking Removal. Guides placed on the roadway for alignment purposes shall not establish a permanent marking on the roadway in the opinion of the Engineer.

When markings are specified in the contract for newly paved asphalt concrete surfaces, they shall be placed immediately after final rolling of the mat. A rubber tired roller cart with a minimum weight of 200 pounds or a truck operated at no more than 3 m.p.h. shall be used to assure proper adhesion when the markings are in place. Steel wheel rollers may not be used for this purpose.

Subsection 722.09Concrete Cylinder Storage. Revise entire subsection to the following:

722.09 Concrete Cylinder Storage-The Contractor shall provide a storage shed/building for temporary storage of concrete acceptance cylinders. The storage facility shall be of sufficient size and construction to protect the concrete cylinders from the elements and damage. The storage facility location shall be approved by the Engineer and access to the storage shed/building shall be under the control of Department personnel. The storage shed shall have a concrete curing box or water curing tank with a heating/circulating system of sufficient size to properly cure all acceptance cylinders before transferring for final storage and testing. The curing box or curing tank and heater/circulator shall comply with AASHTO M-201, and proper curing of the cylinders shall be in accordance with AASHTO T-23.

SECTION 740-GEOTEXTILES. Revise heading to the following:

GEOTEXTILES AND GEOSYNTHETICS

Subsection 740.01-Description. Revise subsection to include Geosynthetics as follows:

This work shall consist of the placement of Geotextiles and Geosynthetics in accordance with these Specifications and/or Standard Drawings, at the locations and in reasonably close conformity with the lines, grades and dimensions shown on the Plans or established by the Engineer.

Subsection 740.02-Materials. Revise subsection to include Geosynthetics as follows:

Materials used in this construction shall meet the requirements of **Subsection 918.27** for the Type Geotextile or Geosynthetic called for in the plans.

The contractor shall furnish a certified laboratory test report from an approved testing laboratory with each shipment of materials. Laboratory test reports shall include the actual numerical test data obtained. All rolls shall be clearly labeled as being part of the same production run from which the test date was derived. Fabric shall be protected to prevent damage during transportation, storage, and installation. Geotextile and geosynthetic rolls shall be covered during storage to protect against UV degradation and shall be stored with rolls elevated up off of the ground. Fabric that is torn, punctured, or otherwise damaged shall not be installed.

Subsection 740.03-General. Revise subsection to include Geosynthetics as follows:

Geotextile and Geosynthetic fabric shall be placed as specified on the Plans for the specific application. The surface on which the Geotextile or Geosynthetic fabric is to be placed shall be compacted, as directed by the Engineer, and prepared as smooth as possible and free from debris, obstructions and depressions which could result in gaps, tears, or punctures in the fabric during cover operations. The Geotextile or Geosynthetic shall be installed in such a manner that placement of cover material will not excessively stretch nor tear the Geotextile or Geosynthetic. After fabric is placed, the initial lift of cover material shall be installed within five (5) calendar days. Under no circumstances shall any equipment operate directly on the Geotextile or Geosynthetic fabric. Cover material shall be placed such that at least the minimum initial lift thickness, as specified by the Engineer, is between the Geotextile or Geosynthetic and equipment tires or tracks at all times. Turning of equipment/vehicles shall not be allowed on the first lift above the Geotextile or Geosynthetic.

Subsection 740.04-Method of Measurement. Revise subsection to include Geosynthetics as follows:

Geotextiles or Geosynthetics of the type specified shall be measured by the yd^2 (m^2), complete in place. No measurement for payment will be made for overlaps, splices, sewing joints, etc.

Subsection 740.05-Basis of Payment. Revise subsection to include Geosynthetics as follows:

The accepted quantities of Geotextiles or Geosynthetics of the type specified, measured as provided for above, will be paid for at the contract unit price per yd^2.(m^2) complete in place, which price shall be full compensation for labor, equipment, materials, tools and all incidentals necessary to complete the work. Fabric that is damaged during or after placement shall be replaced or repaired, as directed by the Engineer, at the expense of the Contractor.

STATE OF TENNESSEE

(Rev. 05-05-10) March 1, 2006

Roadside Development

803.02-Sod. New sod shall consist of live, dense, well-rooted growth of permanent grasses, free from Johnson grass, nut-grass, and other undesirable grasses or weeds, well-suited for the intended purpose and for the soil in which it is to be planted. Installed sod which does not meet these requirements shall be corrected as directed by the Engineer at the Contractors expense.

STATE OF TENNESSEE

(Rev. 09-01-09)
(Rev. 02-06-10)
(Rev. 12-13-10)
(Rev. 02-13-12)
(Rev. 01-07-13)
(Rev. 06-12-13)

March 1, 2006

Supplemental Specifications - Section 900

of the

Standard Specifications for Road and Bridge Construction

March 1, 2006

Subsection 903.03 Coarse Aggregate for Concrete, Revise the fourth paragraph to the following:

Coarse aggregate for prestressed concrete shall be Size No. 57 or Size No. 67, **Subsection 903.22,** as may be specified or directed. Coarse aggregates for precast concrete shall include any size fractions of **Subsection 903.22**, as may be specified or directed.

Subsection 903.12 (b) - Replace with the following:

(b) Aggregate for Micro-Surface. A minimum of 50% of ~~The~~ aggregate shall be crushed slag, crushed granite or crushed stone (crushed stone as specified for the types listed for Grading D in **Subsection 903.11(c)**) meeting the gradation limits below and the physical properties of ASTM D 692 except the percent of fractured pieces shall be 100. The aggregate shall have a minimum sand equivalent (AASHTO T 176) of 65. Blends of more than one aggregate source shall be mixed by means of pug mill only. Blending aggregates with a front end loader will not be permitted. The aggregate shall be proportioned to produce a uniform gradation meeting the following requirements:

GRADATION LIMITS FOR AGGREGATE
BASED ON WASH GRADATION

Design Master Range Mixture Control

Sieve	(Total Percent Passing)	Tolerances
3/8 in.(9.5 mm)	100	
No. 4(4.75 mm)	70-98	±6.0
No. 8(2.36 mm)	45-70	±5.0
No. 16(1.18 mm)	28-50	±5.0
No. 30(600 µm)	19-34	±4.0
No. 50(300 µm)	12-25	±4.0
No. 100(150 µm)	7-18	±2.0
No. 200(75 µm)	4-15	±2.0

Subsection 904.03 Emulsified Asphalts. Replace Entire subsection with the following:

904.03 - Emulsified Asphalts.

Emulsified asphalts shall meet the following test requirements:

	Test Method	CAE-P	CSS-1	CSS-1H	SS-1H	TST-1P	CQS-1H
Saybolt-Furol Viscosity @ 77F, seconds	AASHTO T59	10-50	20-100	20-100	20-100	10-75	20-100
Saybolt-Furol Viscosity @ 122F, seconds	AASHTO T59	n/a	n/a	n/a	n/a	n/a	n/a
Storage Stability Test, 24-h, %	AASHTO T59	1 Max	1 Max	1 Max	1 Max	n/a	n/a
5-day Settlement, %	AASHTO T59	n/a	n/a	n/a	n/a	n/a	n/a
Particle Charge	AASHTO T59	Positive	Positive	Positive	n/a	n/a	Positive
Sieve Test, %	AASHTO T59	0.1 Max	0.1 Max	0.1 Max	0.1 Max	0.1 Max	0.1 Max
Residue by	AASHTO T59	Distillation	Distillation	Distillation	Distillation	Distillation[1]	Distillation
Residue, %	AASHTO T59	n/a	57 Min	57 Min	57 Min	55-60	62 Min
Demulsibility, %	AASHTO T59	n/a	n/a	n/a	n/a	n/a	n/a
Distillate, %	AASHTO T59	55 Max	n/a	n/a	n/a	n/a	n/a
Oil Test, %	AASHTO T59	12.0 Max	n/a	n/a	n/a	n/a	n/a
Stone Coating	AASHTO T59	n/a	n/a	n/a	n/a	n/a	n/a
Cement Mix	AASHTO T59	n/a	2.0 Max	2.0 Max	2.0 Max	n/a	n/a
Float Test, seconds	AASHTO T50	n/a	n/a	n/a	n/a	n/a	n/a
Solubility in Trichlorethylene, %	AASHTO T44	n/a	n/a	n/a	n/a	n/a	n/a
Penetration	AASHTO T49	300 Min	100-250	40-90	40-90	75-150	40-90
Elastic Recovery, %[3]	AASHTO T301	n/a	n/a	n/a	n/a	25 Min	n/a
Ductility @ 77F, cm	AASHTO T51	40 Min	40 Min	40 Min	40 Min	n/a	40 Min
Ductility @ 40F, cm	AASHTO T51	n/a	n/a	n/a	n/a	10-35	n/a
R&B Softening Point, °F	AASHTO T53	n/a	n/a	n/a	n/a	n/a	n/a
Original G*/sinδ @ 82°C	AASHTO T315	n/a	n/a	n/a	n/a	n/a	n/a

1 - Distill at 400°F
2 - Distill at 350°F
3 - Straight-sided mold, 20-cm elongation, 5 min hold, 25°C

	Test Method	CQS-1HP	SS-1	AEP	CRS-2	AE3
Saybolt-Furol Viscosity @ 77F, seconds	AASHTO T59	20-100	20-100	10-50	n/a	n/a
Saybolt-Furol Viscosity @ 122F, seconds	AASHTO T59	n/a	n/a	n/a	100-400	50 Min
Storage Stability Test, 24-h, %	AASHTO T59	n/a	1 Max	n/a	1 Max	n/a
5-day Settlement, %	AASHTO T59	n/a	n/a	5 Max	n/a	5 Max
Particle Charge	AASHTO T59	Positive	n/a	n/a	Positive	n/a
Sieve Test, %	AASHTO T59	0.1 Max	0.1 Max	0.1 Max	0.1 Max	n/a
Residue by	AASHTO T59	Distillation[2]	Distillation	Distillation	Distillation	Distillation
Residue, %	AASHTO T59	62 Min	57 Min	n/a	65 Min	n/a
Demulsibility, %	AASHTO T59	n/a	n/a	n/a	40 Min	n/a
Distillate, %	AASHTO T59	n/a	n/a	55 Max	n/a	30 Max
Oil Test, %	AASHTO T59	n/a	n/a	12.0 Max	3.0 Max	6.0 Max
Stone Coating	AASHTO T59	n/a	n/a	n/a	n/a	90 Min
Cement Mix	AASHTO T59	n/a	2.0 Max	n/a	n/a	n/a
Float Test, seconds	AASHTO T50	n/a	n/a	20 Min	n/a	200 Min
Solubility in Trichlorethylene, %	AASHTO T44	n/a	n/a	n/a	n/a	n/a
Penetration	AASHTO T49	40-90	100-200	n/a	100-250	n/a
Elastic Recovery, %[3]	AASHTO T301	n/a	n/a	n/a	n/a	n/a
Ductility @ 77F, cm	AASHTO T51	70 Min	40 Min	n/a	40 Min	n/a
Ductility @ 40F, cm	AASHTO T51	n/a	n/a	n/a	n/a	n/a
R&B Softening Point, °F	AASHTO T53	135 Min	n/a	n/a	n/a	n/a
Original G*/sinδ @ 82°C	AASHTO T315	n/a	n/a	n/a	n/a	n/a

1 - Distill at 400°F
2 - Distill at 350°F
3 - Straight-sided mold, 20-cm elongation, 5 min hold, 25°C

	Test Method	CRS-2P	RS-2	RS-1	TTT-1	TTT-2
Saybolt-Furol Viscosity @ 77F, seconds	AASHTO T59	n/a	n/a	20-100	30 Min	n/a
Saybolt-Furol Viscosity @ 122F, seconds	AASHTO T59	100-400	75-400	n/a	n/a	15-100
Storage Stability Test, 24-h, %	AASHTO T59	1 Max	1 Max	1 Max	1 Max	1 Max
5-day Settlement, %	AASHTO T59	n/a	n/a	n/a	5 Max	n/a
Particle Charge	AASHTO T59	Positive	n/a	n/a	n/a	Positive
Sieve Test, %	AASHTO T59	n/a	0.1 Max	0.1 Max	0.1 Max	0.1 Max
Residue by	AASHTO T59	*Evaporation*	Distillation	Distillation	Distillation	Distillation[2]
Residue, %	AASHTO T59	65 Min	63 Min	55 Min	40 Min	58 Min
Demulsibility, %	AASHTO T59	40 Min	60 Min	60 Min	n/a	n/a
Distillate, %	AASHTO T59	n/a	n/a	n/a	n/a	n/a
Oil Test, %	AASHTO T59	n/a	n/a	n/a	n/a	n/a
Stone Coating	AASHTO T59	n/a	n/a	n/a	n/a	n/a
Cement Mix	AASHTO T59	n/a	n/a	n/a	n/a	n/a
Float Test, seconds	AASHTO T50	n/a	n/a	n/a	n/a	n/a
Solubility in Trichlorethylene, %	AASHTO T44	n/a	n/a	n/a	n/a	n/a
Penetration	AASHTO T49	75-175	100-200	100-200	5-15	40-90
Elastic Recovery, %[3]	AASHTO T301	50 Min	n/a	n/a	n/a	n/a
Ductility @ 77F, cm	AASHTO T51	40 Min	40 Min	40 Min	40 Min	n/a
Ductility @ 40F, cm	AASHTO T51	n/a	n/a	n/a	n/a	n/a
R&B Softening Point, °F	AASHTO T53	125 Min	n/a	n/a	60-75	n/a
Original G*/sinδ @ 82°C	AASHTO T315	n/a	n/a	n/a	1.0 Min	n/a

1 - Distill at 400°F
2 - Distill at 350°F
3 - Straight-sided mold, 20-cm elongation, 5 min hold, 25°C

Emulsified asphalts used on TDOT projects shall only be from Certified Emulsified Asphalt Suppliers that have an approved Quality Control Plan in accordance with TDOT Standard Operating Procedures.

All emulsified asphalts shall be homogeneous, and shall adhere firmly to the surface of the mineral aggregate. Failure of the emulsified asphalt to perform satisfactorily on the job shall be deemed cause for rejection, notwithstanding its ability to pass laboratory tests.

The test requirement for settlement may be waived when the emulsified asphalt (special tack coat excepted) is used in less than 5 days' time; or the Engineer may require that the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than 5 days.

The AE-3 shall be of such stability that it will remain constant and uniform while being mixed with dry or approximately dry aggregate, and shall thoroughly and uniformly coat the entire surface of each fragment while being manipulated and incorporated into the work. The emulsified asphalt after being incorporated into the work shall show no signs of re-emulsifying.

Solubility in trichloroethylene will be required for information only every 3 months in the supplier's quality control program.

When approved by the Engineer, cationic emulsions may be substituted for anionic emulsions.

Latex, polymer, and other emulsifiers shall be styrene butadiene rubber (SBR) or natural latex, and shall be milled into the asphalt cement and shall show no separation after mixing. When modified emulsions are utilized in microsurface mixtures, the blended mixture when combined with aggregate and mineral filler shall have the following characteristics:

1. Be capable of filling up to 1/2 in.(13 mm) wheel ruts in one pass.
2. Be capable of field regulation of the setting time.
3. Be suitable for nighttime placement.

The latex shall be combined with the asphalt emulsion at the emulsion mill to produce a homogeneous mixture. Latex modified emulsions upon standing undisturbed for a period of 24 hours shall show no color striations, but shall be a uniform color throughout.

Subsection 908.03-Permanent Steel Bridge Deck Forms; Delete ASTM A446 and A525, and **Replace** with A653

Subsection 908.03(C) First paragraph. Change to read as follows:

All high strength bolts, nuts and washers shall be certified to have met the specified tests identified in their individual ASTM Specification designations, both as individual components, and as assemblies (Bolts, Nuts, and Washers).

Subsection 908.07-Gray Iron Castings. Reviseentire subsection to the following:

908.07-Gray Iron Castings. All castings shall be of the type specified and shall be within reasonably close conformity with the dimensions shown on the Plans. The castings shall conform to AASHTO M105, with the additional requirements herein, and unless otherwise specified all castings shall be Class 30.

Test bars for tension testing shall be cast in accordance with AASHTO M 105, Table 2, Test Bar B.

All castings shall be cleaned of sand and scale by sand blasting or other effective methods so as to present a smooth, clean, and uniform surface.

Gray iron castings shall have the date of manufacture cast into each unit.

Manhole castings shall have the lid and lid seat of the rim machined to form a true bearing.

All castings shall weigh at least 95% of the theoretical weight shown on the Plans.

Subsection 910.02-Revise entire Subsection to the following:

910.02-Quick Dry Traffic Marking Paint (White and Yellow). These specifications cover quick dry white and yellow traffic paint, also referred to as pigmented binder, for use in marking traffic lanes or barrier lines on bituminous and concrete highways.

(a) General Requirements. The pigmented binder shall be properly formulated so as to be suitable for application by spray equipment when heated to 130°F(55°C) maximum and applied on bituminous or portland cement concrete pavements.

(b) Drop on Glass Beads. The glass beads drop-on type, shall meet the requirements of AASHTO M 247 Type I.

General: All beads used for Pavement Markings shall be clear, transparent, colorless glass, smooth and spherically shaped, free of milkiness, pits, or excessive air bubbles and conform to the following specific requirements.

Glass Beads shall not contain more than 200 ppm of lead, 200 ppm of antimony, or 200 ppm of arsenic. The contractor shall certify and ensure that all glass beads meet all federal requirements. The contractor shall provide certification that all glass beads contain no more than 200 parts per million of arsenic or lead as determined by a certified independent (third party) laboratory, in accordance with Environmental Protection Agency testing methods 3052, 6010B, or 6010C. The contractor shall provide an independent certified test report showing compliance with these requirements.

Silica content of the glass beads shall be no less than 60%.

Color and Clarity: Beads shall be colorless, clear and free from carbon residues.

Roundness: Minimum true spheres overall shall be 80% when tested in accordance with ASTM-D-1155, for larger beads use visual inspection.

Index of Refraction: Minimum of 1.50, when tested by the liquid emersion method @ 77°F

Air Inclusions: Maximum of 3% overall

(b) Paint.

Characteristic requirements.

1. Pigment content shall be between 58% and 65% by weight. Pigment for white paint shall contain 0.99 lbs/gal.(120 grams/l) of 94% titanium dioxide. Pigment for yellow paint shall be lead free and contain 0.22 lbs/gal.(26 grams/l) minimum of 94% titanium dioxide.
2. Total non-volatile shall not be less than 76% by weight.
3. Vehicle non-volatile shall not be less than 41% by weight. Vehicle shall be Rohm and Haas E-2706, DOW DT211NA or an approved equal.
4. Minimum weight shall not be less than 13.3 lbs./gal.(1,600 grams/l).
5. The paint viscosity shall be between 78 and 95 Kreb units when tested at 77±° F(25±1°C) in accordance with ASTM D 562.
6. Drying Time:

   FIELD -The paint shall dry to a no-tracking condition in 3 minutes when applied at 15 ±1 mil(380 ±25 μm.) wet film thickness with a bead application rate of 6 lbs./gal.(0.7 kgs/l) of glass spheres per gallon(liter) of binder, when the pavement temperature is between 40 and 120° F(4 and 49 C°) and the relative humidity is not exceeding 80%. The pigmented binder shall be applied with specialized equipment so as to have the binder at a temperature of 100 to 130° F(35 to 55° C) at the spray gun. The no-tracking condition shall be determined by passing over the line as applied above in a simulated passing maneuver with a passenger car travelling 35 mph(56 kph.). A line showing no visual deposition when viewed from a distance of 50 ft.(15 m) shall be considered as conforming to this drying requirement.

   LAB - The pigmented binder without glass spheres, shall dry to no-pick-up condition in 10 minutes or less when tested in accordance with ASTM D 711.
7. The paint shall meet the current EPA VOC requirements or 150 grams/l whichever is lower.
8. The ph of the paint shall be a minimum of 9.6.

Qualitative Requirements.

The finished paint shall meet the following quality requirements:

1. Condition in container: The paint received shall show no livering, skinning, mold growth, corrosion of the container, or hard settling of the pigment. Any settling shall be readily dispersed when stirred by hand with no persistent foaming.
2. Color: The color for white after drying shall be flat white, free from tint, furnishing good opacity and visibility under both daylight and artificial light. For yellow, the color shall closely match chip 33538 of Federal Standard 595B.
3. Flexibility: The paint shall show no cracking or flaking when tested on a ½ in.(13 mm) mandrel in accordance with Federal Specification TT-P-1952B.
4. Dry Opacity: The minimum contrast ratio shall be 0.95 when drawn with a 0.005 Bird Applicator.
5. Daylight Reflectance: The daylight directional reflectance of the white paint shall be not less than 85% and not less than 50% for yellow(relative to manganese oxide) when measured in accordance with Federal Test Method No. 1416.
6. Bleeding: The paint shall have a minimum bleeding ratio of 0.97 when tested in accordance with Federal Specification TT-P-1952B.
7. Scrub Resistance: The paint shall pass 300 cycles when tested in accordance with ASTM D 2484.

8. Freeze-Thaw Stability: The paint shall show no change in consistency greater than 10% when tested in accordance with Federal Specification TT-P-1952B.
9. Storage Stability: When stored at 77± °(25 ±2°C) in a 3/4- filled can for a period of 30 days, the paint shall be in a homogeneous state with no skinning, curdling, hard settling or caking that cannot be readily remixed.

(e) Inspection, Testing, Packaging, and Marking.

All paint furnished under this specification shall be proportioned in accordance with the characteristic requirements set forth herein. Compounding shall be from ingredients or component materials that have been found to conform with the detail specifications as set forth herein by reference or otherwise. After manufacture, a 0.5 pt.(l) sample along with certified laboratory analysis for each batch shall be sent to the Division of Materials and Tests. A qt.(l) sample and a manufacturer's certification that the glass beads meet the requirements of ASSHTO M 247 for the type beads, shall be sent to the Division of Materials and Tests for each batch or lot of glass beads shipped for use on Tennessee projects.

Each shipment of paint and beads shall be accompanied by a detailed analysis for that particular batch and certification that all ingredients meet the requirements set forth in this specification.

The Department reserves the right to perform in-plant sampling of ingredients and finished product during manufacturing operations and to sample the packaged product when it is received by the Department. Acceptance of the product may be withheld until analysis of samples has been completed.

All paint shall be shipped in new containers that can be properly sealed.

All containers shall be plainly marked or labeled to show the following information: Description of paint, color, net gal.(liters), name of manufacturer, batch number and date of manufacture(month and year).

Subsection 914.09 Polyvinyl Chloride Pipe (PVC). Revise entire subsection to the following:

914.09-Polyvinyl Chloride Pipe(PVC) . Pressurized pipe accepted under this Specification shall conform to the requirements of ASTM D 1785. Pipe Culverts accepted under this Specification shall conform to the requirements of ASTM D 1784.

Subsection 914.10-High Density Polyethylene Plastic Pipe. Revsie entire subsection to the following:

914.10, High Density Polyethylene Plastic Pipe. Pipe Culverts accepted under this specification shall conform to the requirements of AASHTO M 294, Type S. Slope Drains accepted under this specification shall conform to the requirements of AASHTO M 294, Type C or Type S.

Subsection 916.02 (a) Aluminum flat Sheet; **Revise** as shown below:

(a). Aluminum flat sheet (sign blanks) and plates (permanent and temporary) shall meet ASTM B 209, Alloy 6061 T6 or 5052-H38. Recycled aluminum flat sheet (sign blanks) meeting ASTM B209, Alloy 6061 T6, or 5052-H38 may be used for temporary signing only. Composite material

sign blanks (temporary signing only) shall be selected from the Department's QPL. The sign blanks shall be flat and shall contain no visible lateral bow.

Subsection 918.08: Replace entire section, with the following:

918.08-Preformed plastic pavement Marking Materials. The marking material shall be prefabricated plastic consisting of white or yellow pigmented plastic with reflective glass spheres uniformly distributed throughout the entire cross sectional area and shall be capable of being affixed to bituminous or Portland cement concrete pavement by either a pressure sensitive pre-coated adhesive or liquid contact cement. The material shall be provided complete in a form that will facilitate rapid application and protection during shipment and storage. Solvents, adhesives and necessary equipment for proper application for life shall be in accordance with manufacturer's instructions. The material shall be manufactured and packaged in such a manner to permit storage at normal shelf temperatures for periods of up to one year after purchase. Contact cements, where used, shall have a shelf life of 6 months. The material shall mold itself to pavement contours, breaks, faults, and the like by action of traffic at normal pavement temperatures. The material shall have resealing characteristics so that it will fuse with itself and with previously applied marking materials of the same composition under normal conditions of use.

Prefabricated legends and symbols must conform to the applicable shapes and sizes as outlined in the Manual on Uniform Traffic Control Devices for Streets and Highways. These pavement markings shall be on the Department's QPL.

Materials: The marking material shall be a 60 mil (1.50 mm) retroreflective pliant polymer conforming to the following requirements. The retroreflective pliant polymer pavement marking film shall consist of a mixture of high quality polymeric materials and pigments with 1.50 minimum refractive index glass spheres uniformly distributed throughout its cross sectional area, and with a reflective layer of beads bonded to the top surface. Composition shall be as follows:

Material	Min. % by Weight
Resins & Plasticizers	20
Pigments	30
Graded Glass Beads	33

This material shall be capable of adhering to asphaltic or Portland cement concrete, by means of a pressure sensitive, pre-coated adhesive, or by a liquid contact cement applied at the time of installation.

Tensile Strength. The film shall have a minimum tensile strength of 40 psi (275 kPa) of cross section when tested according to ASTM D 638. A sample 6 x 1 x 0.06 in.(150 x 25 x 1.5 mm) shall be tested at a temperature between 70° and 80° F(21 to 27° C) using a jaw speed of ¼ in.(6 mm) per minute.

Elongation. The film shall have a minimum elongation of 75% when tested according to ASTM D 638.

Plastic Pull Test. A test specimen made the same size as described under "Tensile Strength" above shall support a dead weight of 4 lbs. (1.8 kgs.) for not less than 5 minutes at a temperature between 70 and 80° F (21 to 27° C).

Pigmentation. The pigments shall be selected and blended to provide a marking film that is white or yellow conforming to standard highway colors through the expected life of the film.

Pigments. Sufficient titanium dioxide pigment meeting Federal Specification TT-P-442 shall be used in white markings to insure a dense opaque marking. Pigments shall include titanium dioxide for white plastic and C. P. medium chrome yellow for yellow plastic.

Sufficient medium chrome yellow pigment meeting Federal Specification TT-P-346b, Type 111, shall be used to insure a durable finished color that complies with

Highway Yellow Color Tolerance Chart and matches Chip 33538 of Federal Standard 595. The yellow plastic shall have a minimum of 18% pigment as chrome yellow.

Glass Beads. The glass beads shall be, colorless and have a minimum index of refraction of 1.50 when tested using the liquid oil immersion method. The size and quality of the beads will be such that performance requirements for the retroreflective pliant polymer film shall be met.

Glass beads shall not contain more than 200 ppm of lead, 200 ppm of antimony, or 200 ppm of arsenic. The contractor shall certify and ensure that all glass beads meet all federal requirements. The contractor shall provide certification that all glass beads contain no more than 200 parts per million of arsenic or lead as determined by a certified independent (third party) laboratory, in accordance with Environmental Protection Agency testing methods 3052, 6010B, or 6010C. The contractor shall provide an independent certified test report showing compliance with these requirements.

The film shall have a glass bead retention quality such that when a 2 x 6 in. (50 x 150 mm) sample is bent over a 1/2 in. (13 mm) diameter mandrel, with the 2 in. (50 mm) dimension perpendicular to the mandrel axis, microscopic examination of the area on the mandrel shall show no more than 10% of the beads with entrapment by the binder of less than 40%.

Skid Resistance. The surface of the retroreflective pliant polymer shall provide a minimum skid resistance value of 35 BPN when tested according to ASTM E 303.

Color: ***The color of the white thermoplastic material shall be pure white and conform to Federal standard 595-17778. The color of the yellow thermoplastic material shall conform to Federal Standard 595-33538 and meet the following chromaticity specifications.***

X and **Y** coordinates shall fall in an area bordered by these coordinates:

X	**0.470**	**0.510**	**0.490**	**0.537**
Y	0.455	0.489	0.432	0.462

Reflectance. The white and yellow markings shall have the following minimum initial retroreflectance values as measured in accordance with the testing procedures of ASTM D 4061. The photometric quantity to be measured shall be specific luminance (SL) and shall be expressed as millicandelas per square foot per footcandle.

	White		Yellow	
Entrance Angle	86.0	86.5	86.0	86.5
Observation Angle	0.2	1.0	0.2	1.0
Specific Luminance	500	300	400	175

Thickness. The retroreflective pliant polymer film without adhesive shall be supplied in a standard thickness of 60 mils (1.5 mm).

Performance. The retroreflective pliant polymer, when applied according to the recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to temperature if the pavement surface remains stable. The pliant polymer shall provide a cushioned resilient substrate that reduces bead crushing and loss. The film shall be weather resistant, and through normal traffic wear shall show no appreciable fading, lifting or shrinkage throughout the useful life of the marking. It shall also show no significant tearing, roll back or other signs of poor adhesion.

Subsection 918.09 B 3 Chemical Additives, Add the following as **Subsection B-3:**

3 Warm Mix Asphalt (WMA) additives. Organic wax or foaming additives may be added to bituminous plant mix to reduce placement temperatures in accordance with subsection 407.11. WMA additives should be introduced into the mixture at a constant rate satisfactory to produce mix temperatures as per subsection 407.11. If the proportions of the additive change during the course of mix production, these changes shall be noted and recorded. The manner in which the additive is introduced into the mixture shall be approved by the Department. The Department will maintain a list of qualified WMA additives. No product shall be used unless it appears on this list.

Subsection 918.18-Mulch Material, Add the following as the last sentence:

"An approved tackifier from the QPL shall be used to hold mulch in place."

Subsection 918.23; Remove and Replace entire subsection with the following:

918.23- Thermoplastic Pavement Marking Material. This material shall conform to AASHTO M-249 with the following changes. The material requirements are as follows.

Composition: The retroreflective pavement marking material shall be an Alkyd / Maleic based thermoplastic material consisting of homogeneously mixed pigments, filler, resins and glass beads. The pigment, beads, and filler shall be uniformly dispersed in the resin. The material shall be manufactured from virgin material using no reprocessed components.
The material shall be free from all skins, dirt, and foreign objects and shall comply with requirements from the following table.

TABLE 1

Component	White	Yellow
% Binder Content	19.0 min	19.0 min
% TiO_2 Pigment,	10.0 min	N/A
% Intermix Glass Beads	35 min	35 min
% Calcium Carbonate \ Fillers	36 max*	46 max*

*The amount of Calcium Carbonate and inert fillers shall be as opted by the manufacturer, providing all other specifications are met.

The Titanium Dioxide shall be Rutile Type II in accordance with ASTM D 476 with a minimum purity of 93%.

Use white thermoplastic which does not contain anatase titanium dioxide pigment.

The total silica content used in the formulation of the thermoplastic shall be the premixed beads. Uniformly disperse the pigment, beads and filler in the binder.

The Alkyd / Maleic binder shall consist of a mixture of synthetic resins and high boiling point plasticizers one of, which shall be solid at room temperature. At least one-half of the binder composition shall be 100% Maleic modified glycerol ester of resin and shall be no less than 15% of the entire material formulation. The binder shall contain no petroleum, hydrocarbon resins, tall oil resins or rosins.

The thermoplastic material shall be free of contaminates and shall be dry blended or hot mixed from 100% virgin stock using no reprocessed materials.

The Thermoplastic material shall be formulated such that when it is on the roadway surface at any natural temperature it exists in a hard, solid state with cold ductility that permits normal movement with the road surface without chipping, or cracking.

The thermoplastic shall not deteriorate or discolor when held at the application temperature for periods of time up to 4 hours or upon repeated reheating (a minimum of 4 times).

The color, viscosity, and chemical properties versus temperature characteristics of the thermoplastic material shall remain constant for up to 4 hours at the application temperature and shall be the same from batch to batch.

The thermoplastic material shall be readily applicable at temperatures between 400°F and 440°F from the approved equipment to produce lines and symbols of the specified thickness above the pavement surface.

Physical Requirements: After 4 hours @ 425°F

The thermoplastic material after heating for 4 hours ± 5 minutes at 218 ± 2°C (425 ± 3°F) and cooled to 25 ± 2°C (77 ± 3°F) shall meet the physical requirements set forth in AASHTO M-249 with the following changes.

The material shall be tested in accordance with AASHTO T-250 and or with the appropriate method in Federal Test Method Standard #141 or ASTM Designation.

Safety – No toxic fumes.

Bond Strength – (ASTM-D4796), 180 p.s.i. min.

Specific Gravity – Not to exceed 2.30

Yellowness Index – The white thermoplastic shall not exceed a yellowness index of 0.15.

Glass Beads

General: All beads used for Thermoplastic Pavement Markings shall be clear, transparent, colorless glass, smooth and spherically shaped, free of milkiness, pits, or excessive air bubbles and conform to the following specific requirements.

Glass Beads shall not contain more than 200 ppm of lead, 200 ppm of antimony, or 200 ppm of arsenic. The contractor shall certify and ensure that all glass beads meet all federal requirements. The contractor shall provide certification that all glass beads contain no more than 200 parts per million of arsenic or lead as determined by a certified independent (third party) laboratory, in accordance with Environmental Protection Agency testing methods 3052, 6010B, or 6010C. The contractor shall provide an independent certified test report showing compliance with these requirements.

Silica content of the glass beads shall be no less than 60%.

Color and Clarity: Beads shall be colorless, clear and free from carbon residues.

Roundness: Minimum true spheres overall shall be 80% when tested in accordance with ASTM-D-1155, for larger beads use visual inspection.

Index of Refraction: Minimum of 1.50, when tested by the liquid emersion method @ 77°F

Air Inclusions: Maximum of 3% overall

Intermix Glass Beads

Glass Beads used for intermix shall be premixed into the thermoplastic mixture and shall consist of 35% of the overall thermoplastic formulation. Intermix beads shall be uncoated and defined by two distinct gradations and meet the following requirements.

Type 1 Intermix glass beads shall comprise 50% minimum of the 35% of the overall thermoplastic formulation (Intermix Glass Beads) and shall conform to AASHTO M-247-09, Type 1 with the exception of minimum true spheres overall shall be 80% as stated above, when tested in accordance with ASTM D-1155.

Type 3 Intermix glass beads shall comprise 50% minimum of 35% of the overall thermoplastic formulation (Intermix Glass Beads) and shall conform to AASHTO M-247-09, Type 3 with the exception of minimum true spheres overall shall be 80% as stated above, when tested in accordance with ASTM D-1155.

Specification for Double Drop System

The double drop system shall be capable of applying glass beads at the specified application rates. Beads shall be applied across the entire line width assuring uniform application and embedment of the beads to 50 to 60% of the bead diameter.

Type 1 drop on beads shall be dual coated for moisture resistance and adhesion , Also meet the requirements of AASHTO M-247-09 Type 1 with the exception that the beads shall be 80% round overall.

Type 4 drop on beads shall be dual coated for moisture resistance and adhesion , Also shall meet the requirements of AASHTO M-247-09 Type 4 with the exception that the beads shall be 80% round overall.

918.26-Raised Reflective Pavement Markers with Adhesive. Remove "with Adhesive" from the subsection title.

Subsection 918.27-Geotextile. Add "and Geosynthetics" to subsection title. **Replace** entire subsection with the following:

Geotextile and Geosynthetic materials and their types shall be on the Departments Qualified Products List. Geotextile and Geosynthetic material used shall meet the material requirements of the Standard Drawing.

The contractor shall furnish a certified laboratory test report from an approved testing laboratory and a certified letter stating the product is the same as on the Department's Qualified Products List with each shipment of materials. Laboratory test reports shall include the actual numerical test data obtained. All rolls shall be clearly labeled as being part of the same production run from which the test date was derived. Fabric shall be protected to prevent damage during transportation, storage, and installation. Geotextile and Geosynthetic rolls shall be covered during storage to protect against UV degradation and shall be stored with rolls elevated up off of the ground. Fabric that is torn, punctured, or otherwise damaged shall not be installed.

STATE OF TENNESSEE

March 1, 2006

SPECIAL PROVISION

REGARDING

UNBALANCED BIDS

The Department will review all unit prices submitted by the apparently lowest responsible bidder and will decide whether any of the unit prices are excessively above or below a reasonable cost analysis value determined by the Engineer.

In the event any unit prices are determined to be unbalanced and contrary to the interest of the Department, the right is reserved to reject such bid at the discretion of the Department or to award the Contract and limit progress payments on units of work performed on any excessively priced items to costs that are satisfactorily documented by the Contractor plus 20 percent, until 85 percent of the Contract has been completed. Upon completion of 85 percent of the Contract, the Contractor will be reimbursed in accordance with **Subsection 109.06** of the Standard Specifications for the accepted quantities of work performed on the excessively priced items.

STATE OF TENNESSEE

October 1, 2006

REV: February 5, 2007

SPECIAL PROVISION

REGARDING

EMPLOYING AND CONTRACTING WITH ILLEGAL IMMIGRANTS

The State shall endeavor to do business only with those contractors and subcontractors that are in compliance with the Federal Immigration and Nationality Act. This policy shall apply to all State Contractors including subcontractors. This policy statement is issued to establish implementation guidance to procuring state agencies and contractors reflecting the requirements of Governor's Executive Order #41, An Order Regarding Compliance with Federal and State Laws Related to Employing and Contracting with Illegal Immigrants, and the requirements of Public Acts of 2006, Chapter Number 878 of the State of Tennessee (codified at *Tennessee Code Annotated,* Title 12, Chapter 4, Part 1).

1. The Contractor hereby attests, certifies, warrants, and assures that the Contractor shall not knowingly utilize the services of an illegal immigrant in the performance of this Contract and shall not knowingly utilize the services of any subcontractor who will utilize the services of an illegal immigrant in the performance of this Contract. The Contractor shall reaffirm this attestation, in writing, by submitting to the State a completed and signed copy of the "Attestation form" provided by the Department, semi-annually during the period of this Contract.

2. Prior to the use of any subcontractor in the performance of this Contract, and semi-annually thereafter, during the period of this Contract, the Contractor shall obtain and retain a current, written attestation that the subcontractor shall not knowingly utilize the services of an illegal immigrant to perform work relative to this Contract and shall not knowingly utilize the services of any subcontractor who will utilize the services of an illegal immigrant to perform work relative to this Contract.

3. The Contractor shall maintain records for its employees used in the performance of this Contract. Said records shall include a completed federal Department of Homeland Security Form I-9, *Employment Eligibility Verification*, for each employee and shall be subject to review and random inspection at any reasonable time upon reasonable notice by the State.

SP102I

4. The Contractor understands and agrees that failure to comply with this section will be subject to the sanctions of Public Chapter 878 of 2006 for acts or omissions occurring after its effective date. This law requires the Commissioner of Finance and Administration to prohibit a contractor from contracting with, or submitting an offer, proposal, or bid to contract with the State of Tennessee to supply goods or services for a period of one year after a contractor is discovered to have knowingly used the services of illegal immigrants during the performance of this contract.

For the Purposes of this policy, "illegal immigrant" shall be defined as a non-citizen who has entered the United State of America without federal government permission or stayed in this country beyond the period allowed by a federal government-issued visa authorizing the non-citizen to enter the country for specific purposes and a particular time period.

Compliance and non-compliance procedures will be as specified in the Tennessee Department of Finance and Administration's Policy on "Ensuring Compliance with Federal Immigration Laws by State Contractors and Subcontractors".

STATE OF TENNESSEE

(Revised 02-25-05) March 1, 2006(Revised 10-19-12)

SPECIAL PROVISION

REGARDING

SECTION 105 – CONTROL OF WORK

CRITICAL PATH METHOD (CPM) SCHEDULE

The Contractor shall develop a schedule of activities for this project, in accordance with Subsection 105.06 of the Standard Specifications and to achieve the required completion date as specified in the contract, using the Critical Path Method (CPM). The CPM schedule shall be provided to the Engineer at the pre-construction conference.

Once the work begins, the Contractor shall furnish the Engineer with an updated schedule at 30-day intervals thereafter for the duration of the project. Cost of developing and maintaining this schedule shall be included in the cost of other items of construction.

If the Contractor fails to deliver an updated schedule as required, the Engineer may withhold payment of estimated earnings until the updated schedule is received.

STATE OF TENNESSEE

(Rev. 6-19-95)
(Rev. 6-1-04)
(Rev. 06-20-2011)

March 1, 2006

SPECIAL PROVISION

REGARDING

BUY AMERICA REQUIREMENTS

All manufacturing processes for iron and steel products, and coatings applied thereon, used in this project shall occur in the United States except that if the proposal has bid items for furnishing domestic and foreign iron and steel, the bidder will have the option of (1) submitting a bid for furnishing domestic iron and steel, or (2) submitting a bid for furnishing domestic iron and steel and a bid for furnishing foreign iron and steel. If option (2) is chosen the bid will be tabulated on the basis of (a) the total bid price using the bid price for furnishing domestic iron and steel and, (b) the total bid price using the bid price for furnishing foreign iron and steel.

For the total bid based on furnishing foreign iron and steel to be considered for award, the lowest total bid based on furnishing domestic iron and steel must exceed the lowest total bid based on furnishing foreign iron and steel by more than 25 percent. The 25 percent differential applies to the total bid for the entire project, not just the bid prices for the steel or iron products.

Iron and steel products are defined as products rolled, formed, shaped, drawn, extruded, forged, cast, fabricated or otherwise similarly processed from iron and steel made in the United States. Iron products are included, however, pig iron and processed, pelletized, and reduced iron ore may be purchased outside the United States.

Manufacturing begins with initial melting and continues through the coating stage. Any process which modifies chemical content, physical size or shape, or the final finish is considered a manufacturing process. Coatings include epoxy, galvanizing, painting or any other surface protection that enhances the value and/or durability of a material.

The contractor shall provide a certification to the Engineer with each shipment of iron and steel products to the project site that the manufacturing processes for the iron and steel products occurred in the United States. No steel shall be placed until the contractor ensures the requirements of this Special Provision are met.

The above requirements do not prevent a minimal use of foreign materials, if the cost of such materials used does not exceed 0.1 percent of the total contract cost or $2,500.00, whichever is greater. If steel not meeting the requirements of this Special Provision is used, the contractor

SP106A

shall provide a written statement to the Department prior to its use indicating where the steel will be incorporated in the work, the value of the steel, the percentage of the contract amount, and the appropriate invoices shall be submitted as documentation.

The contractor shall be responsible for all cost associated with any steel that is permanently incorporated into the project that does not meet the requirements of this Special Provision without prior written approval from the Department, up to and including removal and replacement.

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING
SUITE 700, JAMES K. POLK BUILDING
505 DEADERICK STREET
NASHVILLE, TENNESSEE 37243-1402
(615) 741-0791

JOHN C. SCHROER
COMMISSIONER

BILL HASLAM
GOVERNOR

MEMORANDUM

TO: Regional Construction Supervisors
Regional Project Supervisors
Regional Materials and Tests
Headquarters Materials and Tests

FROM: Brian Egan, Construction Division Director

DATE: January 14, 2013

SUBJECT: **Buy America Requirements and SP106A**

Over the last few years we have placed a great deal of emphasis on assuring that all iron and steel products used on TDOT projects with federal funds meet the Buy America Requirements of SP106A. While the Federal Regulations have not changed (23 CFR 635.410), the Federal Highway Administration (FHWA) has issued the attached Memorandum (December 21, 2012 by Mr. John R. Baxter) to provide some "Clarification of Manufactured Products under Buy America".

Please note specifically the following three (3) excerpts in the Memorandum as you interpret and apply the requirements of SP106A:

1) *"Thus, in order for a manufactured product to be considered subject to Buy America, the product must be manufactured predominantly of steel or iron. The FHWA deems a product to be manufactured predominantly of steel or iron if the product consists of at least 90% steel or iron content when it is delivered to the job site for installation"*, and,

2) *"Examples of products that are subject to Buy America coverage include, but are not limited to, the following:*

- *steel or iron products used in pavements, bridges, tunnels or other structures, which include, but are not limited to, the following: fabricated structural steel, reinforcing steel, piling, high strength bolts, anchor bolts, dowel bars, permanently incorporated sheet piling, bridge bearings, cable wire/strand, prestressing / post-tensioning wire, motor/machinery brakes and other equipment for moveable structures;*
- *guardrail, guardrail posts, end sections, terminals, cable guardrail;*

- *steel fencing material, fence posts;*
- *steel or iron pipe, conduit, grates, manhole covers, risers;*
- *mast arms, poles, standards, trusses, or supporting structural members for signs, luminaires, or traffic control systems; and*
- *steel or iron components of precast concrete products, such as reinforcing steel, wire mesh and pre-stressing or post-tensioning strands or cables.*", and,

3) "*The miscellaneous steel or iron components, subcomponents and hardware necessary to encase, assemble and construct the above components (or manufactured products that are not predominantly steel or iron) are not subject to Buy America coverage. Examples include, but are not limited to, cabinets, covers, shelves, clamps, fittings, sleeves, washers, bolts, nuts, screws, tie wire, spacers, chairs, lifting hooks, faucets, door hinges, etc.* "

Utilities are required to meet the requirements of Buy America.

Also, as allowable in SP106A, a small amount of foreign materials may be used in the project with prior approval and proper supporting documentation. The maximum amount of foreign materials, subject to meeting the Buy America Requirements, allowed is $2,500 or 0.1 percent (%) of the total contract amount (awarded contract amount), whichever is greater. The cost includes the total cost of iron and steel plus the cost of transportation to the project site, as evidenced by delivery receipt, but does not include labor costs involved in final assembly.

For additional information on the Buy America Requirements, please visit the following FHWA website:

http://www.fhwa.dot.gov/construction/cqit/buyam.cfm
http://www.fhwa.dot.gov/construction/contracts/buyam_qa.cfm

cc: Mr. Paul Degges
Mr. Greg Duncan
Mr. Gerald Varney, FHWA
Mr. Kent Starwalt, TRBA

U.S. Department of Transportation
Federal Highway Administration

Memorandum

Subject: **ACTION:** Clarification of Manufactured Products under Buy America

Date: DEC 2 1 2012

From: Mr. John R. Baxter
Associate Administrator for Infrastructure

In Reply Refer To:
HIPA-30

To: Division Administrators
Directors of Field Services

This memo clarifies the Federal Highway Administration's (FHWA) position regarding application of Buy America requirements to manufactured products. Our current Buy America policy is based upon the statutory provisions in the Surface Transportation Assistance Act of 1982, as implemented with a November 25, 1983, final rule.

In the preamble to the 1983 final rule (48 FR 53099), after soliciting and considering public comments, the FHWA found that it was in the public interest to waive application of Buy America to manufactured products other than steel and iron manufactured products. As the Federal-aid Highway Program evolved and technology improved, the FHWA clarified the applicability of the standing waiver for manufactured products in a December 12, 1997, memo. In this 1997 memo, the FHWA clarified that, while Buy America does not apply to manufactured products, Buy America does apply to components of "predominately steel products."

With enactment of the American Recovery and Reinvestment Act (ARRA), the FHWA formed National Review Teams (NRT) (now known as Project Management Improvement Teams) to conduct reviews and make recommendations on how to improve the delivery of ARRA funded projects. One NRT review recommended that a State's Buy America certification be clarified to ensure that all covered steel and iron meets FHWA Buy America requirements. In working to address this finding, questions have arisen regarding the scope of the application of the 1983 public interest waiver for manufactured products. For example, it has been suggested that nuts, bolts, washers, and other miscellaneous steel or iron parts used in common off-the-shelf products such as toilets and the filaments in light bulbs must be Buy America compliant. Given these questions, the FHWA is concerned that such a reading of Buy America is inconsistent with the previous 1983 waiver decision and is not cost-effective to administer. Accordingly, it has become necessary to clarify the applicability of the waiver for manufactured products.

The FHWA continues to support the Buy America waiver for manufactured products in the 1983 final rule, as clarified by the 1997 memo. In particular, the waiver was intended to apply to all manufactured products except for steel and iron manufactured products. For example, the 1983 rule specified that traffic controllers are covered by the waiver since these products have many different components that are difficult to trace. Over time, however, some States have subjected signal heads and other traffic control equipment to Buy America and have sought project specific waivers. In reexamining the extent of the 1983 waiver in light of the NRT finding, we believe that the scope of the waiver was intended to encompass miscellaneous steel or iron components and subcomponents that are commonly available as off-the-shelf products such as faucets, door hardware, and light bulbs.

Thus, in order for a manufactured product to be considered subject to Buy America, the product must be manufactured predominantly of steel or iron. The FHWA deems a product to be manufactured predominantly of steel or iron if the product consists of at least 90% steel or iron content when it is delivered to the job site for installation. For purposes of applying Buy America and determining whether a product is a steel or iron manufactured product, the job site includes the sites where any precast concrete products are manufactured.

Examples of products that are subject to Buy America coverage include, but are not limited to, the following:

- steel or iron products used in pavements, bridges, tunnels or other structures, which include, but are not limited to, the following: fabricated structural steel, reinforcing steel, piling, high strength bolts, anchor bolts, dowel bars, permanently incorporated sheet piling, bridge bearings, cable wire/strand, prestressing / post-tensioning wire, motor/machinery brakes and other equipment for moveable structures;
- guardrail, guardrail posts, end sections, terminals, cable guardrail;
- steel fencing material, fence posts;
- steel or iron pipe, conduit, grates, manhole covers, risers;
- mast arms, poles, standards, trusses, or supporting structural members for signs, luminaires, or traffic control systems; and
- steel or iron components of precast concrete products, such as reinforcing steel, wire mesh and pre-stressing or post-tensioning strands or cables.

The miscellaneous steel or iron components, subcomponents and hardware necessary to encase, assemble and construct the above components (or manufactured products that are not predominantly steel or iron) are not subject to Buy America coverage. Examples include, but are not limited to, cabinets, covers, shelves, clamps, fittings, sleeves, washers, bolts, nuts, screws, tie wire, spacers, chairs, lifting hooks, faucets, door hinges, etc.

If you have any questions, please contact either Mr. Gerald Yakowenko at 202-366-1562 or Mr. Edwin Okonkwo at 202-366-1558.

STATE OF TENNESSEE

Rev. 04-03-2006
Rev. 11-22-2011
Rev. 02-13-2012

March 1, 2006

SPECIAL PROVISION

REGARDING

WATER QUALITY AND STORM WATER PERMITS

Scope

The conditions of this Special Provision apply to all construction on this project pursuant to the following:

1. Section 404 of the Federal Clean Water Act (33 U.S.C. §1344), and all implementing regulations, including without limitation regulations of the U.S. Army Corps of Engineers governing permits for discharges of dredged or fill material into waters of the United States in 33 CFR Part 323; and
2. The Tennessee Water Quality Control Act (T.C.A. §69-3-101, et seq.) and all implementing regulations, including without limitation the Rules of the Tennessee Department of Environment and Conservation governing NPDES permits in Chapter 1200-4-10, and Aquatic Resource Alteration permits in Chapter 1200-4-7; and
3. Section 26a of the TVA Act of 1933 as amended (49 Stat. 1079, 16 U. S. C. sec. 831y1.) and all implementing regulations, including without limitation the regulations of the Tennessee Valley Authority governing construction in the Tennessee River System in 18 C.F.R., Part 1304; and
4. The Tennessee Wildlife Resources Agency Reelfoot Lake Watershed Management permit program (T.C.A. section 70-5-1,), and all implementing regulations, including without limitation regulations authorizing any activity, practice, or project which has or is likely to have the effect of diverting surface or subsurface water from the Lake or have the effect of draining or otherwise removing water from Reelfoot Lake; and
5. Coast Guard Bridge Permit (USCG) (Section 9 of the Rivers and Harbors Appropriation Act of 1899) and all implementing regulations, including but not without limitation for projects which impact streams deemed navigable by the U.S. Coast Guard.

Responsibility

It is understood and agreed that the Contractor assumes all responsibilities of the permittee as indicated in the permit that relates to protection of the "waters of the United States" and/or "waters of the State of Tennessee."

It is also understood and agreed that the Contractor shall be responsible for obtaining any additional permits required by the Contractor's method of construction, including without limitation haul roads, temporary channels or temporary ditches, or off-site waste and/or borrow areas.

It is also understood that the Contractor shall be responsible for implementing the provisions of the Water Quality (including, but not limited to, TDEC ARAP, USACE 404, TVA Section 26a, Coast Guard, TWRA) and Storm Water [including, but not limited to, National Pollution Discharge Elimination System (NPDES), Statewide Stormwater Management Plan (SSWMP)] Permits and requirements that pertain to construction activities.

The Contractor by signing this contract is indicating that the Contractor has reviewed a copy of the permit provisions, including NPDES Permit provisions at http://www.tdot.state.tn.us/construction/permits/npdes.pdf, the site specific SWPPP, the contract plans, Standard Specifications and contract Special Provisions and finds the permit requirements and erosion prevention and sediment control (EPSC) procedures to be reasonable, workable, and binding.

It is also understood that the Contractor shall not be released from the project site responsibilities under the NPDES permit provisions until the Notice of Termination (NOT) is submitted to TDEC by the TDOT Regional Construction Supervisor. The NOT is a certification that the construction project site is permanently stabilized and that all construction related discharges have ceased. This means that the use of EPSC measures to alleviate concerns of surface erosion and transport of sediment to surface water conveyances or to waters of the state is no longer necessary. Furthermore, it means that permanent controls, hard surfaces and/or vegetation, employed at the site are deemed adequate to prevent erosion and sediment transport and no other potential sources of construction-related pollution are on the project.

It is also understood that the Contractor shall not be released from any warranty provided for EPSC plantings, including sod and trees. If the entire project is complete as outlined in **Subsection 105.15** of the **Standard Specifications,** the Contractor shall be required to supply a performance bond as outlined in **Subsection 802.15** of the **Standard Specifications** to cover any warranty for EPSC plantings.

NPDES Permit Required Action

The Contractor (or their representative) shall accompany the EPSC inspector (TDOT personnel or TDOT hired consultant) on all EPSC inspections of the entire construction project including permitted locations and potentially impacted streams as well as attend all QA/QC Project Assessments.

EPSC Inspections shall be conducted as required in the most current TN Construction General Permit.

EPSC inspections shall be performed on the schedule established in the TN Construction General Permit until the site is permanently stabilized to determine if the permit requirements are being met. Where sites or portion(s) of construction sites have been temporarily stabilized, or runoff is unlikely due to winter conditions (e.g. site covered with snow or ice), such inspection only has to be conducted once per month until thawing or precipitation results in runoff or construction activity resumes. Written notification of the intent to change the inspection frequency and the justification for such request must be submitted to the TDOT Project Supervisor and the TDEC Central Office before proceeding.

An individual representing the Contractor, who holds a current TDEC "*Fundamentals of Erosion Prevention and Sediment Control Level I*" certification shall accompany the EPSC inspector on all required EPSC inspections. The Contractors project supervisor(s) shall also hold a current TDEC "*Fundamentals of Erosion Prevention and Sediment Control Level I*"

certification. Proof of required personnel training for the individual(s) shall be provided to the TDOT Project Supervisor prior to beginning of construction.

The TDOT EPSC inspector shall document all deficiencies on the required TDOT EPSC Inspection Report form (provided in the SWPPP). The Contractor (or their representative) shall sign the TDOT EPSC Inspection Report form and any supporting documentation indicating that he is in agreement with the report, recommendations and repair schedule as stated within the documentation.

Additionally, the Contractor shall make necessary maintenance and repairs relative to deficiencies in these permit conditions or requirements within twenty-four (24) hours after an inspection identifies the maintenance or repair need, and/or when directed to do so by the TDOT Project Supervisor, unless conditions make a particular activity impracticable. Any such conditions that make immediate repairs impracticable shall be documented and provided to the TDOT Project Supervisor, via the inspection report, and be accompanied by an expected repair schedule based on forecasted weather conditions.

The Contractor further agrees that he will execute two (2) copies of the Notice of Intent (NOI) form of the permit (provided by the Department), indicating his acceptance of the stipulations contained therein. The Contractor further agrees, that should he fail to execute said copies and return them to the TDOT Construction Division within ten (10) calendar days after submittal of the contract proposal to him, that the Department may at its discretion cancel the award with the Contractor forfeiting his bid bond.

Further, the Contractor agrees to review the site specific Stormwater Pollution Prevention Plan (SWPPP) that will be made available prior to or at the pre-construction conference, for any additional EPSC requirements. The Contractor shall sign and submit two copies of the SWPPP signature page (provided by the Department within the site specific SWPPP). The Contractor may submit for review and approval changes/revisions to the SWPPP to better prevent erosion and sediment transport at any time after contract execution. Rejection of any submittals does not relieve the contractor of any liability for appropriate Best Management Practices (BMPs).

If at any time during this contract, the requirements for the Water Quality Permits and/or the Storm Water Permits for Construction Related Activities are changed/revised/updated, the Contractor shall be notified in writing by the Department of such requirements. The Contractor shall comply with the new requirements within thirty (30) days of the Department notification.

If at any time the Contractor becomes aware that sedimentation is occurring or has occurred in streams impacted by the specified project, the Contractor shall immediately notify the TDOT Project Supervisor to evaluate the EPSC measures employed. A determination of the cause for sedimentation will be made by the Department. The Contractor shall immediately repair or replace defective EPSC measures, and install, as applicable, additional or other EPSC measures with the goal of eliminating future sedimentation. Once a remediation plan is provided by the Department, the Contractor shall, within twenty-four (24) hours after notification, begin the remediation as required. Based on the cause of sedimentation, the Department will determine if the cost of remediation will be performed at the Contractor's expense.

Failure to Comply

In the event a Notice of Violation (NOV) or Order pursuant to the Tennessee Water Quality Control Act or the Federal Clean Water Act is issued on this project, any and all fines will be the sole responsibility of the Contractor as outlined in **Subsection 107.01** of the **Standard Specifications for Road and Bridge Construction.**

Failure of the Contractor to comply with this Special Provision or take immediate corrective actions required within twenty-four (24) hours (unless documented conditions make a particular maintenance or repair activity impracticable immediately) shall be reason for the TDOT Project Supervisor to suspend all other work on the Project, except erosion prevention and sediment control (EPSC) and traffic control, applying non-refundable deductions of monies from the Contract per calendar day from monies due to the Contractor for any EPSC work on the Project. This deduction can be made for each location, as determined by the TDOT Project Supervisor, for each calendar day that the deficiency is allowed to remain and charged as item description *"Failure to Comply with Permit Deduction"*. A deduction shall be made from monies due the Contractor, not as a penalty, but as liquidated damages, as indicated in **Subsection 108.07** of the **Standard Specifications for Road and Bridge Construction March 1, 2006**, as amended.

If the Contractor does not make necessary corrections/adjustments in a timely manner as required above, the Department will implement the provisions of **Subsection 209.07 and Subsection 109.08** of the **Standard Specifications for Road and Bridge Construction** that provides for the Department making repairs and recovering the costs thereof from the Contractor.

The Department will not participate in any payment or reimbursement for fines and will not authorize time extensions due to delays in project progress for work stoppage, to remedy the violations stated within the NOV, required by the TDOT Project Supervisor as stated in **Subsection 105.01** of the **Standard Specifications for Road and Bridge Construction**.

STATE
February 6, 2010

OF

TENNESSEE
March 1, 2006

CONTRACTOR EMPLOYEE SAFETY AND HEALTH PROGRAM (EFFECTIVE THE MARCH 19, 2010 LETTING)

At the preconstruction meeting, the Contractor shall submit to the Project Supervisor written certification of an Employee Safety and Health Program (ESHP) developed by a safety professional with a minimum of 30 hours OSHA Construction Training. The certification letter shall include the following:

1. Certification that the ESHP meets or exceeds all Federal, State, and local safety and health standards.
2. Qualifications of safety professional responsible for developing and maintaining the ESHP.
3. Chief Safety Personnel- Management-level personnel responsible for managing and implementing the ESHP for the company. Include the name and 24/7contact information.
4. On-Site Safety Personnel - Supervisory-level personnel responsible for implementing and monitoring the ESHP. Include 24/7 contact information.
5. Traffic Control Coordinator. Include the name and 24/7 contact information.
6. Prime contractor shall insure all sub-contractors have a safety program. The Prime Contractor is responsible for work site safety. The Prime contractor is responsible for conducting all operations so as to protect the workers engaged in duties connected with the work.

The ESHP is a living document and shall be updated as needed. The Contractor shall maintain an original copy at the company's headquarters and shall provide to the Department upon request. Certification of an ESHP will be required before any work can begin.

The ESHP shall at a minimum include the following:

1. **Description.** Describe in detail how the ESHP is implemented and monitored. Provide guidelines for protecting personnel from hazards associated with project operations and activities. Establish the policies and procedures for safety practices that are necessary for the work to be in compliance with the requirements of TOSHA, the MUTCD and other State and Federal regulatory agencies with jurisdiction, rules, regulations, standards, or guidelines in effect at the time the work is in progress.

2. **Certification, Responsibility, and Identification of Personnel.** Identify the safety professional responsible for developing the ESHP and provide that person's qualifications

for developing the ESHP. Qualifications should include but not limited to: education, training, certifications, and experience in developing this type of ESHP.

a. Provide a certification, executed by the safety professional that developed the ESHP, stating that the safety program complies with the rules, regulations, standards, and guidelines in effect at the time the work is in progress, of TOSHA, the MUTCD and other applicable Federal, State, and local regulatory agencies having jurisdiction.

b. Identify the Chief Safety Personnel and designate the On-Site Safety Personnel at supervisory-level responsible for implementing and monitoring the ESHP and having the authority to take prompt corrective measures to eliminate hazards, including the authority to stop work. Include documentation of training provided to the On-Site Safety Personnel.

c. For work that requires a competent person as defined by TOSHA, ensure that the On-Site Safety Personnel is capable of identifying existing and predictable hazards and has the authority to take prompt corrective measures to eliminate the hazards, including the authority to stop work. Include documentation of the qualifications of such competent persons identified, including certifications received.

d. For work that requires flagging, all flaggers will have proof they have completed an approved Flagging Course.

3. **Elements of the Program.** Include information and procedures for the following elements:

a. **Chain of Command.** Include the responsibilities of the management, supervisors, safety personnel, and employees.

b. **Traffic Control Coordinator.** Include the name and 24/7 contact information. Ensure that the traffic control coordinator meets the requirements specified in the MUTCD and holds a Work Zone Safety Supervisor certificate (ATSSA, NHI, UT).

c. **Chief Safety Personnel.** The Chief Safety Personnel shall have a minimum of 10 hours OSHA Construction training and the authority to make immediate decisions concerning safety and health, including the authority to stop work. Include the name and 24/7contact information. Ensure that the Chief Safety Officer meets the requirements specified in TOSHA.

d. **On-site Safety Personnel.** The On-Site Safety Personnel shall have a minimum of 10 hours OSHA Construction training and the authority to make immediate decisions concerning safety and health. Include the name and 24/7contact information. Ensure that the On-Site Safety Personnel meets the requirements specified in TOSHA.

e. **Emergency Procedures.** Provide guidelines for handling emergencies, including emergency action plans for incidents involving a worker's death or serious injury, property damage, fires, explosions, and severe weather. Include the 24/7 emergency

contact information of the Contractor's personnel responsible for handling emergencies.

f. **Local Emergency Telephone Numbers.** Include police, fire, and medical numbers. This item will be in the project specific copy to be kept at each worksite.

g. **Training Topics.** Include regulatory and jobsite safety meetings.

h. **Contractor's Safety Rules.** Include employee safety, housekeeping procedures and personal protective equipment requirements.

i. **Employee Disciplinary Policy as related to safety issues.** Documentation shall be maintained at the contractor's headquarters.

j. **Work-Site Safety Checklists.** Include project safety-planning, emergency plans and procedures, documentation, and protective materials and equipment. Define procedures for routine work site inspections and correcting hazards reported by employees.

k. **Personnel Injuries.** Record all work-site accidents including cause and correction and provide to the department upon request.

l. **Hazard Communication Program.** Provide the following:

1. The location of and instructions for understanding the Manufactures Safety Data Sheet (MSDS). Ensure that the location and instruction are available to anyone within the project Limits.
2. The person responsible for the hazard communication program and the method of informing personnel of the hazardous communication program. Attendance sheets of hazard communication meetings shall be maintained.
3. Provide employees a procedure for reporting and recording safety and health concerns to the On-Site Safety Personnel and the Chief Safety Personnel who have the authority to make immediate corrections.
4. When performing work that generates airborne crystalline silica or lead, include engineering and work practice controls to limit exposure levels to, at, or below the permissible exposure limit according to TOSHA. Ensure that the program includes employee training and respiratory protection measures according to TOSHA and control of the area when the permissible exposure limit is exceeded. Provide a trained and competent person, according to TOSHA, within the Project Limits at all times when performing work that produces airborne crystalline silica or lead.

m. **Additional Requirements.** Provide additional procedures for Project specific topics including but not limited to:

1. Compressed gas cylinders.
2. Confined spaces.

3. Cranes.
4. Electrical.
5. Equipment operators.
6. Fall protection.
7. Hand and power tools.
8. Hearing conservation.
9. Highway safety. See supplement specification 700SS
10. Lead.
11. Lock out/tag out.
12. Materials handling, storage, use, and disposal.
13. Night work.
14. Personal protective equipment.
15. Project entry and exit.
16. Respiratory protection.
17. Sanitation.
18. Signs, signals, and barricades.
19. Subcontractors.
20. Trenching.
21. Flagging.

The Contractor is responsible for implementing, monitoring, updating, and revising the ESHP. If an incident occurs that requires hospitalization, or TOSHA Citation to be submitted, notification of the incident shall be sent to the Project Supervisor and forwarded to the Regional Safety Coordinator.

On-call guardrail, sweeping, on-call striping/retracing, litter removal, tree services, mowing, and work performed at Welcome Centers and Rest Stops, will be considered Maintenance Contracts. The Maintenance Contractor, while performing the above listed projects, will have a Safety and Health Program, a Work Zone Traffic Control Supervisor and a Safety Manager. . Certification of an ESHP will be required before any work can begin. The certification letter shall include the following items and names (with 24/7 contact numbers) for:

- Safety and Health Program developed by a safety professional with a minimum of 30 hours OSHA Construction Training. This plan will cover the unique and specific hazards posed by the intended work including a Hazard Communication Program as defined as above.
- Traffic Control and Safety Supervisor to ensure that the traffic control meets the requirements specified in the MUTCD and holds a Work Zone Safety Supervisor certificate (ATSSA, NHI, UT); also have a minimum of 10 hours OSHA Construction training. This employee must have the authority to make immediate decisions concerning safety and health, including the authority to stop work.

SP108A

STATE OF TENNESSEE

March 1, 2006
Project No.: STP-M-7900(29)
& 79946-2455-54
County: Shelby

SPECIAL PROVISION

REGARDING

"SPECIALTY ITEMS"

In accordance with the provisions of Subsection 108.01, *Standard Specifications for Road and Bridge Construction,* 2006, all construction items included in the following described work are hereby designated as "Specialty Items":

Items 105-01 – Construction Stakes, Lines and Grades

Items 209 – EPSC Items

Items 604 – Texture Finish

Items 705 – Guardrail, Anchors, etc.

Items 712 – Traffic Control Items

Items 713 – Signing Items

Items 716 – Pavement Marking Items

Items 730 – Traffic Control Items

Items 797 – Utility Items

Items 801 – Seeding

Items 802 – Landscaping Items

Items 803 – Sodding

Items 805 – Erosion Control

STATE OF TENNESSEE

(Rev. 12-18-95)
(Rev. 6-6-97)
(Rev. 2-1-02)

March 1, 2006

SPECIAL PROVISION

REGARDING

EMBANKMENT (COMPACTED IN PLACE)

Description: This work shall consist of constructing roadway embankments in accordance with the Standard Specifications except as modified herein. All work shall be performed in reasonably close conformity with the lines and grades shown on the plans or as directed by the Engineer and shall include roadway excavation, the furnishing of borrow material, the preparation of the area upon which embankments are to be placed, the placing and compacting of approved material within roadway areas, removal and replacement of unsuitable material, clearing and grubbing of borrow sites, and transporting borrow material.

Materials. Materials used in the construction of embankments shall meet the requirements of Section 205 of the Standard Specifications unless otherwise specified on the plans.

Construction Requirements. Roadway excavation and embankment construction shall be performed in accordance with Section 203 and Section 205 respectively of the Standard Specifications except as modified herein.

The Contractor shall perform all excavation indicated or described in the plans or directed by the Engineer. All suitable material obtained from the roadway excavation, bridge excavation, channel excavation or other excavation may be used in the formation of embankments. All additional material required for completion of the embankments shall be furnished by the Contractor from locations approved by the Engineer.

Unsuitable material encountered in the roadway excavation will be removed and disposed of in accordance with the Standard Specifications except that the unsuitable material will be measured and paid for under Item No. 203-10, Embankment (Compacted in Place). No other material shall be removed from the project without the written consent of the Engineer except as provided for in the Plans and Specifications.

Topsoil shall be stripped and stockpiled in accordance with Subsection 203.06 of the Standard Specifications. The Engineer may at his discretion measure and pay for topsoil prior to placing and spreading, however, such payment shall not exceed 50% of the estimated volume of the stockpile.

Method of Measurement. Embankment (Compacted in Place) will be measured by the cubic yard complete in place. Final volume of Embankment (Compacted in Place) will be computed using the average end area method and shall be based on original cross-sections taken after removal of topsoil and unsuitable material from the embankment areas and after placement of rock or other select material paid for under other items. Final cross sections will be taken on the completed embankment prior to placement of topsoil, mineral aggregate or other material which is paid separately. Boundaries of the embankment shall be the neat lines established by the slope stakes and the elevations shown on the plans or established by the Engineer. No measurement for payment will be made beyond these boundaries except as specified herein.

The centerlines, baselines or other lines shown on the Plans or established by the Engineer shall be used as reference lines for measurement of embankments. Cross-sections shall be taken from these reference lines at intervals not to exceed 50 feet.

The volume of embankment displaced by box culverts, box bridges, span bridges, pipe(s) with cumulative diameter(s) of 60" or greater and retaining walls including all structural backfill required for the structures will be deducted from the embankment quantity. Materials placed in the embankment area including but not limited to rock pads, sinkhole treatment and rock caps on subgrade which are paid for under other items will not be measured as part of the embankment.

Roadway excavation will not be measured on this project, but shall be a responsibility to be assumed by the Contractor in connection with the pay item(s) specified herein.

Basis of Payment. The amount of completed and accepted work, measured as provided for above, shall be paid for at the contract unit price bid for Embankment (Compacted in Place), which price shall be full compensation for furnishing all materials, placing and forming of embankments, all roadway excavation shown on the plans, clearing and grubbing of borrow pits, and all equipment, tools, labor, and incidentals necessary to complete the work.

Roadway excavation will not be paid for directly. The contract unit price for Embankment (Compacted in Place) shall be full compensation for all roadway excavation performed in accordance with the Plans and Specifications.

No additional payment will be made for undercutting at locations where the plans indicate undercutting is required. However, if the Engineer directs undercutting at locations not indicated on the plans, the unsuitable material removed will be measured by the cubic yard in its original location and paid for at 1.5 times the contract unit price bid for Embankment (Compacted in Place). Material used to replace unsuitable material will be measured and paid for under the appropriate contract item.

STATE OF TENNESSEE

Effective 04-04-2011

March 1, 2006

SPECIAL PROVISION

REGARDING

ASPHALT PAVEMENT SAFETY EDGE

The contractor shall attach a device to the screed of the paver such that material is confined at the end gate and extrudes the asphalt material in such a way that results in a consolidated wedge-shape pavement edge of approximately 25 to 30 degrees as it leaves the paver (measured from a line parallel to the pavement surface). The device shall maintain contact to the graded material adjacent to the pavement and must be adjustable to allow for transition to cross roads, driveways and obstructions without requiring the paver to be stopped routinely. The device shall constrain the asphalt head and increase the density of the extruded profile. To achieve desired results, rolling is not required on the wedge. The desired pavement edge angle is 30 degrees but angles as steep as 38 degrees are acceptable after the mat has been rolled for compaction.

The contractor shall use the TransTech Shoulder Wedge Maker, the Advant-Edge Edger or Ramp Champ, Carlson's Safety Edge Endgate or an equivalent device that produces the same wedge consolidation results. If the contractor uses a similar device, he must provide proof that his device has been used on previous projects with acceptable results (proof shall consist of, at a minimum, approval and endorsement of another State D.O.T. or FHWA Division). Short sections of handwork will be allowed when necessary for transitions and turnouts or otherwise authorized by the engineer. Conventional single plate strike off devices will not be allowed.

No direct payment will be made for the Safety Edge and all cost of furnishing and/or operation of this device will be included in other items.

Contact information for these wedge shape compaction devices is as follows:

1. **TransTech Systems, Inc.**
   1594 State Street
   Schenectady, NY 12304
   1-800-724-6306
   http:/www.transtechsys.com

2. **Advant-Edge Paving Equipment LLC**
   P.O. Box 9163
   Niskayuna, NY 12309-0163
   Ph. 518-280-6090
   http://www.advantedgepaving.com

3. **Carlson Paving Products, Inc.**
   18425 50th Ave E, Tacoma WA 98446
   Phone (253) 875-8000 | Toll Free 1-800-216-2108 | General Fax# (253) 846-2703
   http://www.carlsonpavingproducts.com

STATE OF TENNESSEE

Date: 08-08-08
(Rev. 12-03-10)
(Rev. 08-06-12)

March 1, 2006

SPECIAL PROVISION
REGARDING
RETAINING WALLS

General Description

This Special Provision covers the design, submittal of working drawings, materials, construction, measurement, and payment for earth retaining walls. The scope of work for retaining wall construction includes, but is not limited to, the following as required:

1. All grading necessary for wall construction,
2. Undercutting and backfilling of weak surficial zones, and or ground improvement as required by plans
3. Compaction of wall foundations
4. General and local dewatering as required for proper execution of the work
5. Construction of leveling pads
6. Formwork, placement of reinforcing steel, placement and curing of concrete
7. Texture coating or architectural treatment
8. Placement of drainage materials
9. Installation of piling
10. Placement of soil reinforcing devices
11. Placement and compaction of backfill
12. Preparation and erection of wall units
13. Construction of any required reinforced concrete appurtenances such as caps, copings, or end sections

All items included in the construction of the retaining wall shall conform to this Special Provision, the *Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction,* henceforth referred to as the Standard Specifications, American Society for Testing Materials Standards (ASTM), Federal Highway Administration (FHWA) Technical Publications, and the current *AASHTO LRFD Bridge Design Specifications* with interims, henceforth referred to as the AASHTO LRFD. The architectural treatment and/or texture finish of the walls shall be in accordance with the contract plans.

Design Criteria

The design of all types of earth retaining walls shall be in accordance with this Special Provision and the following Specifications as required:

1. AASHTO *LRFD Bridge Design Specifications* with interims
2. Publication no. FHWA-NHI-10-024, *Mechanically Stabilized Earth Walls and Reinforced Soil Slopes*
3. (FHWA Report No. FHWA-SA-99-018, 1999)*Geotechnical Engineering Circular No. 4, Ground Anchors and Anchored Systems*

The soil properties and specific design values shall be shown on the contract plans.

Submittal Requirements for Contractor/Supplier Prepared Design Plans

The Contractor shall utilize the information contained on the Retaining Wall Conceptual drawing as well as information shown elsewhere in the plans to prepare his bid for the wall during the project bidding process and to prepare wall design plans during the construction of the project. The final design shall be submitted subsequent to contract award and a minimum of sixty (60) days prior to wall construction and shall include detailed design computations and all details, dimensions, quantities and cross sections necessary to construct the wall. Acceptable wall types will be identified on the concept drawing. Specific wall systems will typically be selected from the Department's Qualified Products List (QPL) in effect at time of bid letting. In certain circumstances, TDOT may elect to provide a complete, detailed wall design in the contract plans. The Contractor shall not bid for nor shall the Contractor submit plans for wall types and/or specific wall systems not listed as an Acceptable Wall Type on the Retaining Wall Conceptual Drawing and related drawings or the specific wall design if provided for in the contract plans.

The plans shall be prepared to include but not be limited to the following items:

1. A plan and elevation sheet or sheets for each wall containing the following:

    a. An elevation view of the wall showing grades at the top of the wall, every 50 feet along the wall and at all horizontal and vertical break points. Elevations at the top of leveling pads and footings, the distance along the face of the wall to all steps in the footings, and leveling pads, the designation as to the type of panel or module, the length, size and number of tiebacks, nails, mesh or strips and all the distances along the face of the wall to where changes in length of the reinforcing elements occur and the location of the original and final ground line should be shown. The Contractor shall be responsible for field verifying original ground elevations.

b. A plan view of the wall shall indicate the offset from the construction centerline to the face of the wall at all changes in horizontal alignment, the limit of the widest module, tiebacks, nails, mesh or strip and the centerline of any drainage pipe which is behind or passes under or through the wall.
c. Any general or special notes, standard or special drawings, or other unique provisions required for construction of the wall.
d. All horizontal and vertical curve data affecting wall construction.
e. Cross sections showing limits of construction and in fill sections, limits and extent of select granular backfill material placed above original ground.
f. Limits and extent of reinforced soil volume
g. Limits and extent of any ground improvements as require by the contract plans.

2. Details

a. All structural details including reinforcing bar bending details. Bar bending details shall be in accordance with CRSI standards.
b. All details for foundations and leveling pads, including details for steps in the footings or leveling pads, as well as allowable and actual maximum bearing pressures.
c. All modules and facing elements shall be detailed. The details shall show all dimensions necessary to construct the elements, all reinforcing steel in the element, and the location of reinforcement element attachment devices embedded in the facing.
d. All details for construction of the wall around drainage facilities, overhead sign footings and abutment piles shall be clearly shown.
e. All details for connections to traffic barriers, coping, parapets, noise walls and attached lighting shall be shown.
f. All details for drainage behind wall or reinforced soil volume.
g. If vehicular impact protection is required due to the wall system not satisfying the minimal design requirements of Section 5.0, details of the barrier wall and end terminals shall be shown on the Contractor/Supplier Design plans for the proposed wall.

3. Detailed design computations which clearly demonstrate compliance with design requirements provided in this specification.

4. Limits of design responsibility, if any.

5. Each design submittal shall include a detailed list of quantities for each wall unit. The quantities shall include but not be limited to: concrete cast in-place, pre-cast concrete, select backfill material, backfill material, reinforcing steel, geomembrane/geogrid reinforcement, modular blocks, structural steel, pre-stressing steel, etc... If known, all materials sources shall be identified so acceptance and verification sampling and testing can be conducted. All

quantities listed are for informational purposes only. All retaining walls shall only be paid for under the respective retaining wall bid item measured as described herein.

6. The plans shall be signed, stamped and dated by a qualified registered Professional Engineer licensed in the State of Tennessee.

7. Submittals and Approval

   Four sets of design drawings and detail design computations shall be submitted to the Structures Division. The computations shall include a detailed explanation of any symbols and computer programs used in the design of walls. All designs and construction details will be checked by the Structures Division and the Materials and Tests Division against the pre-approved design drawings and procedures for that particular system. (Structures Division will submit two of their four copies to the Division of Materials and Tests.) Each design drawing shall contain in the title block the project number, county, structure name, structure number, station and contract number. Design drawings shall be submitted in sets with the drawing numbers running consecutively in each set, and if more than five (5) sheets in a set, shall be appropriately bound. Approval of the detailed design and plans shall be made by the Structures Division and Materials and Tests Division. Notification to proceed shall be made by the Structures Division. After approval, the Contractor shall submit additional sets of the design drawings (full size and half size) as determined by the Structures Division for Departmental distribution. Also, an electronic copy of the design drawings and detail design computations shall be submitted to the Structures Division and the Materials and Tests Division upon completion of the project.

8. Other Submission Requirements

   As discussed in the previous sections, the Contractor shall bid for and, subsequently, (for the Contractor for which the project was awarded) prepare plans for and be prepared to construct the wall type(s) given on the Retaining Wall Conceptual Drawing or, under special circumstances, the specific wall type as provided by in the Contract Plans. The Contractor awarded the project may only under the circumstances discussed below request that a wall type, wall system, or associated construction for a wall (i.e., foundation improvement requirements, construction sequence requirements, etc.) be changed, altered, or eliminated from those requirements set forth in the plans.

   The Contractor may request the Department consider a change in the wall type, specific system, and associated construction through the submission of a Value Engineering Change Proposal (VECP) unless the contract prohibits submission of a VECP. Furthermore, any conditions of a VECP, such as a minimum cost savings required by the contract must be followed. The

Department's agreement to review a VECP for a retaining wall shall in no way imply subsequent acceptance of the VECP or any part thereof. Any costs associated with preparation and submittal of a VECP shall be borne by the Contractor and no construction scheduling changes or time delays shall be caused by the Contractor's submission of the VECP and the Department's review of the VECP. If the proposed change involves a wall system not on the Approved Wall System list, then the contractor must coordinate with the system supplier to gain approval of the system and shall be aware of the time considerations for this approval process.

The Contractor may request the Department consider a change in the wall type, specific system, and/or associated construction if the Contractor determines that project conditions exist that may substantially differ from those conditions upon which the decision to specify in the plans a particular wall type(s), wall system, or associated construction was made. An example of this would be where a soldier pile-lagging wall is specified as the only wall type due to right-of-constraints not allowing for a typical wall type to be built, then subsequently it is determined TDOT can acquire or has sufficient right-of-way available to make another wall type feasible

The request for consideration of changing of a wall type, system, or associated construction shall be made in writing and be submitted to the Construction Engineer. The Construction Engineer will distribute the request to the Regional Construction Engineer, Structures Division, Geotechnical Engineering Section, Design Division, and Right-of-Way Division, if applicable. The parties will review the request and provide recommended action (approval, rejection, alterations) to the Construction Engineer. If necessary, a plans revision will be made. Note that the Contractor's submission of a request does not imply acceptance by the Department and that the request process shall not be justification for a project schedule change or time extension. The Department reserves the right to require the Contractor to construct the wall as shown in the plans if a condition does not exist that renders the contract plan wall not constructible.

The Contractor must provide documentation in the request to demonstrate that the proposed change does not in any way cause additional cost to the wall and associated construction or to other aspects of the project. If the Contractor judges that a change involving wall construction must be made due to differing site conditions, the Contractor must follow procedures given in Sections 104.02 and 104.03 of TDOT Standard Specifications for Road and bridge Construction.

Requirements for retaining wall protection provided by the retaining wall system

When noted on the plans that a retaining wall is located in a hazard zone subject to vehicular impact, the Contractor shall be aware that retaining wall protection against vehicular collision for the wall may be required. If the retaining wall facing meets any one of the following criteria, an independent barrier wall shall be provided in front of the wall and included in the square foot cost of the wall:

1. Any retaining wall facing that is constructed of non-reinforced concrete (cast-in-place concrete gravity walls are exempt from this requirement and do not require protection.
2. Any dimension of a retaining wall facial panel that is less than 5'0" x 5'0" x 6" thick reinforced panel.
3. Any type of crib retaining walls.
4. A cast in place reinforced facing that has a thickness less than 6 inches

Materials Approval

The materials used in the construction of the earth retaining walls shall conform to this Special Provision and/or the Standard Specifications. Prior to delivery of any material used in the retaining wall construction, the materials must be accepted in conformance with the specifications associated with the wall type being constructed.

Materials

Unless other otherwise stated in specific retaining wall specifications, the materials used in the construction of earth retaining walls shall conform to the following specifications:

1. Concrete Class "A" shall be in accordance with Section 604 of the Standard Specifications.
2. Concrete Class "D" Shall be in accordance with Section 604 of the Standard Specifications.
3. Reinforcing steel shall conform to ASTM A 615, Grade 60.
4. The sources for all backfill material shall be approved in conformance with the Standard Specifications before the material is delivered to the job site. Any select backfill material must be approved or tested for compliance prior to construction.
5. Lifting hooks and threaded inserts shall be of the size indicated on the working drawings.
6. When required, imbedded items must be galvanized in accordance with AASHTO M 232 or ASTM A 153.
7. Acceptance of materials furnished for work will be in accordance with the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1) and certified test reports as specified in

Section 106 – Control of Materials supplemented by routine tests run by the Department as defined in the various applicable sections of the Standard Specifications.

8. Clearing and grubbing, removal of structures and obstructions, and excavation and undercutting shall be performed in accordance with the provisions of Sections 201, 202, and 203, respectively, of the Standard Specifications. Cost of these items, however, shall be included in the square foot price bid for retaining walls as shown in contract plans.
9. Reinforced Concrete Facing Panels - The panels shall be fabricated in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels."
10. Stone masonry shall be in accordance with Section 612 of the Standard Specifications.
11. The sources for all backfill material shall be approved in conformance with the specifications before the material is delivered to the job site. Any select backfill material must be approved or tested for compliance prior to construction.
12. All fabricated or precast retaining wall assemblies shall be selected from the TDOT's Qualified Products List.

All concrete, reinforcing steel, and backfill materials shall be tested at the specified frequencies in accordance with the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)".

A. Cast-in-Place (CIP) Concrete Gravity Retaining Walls

1. Construction

The construction of the wall shall be in accordance with this Special Provision and the Standard Specifications.

B. Cast-In-Place (CIP) Concrete Cantilever And Counterfort Retaining Walls

1. Construction

The construction of the wall shall be in accordance with this Special Provision and the Standard Specifications. If the use of piles is anticipated, the foundation information shown on the contract plans shall include the skin friction (Fs) and end bearing (Qb) values, or the location of the rock line. Based on this information, estimated pile lengths shall be shown on the contract plans for fifty (50) and one hundred (100) tons ultimate bearing capacity for Size 1 concrete friction piles. The contractor shall estimate point bearing steel pile refusal lengths based on the given rock line information.

Concrete friction piles shall be installed to provide a minimum factor of safety of 2.0 if a load test is used and a minimum factor of safety of 3.0 if a load test is not used. Pile types, load test procedures, and driving equipment shall be in accordance with the Standard Specifications and shall be approved by the

Engineer. The number and location of test piles and load tests shall be approved by the Engineer. Test pile lengths shall be ten (10) feet longer than the estimated pile lengths. Test piles shall be driven in accordance with the Standard Specifications, and shall be required at least every fifty (50) feet along the wall, unless otherwise approved by the Engineer. No pile shall be any farther than five hundred (500) feet from a load test, if a load test is used, unless otherwise approved by the Engineer. The length of production piles to be driven and the required bearing based on the driving equation shall be determined by the Engineer based on the required design bearing, the results of the test piles and load tests (if used), and applicable safety factors. Driven pile lengths and final bearings shall be approved by the Engineer.

Point Bearing Steel Piles shall be driven to refusal. Pile tips shall be used when indicated on the contract plans.

All reinforcing steel projecting from footing into the wall in the back face (fill side) shall be epoxy coated.

C. Concrete Crib Walls

1. Materials

The following items are the construction materials requirements necessary for crib wall design fabrication. All materials shall be approved prior to use.

a. Pre-Cast Concrete Crib Units

The pre-cast crib units are to be made of Class D Portland cement concrete conforming to Section 604 of the Standard Specifications.

b. Crib Backfill

All backfill material shall be tested prior to use and at the established frequencies in the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)".

i. The crib backfill material shall consist of an AASHTO classified A-1-a, A-1-b, or A-3 soil with the additional requirement no more than ten percent by weight pass the #200 sieve.

ii. The unit weight of the crib fill should be a minimum 115 lb. per cubic foot.

iii. Filter protection (geotextile) may be required.

c. Backfill Behind the Crib Type Structure

All backfill material shall be tested prior to use and at the established frequencies in the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)".

i. If a filter blanket is placed behind the wall, native soil may be used as backfill behind the structure.

ii. Select fill, as defined in 4.2.1 of this document, can be used as backfill behind the structure. The backfill unit weight must be a

minimum of 115 pcf. An internal angle of friction can be assumed equal to 35 degrees.

2. Fabrication of Precast Concrete Crib Units

a. All pre-cast concrete shall be produced in an approved plant in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels".

Out-of-state producers shall provide documentation of material quality before the manufacture of any pre-cast products (i.e. aggregate quality reports, cement/steel mill test reports, etc.)

The fabricator shall provide two precast modular units to the Engineer for approval.

i. These approved precast modular units will serve as standard models. The finished exposed faces of the production precast modular units should be similar to the exposed faces of the model precast modular units.

ii. One of the model precast modular units should be kept at the production plant for relative comparison to future modular units. The other model should be kept on the construction site for comparison to the other delivered units.

b. To assure uniform unit production steel forms must be used.

c. The placement of reinforcing steel within the precast units should conform to the design placement shown in the shop drawings.

d. Final acceptability of the precast units shall be determined on the basis of compression tests, production defects and tolerances, and visual inspection. The manufacturer shall furnish all sampling and testing facilities.

e. Section 604 of the Standard Specifications states the units shall be steam or moist cured until developing the specified compressive strength set forth in the shop drawings. Any unit not developing the specified compressive strength shall be rejected.

f. The precast units should not be delivered before samples have attained the required compressive strength of 4,000 psi (f'_c).

g. Prior to shipment, the finished units are subject to visual inspection by the Engineer. Individual crib units may be rejected for any of the reasons listed below.

i. Variations in the exposed face texture relative to the approved model face texture.

ii. The length or height of the unit not satisfying the unit allowable tolerance limit of 3/16".

iii. Honeycombed or open texture units which are not properly repaired.

iv. Individual defects which could affect the structural integrity of the unit.

h. TDOT will verify products before shipment in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels". If products are manufactured out of state, TDOT may verify at the project site PRIOR to the placement of the units. The Contractor, or producer, shall notify the Regional Materials and Tests Division that products need to be verified.

i. Upon delivery, the exposed surface of the precast units shall be examined. If the exposed faces of any of the units are below the standards of the approved model on site, the units shall be replaced or properly repaired until conforming to the appearance, strength, and durability of the approved model.

j. The date of manufacture shall be clearly and permanently marked on one of the inside surfaces of each unit. Each shipment must be accompanied with a certification letter as stated in the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels

3. Construction

a. The Contractor should perform any soil improvement, such as undercutting and backfilling before foundation preparation.

b. Compact the top 12" of soil on which the structure will rest to at least 95% of the maximum laboratory dry density as specified in AASHTO T-99.

c. No Crib-type wall should be built upon frozen ground.

d. Following excavation for the crib wall system, the Contractor shall notify the Engineer for approval of the footing depth and character of the foundation material. No crib wall system work shall proceed until approval has been granted.

e. The correct batter of the wall shall not exceed ½" per 10 ft. of wall height.

f. The crib backfill should be placed and compacted to at least 95% of the maximum laboratory dry density (AASHTO T-99) in layers no thicker than 12".

g. Backfilling behind the crib system shall follow erection as closely as possible. The wall height should never be greater than three feet above the backfill.

h. Any underdrain shall be placed in accordance with the details of the working plans.

i. The Contractor shall furnish, install, operate, and maintain satisfactory dewatering systems as required to maintain the site in a dry and workable condition. These systems shall be continued as long as necessary. No separate measurement or payment will be made for dewatering.

D. Bin Wall

1. Materials

a. Filler for horizontal joints between modular units shall be resin-bonded cork filler or closed cell foam, cross linked polyethylene polymer, conforming to test requirements of AASHTO M 153 or ASTM D 1752 (Type II) or equal. Filter fabric placed behind front vertical joints shall be at least 6" wide and conform to section 918.27 of the TDOT Standard Specifications).

b. Backfill: All select granular material shall be free from shale and organic or otherwise deleterious material and conform to the following gradation limits:

Sieve Size	Percent Passing
6 inch	100
3 inch	75-100
No. 200	0-15

The Contractor, at his option, may produce the select granular material by processing the excavation from the project or from approved material from other sources. No direct payment will be made for producing the select granular material.

All backfill material shall be tested prior to use and at the established frequencies in the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)".

c. Bearing pads shall be rubber of size, and manufacture shown on shop drawings, with the following properties perpendicular to the pad thickness:

i. Compression- minimum ultimate strength 8000 psi
ii. Initial Cracking Strain- 40% of thickness
iii. Hardness (Shore A) – 75 +/- 5
iv. Tensile Strength- ASTM D 412, die "C", 1000 psi +/- 100 psi
v. Tear Strength- ASTM D 624, die "B" – 360 psi minimum

d. Acceptance of materials furnished for work will be in accordance with the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1) and certified test reports as specified in Section 106 – Control of Materials supplemented by routine tests run by the Department as defined in the various applicable sections of the Standard Specifications.

2. Construction

a. Bin Fabrication

i. All pre-cast concrete shall be produced in an approved plant in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels".

Out-of-state producers shall provide documentation of material quality before the manufacture of any pre-cast products (i.e. aggregate quality reports, cement/steel mill test reports, etc.)

Before proceeding with production, a model precast modular unit shall be provided by the fabricator for the Engineer's approval to establish a guide and standard for the type of finish to be furnished on the exposed face. This model shall be kept at the fabricator's plant to be used for comparison purposes during production. Formed surfaces other than the exposed face shall not require a special finish

ii. Forms: Forms for the units shall be constructed of steel with dimensional tolerances that will assure the production of uniform units. Finish for the front face of the wall shall be in accordance with the finish specified on the contract plans.

iii. Mixing and Placing Concrete: The concrete mix as designed shall be proportioned and mixed in a batch mixer to produce a homogeneous concrete. The transporting, placement, and compaction of concrete shall be by methods that will prevent segregation of the concrete materials and the displacement of the reinforcement steel from its proper position in the form. Concrete shall be carefully placed in the forms and vibrated sufficiently to produce a surface free from imperfections such as honeycomb, segregation or cracking. Clear form oil of the same manufacture shall be used throughout the casting operation.

iv. Reinforcing Steel: All reinforcing steel for the precast modules and other components shall be fabricated and placed in accordance with plans and Standard Specifications.

v. Testing and Inspection: Acceptability of the precast units at the casting yard shall be determined on the basis of compression tests and visual inspection during casting. The manufacturer shall furnish such facilities and assistance as is required to carry on the sampling and testing in an expeditious and satisfactory manner. The manufacturer shall document and provide all test data and certify in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels".

vi. Curing: The units shall be steam or moist cured as specified in Section 604 of the Standard Specifications for a sufficient length of time so that the concrete will develop the specified compressive

strength. Any panel which does not reach specified strength within 28 days shall be rejected.

vii. Compressive Strength: Compressive tests to determine the minimum strength requirements shall be made on cylinders. A minimum of six cylinders for determining when the units may be put into service will be made from each day's production and cured in accordance with AASHTO T 23 or ASTM C 31. The 28 day compressive strength shall be at least 5000 psi. Compressive strength tests shall be in accordance with AASHTO T 22 or ASTM C 39.

viii. Rejection: The quality of materials, the process of manufacture, and the finished units shall be subject to inspection by the Engineer prior to shipment. Precast units may be subject to rejection on account of failure to conform to the requirements set forth herein. Individual units may be rejected because of any of the following:

- Variations in the exposed face that substantially deviate from the approved model as to texture in accordance with precast concrete industry standards.
- Dimensions not conforming to the following tolerances:
    - Face of panel, length or height: plus/minus 3/16"
    - Deviation from square when measured on diagonal: 5/16" for modules up to 10' wide, 3/4" for larger units.
- Honeycombed or open texture not properly repaired.
- Defects which would affect the structural integrity of the unit.

ix. Shipment: The precast units shall not be shipped until they have achieved the required concrete strength (f'c) of 5000 psi. TDOT will verify products before shipment in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels". If products are manufactured out of state, TDOT may verify at the project site PRIOR to the placement of the units. The Contractor, or producer, shall notify the Regional Materials and Tests Division that products need to be verified

x. Repairs at Plant: Before shipment, surfaces of all precast units shall be examined. If the exposed face of a unit is below the standard of the approved model then it shall be properly repaired to conform to the balance of the work with respect to appearance, strength and durability.

xi. Handling and Storage: Handling devices, as required, shall be provided in each precast modular unit for the purpose of handling

and placing. Care shall be taken during storage, transporting, hoisting and handling of all units to prevent cracking or damage. Units damaged by improper storing, transporting or handling shall be replaced or repaired to the satisfaction of the Engineer.

xii. Marking: The date of manufacture and production lot number shall be clearly and permanently marked on the rear face of each unit.

b. Erection:

i. Foundation Preparation: The foundation for the bin wall shall be graded to the elevations and dimensions shown on the contract plans. Prior to wall construction, the top 12 inches of the foundation shall be compacted to at least 95% of the maximum laboratory dry density as determined by AASHTO T 99. Any foundation soils found to be unsuitable or incapable of sustaining the required compaction shall be removed and replaced. After the excavation for each location of the bin wall has been performed, the Contractor shall notify the Engineer. No concrete leveling footing shall be placed until the depth of excavation and the character of the foundation material has been approved by the Geotechnical Engineering Section of the Division of Materials and Tests and permission has been given to proceed by the Engineer.

ii. At each unit foundation level, either a precast or cast-in-place footing and/or leveling pad shall be provided as shown on the shop drawings. The footings shall be given a wood float finish and shall reach the required compressive strength of 3000 psi, before placement of wall modules. The completed footing surface shall be constructed in accordance with grades and cross slopes shown on the shop drawings. When tested with a 10' straight edge, the surface shall not vary more than 1/8" in 10'. Any additional depth of footing required to level the top surface and bear on approved foundations shall be at the Contractor's expense.

iii. The modular units shall be installed in accordance with the manufacturer's recommendations. Special care shall be taken in setting the bottom course of units to true line and grade. Joint filler and neoprene pads, when required, shall be installed in the horizontal joints. Joints at corners or angle points shall be closed as shown on the plans or in accordance with recommendation of the manufacturer.

iv. All units above the first course shall interlock with the lower courses. Vertical joints shall be staggered with each successive course, or as shown on shop drawings. The vertical joint opening on the front face of the wall shall not exceed 3/4".

v. The interior of each successive course of precast modular units shall be filled with select granular backfill. The maximum lift thickness shall be 2 feet, and shall then be thoroughly consolidated with a vibratory tamping device.

vi. Backfill behind the wall shall be compacted to at least 95 percent of the maximum laboratory dry density as defined in AASHTO T 99 to within one foot of the top of the wall. The top 12 inches shall be compacted to at least 100 percent of the maximum laboratory dry density.

vii. When erecting a battered wall, placement of backfill behind the wall shall closely follow erection of successive courses of units. At no time shall the difference in elevation between the backfill and the top of the last erected course exceed seven feet.

viii. The overall vertical tolerance of the wall shall not exceed 1/2 inch per 10 feet of wall as shown per plans.

ix. Underdrain, if required, shall be placed in accordance with the details shown on the plans or shop drawings.

x. Storm Drains: Where required, precast concrete wall units shall be provided with the appropriate storm drain openings cast into units at the appropriate elevation and locations indicated on drainage profiles. Catch basins shall be located so pipes will enter perpendicular (plan view) to the precast wall units or below the leveling footing as shown on the plans. Construction of catch basins and placement of storm drains must be coordinated with the bin wall construction.

xi. Cooperation between contractors: Contractors must coordinate all phases of the work to prevent delays and expedite construction.

xii. Dewatering: The Contractor shall furnish, install, operate, and maintain satisfactory dewatering systems as required to maintain the site in a dry and workable condition so as to permit grading and compaction of the wall foundation and proper erection and backfill of the wall. These systems shall include all equipment and materials, and shall be continued as long as necessary. No separate measurement or payment will be made for dewatering.

xiii. Technical Consultations: The fabricator will be required as a part of the contract to provide onsite technical expertise to the Contractor and/or the State upon request. Response to requests shall be required within five (5) days of the request. The cost of furnishing such technical consultations shall be at no cost to the State.

c. On Site Inspection

The quality of materials, the process of manufacture, and the finished member shall be subject to inspection and approval by the Engineer. Any bin wall units damaged prior to acceptance shall be repaired or reconstructed as directed by the Engineer. All costs of repairs or reconstruction shall be at the Contractor's expense.

E. Gabion Wall

1. Description

This section covers the furnishing, assembling, filling with stone and tying open wire mesh rectangular compartmented gabions placed on filter cloth or filter stone as specified herein, and in reasonably close conformity with the lines, grades, dimensions, and cross-sections shown on the plans or as directed by the Engineer, and the design, working drawings, materials, construction, measurement and payment for gabions. Specific Gabion Wall Systems/manufacturers on the approved system list must be used.

2. Materials

a. Galvanized Steel Wire Mesh

Gabion basket units shall be of non-raveling construction and fabricated from a triple twisted hexagonal mesh of hot-dipped galvanized steel wire having a minimum diameter of 0.118 inches after galvanization. Gabion basket units may also be constructed of welded wire construction. The steel wire used shall be galvanized prior to fabrication into mesh. All gabion diaphragm and frame wire shall equal or exceed ASTM A 853, ASTM A 818, ASTM A 641, ASTM A 809, possess an average tensile strength of 60,000 PSI, and a Finish 5 Class 3 zinc coating of not less than 0.80 oz/sq. ft. of uncoated wire surface. The weight of zinc coating shall be as determined by AASHTO T 65 or ASTM A 90. The uniformity of coating shall equal or exceed four (4) one minute dips by the Preece Test, ASTM A 239. Mesh openings shall be hexagonal in shape, and uniform in size measuring not more than 3-1/4 inches by 4-1/2 inches.

Selvedge or perimeter basket frame wire shall be of heavier gauge than the wire mesh with a minimum diameter after galvanization of 0.1535 inches. Wire used for lacing or as internal connecting wire within basket cells shall meet the same specifications described above for the mesh wire, except that it may be of lighter gauge with a minimum diameter after galvanization of 0.0866 inches and the zinc coating shall not be less than 0.70 oz./sq. ft. When a P.V.C. coating is specified, all wire used in the fabrication of the gabions and in the wiring operations during construction shall, after zinc coating have extruded onto it a coating of poly vinyl chloride. The coating shall be grey in color of nominal thickness 0.02165 inches and shall nowhere be less than 0.015 inches in thickness. It shall be capable of resisting deleterious effects of natural weather exposure, immersion in salt water and shall not show any material difference in its initial characteristics.

b. Stone Fill

All stone fill shall be approved by the Engineer and shall be of suitable quality to ensure durability. When the stone is subjected to five alterations of sodium sulfate soundness testing, in accordance with AASHTO T-104, the weighted percentage of loss shall not be more than twelve percent. The inclusion of objectionable quantities of shale, dirt, sand, clay, rock fines, and other deleterious material will not be permitted. Stone fill shall be of well-graded mixture with sizes ranging between 4 inches and 10 inches in diameter, based on U.S. Standard square mesh sieves. No stone shall have minimum dimension less than 4 inches. Stone fill material selected for use in the gabions shall meet the minimum in-place density specified on the plans.

c. Filter Cloth

All filter cloth shall meet the applicable requirements of Section 918.27, Sub-Section 27, of the Standard Specifications.

d. Filter Stone

All filter stone shall meet the applicable requirements of Grading Size 68 or 57. See the Standard Specifications section 903.22.

3. Construction

a. Filter Cloth or Filter Stone

Upon final foundation preparation and acceptance by the Engineer, the filter cloth or filter stone shall be placed directly on the foundation at those locations shown on the plans or as directed by the Engineer. All end and side laps shall be a minimum of 18 inches for the filter cloth.

b. Assembly (Fabrication)

Gabions shall be fabricated in such a manner that the sides, ends, lid, and diaphragms can be assembled at the construction site into rectangular baskets. Gabions shall be of single unit construction, i.e., the base, lid, ends, and sides shall be either woven into a single unit or one edge of these members connected to the base section of the gabion in such a manner that strength and flexibility at the point of connection is at least equal to that of the mesh. Gabion units shall be equally divided, by diaphragms of the same mesh and gauge as the body of the gabions, into cells whose length does not exceed the horizontal width. The gabion shall be furnished with the necessary diaphragms secured in proper position on the base in such a manner that no additional tying at this juncture will be necessary. All perimeter edges of the mesh forming the gabion shall be securely selvedged so that the joints formed by tying the selvedges have at least the same strength as the body of the mesh. Lacing wire or connecting wire shall be supplied in sufficient quantity for securely fastening all diaphragms and edges of the gabion.

c. Assembly (Field)

i. Empty gabion units shall be placed on the filter blanket when required on contract drawings and shall be assembled individually to the lines and grades indicated on the Plans. Or as directed by the Engineer, with the sides, ends, and diaphragms erected in such a manner to ensure the correct position. All adjoining empty gabion units must be connected by tie wire lacing along the perimeter of their contact surfaces in order to obtain a monolithic structure. Lacing of adjoining basket units shall be accomplished by continuous stitching with alternating single and double loops at intervals of not more than 5 inches. All lacing wire terminals shall be securely fastened. The use of expedient clip connections for this purpose or as final lid closing will not be permitted. After adjoining empty basket units are set to line and grade and common sides with adjacent units thoroughly laced, they shall be placed in tension and stretched to remove any kinks from the mesh and to a uniform alignment. The stretching of empty basket units shall be accomplished in such a manner as to prevent any possible unraveling and distortion.

ii. Stone filling operations shall carefully proceed with placement by hand or machine so as not to damage galvanized wire coating, to assure a minimum of voids between the stones, to prevent damage to the underlying filter blanket, and to ensure the maintenance of alignment throughout the filling process. The maximum height from which the stone may be dropped into the basket units shall be 36 inches. Along all exposed faces, the outer layer of stone shall be carefully placed and arranged by hand to ensure a neat and compact appearance. The last layer of stone shall be leveled with the top of the gabions to allow for the proper closing of the lid and to provide an even surface that is uniform in appearance.

iii. Lids shall be stretched tight over the stone fill using crowbars or lid closing tools until the lid meets the perimeter edges of the front and end panels. The lid shall then be tightly laced with tie wire along all edges, ends and internal cell diaphragms by continuous stitching with alternating single and double loops at intervals of not more than 5 inches. Special attention shall be given to see that all projections or wire ends are turned into the baskets. Where shown on the drawings or as directed by the Engineer, or where a complete gabion unit cannot be installed because of space limitations, the basket unit shall be cut, folded and wired together to suit existing site conditions. The mesh must be cleanly cut and the surplus mesh cut out completely or folded back and neatly wired to an adjacent gabion face. The assembling, installation, filling, lid closing, and lacing of the reshaped gabion units shall be carried out as specified above.

d. Backfill

Backfilling of the gabion wall shall follow erection as closely as possible and in no case should the height of the wall be greater than seven feet above the backfill. Underdrains, if required, shall be placed in accordance with the details shown on plans. Gabion walls backfill shall have a density of 100 pounds per cubic foot or as specified on contract plans and shall be compacted to at least 95 percent of the maximum laboratory dry density as defined in AASHTO T 99 to within one foot of the top of the wall. The top 12 inches shall be compacted to at least 100 percent of the maximum laboratory dry density. The backfill material shall consist of broken or crushed stone, gravel, sand, slag or other suitable coarse granular material to insure proper drainage. Shale, clay or cinders shall not be permitted as backfill material. Prior to placement, the backfill material must be approved by the Engineer. The Contractor shall furnish, install, operate, and maintain satisfactory dewatering system as required to maintain the site in a dry and workable condition so as to permit grading and compaction of the wall foundation and proper erection and backfill of the wall. These systems shall include all equipment and materials, and shall be continued as long as necessary. No separate measurement or payment will be made for dewatering or dewatering systems.

All backfill material shall be tested prior to use and at the established frequencies in the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)".

e. Vertical Wall Tolerance

The overall vertical tolerance of the wall (plumbness from top to bottom) shall not deviate more than ½ inch per 10 feet of wall height from the contract drawings batter of the wall.

f. On Site Inspection

The quality of materials, the process of manufacture, and the finished members shall be subject to inspection and approval by the Engineer. Any gabions damaged prior to acceptance shall be repaired or reconstructed as directed by the Engineer. All costs of repairs or reconstruction shall be at the Contractor's expense.

F. Segmental, Precast Facing Mechanically Stabilized Earth (MSE) Wall

1. Materials

General - The Contractor shall make arrangements to purchase or manufacture the facing elements, reinforcing mesh or strips, attachment devices, joint filler, and all other necessary components. Materials not conforming to this section or the Standard Specifications or from sources not listed in the contract document shall not be used without written consent from the Engineer.
Out-of-state producers shall provide documentation of material quality before the manufacture of any pre-cast products (i.e. aggregate quality reports, cement/steel mill test reports, etc

a. Reinforced Concrete Facing Panels - The panels shall be fabricated in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels."

i. Acceptability of the precast units will be determined on the basis of compressive strength tests, production tolerances, and visual inspection. The Contractor, or the supplier, shall furnish facilities and perform all necessary sampling and testing in an expeditious and satisfactory manner as directed by the Engineer.

ii. The Portland cement shall be types 1, 2, or 3 and shall conform to the requirements of AASHTO M 85 (ASTM C 150). Concrete for precast panels shall be Class D (4000 psi) as specified in Section 604 of the TDOT Standard Specifications. Admixtures containing chlorides shall not be used.

iii. The panels shall be cast using steel forms. The front face of the panel (face exposed to view when installed in the wall) shall be cast against a steel form or architectural form liner. The back face is to be float finished. The concrete in each panel shall be placed without interruption and shall be consolidated by the use of an approved vibrator, supplemented by such hand tamping as may be necessary to force the concrete into the corners of the forms and prevent the formation of stone pocket or cleavage planes. Clear form oil of the same type shall be used throughout the casting operation.

iv. Unless otherwise indicated on the plans or elsewhere in the Standard Specifications, the concrete surface for the front face shall have a Class 1 finish as defined by Section 8.12 of AASHTO, Division II, and for the rear face a uniform surface finish. The rear face of the panel shall be float finished sufficiently to eliminate open aggregate pockets and surface distortions in excess of 1/4 inch. The panels shall be cast on a flat area. The strips or other galvanized attachment devices shall not contact or be attached to the face panel reinforcement steel.

v. Curing and forms removal shall be in accordance with the requirements of Section 604.20 and 604.24 of the Standard Specifications, unless otherwise approved by the Engineer. The forms shall remain in place until they can be removed without damage to the panel.

vi. The units shall be fully supported until the concrete reaches a minimum compressive strength of 1000 psi. The units may be shipped after reaching a minimum specified compressive strength of 4000 psi. TDOT will verify products before shipment in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall

panels, and Retaining wall panels". If products are manufactured out of state, TDOT may verify at the project site PRIOR to the placement of the units. The Contractor, or producer, shall notify the Regional Materials and Tests Division that products need to be verified.

vii. Marking - The date of manufacture, the production lot number, and the piece mark shall be clearly scribed on an unexposed face of each panel.

viii. Handling, Storage, and Shipping - All units shall be handled, stored, and shipped in such a manner as to eliminate the dangers of chipping, discoloration, cracks, fractures, and excessive bending stresses. Panels damaged during handling or storage at the casting plant shall be repaired at the plant as directed by the Engineer. Any panels damaged during handling, storing, or shipping may be rejected upon delivery at the option of the Engineer. Panels in storage shall be supported in firm blocking located immediately adjacent to embedded connection devices to avoid bending the connection devices.

ix. Tolerances - All units shall be manufactured within the following tolerances:

- Panel Dimensions - Position panel connection devices within 1 inch, except for all other dimensions within 3/16 inch.
- Panel Squareness - Squareness as determined by the difference between the two diagonals shall not exceed 1/2 inch.
- Angular distortion with regard to the height of the panel shall not exceed 3/16 inch in 5 feet.
- Panel Surface Finish - Surface defects on smooth formed surfaces measured over a length of 5 feet shall not exceed 1/8 inch. Surface defects on the textured-finish surfaces measured over a length of 5 feet shall not exceed 5/16 inch.

x. Steel - In accordance with the Standard Specifications.

xi. Compressive Strength - Acceptance of the concrete panels, with respect to compressive strength, will be determined on the basis of production lots. A production lot is defined as a group of panels that will be represented by a single compressive strength sample and will consist of a single day's production as defined in the certify in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels".

xii. During the production of the concrete panels, the Engineer will sample the concrete in accordance with AASHTO T 141 (ASTM C 172). A single compressive strength sample, consisting of a

minimum of six (6) cylinders, will be randomly selected for every production lot.

xiii. Cylinders for compressive strength tests shall be prepared in accordance with AASHTO T 23 (ASTM C 31) on 6" x 12" or 4" x 8" specimens. For every compressive strength sample, a minimum of two (2) cylinders will be cured in the same manner as the panels and tested for acceptance no later than twenty-eight (28) days. The average compressive strength of these two cylinders, when tested according with AASHTO T 22 (ASTM C 39), will determine the compressive strength of the production lot.

xiv. If the Contractor wishes to remove forms or ship the panels prior to 28 days, a minimum of two (2) additional cylinders will be cured in the same manner as the panels. The average compressive strength of these cylinders when tested in accordance with AASHTO T 22, will determine whether the forms can be removed and the panels are acceptable.

xv. Acceptance of a production lot will be made if the compressive strength test result is greater than or equal to 4,000 psi when tested for acceptance no later than 28 days.

xvi. In the event that a production lot fails to meet the specified compressive strength requirements, the production lot shall be rejected. Such rejection shall prevail unless the manufacturer, at their own expense, obtains and submits cores for testing and the results show that the strength and quality of the concrete placed within the panels of the production lot is acceptable. The cores shall be taken from the panels within the production lot and tested in accordance with the specifications of AASHTO T 24 (ASTM C 42). Two cores per each cylinder that failed will be required. In addition, any or all of the following defects shall be sufficient cause for rejection:

- Defects that indicate imperfect molding.
- Defects indicating honeycombing or open texture concrete.
- Defects in the physical characteristics of the concrete such as cracked or severely chipped panels.
- Color variation on front face of panel due to excess form oil or other reasons.
- Damage due to handling, storing or shipping.

xvii. The Engineer shall determine whether spalled, honeycombed, chipped or otherwise defective concrete shall be repaired or rejected. Repair of concrete, if allowed, shall be done with a TDOT approved cementitious polymer patching mortar in a manner satisfactory to the Engineer. Repair to concrete surfaces

that will be exposed to view after completion of construction must be approved by the Engineer.

b. Soil Reinforcing and Attachment Devices - All reinforcing and attachment devices shall be shop fabricated and carefully inspected to ensure they are true to size and free from defects that may impair their strength and durability.

i. Reinforcing Strips - Reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Their physical and mechanical properties shall conform to either AASHTO M 183 (ASTM A 36) or AASHTO M 223 (ASTM A 572) grade 65 or equal. Galvanization shall conform to the minimum requirements or AASHTO M 111 (ASTM A 123).

ii. Tie Strips - The tie strips shall be shop- fabricated of a hot rolled steel conforming to the minimum requirements of ASTM 570, Grade 50 or equivalent. Galvanization shall conform to AASHTO M 111 (ASTM A 123). Tie straps may be partially bent before shipment to the precast yard. Minimum bending radius shall be one inch. Final bending may be accomplished at the precast yard.

iii. Reinforcing Mesh - Reinforcing mesh shall be shop fabricated of cold drawn steel wire conforming to the minimum requirements of AASHTO M 32 (ASTM A 82) and shall be welded into the finished mesh fabric in accordance with AASHTO M 55 (ASTM A 185). Galvanization shall be applied after the mesh is fabricated and conform to the minimum requirements of AASHTO M 111 (ASTM A 123).

iv. Fasteners - Fasteners shall be high strength hexagonal cap screw bolts and nuts conforming to AASHTO M 164 (ASTM A 325). Galvanizing fastener elements, including washers, shall be in accordance with AASHTO M 232 (ASTM A 153). Bolts and nuts nominal diameter will be shown in the plans and supplied in accordance with the fasteners as specified previously.

v. Steel Strap Connections - The steel strap connection bar and plate shall meet the same requirements as the reinforcing and tie strips specified above. Bolts, nuts, and washers shall conform to the requirements for the fasteners specified above. Coatings for connecting devices shall be as specified below.

vi. Clevis Loop and Mesh Loop - Clevis loops and mesh loops shall be fabricated of cold drawn steel wire conforming to the requirements of AASHTO M 32 (ASTM A 82) and welded in accordance with AASHTO M 55 (ASTM A 185) and shall develop a minimum stress of 0.9 F_y.

vii. Connector Bar - Connector bar shall be fabricated of cold drawn steel wire conforming to the requirements of AASHTO M 32 (ASTM A 82).

viii. Holes for bolts shall be punched in the location shown. Surfaces resulting from punching holes for bolts shall be galvanized in accordance with AASHTO M 111 (ASTM A 123). Those parts of the connecting devices which are threaded shall be galvanized in accordance with AASHTO M 232 (ASTM A 153). Alignment pins are to be hot dip galvanized.

ix. All connecting devices shall be to the dimensions shown on the plans. Connecting members and soil reinforcement devices shall be assembled prior to galvanization. All connecting devices shall be true to size and free from defects that may impair their strength or durability.

x. Any damage sustained to any part of the connecting devices, bolts or reinforcing devices during any phase of fabrication, storage or erection shall be repaired to the satisfaction of the Engineer at no increase in contract cost.

c. Geosynthetic Reinforcement Material - Where geosynthetic reinforcements are used for the construction of MSE walls the following requirements shall apply:

i. Geotextiles and Thread for Sewing - Woven or nonwoven geotextiles shall consist only of long chain polymeric filaments or yarns formed into a stable network such that the filaments or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the long chain polymer shall be polyolefin or polyester. The material shall be free of defects and tears. The geotextile shall conform as a minimum to the properties indicated for Separation, Medium Survivability indicated under AASHTO T 288. The geotextile shall be free from any treatment or coating that might adversely alter its physical properties after installation.

ii. Geogrids - The geogrid shall be a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil or rock. The geogrid structure shall be dimensionally stable and able to retain its geometry under manufacture, transport and installation.

iii. Required Properties - The specific geosynthetic material(s) shall be preapproved by the Department and shall have certified long-term strength (T_{al}) as determined by:

- Long-Term strength (T_{al}) based on $T_{al}= T_{ULT}/(RF_D)*(RF_{ID})*(RF_{CR})$ where RF_{CR} is developed from

creep tests performed in accordance with ASTM D 5262, RF_{ID} obtained from site installation damage testing and RF_{ID} from hydrolysis or oxidative degradation testing extrapolated to 75 or 100 year design life.

- Ultimate Strength (TULT) based upon minimum average roll values (MARV) (lb/ft), ASTM D4595.
- Pullout Resistance Factor developed in accordance with Chapter 3 of chapter 3 of FHWA-SA-96-071.

iv. Certification - The Contractor shall submit a manufacturer's certification that the geosynthetics supplied meet the respective index criteria set when the geosynthetic was approved by the Department, measured in full accordance with all test methods and standards specified and as set forth in this document.

The manufacturer's certificate shall state that the furnished geosynthetic meets the requirements of this document as evaluated by the manufacturer's quality control program. The certificates shall be attested to by a person having legal authority to bond the manufacturer. In case of dispute over validity of value, the Engineer can require the Contractor to supply test data from a Department approved laboratory to support the certified values submitted.

v. Manufacturing Quality Control: The geosynthetic reinforcement shall be manufactured with a high degree of quality control. The manufacturer is responsible for establishing and maintaining a quality control program to ensure compliance with the requirements of this document. The purpose of the QC testing program is to verify that the reinforcement geosynthetic being supplied to the project is representative of the material used for performance testing and approval by the Department.

Conformance testing shall be performed as part of the manufacturing process and may vary for each type of product. As a minimum, the following index tests shall be considered as applicable for an acceptable QA/QC program:

Property	**Test Procedure**
Specific Gravity (HDPE only)	ASTM D 1505
Wide Width Tensile	ASTM D 4595; GRI:GG1
Melt Flow (HDPE and PP only)	ASTM D 1238
Intrinsic Viscosity (PET only)	ASTM D 4603
Carboxyl End Group (PET only)	ASTM D 2455

vi. Sampling, Testing, and Acceptance - Sampling and conformance testing shall be in accordance with ASTM D 4354. Conformance testing procedures shall be as established under 4.3.5. Geosynthetic product acceptance shall be based on ASTM D 4759.

The quality control certificate shall include:

- Roll numbers and identification
- Sampling procedures
- Result of quality control tests, including a description of test methods used

vii. Select Granular Backfill Material - The backfill material shall conform to the requirements set forth in Section F.1.e. except that the maximum size of the backfill shall be 3/4 inch, unless full scale installation damage tests are conducted in accordance with ASTM D 5818.

d. Joint Materials - Installed to the dimensions and thicknesses in accordance with the plans or approved shop drawings.

i. If required, provide flexible foam strips for filler for vertical joints between panels, and in horizontal joints where pads are used, where indicated on the plans.

ii. Provide in horizontal joints between panels preformed EPDM rubber pads conforming to ASTM D 2000 for 4AA, 812 rubbers, neoprene elastomeric pads having a Durometer Hardness of 55 ± 5, or high density polyethylene pads with a minimum density of 59 lb/ft^3 in accordance with ASTM D 1505.

iii. Cover all joints between panels on the back side of the wall with a geotextile meeting the minimum requirements for filtration applications as specified by AASHTO M 288. The minimum width and lap shall be 12 inches. Adhesive used to attach the filter fabric to the back of the panels shall be approved by the wall supplier.

e. Select Granular Backfill Material - All backfill material used in the Mechanically Stabilized Earth structure volume, as shown on the plans, shall be reasonably free (maximum of 0.1%) from organic and otherwise deleterious materials, and it shall be approved by the Engineer prior to use. The material shall conform to the following gradation limits and be tested at the established frequencies in the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)". The Contractor shall also provide test data from an approved laboratory certifying that the material meets the following:

i. Gradation as determined by AASHTO T 27.

Sieve Size	Percent Passing
4 inches	100

3/8 inch	0-75
No. 4	0-25
No. 8	0-10
No. 16	0-5

Note: Size Nos. 1 through 78 as listed in order of Table 1 Standard Sizes of Processed Aggregate in Section 903.22 of Standard Specifications meet the above gradation requirements.

ii. In addition, the backfill must conform to all of the following requirements:

- Soundness - The material shall be substantially free from shale or other soft, poor durability particles. The material shall have a sodium sulfate loss of less than 12 percent after five (5) cycles determined in accordance with AASHTO T 104.
- The material shall exhibit an angle of internal friction of not less than 34 degrees as determined by the standard direct shear test AASHTO T 236 on the portion finer than the No. 4 sieve, using a sample of the material compacted to 95 percent of AASHTO T 99. No testing is required for backfills where 80 percent of sizes are greater than 3/8 inch.
- Electrochemical requirements - The backfill shall meet the following criteria:

REQUIREMENTS	**TEST METHOD**
ph = 5-10	AASHTO T 289 – 91
Resistivity > 3000 ohm centimeters[1]	AASHTO T 288 – 91
Chlorides < 100 parts per million	AASHTO T 291 – 91
Sulfates < 200 parts per million	AASHTO T 290 – 91
Organic Content < 1 %	AASHTO T 267 – 86

1. If the resistivity is greater or equal to 5000 ohm centimeters the chloride and sulfates requirements may be waived.

- Unit weight- The unit weight of the backfill material (at optimum condition) shall meet the requirements of the approved shop drawings or plans.

f. Concrete Leveling Pad, Traffic Barrier and Coping - The concrete shall conform to the requirements of the Standard Specifications for Class A concrete.

g. Acceptance of Material - The Contractor shall furnish the Engineer a Certificate of Compliance certifying the above materials comply with the applicable contract specifications. A copy of all test results performed by the Contractor necessary to assure contract compliance shall be furnished to the Engineer.

Acceptance will be based on the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)".

2. Construction

a. Foundation Preparation - The foundation for the MSE wall shall be graded level for a minimum width equal to the width of the reinforced volume and leveling pad plus one (1) foot, or as shown on the plans, using the top of the leveling pad as the grade elevation. Prior to wall construction, the foundation shall be compacted to 95 percent of optimum density, as directed by the Engineer. Any foundation soils found to be unsuitable shall be removed as directed by the Engineer and replaced with select granular backfill material compacted to 95 percent of AASHTO T 99. The contractor shall conduct any ground improvements required by the contract plans as part of foundation preparation.

At each panel foundation level, a precast reinforced or a cast-in-place unreinforced concrete leveling pad of the type shown on the plans shall be provided. The concrete shall be Class "A" concrete with compressive strength of 3000 psi (28 day strength). The leveling pad shall be cured a minimum of 12 hours before placement of wall panels.

b. Wall Erection - Where a proprietary wall system is used, a field representative shall be available during the erection of the wall to assist the fabricator, Contractor, and Engineer. If there is more than one wall of the same type on the project, this requirement will apply to construction of the initial wall only. After construction of the initial wall, the representative will be available on an as-needed basis, as requested by the Engineer, during construction of the remainder of the walls. Wall erection shall be in conformance with the latest edition of the MSE wall construction manual as published by the wall supplier. For erection, panels are handled by means of a lifting device set into the upper edge of the panel. Precast concrete panels shall be placed such that a final vertical face will be obtained.

It shall be the responsibility of the Contractor to consult with the designer/supplier and to utilize the proper methods necessary to achieve a vertical face for the final wall. Panels should be placed in successive horizontal lifts as backfill placement proceeds. As backfill material is placed behind the panels, the panels shall be maintained in position by means of temporary wedges or bracing according to the wall supplier's recommendations. External bracing shall also be required for this initial lift. The wedges shall remain in place until the fourth layer of panels is placed, at which time the bottom layer of wedges shall be removed. Each

succeeding layer of wedges shall be removed as the succeeding panel layers are placed. When the wall is completed, all wedges shall be removed. No wedges shall be used as a means of leveling panels on leveling pads. Wedges placed below the ground line on the front face of the wall shall be removed before this area is backfilled.

Tolerances and alignment shall be as follows:

i. Horizontal and vertical joint openings between panels shall be uniform. The maximum allowable offset in any panel joint shall be 3/4 inch.

ii. Vertical tolerance (plumbness) and horizontal alignment tolerances as the wall is constructed shall not exceed 3/4 inch when measured along a 10 foot straightedge.

The overall vertical tolerance of the wall (plumbness from top to bottom) in its final position shall not exceed 3/4 inch per 10 feet of wall height.

Cast-in-place concrete shall be placed on top of wall panels to allow precast coping elements on top of the wall to be brought to proper grade.

Prior to placing any select backfill material on any soil reinforcement device, all connections to the panels shall be completed.

c. Backfill Placement - Backfill placement shall closely follow the erection of each lift of panels. Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials including panels, soil reinforcements, and connections, or misalignment of the facing panels or reinforcing elements. Any wall materials which may become damaged or disturbed during backfill placement, or due to wall settlement prior to completion of the project shall be either removed and replaced at the Contractor's expense or corrected, as directed by the Engineer. Any misalignment or distortion of the wall facing panels due to placement of backfill outside the limits of this section shall be corrected, as directed by the Engineer at the Contractor's expense. Backfill placement methods near the facing shall assure that no voids exist directly beneath the reinforcing elements.

Backfill shall be compacted to 95 percent of the maximum density as determined by AASHTO T 99. When the backfill supports a spread footing of a bridge or other structural load, the top 5 feet shall be compacted to 100 percent of the maximum density. For backfills containing more than 30 percent retained on the ¾ inch sieve, a method compaction consisting of a minimum of 2 passes of a steel drum roller or truck equipment equivalent or larger than a Caterpillar D-6 Bulldozer shall be used.

The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer. Backfill materials shall be placed at a moisture content not more than 2 percentage points less than or equal to the optimum moisture content. Backfill

material with a placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniformly acceptable throughout the entire lift. The optimum moisture content shall be determined in accordance with AASHTO T 99.

At each soil reinforcement device level, backfill shall be compacted to the full length of reinforcement devices and be sloped to drain away from the wall before placing and attaching the next layer of reinforcement devices. The compacted backfill shall be level with the connecting device before the reinforcement device can be connected. Compaction within three feet of the back face of the wall facing panel shall be achieved with at least three (3) passes of a light weight mechanical tamper, roller, or vibratory system.

Unless otherwise indicated on the plans or directed by the Engineer, soil reinforcement devices shall be placed at 90 degrees to the face of the wall. The maximum lift thickness before compaction shall be ten (10) inches and shall closely follow panel erection. The Contractor shall decrease this lift thickness, if required, to obtain the specified density.

At the end of each day's operation, the Contractor shall slope the last level of backfill away from the wall facing to rapidly direct runoff or rainwater away from the wall face. In addition, the Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

G. Prefabricated Modular Block Facing Mechanically Stabilized Earth (MSE) Wall

1. Materials

General - The contractor shall make arrangements to purchase or manufacture the facing elements, reinforcing mesh or strips, attachment devices, joint filler, and all other necessary components. Materials not conforming to this section or from sources not listed in the contract document shall not be used without written consent from the Engineer.

a. Concrete Modular Block Facing - The concrete modular blocks shall be either hollow or solid concrete structural retaining wall units, machine made from Portland cement, water, and mineral aggregates with or without the inclusion of other materials. The units are intended for use in the construction of mortarless, modular block retaining (MBW) walls.

i. Cementious Materials - Materials shall conform to the following:

- Portland Cement - AASHTO M 85 (ASTM C 150).
- Blended Cements – Type IP -AASHTO M 240 (ASTM C 595).
- Pozzolans – Class C or Class F fly ash -AASHTO M 295 Blast Furnace Slag Cement – grade 100 or 120- AASHTO M 302 (ASTM C 989).

ii. Aggregates - Aggregates shall conform to the following specifications, except that grading requirements shall not necessarily apply:

- Normal Weight Aggregates – TDOT Standard Specification sections 903.01 and 903.03.
- Lightweight Aggregates - TDOT Standard Specification section 903.19.

iii. Other Constituents - Air-entraining agents, coloring pigments, integral water repellants, finely ground silica, and other constituents shall be previously established as suitable for use in concrete MBW units and shall conform to applicable AASHTO Standards or, shall be shown by test or experience to be not detrimental to the durability of MBW units or any material customarily used in masonry construction.

iv. Physical Requirements. Prior to delivery to the work site, the units shall conform to the following physical requirements:

1. Minimum required compressive strength = 4,000 psi (Average 3 coupons)
2. Minimum required compressive strength = 3,500 psi (Individual coupon)
3. Maximum water absorption = 5%
4. Maximum number of blocks per lot = 2,000

Also, prior to delivery, TDOT will conduct verification testing on the modular blocks in accordance with the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)

If products are manufactured out of state, TDOT may verify at the project site PRIOR to the placement of the units. The Contractor, or producer, shall notify the Regional Materials and Tests Division that products need to be verified.

v. Tolerances. Blocks shall be manufactured within the following tolerances:

- The length and width of each individual block shall be within 1/8 inch of the specified dimension. Hollow units shall have a minimum wall thickness of 1-1/4 inch.
- The height of each individual block shall be within 1/16 inch of the specified dimension.
- When a broken face finish is required, the dimension of the front face shall be within 1 inch of the theoretical dimension of the unit.

- Finish and Appearance. All units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the construction. Minor cracks (e.g. no greater than 1/32 inch in width and no longer than 25 % of the unit height) incidental to the usual method of manufacture or minor chipping resulting from shipment and delivery, are not grounds for rejection.

  The face or faces of units that are to be exposed shall be free of chips, cracks or other imperfections when viewed from a distance of 30 feet under diffused lighting. Up to five (5) percent of a shipment may contain slight cracks or small chips not larger than 1 inch.

  Color and finish shall be as shown on the plans and shall be erected with a running bond configuration.

- If pins are required to align MBW units, they shall consist of a nondegrading, polymer or galvanized steel and be made for the express use with the MBW units supplied.

- Cap units shall be cast to or attached to the top MBW units in strict accordance with the manufacturer's requirements and the adhesive manufacturer's recommended procedures. The Contractor shall provide a written 10 year warranty acceptable to the Department that the integrity of the materials used to attach the cap blocks will preclude separation and displacement of the cap blocks for the warranty period.

vi. Sampling and Testing. Acceptance of the concrete block with respect to compressive strength and absorption, will be determined on a lot basis. The lot will be randomly sampled in accordance with ASTM C 140. Compressive strength and absorption tests shall be performed by the manufacturer and submitted to the Department. Compressive strength test specimens shall be cored or shall conform to the saw-cut coupon provisions of section 6.2.4 of ASTM C 140. Blocks represented by test coupons that do not reach an average compressive strength of 4,000 psi or an individual strength of 3500 psi, or have less than 5 % absorption will be rejected.

vii. Rejection. Blocks shall be rejected because of failure to meet any of the requirements specified above. In addition, any or all of the following defects shall be sufficient cause for rejection.

- Defects that indicate imperfect molding.

- Defects indicating honeycomb or open texture concrete.

- Cracked or severely chipped blocks.

- Color variation on front face of block due to excess form oil or other reasons.

Blocks may also be rejected if TDOT verification test results do not comply with the requirements specified above.

b. Unit Fill - The unit fill and drainage aggregate shall be a well graded crushed stone or granular fill meeting the following gradation:

U.S. Sieve Size	Percent Passing
1 inch	100-75
3/4 inch	50-75
No. 4	0-60
No. 40	0-50
No. 200	0-5

c. Geosynthetic Reinforcement Material - The following requirements shall apply for geosynthetic reinforcement material:

i. Geotextiles and Thread for Sewing - Woven or nonwoven geotextiles shall consist only of long chain polymeric filaments or yarns formed into a stable network such that the filaments or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the long chain polymer shall be polyolefin or polyester. The material shall be free of defects and tears. The geotextile shall conform as a minimum to the properties indicated for Separation, Medium Survivability indicated under AASHTO T 288. The geotextile shall be free from any treatment or coating that might adversely alter its physical properties after installation.

ii. Geogrids - The geogrid shall be a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil or rock. The geogrid structure shall be dimensionally stable and able to retain its geometry under manufacture, transport and installation.

iii. Required Properties - The specific geosynthetic material(s) shall be pre-approved by the Department and shall have certified long-term strength (T_{al}) as determined by:

- Long-Term strength (T_{al}) based on $T_{al} = T_{ult}/(RF_D)*(RF_{ID})*(RF_{CR})$ where RF_{CR} is developed from creep tests performed in accordance with ASTM D 5262, RF_{ID} obtained from site installation damage testing and RF_{ID}

from hydrolysis or oxidative degradation testing extrapolated to 75 or 100 year design life.

- Ultimate Strength (T_{ULT}) based upon minimum average roll values (MARV) (lb/ft), ASTM D4595.
- Pullout Resistance Factor developed in accordance with chapter 3 of FHWA-SA-96-071.

iv. Certification - The Contractor shall submit a manufacturer's certification that the geosynthetics supplied meet the respective index criteria set when the geosynthetic was approved by the Department, measured in full accordance with all test methods and standards specified and as set forth in this section of the TDOT Earth Retaining Structures Manual. The manufacturer's certificate shall state that the furnished geosynthetic meets the requirements of this document as evaluated by the manufacturer's quality control program. The certificates shall be attested to by a person having legal authority to bond the manufacturer. In case of dispute over validity of values, the Engineer can require the Contractor to supply test data from a Department approved laboratory to support the certified values submitted.

v. Manufacturing Quality Control: The geosynthetic reinforcement shall be manufactured with a high degree of quality control. The manufacturer is responsible for establishing and maintaining a quality control program to ensure compliance with the requirements of the TDOT Earth Retaining Structures Manual. The purpose of the QC testing program is to verify that the geosynthetic being supplied to the project is representative of the material used for performance testing and approval by the Department.

Conformance testing shall be performed as part of the manufacturing process and may vary for each type of product. As a minimum the following index tests shall be considered as applicable for an acceptable QA/QC program:

Property	**Test Procedure**
Specific Gravity (HDPE only)	ASTM D 1505
Wide Width Tensile	ASTM D 4595; GRI:GG1
Melt Flow (HDPE and PP only)	ASTM D 1238
Intrinsic Viscosity (PET only)	ASTM D 4603
Carboxyl End Group (PET only)	ASTM D 2455

vi. Sampling, Testing, and Acceptance - Sampling and conformance testing shall be in accordance with ASTM D 4354. Conformance testing procedures shall be as established under section 4.3.5. Geosynthetic product acceptance shall be based on ASTM D 4759.

The quality control certificate shall include:

- Roll numbers and identification
- Sampling procedures
- Result of quality control tests, including a description of test methods used.

vii. Select Granular Backfill Material - The backfill material shall conform to the requirements set forth in Section G. 1.e. except that the maximum size of the backfill shall be 3/4 inch, unless full scale installation damage tests are conducted in accordance with ASTM D 5818.

All backfill material shall be tested prior to use and at the established frequencies in the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)".

d. Soil Reinforcing and Attachment Devices - Where steel reinforcing and attachment devices are used in the construction of the MSE wall the following requirements shall apply.

i. Reinforcing Strips - Reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Their physical and mechanical properties shall conform to either AASHTO M 183 (ASTM A 36) or AASHTO M 223 (ASTM A 572) grade 65 or equal. Galvanization shall conform to the minimum requirements or AASHTO M 111 (ASTM A 123).

ii. Tie Strips - The tie strips shall be shop-fabricated of hot rolled steel conforming to the minimum requirements of ASTM A 570, Grade 50 or equivalent. Galvanization shall conform to AASHTO M 111. Tie straps may be partially bent before shipment to the precast yard. Minimum bending radius shall be one inch. Final bending may be accomplished at the precast yard.

iii. Reinforcing Mesh - Reinforcing mesh shall be shop fabricated of cold drawn steel wire conforming to the minimum requirements of AASHTO M 32 (ASTM A 82) and shall be welded into the finished mesh fabric in accordance with AASHTO M 55 (ASTM A 185). Galvanization shall be applied after the mesh is fabricated and conform to the minimum requirements of AASHTO M 111

iv. Fasteners - Fasteners shall be high strength hexagonal cap screw bolts and nuts conforming to AASHTO M 164 (ASTM A 325).

SP624

Galvanizing fastener elements, including washers, shall be in accordance with AASHTO M 232 (ASTM A 153). Bolts and nuts nominal diameter will be shown in the plans and supplied in accordance with the fasteners as specified previously.

v. Steel Strap Connections - The steel strap connection bar and plate shall meet the same requirements as the reinforcing and tie strips specified above. Bolts, nuts, and washers shall conform to the requirements for the fasteners specified above. Coatings for connecting devices shall be as specified below.

vi. Clevis Loop and Mesh Loop - Clevis loops and mesh loops shall be fabricated of cold drawn steel wire conforming to the requirements of AASHTO M 32 and welded in accordance with AASHTO M 55 and shall develop a minimum stress of 0.9 F_y.

vii. Connector Bar - Connector bar shall be fabricated of cold drawn steel wire conforming to the requirements of AASHTO M 32.

Holes for bolts shall be punched in the location shown. Surfaces resulting from punching holes for bolts shall be galvanized in accordance with AASHTO M 111. Those parts of the connecting devices which are threaded shall be galvanized in accordance with AASHTO M 232. Alignment pins are to be hot dip galvanized.

All connecting devices shall be to the dimensions shown on the plans. Connecting members and soil reinforcement devices shall be assembled prior to galvanization. All connecting devices shall be true to size and free from defects that may impair their strength or durability.

Any damage sustained by any part of the connecting devices, bolts or reinforcing devices during any phase of fabrication, storage or erection shall be repaired to the satisfaction of the Engineer at no increase in contract cost.

e. Select Granular Backfill Material - All backfill material used in the Mechanically Stabilized Earth structure volume, as shown on the plans, shall be reasonably free (maximum of 0.1%) from organic and otherwise deleterious materials, and it shall be approved by the Engineer prior to use. The material shall conform to the following gradation limits and be tested at the established frequencies in the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)". The Contractor shall also provide test data from an approved laboratory certifying that the material meets the following:

i. Gradation as determined by AASHTO T 27.

Sieve Size	Percent Passing
4 inches	100
3/8 inch	0-75

No. 4	0-25
No. 8	0-10
No. 16	0-5

Note: Size Nos. 1 through 78 as listed in order of Table 1 Standard Sizes of Processed Aggregate in Section 903.22 of Standard Specifications meet the above gradation requirements.

ii. In addition, the backfill must conform to all of the following requirements:

- Soundness - The material shall be substantially free from shale or other soft, poor durability particles. The material shall have a sodium sulfate loss of less than 12 percent after five (5) cycles determined in accordance with AASHTO T 104.
- The Plasticity Index (P.I.), as determined by AASHTO T 90, shall not exceed 6.
- The material shall exhibit an angle of internal friction of not less than 34 degrees as determined by the standard direct shear test AASHTO T 236 on the portion finer than the No. 4 sieve, using a sample of the material compacted to 95 percent of AASHTO T 99. No testing is required for backfills where 80 percent of sizes are greater than 3/8 inch.
- Electrochemical requirements - The backfill shall meet the following criteria:

REQUIREMENTS	**TEST METHOD**
ph= 5-10	AASHTO T 289 – 91
Resistivity > 3000 ohm centimeters[1]	AASHTO T 288 – 91
Chlorides < 100 parts per million	AASHTO T 291 – 91
Sulfates < 200 parts per million	AASHTO T 290 – 91
Organic Content < 1%	AASHTO T 267 – 86

1. If the resistivity is greater or equal to 5000 ohm centimeters the chloride and sulfates requirements may be waived.

- Unit weight- The unit weight of the backfill material (at optimum condition) shall meet the requirements of the approved shop drawings or plans.

f. Concrete Leveling Pad, Traffic Barrier and Coping - The concrete shall conform to the requirements of the Standard Specifications for Class A concrete.

g. Acceptance of Material - The contractor shall furnish the Engineer a Certificate of Compliance certifying the above materials comply with the applicable contract specifications. A copy of all test results performed by the Contractor necessary to assure contract compliance shall be furnished to the Engineer.

2. Construction

a. Wall Excavation - Unclassified excavation shall be in accordance with the requirements of the Standard Specifications and in reasonably close conformity with the limits and construction lines shown on the plans. Temporary excavation support as required shall be the responsibility of the Contractor.

b. Foundation Preparation - The foundation for the MSE wall shall be graded level for a minimum width equal to the width of the reinforced volume and leveling pad plus one (1) foot, or as shown on the plans, using the top of the leveling pad as the grade elevation. Prior to wall construction, the foundation shall be compacted to 95 percent of optimum density, as directed by the Engineer. Any foundation soils found to be unsuitable shall be removed as directed by the Engineer and replaced with select granular backfill material compacted to 95 percent of AASHTO T 99 methods. The contractor shall conduct any ground improvement required by the contract plans as part of foundation preparation.

At each block foundation level, a precast reinforced or a cast-in-place unreinforced concrete leveling pad of the type shown on the plans shall be provided. The concrete shall be Class A concrete with compressive strength of 3000 psi (28 day strength). The leveling pad shall be cured a minimum of 12 hours before placement of wall panels.

c. Wall Erection - Where a proprietary wall system is used, a field representative shall be available during the erection of the wall to assist the fabricator, Contractor, and Engineer. If there is more than one wall of the same type on the project, this requirement will apply to construction of the initial wall only. After the initial wall, the representative will be available on an as-needed basis, as requested by the Engineer, during construction of the remainder of the walls. Wall erection shall be in conformance with the latest edition of the MSE wall construction manual as published by the wall supplier.

It shall be the responsibility of the Contractor to consult with the designer/supplier and to utilize the proper methods necessary to achieve a

vertical face for the final wall. Blocks should be placed in successive horizontal lifts as backfill placement proceeds per the manufacturer's recommendations.

Cast-in-place concrete shall be placed on top of wall panels to allow precast coping elements on top of the wall to be brought to proper grade.

Prior to placing any select backfill material on any soil reinforcement device, all connections to the blocks shall be completed.

d. Backfill Placement - Backfill placement shall closely follow the erection of each lift of blocks. Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials including blocks, soil reinforcements, and connections, or misalignment of the facing blocks or reinforcing elements. Any wall materials which may become damaged or disturbed during backfill placement, or due to wall settlement prior to completion of the project shall be either removed and replaced at the Contractor's expense or corrected, as directed by the Engineer. Any misalignment or distortion of the wall facing blocks due to placement of backfill outside the limits of this section shall be corrected, as directed by the Engineer. Backfill placement methods near the facing shall assure that no voids exist directly beneath the reinforcing elements.

Backfill shall be compacted to 95 percent of the maximum density as determined by AASHTO T 99. When the backfill supports a spread footing of a bridge or other structural load, the top 5 feet shall be compacted to 100 percent of the maximum density. For backfills containing more than 30 percent retained on the ¾ inch sieve, a method compaction consisting of a minimum of 2 passes of a steel drum roller or tracked equipment equivalent or larger than a Caterpillar D-6 Dozer shall be used.

The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer. Backfill materials shall have a placement moisture content less than or equal to the optimum moisture content. Backfill material with a placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniformly acceptable throughout the entire lift. The optimum moisture content shall be determined in accordance with AASHTO T 99.

At each soil reinforcement device level, backfill shall be compacted to the full length of reinforcement devices and be sloped to drain away from the wall before placing and attaching the next layer of reinforcement devices. The compacted backfill shall be level with the connecting device before the reinforcement device can be connected. Compaction within three feet of the back of the wall facing shall be achieved with at least three (3) passes of a light weight mechanical tamper, roller, or vibratory system.

Unless otherwise indicated on the plans or directed by the Engineer, soil reinforcement devices shall be placed at 90 degrees to the face of the wall. The maximum lift thickness before compaction shall be ten (10) inches and shall closely follow panel erection. The Contractor shall decrease this lift thickness, if required, to obtain the specified density.

At the end of each day's operation, the Contractor shall slope the last level of backfill away from the wall facing to rapidly direct runoff or rainwater away from the wall face. In addition, the contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

H. Anchored Wall

Part A - Part A covers specifications for permanent ground anchor walls exclusive of the ground anchors.

1. Design Criteria

Unless otherwise directed the Contractor shall select the type of wall element to be used. The wall shall be designed for shear, moment, and lateral and axial capacity in accordance with AASHTO LRFD procedures. The Contractor shall be responsible for determining the length of the wall element and required section necessary to resist loadings due to earth, and water forces while controlling ground movements. Structure design life and corrosion protection requirements for sheet-piles and soldier beams will be provided on the contract drawings. Soil properties, safety factors, anchor tendon corrosion protection requirements, wall finish and color requirements, and appurtenance locations are given in the contract plans or specifications.

The Contractor shall be familiar with the requirements for ground anchors described in Part B, "Ground Anchors". The contractor shall incorporate all dimensional and location restrictions on ground anchor locations, spacing, and length of anchor bond length and unbonded length that may affect the design of the wall system covered by this section.

a. The wall system shall be designed to resist maximum anticipated loadings calculated for the effects of any special loadings shown on the contract plans.

b. The wall shall be designed to ensure stability against passive failure of the embedded portion of the vertical wall elements (below the base of excavation). The minimum FS shall be 1.5, unless otherwise noted on the contract plans.

c. The axial load carrying capacity of the embedded portion of the vertical wall elements (below the base of the excavation) shall be evaluated. The minimum FS shall be 2.5 for elements terminating in soil and 2.0 for elements terminating on rock, unless otherwise noted in the contract plans. The wall shall be designed to resist vertical loads including vertical anchor forces and the weight of the lagging and the vertical wall elements. Relying on transfer of vertical load into the soil behind the wall by friction shall not be permitted, unless approved by the Engineer.

d. Permanent facing shall be precast or cast-in-place reinforced concrete. Architectural facing treatments, if required, shall be as indicated on the contract drawings. The facing shall extend a minimum of 2.0ft below the gutter line or, if applicable, the ground line adjacent to the wall unless otherwise indicated on the contract drawings.

e. The external stability of the wall shall be evaluated. Failure surfaces extending beyond the ends of the ground anchors and below the bottom of the wall shall be checked using slope stability calculations. The minimum FS with respect to external stability shall be 1.3 or 1.5 for critical wall systems as designated in the contract plans.

f. Wall Drainage. The wall drainage system shall operate by gravity and shall be capable of relieving water pressures on the back face of the wall under anticipated worst case water pressure conditions. When drainage systems are incorporated into the specific design, hydrostatic head on the back of the wall shall not exceed 6 inches above the elevation of the drainage collection pipe.

2. Materials

The Contractor shall not deliver materials to the site until the Engineer has approved the submittals outlined in section 3.0. The Contractor shall protect the materials from the elements by appropriate means. Prestressing steel strands and bars shall be stored and handled in accordance with the manufacturer's recommendations and in such a manner that no damage to the component parts occurs. All steel components shall be stored under cover and protected against moisture.

a. Soldier Beam and Structural Steels

i. Steel Soldier Beams - Steel soldier beams shall be of the type and weight indicated on the approved working drawings. Steel soldier beams shall conform to the requirements of AASHTO M 183 (ASTM A 36) or AASHTO M 223 (ASTM A 572) unless otherwise specified.

ii. Steel Sheet Piles - Steel sheet piles shall be of the type and weight indicated on the approved working drawings. Steel sheet piles shall conform to the requirements of AASHTO M 202 (ASTM A 328) or AASHTO M 270 (ASTM A 709) Grade 50.

iii. Steel Plate - Steel used to fabricate steel studs and other devices shall conform to the requirements of AASHTO M 169 (ASTM A 108)

iv. Steel Tube - Steel tube shall conform to the requirements of ASTM A 500.

v. Reinforcing Steel - Reinforcing steel shall conform to ASTM A 615. The minimum yield stress for No. 6 reinforcing bars and for

smaller diameter bars shall be 40 ksi. The minimum yield stress for No. 7 reinforcing bars and larger diameter bars shall be 60 ksi.

b. Concrete

i. Cement - Portland cement shall be Type I or II and shall conform to AASHTO M 85.

ii. Structural Concrete - Structural concrete shall conform to the requirements of Section 604 of the TDOT Standard Specifications Structural concrete shall be Class A with a minimum 28-day compressive strength of 3000 psi, unless otherwise noted on the contract drawings.

iii. Lean-Mix Concrete Backfill - Lean-mix concrete backfill shall consist of Type I or Type II Portland cement, fine aggregate and water. Each cubic yard of lean-mix concrete backfill shall consist of a minimum of one sack (94lbs) of Portland cement.

iv. Precast Concrete - Precast concrete elements such as panels shall be made by an approved plant in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels".

Out-of-state producers shall provide documentation of material quality before the manufacture of any pre-cast products (i.e. aggregate quality reports, cement/steel mill test reports, etc.)

Unless otherwise shown on the contract drawings, Portland cement concrete used in precast elements shall conform to Class D with a minimum 28-day compressive strength of 4000 psi

c. Drainage Materials

i. Drainage Aggregate - Drainage aggregate to be used as a drainage medium shall conform to section 903.17 of the Standard Specifications.

ii. Preformed Permeable Geocomposite Drains – The preformed permeable geocomposite drains shall be continuous and a minimum of one (1) foot wide. The drains shall be placed in sections with a minimum overlap of one (1) foot and be spliced to assure continuous drainage.

iii. Pipe and Perforated Pipe - Pipe and perforated pipe shall conform to section 610 of the Standard Specifications.

d. Lagging

i. Temporary Timber Lagging - Temporary timber lagging shall be construction grade rough cut and shall be a minimum of 3 inches thick. Where necessary, the Contractor shall provide certification that the timber conforms to the grade, species, and other specified

requirements. If the timber is to be treated with a preservative, a certificate of compliance shall be furnished.

ii. Permanent Timber Lagging – Permanent timber lagging shall conform to all requirements of section 2.d.i. and shall be constructed from structural stress-graded lumber.

3. Construction

a. General Considerations

i. Wall elements for anchored walls designed and constructed in accordance with this manual shall be either continuous interlocking sheet-piles or steel soldier beams that are either driven or placed in pre-drilled holes that are subsequently backfilled with lean mix or structural concrete.

b. Excavation

i. Excavation below a level of anchors shall be limited to 2 feet below the anchor level and shall not commence below this level until anchors at that level have been installed, load tested, locked off and accepted by the Department. Placement of timber lagging shall immediately follow excavation in the front of the wall.

c. Driven Sheet Pile and Soldier Beam Installation.

i. Driven sheet piles and soldier beams shall be driven to the specified minimum tip elevation shown on the approved working drawings. The Contractor shall select a sheet pile or soldier beam section that satisfies all design criteria. The Contractor shall select a driving method and pile driving and ancillary equipment consistent with the expected ground conditions at the site. The sheet-pile or soldier beam shall be driven to the specified minimum tip elevation or to the approved elevation based on bearing capacity without damaging the sheet pile or soldier beam. The interlocks between adjacent sheet piles shall not be damaged. Equipment shall be used to permit the impact energy to be distributed over the tops of the sheet pile or soldier beam.

d. Soldier Beam Installation in Pre-drilled Holes

i. Excavations required for soldier beam placement shall be performed to the dimensions and elevations on the approved working drawings. The methods and equipment used shall be selected by the Contractor.

ii. The Contractor shall ensure that the sidewalls of the pre-drilled holes (i.e. shafts) do not collapse during drilling. Uncased shafts may be used where the sides and the bottom of the shaft are stable and may be visually inspected prior to placing the soldier beam and concrete. Casing or drilling muds shall be used where the sides of the shaft require additional support.

iii. The Contractor shall provide equipment for checking the dimensions and alignment of each shaft excavation. The dimensions and alignment shall be determined by the Contractor but shall be observed by the Inspector. The Inspector will check the alignment of the drilling equipment at the beginning of shaft construction and periodically thereafter. Final shaft depth shall be measured after final cleaning by the Contractor.

iv. Loose material shall be removed from the bottom of the shaft. No more than 2 feet of standing water shall be left in the bottom of the shaft prior to beginning soldier beam installation.

v. The soldier beam shall be placed in the shaft without difficulty and aligned prior to general placement of concrete. The Contractor may place up to 2 feet of concrete at the bottom of the shaft to assist in aligning the soldier beam. The soldier beam shall be blocked or clamped in place at the ground surface, prior to placement of concrete.

vi. For shafts constructed without casing or drilling muds, concrete (either structural or lean-mix backfill) may be placed by free-falling the concrete from the ground surface down the shaft and around the soldier beam. If casing is used, the placement of concrete shall begin prior to casing removal. Remove the casing while the concrete remains workable. For shafts constructed using slurry, concrete shall be placed using the tremie method from the bottom of the shaft. The tremie pipe shall be withdrawn slowly as the level of the concrete rises in the shaft and the level of the tremie pipe outlet shall never exceed the height of the slurry.

e. Wall Tolerances

i. Soldier beams shall be placed at the locations shown on the approved working drawings and shall not deviate by more than 1 foot along the horizontal alignment of the wall. The wall shall not deviate from the vertical alignment shown of the contract drawings by more than 4 inches in each plane.

ii. The soldier beam or sheet pile tip shall be installed to within 1 foot of the specified tip elevation shown on the approved working drawings.

iii. Whenever a soldier beam deviates in location or plumbness by more than the tolerance given in these guidelines, the Contractor, at his option, may provide corrective measures such as 1) rebuilding soldier beams; 2) redesigning soldier beam; 3) adjust soldier beam spacing by adding additional soldier beams; 4) redesigning concrete facing; 5) building up the soldier beam section, or 6) other methods.

f. Welding and Splicing

i. Splicing of sheet piles or soldier beams shall not be permitted, unless approved by the Department. All structural welding of steel and steel reinforcement shall be performed by certified welders qualified to perform the type of welding shown on the shop drawings. All sheet piles or soldier beams shall be cutoff to a true plane at the elevations shown on the approved working drawings. All cutoff lengths shall remain the property of the Contractor and shall be properly disposed.

g. Timber Lagging Installation

i. Timber lagging shall be placed from the top-down in sufficiently small lifts immediately after excavation to prevent erosion of materials into the excavation. Prior to lagging placement, the soil face shall be smoothed to create a contact surface for the lagging. Large gaps behind the lagging shall be backfilled and compacted prior to applying any loads to the ground anchors.

ii. A gap shall be maintained between each vertically adjacent lagging board for drainage between adjacent lagging sections. In no case shall lagging be placed in tight contact to adjacent lagging.

h. Drainage System Installation

i. The Contractor shall handle preformed permeable geocomposite drains in such a manner as to ensure the geocomposite drain is not damaged in any way. Care shall be taken during placement of the geocomposite drain not to entrap dirt or excessive dust in the geocomposite drain that could cause clogging of the drainage system. Delivery, storage, and handling of the geocomposite drains shall be as provided in the plans or based on manufacturer's recommendations.

ii. Drainage geocomposite strips shall be placed and secured tightly against the timber lagging with the fabric facing the lagging. A continuous sheet of drainage geocomposite that spans between adjacent soldier beams shall not be allowed. Seams and overlaps between adjacent composites shall be made according to the special provisions or manufacturer's recommendations and specifications. Repairs shall be performed at no additional cost to the Department and shall conform to the plans or manufacturer's recommendation.

iii. Where drainage aggregate is used to construct a vertical drain behind the permanent wall and in front of the lagging, the drainage aggregate shall be placed in horizontal lifts. The construction of the vertical drain should closely follow the construction of the precast facing elements. Care should be exercised to ensure that

connection devices between wall elements and facing elements are not damaged during the placement of the drainage aggregate.

iv. Perforated collector pipe shall be placed within the permeable material to the flow line elevations and at the location shown on the approved working drawings. Outlet pipes shall be placed at the low end of the collector pipe and at other locations shown or specified in the approved working drawings.

i. Concrete Facing Installation

i. For permanent cast-in-place and precast concrete facings, concrete manufacture, handling, placement, and finishing shall conform to the requirements in Section 8 "Concrete Structures" of the AASHTO *LRFD Bridge Design Specifications* with interims. Connections used to secure the facing to wall elements shall conform to the details shown on the approved working drawings. The exposed surface of the concrete facing shall receive a Class I finish as specified in Section 8 "Concrete Structures," unless a special architectural treatment is specified.

Part B, Anchored Wall – Part B covers specifications for the design, construction and testing of Permanent Ground Anchors.

1. Description

The work covered under this section includes the furnishing of all materials, labor, tools, equipment, and other incidental items for the designing, detailing, and construction of permanent ground anchors. All other items included in the construction of the permanent ground anchors not specifically mentioned herein shall conform to all applicable sections of the *Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction*, henceforth referred to as the Standard Specifications, the current *AASHTO LRFD Bridge Design Specifications* with latest revisions and the latest version of Post Tensioning Institute (PTI) Standards, including 1. *PTI, "Post Tensioning Manual"*, 2. *PTI "Specification for Unbonded Single Strand Tendons"*, 3. *PTI "Recommendations for Prestressed Rock and Soil Anchors."*

Unless otherwise noted the Contractor shall select the ground anchor type, drilling method, grouting method, and grout pressures, determine the ground anchor capacity, bond length, free stressing (unbonded) length, and anchor diameter. The Contractor shall be responsible for installing ground anchors that will develop the load-carrying capacity indicated on the approved working drawings in accordance with the testing subsection of this section. The anchor tendon shall be protected from corrosion as shown on the approved working drawings and in accordance with the requirements of this specification.

2. Design Criteria

a. Unless otherwise directed the Contractor shall select the type of tendon to be used. The tendon shall be sized so the design load does not exceed 60 percent of the specified minimum tensile strength of the prestressing steel. The lock-off load for the tendon shall be chosen based on anticipated time or activity dependent load changes, but shall not exceed 70 percent of the specified minimum tensile stress of the prestressing steel. The prestressing steel shall be sized so the maximum test load does not exceed 80 percent of the specified minimum tensile strength of the prestressing steel.

b. The Contractor shall be responsible for determining the bond length necessary to develop the design load indicated on the approved working drawings. The minimum bond length shall be 15 feet for strand tendons in rock and 10 feet for bar tendons in rock. The minimum bond length shall be 15 feet for strand and bar tendons in soil. The minimum tendon bond length shall be 10 feet.

c. The free stressing length (unbonded length) for rock and soil anchors shall not be less than 10 feet for bar tendons and 15 feet for strand tendons. The free stressing length shall extend at least 5 feet or 20 percent of the height of the wall, whichever is greater, behind the critical failure surface. The critical failure surface shall be evaluated using slope stability or similar procedures.

3. Submittals

Requirements for submittals are as outlined above and also include the following:

a. Contractor qualifications as outlined in Part A, of these anchored wall design and construction requirements.

b. The working drawings and design submission shall include the following:

i. A ground anchor schedule giving:

- Ground anchor number
- Ground anchor design load
- Type and size of tendon
- Minimum total anchor length
- Minimum bond length
- Minimum tendon bond length
- Minimum unbonded length

ii. A drawing of the ground anchor tendon and the corrosion protection system including details for the following:

- Spacers and their location

- Centralizers and their location
- Unbonded length corrosion protection system
- Bond length corrosion protection system
- Anchorage and trumpet
- Anchorage corrosion protection system

c. Certificates of Compliance for the following materials , if used. The certificate shall state that the materials or assemblies to be provided will fully comply with the requirements of the contract.

i. Prestressing steel, strand or bar
ii. Portland cement
iii. Prestressing hardware
iv. Bearing plates
v. Corrosion protection system

d. The Contractor shall submit to the Engineer for review and approval or rejection mill test reports for the prestressing steel and the bearing plate steel. The Engineer may require the Contractor to provide samples of any ground anchor material intended for use on the project. The prestressing steel and bearing plates shall not be incorporated in the work without the Engineer's approval.

e. The Contractor shall submit to the Engineer for review and approval or rejection calibration data for each test jack, load cell, primary pressure gauge and reference pressure gauge to be used. Testing cannot commence until the Engineer has approved these calibrations.

f. The Contractor shall submit to the Engineer within twenty calendar days after the completion of the ground anchor work a report containing the following:

i. Prestressing steel manufacturer's mill test reports for the tendons incorporated in the installation
ii. Grouting records indicating the cement type, quantity injected and the grout pressures
iii. Ground anchor test results
iv. As-built drawings showing the location and orientation of each ground anchor, anchor capacity, tendon type, total anchor length, bond length, unbonded length, and tendon bond length as installed and locations of all instruments installed by the Department.

g. Existing Conditions – Prior to beginning work, the Department shall provide utility location plans to the Contractor. The Contractor is responsible for contacting a utility location service to verify the location of underground utilities before starting work.

The Contractor shall survey the condition of adjoining properties and make records and photographs of any evidence of settlement or cracking of any adjacent structures. The Contractor's report of this survey shall be delivered to the Department before work begins.

4. Materials

a. General

i. The Contractor shall not deliver materials to the site until the Engineer has approved the submittals outlined in Section 3.0.

ii. The Contractor shall protect all materials from theft, vandalism, and the elements by appropriate means. Prestressing steel strands and bars shall be stored and handled in accordance with the manufacturer's recommendations and in such a manner that no damage to the component parts occurs. All steel components shall be protected from the elements at all times. Cement and additives for grout shall be stored under cover and protected against moisture.

b. Anchorage Devices

i. Stressing anchorages shall be a combination of either steel bearing plate with wedge plate and wedges, or a steel bearing plate with a threaded anchor nut. The steel bearing and wedge plate may also be combined into a single element. Anchorage devices shall be capable of developing 95 percent of the specified minimum ultimate tensile strength of the prestressing steel tendon. The anchorage devices shall conform to the static strength requirements of Section 3.1.6 (1) and Section 3.1.8 (1) and (2) of the latest edition of the PTI *"Guide Specifications for Post-Tensioning Materials."*

ii. The bearing plate shall be fabricated from steel conforming to AASHTO M 183 or M 222 specifications, or equivalent, or may be a ductile iron casting conforming to ASTM A 536.

iii. The trumpet shall be fabricated from a steel pipe or tube or from PVC pipe. Steel pipe or tube shall conform to the requirements of ASTM A 53 for pipe or ASTM A 500 for tubing. Steel trumpets shall have a minimum wall thickness of 0.1 inch for diameters up to 4 inches and 0.2 inch for larger diameters. PVC pipe shall conform to ASTM A 1785, Schedule 40 minimum. PVC trumpets shall be positively sealed against the bearing plate and aligned with the tendon to prevent cracking during stressing.

iv. Anchorage covers shall be fabricated from steel or plastic with a minimum thickness of 0.1 inch. The joint between the cover and the bearing plate shall be watertight.

v. Wedges shall be designed to preclude premature failure of the prestressing steel due to notch or pinching effects under static and dynamic strength requirements of Section 3.1.8 (1) and 3.1.8 (2) of the PTI *"Post Tensioning Manual."* Wedges shall not be reused.

vi. Wedges for epoxy coated strand shall be designed to be capable of biting through the epoxy coating and into the strand. Removal of the epoxy coating from the strand to allow the use of standard wedges shall not be permitted. Anchor nuts and other threadable hardware for epoxy coated bars shall be designed to thread over the epoxy coated bar and still comply with the requirements for carrying capacity.

c. Prestressing Steel

i. Ground anchor tendons shall be fabricated from single or multiple elements of one of the following prestressing steels:

- Steel bars conforming to AASHTO M 275
- Seven-wire, low relaxation strands conforming to AASHTO M 203
- Compact,seven-wire, low-relaxation strands conforming to ASTM A 779
- Epoxy coated strand conforming to ASTM A 882
- Epoxy coated reinforcing steel bars conforming to ASTM A 775

ii. Centralizers shall be provided at maximum intervals of 10 feet with the deepest centralizer located 1 foot from the end of the anchor and the upper centralizer for the bond zone located no more than 5 feet from the top of the tendon bond length. Spacers shall be used to separate the steel strands of strand tendons. Spacers shall be provided at maximum intervals of 10 feet and may be combined with centralizers.

d. Prestressing Steel Couplers

Prestressing steel bar couplers shall be capable of developing 100 percent of the minimum specified ultimate tensile strength of the prestressing steel bar. Steel strands used for a soil or rock anchor shall be continuous with no splices, unless approved by the Engineer.

e. Centralizers

i. Centralizers shall be fabricated from plastic, steel or material, which is non-detrimental to the prestressing steel. Wood shall not be used. The centralizer shall be able to support the tendon in the drill hole and position the tendon so a minimum of 2 inches of grout cover is provided and shall permit grout to freely flow around the tendon and up the drill hole.

ii. Centralizers are not required on pressure injected anchors installed in coarse grained soils when the grouting pressure exceeds 145 psi or on hollow stem-augured anchors when they are grouted through the auger with grout having a slump of 9 inches or less.

f. Spacers

Spacers shall be used to separate elements of a multi-element tendon and shall permit grout to freely flow around the tendon and up the drill hole. Spacers shall be fabricated from plastic, steel or material, which is non-detrimental to the prestressing steel. Wood shall not be used. A combination centralizer-spacer may be used.

g. Tendon Bond Length Encapsulations

When the contract plans require the tendon bond length to be encapsulated to provide additional corrosion protection, the encapsulation shall be fabricated from one of the following:

i. High density corrugated polyethylene tubing conforming to the requirements of AASHTO M 252 and having a minimum wall thickness of 0.06 inch except pregrouted tendons, which may have a minimum wall thickness of 0.04 inch.
ii. Deformed steel tubing or pipes conforming to ASTM A 52 or A 500 with a minimum wall thickness of 0.2 inch.
iii. Corrugated, polyvinyl chloride tubes manufactured from rigid PVC compounds conforming to ASTM D 1784, Class 13464- B.
iv. Fusion-bonded epoxy conforming to the requirements of AASHTO M 284.

h. Heat Shrinkable Sleeves

Heat shrinkable sleeves shall be fabricated from a radiation cross-linked polyolefin tube internally coated with an adhesive sealant. Prior to shrinking, the tube shall have a nominal wall thickness of 0.025 inch. The

adhesive sealant inside the heat shrinkable tube shall have a nominal thickness of 0.02 inch.

i. Sheath

A sheath shall be used as part of the corrosion protection system for the unbonded length portion of the tendon. The sheath shall be fabricated from one of the following:

i. A polyethylene tube pulled or pushed over the prestressing steel. The polyethylene shall be Type II, III or IV as defined by ASTM D 1248 (or approved equal). The tubing shall have a minimum wall thickness of 0.06 inch.

ii. A hot-melt extruded polypropylene tube. The polypropylene shall be cell classification B55542-11 as defined by ASTM D 4101 (or approved equal). The tubing shall have a minimum wall thickness of 0.06 inch.

iii. A hot-melt extruded polyethylene tube. The polyethylene shall be high density Type III as defined by ASTM D 1248 (or approved equal). The tubing shall have a minimum wall thickness of 0.06 inch.

iv. Steel tubing conforming to ASTM A 500. The tubing shall have a minimum wall thickness of 0.2 inch.

v. Steel pipe conforming to ASTM A 53. The pipe shall have a minimum wall thickness of 0.2 inch.

vi. Plastic pipe or tube of PVC conforming to ASTM D 1784 Class 13464-B. The pipe or tube shall be Schedule 40 at a minimum.

vii. A corrugated tube conforming to the requirement of the tendon bond length encapsulation Subsection 4.g. above.

j. Bondbreaker

The bondbreaker shall be fabricated from a smooth plastic tube or pipe having the following properties: (1) resistant to chemical attack from aggressive environments, grout, or corrosion inhibiting compound; (2) resistant to aging by ultraviolet light; (3) fabricated from material non-detrimental to the tendon; (4) capable of withstanding abrasion, impact,

and bending during handling and installation; (5) enable the tendon to elongate during testing and stressing; and (6) allow the tendon to remain unbonded after lockoff.

k. Cement Grout

Type I, II, III or V Portland cement conforming to AASHTO M 85 shall be used for grout. The grout shall be a pumpable neat mixture of cement and water and shall be stable (bleed less than 2 percent), fluid, and provide a minimum 28-day compressive strength of at least 3000 psi measured in accordance with ASTM C 109 at the time of stressing.

l. Admixtures

Admixtures which control bleed, improve flowability, reduce water content, and retard set may be used in the grout subject to the approval of the Engineer. Admixtures, if used, shall be compatible with the prestressing steels and mixed in accordance with the manufacturer's recommendation. Expansive admixtures may only be added to the grout used for filling sealed encapsulations, trumpets, and anchorage covers. Accelerators shall not be permitted.

m. Water

Water for mixing grout shall be potable, clean, and free of injurious quantities of substances known to be harmful to Portland cement or prestressing steel.

n. Corrosion Inhibiting Compound

The corrosion inhibiting compound placed in either the free length or the trumpet areas shall be an organic compound (i.e. grease or wax) with appropriate polar moisture displacing, corrosion inhibiting additives and self-healing properties. The compound shall permanently stay viscous and be chemically stable and nonreactive with the prestressing steel, the sheathing material, and anchor grout.

o. Grout Tubes

Grout tubes shall have an adequate inside diameter to enable the grout to be pumped to the bottom of the drill hole. Grout tubes shall be strong enough to withstand a minimum grouting pressure of 145 psi. Post-grout tubes shall be strong enough to withstand post-grouting pressures.

5. Construction

a. Tendon Storage and Handling

i. Tendons shall be handled and stored in such a manner as to avoid damage or corrosion. Damage to the prestressing steel, the corrosion protection, and/or the epoxy coating as a result of abrasions, cuts, nicks, welds or weld splatter will be cause for rejection by the Engineer. The prestressing steel shall be protected if welding is to be performed in the vicinity. Grounding of welding leads to the prestressing steel is forbidden. Prestressing steel shall be protected from dirt, rust, or other deleterious substances. A light coating of rust on the steel is acceptable. If heavy corrosion or pitting is noted, the Engineer shall reject the affected tendons.

ii. The Contractor shall use care in handling and storing the tendons at the site. Prior to inserting a tendon in the drill hole, the Contractor and the Inspector shall examine the tendon for damage to the encapsulation and the sheathing. If, in the opinion of the Inspector, the encapsulation is damaged, the Contractor shall repair the encapsulation in accordance with the tendon supplier's recommendations. If, in the opinion of the inspector, the smooth sheathing has been damaged, the Contractor shall repair it with ultra-high molecular weight polyethylene tape. The tape should be spiral wound around the tendon to completely seal the damaged area. The pitch of the spiral shall ensure a double thickness at all points.

iii. Banding for fabricated tendons shall be padded to avoid damage to the tendon corrosion protection. Upon delivery, the fabricated anchors or the prestressing steel for fabrication of the tendons on site and all hardware shall be stored and handled in such a manner to avoid mechanical damage, corrosion, and contamination with dirt or deleterious substances.

iv. Lifting of the pre-grouted tendons shall not cause excessive bending, which can debond the prestressing steel from the surrounding grout.

v. Prestressing steel shall not be exposed to excessive heat (i.e. more than 446° F).

b. Anchor Fabrication

i. Anchors shall be either shop or field fabricated from material conforming to part 4 of this section and as shown in the approved working drawings and schedules.

ii. Prestressing steel shall be cut with an abrasive saw or, with the written approval of the prestressing steel supplier, an oxyacetylene torch.

iii. All of the tendon bond length, especially for strand, must be free of dirt, manufacturer's lubricants, corrosion-inhibitive coatings, or other deleterious substances that may significantly affect the grout-to-tendon bond or the service life of the tendon.

iv. Pre-grouting of encapsulated tendons shall be done on an inclined, rigid frame or bed by injecting the grout from the low end of the tendon.

c. Drilling

i. Drilling methods shall be left to the discretion of the Contractor, whenever possible. The Contractor shall be responsible for using a drilling method to establish a stable hole of adequate dimensions, within the tolerances specified. Drilling methods may involve, amongst others, rotary, percussion, rotary/percussive or auger drilling; or percussive or vibratory driven casing.

ii. Holes for anchors shall be drilled at the locations and to the length, inclination and diameter shown on the approved working drawings. The drill bit or casing crown shall not be more than 0.12 inch smaller than the specified hole diameter. At the ground surface the drill hole shall be located within 1 foot of the location shown on the approved working drawings. The drill hole shall be located so the longitudinal axis of the drill hole and the longitudinal axis of the tendon are parallel. In particular, the ground anchor hole shall not be drilled in a location that requires the tendon to be bent in order to enable the bearing plate to be connected to the supported structure. At the point of entry the ground anchor shall be installed within plus/minus three (3) degrees of the inclination from horizontal shown on the approved working drawings. At the point of entry the horizontal angle made by the ground anchor and the structure shall be within plus/minus three (3) degrees of a line drawn perpendicular to the plane of the structure unless otherwise shown on the approved working drawings. The ground anchors shall not extend beyond the right of-way or easement limits shown on the contract drawings.

d. Tendon Insertion

i. Tendons shall be placed in accordance with the approved working drawings and details and the recommendations of the tendon manufacturer or specialist anchor contractor. The tendon shall be inserted into the drill hole to the desired depth without difficulty.

SP624

When the tendon cannot be completely inserted, the Contractor shall remove the tendon from the drill hole and clean or redrill the hole to permit insertion. Partially inserted tendons shall not be driven or forced into the hole.

ii. Each anchor tendon shall be inspected by Department field personnel during installation into the drill hole or casing. Damage to the corrosion protection system shall be repaired, or the tendon replaced if not repairable. Loose spacers or centralizers shall be reconnected to prevent shifting during insertion. Damaged fusion bonded epoxy coatings shall be repaired in accordance with the manufacturer's recommendations. If the patch is not allowed to cure prior to inserting the tendon in the drill hole, the patched area shall be protected by tape or other suitable means.

iii. The rate of placement of the tendon into the hole shall be controlled such that the sheathing, coating, and grout tubes are not damaged during installation of the tendon. Anchor tendons shall not be subjected to sharp bends. The bottom end of the tendon may be fitted with a cap or bullnose to aid its insertion into the hole, casing or sheathing.

e. Grouting

i. The Contractor shall use a neat cement grout or a sand-cement grout. The cement shall not contain lumps or other indications of hydration. Admixtures, if used, shall be mixed in accordance with the manufacturer's recommendation.

ii. The grouting equipment shall produce a grout free of lumps and undispersed cement. A positive displacement grout pump shall be used. The pump shall be equipped with a pressure gauge to monitor pressures. The pressure gauge shall be capable of measuring pressures of at least 145 psi or twice the actual grout pressure used by the Contractor, whichever is greater. The grouting equipment shall be sized to enable the grout to be pumped in one continuous operation. The mixer should be capable of continuously agitating the grout.

iii. The grout shall be injected from the lowest point of the drill hole. The grout may be pumped through grout tubes, casings, hollowstem-augers, or drill rods. The grout can be placed before or after insertion of the tendon. The quantity of the grout and the grout pressures shall be recorded. The grout pressures and grout takes shall be controlled to prevent excessive heave or fracturing.

SP624

iv. After the tendon is installed, the drill hole may be filled in one continuous grouting operation except that pressure grouting shall not be used in the free length zone. The grout at the top of the drill hole shall not contact the back of the structure or the bottom of the trumpet.

v. If the ground anchor is installed in a fine-grained soil using drill holes larger than 6 inches in diameter, then the grout above the top of the bond length shall be placed after the ground anchor has been tested and stressed. The Engineer will allow the Contractor to grout the entire drill hole at the same time if the Contractor can demonstrate that their particular ground anchor system does not derive a significant portion of its load-carrying capacity from the soil above the bond length portion of the ground anchor.

vi. If grout protected tendons are used for ground anchors anchored in rock, then pressure grouting techniques shall be utilized. Pressure grouting requires that the drill hole be sealed and that the grout be injected until a minimum 50 psi grout pressure (measured at the top of the drill hole) can be maintained on the grout for at least five (5) minutes.

vii. The grout tube may remain in the hole on completion of grouting if the tube is filled with grout.

viii. After grouting, the tendon shall not be loaded for a minimum of three (3) days.

f. Anchorage Installation

i. The anchor bearing plate and the anchor head or nut shall be installed perpendicular to the tendon, within plus/minus three (3) degrees and centered on the bearing plate, without bending or kinking of the prestressing steel elements. Wedge holes and wedges shall be free of rust, grout and dirt.

ii. The stressing tail shall be cleaned and protected from damage until final testing and lock-off. After the anchor has been accepted by the Engineer, the stress tail shall be cut to its final length according to the tendon manufacturer's recommendations.

iii. The corrosion protection surrounding the unbonded length of the tendon shall extend up beyond the bottom seal of the trumpet or 4 inches into the trumpet if no trumpet seal is provided. If the protection does not extend beyond the seal or sufficiently far

enough into the trumpet, the Contractor shall extend the corrosion protection or lengthen the trumpet.

iv. The corrosion protection surrounding the unbonded length of the tendon shall not contact the bearing plate or the anchor head during testing and stressing. If the protection is too long, the Contractor shall trim the corrosion protection to prevent contact.

g. Corrosion Protection

i. Protection Requirements

Corrosion protection requirements shall be determined by the Department and shall be shown on the contract plans. The corrosion protection systems shall be designed and constructed to provide reliable ground anchors for temporary and permanent structures.

ii. Anchorage Protection

- All stressing anchorages permanently exposed to the atmosphere shall receive a grout-filled cover, except, for restressable anchorages where a corrosion inhibiting compound must be used. Stressing anchorages encased in concrete at least 2 inches thick do not require a cover.

- The trumpet shall be sealed to the bearing plate and shall overlap the unbonded length corrosion protection by at least 4 inches. The trumpet shall be long enough to accommodate movements of the structure and the tendon during testing and stressing. On strand tendons, the trumpet shall be long enough to enable the tendon to make a transition from the diameter of the tendon along the unbonded length to the diameter of the tendon at the wedge plate without damaging the encapsulation.

- The trumpet shall be completely filled with grout, except restressable anchorages must use corrosion inhibiting compounds. Compounds may be placed any time during construction. Compound filled trumpets shall have a permanent seal between the trumpet and the unbonded length corrosion protection. Grout must be placed after the ground anchor has been tested and stressed to the lock-off load. Trumpets filled with grout shall have either a temporary seal between the trumpet and the unbonded length corrosion protection or the trumpet shall fit tightly over the unbonded length corrosion protection for a minimum of 4 inches.

iii. Unbonded Length Protection

- Corrosion protection of the unbonded length shall be provided by a combination of sheaths, sheath filled with a corrosion inhibiting compound or grout, or a heat shrinkable tube internally coated with a mastic compound, depending on the tendon class. The corrosion inhibiting compound shall completely coat the tendon elements, fill the void between them and the sheath, and fill the interstices between the wires of 7-wire strands. Provisions shall be made to retain the compound within the sheath.

- The corrosion protective sheath surrounding the unbonded length of the tendon shall be long enough to extend into the trumpet, but shall not come into contact with the stressing anchorage during testing. Any excessive protection length shall be trimmed off.

- For pregrouted encapsulations and all Class I tendons, a separate bondbreaker or common sheath shall be provided for supplemental corrosion protection or to prevent the tendon from bonding to the grout surrounding the unbonded length.

iv. Unbonded Length/Bond Length Transition

The transition between the corrosion protection for the bonded and unbonded lengths shall be designed and fabricated to ensure continuous protection from corrosive attack.

v. Tendon Bond Length Protection for Grout Protected Tendons (Class II)

- Cement grout can be used to protect the tendon bond length in non-aggressive ground when the installation methods ensure that the grout will remain fully around the tendon. The grout shall overlap the sheathing of the unbonded length by at least 1 inch.

- Centralizers or grouting techniques shall ensure a minimum of 0.5 inch of grout cover over the tendon bond length.

vi. Tendon Bond Length Protection for Encapsulated Tendons (Class I)

SP624

- A grout-filled, corrugated plastic encapsulation or a grout-filled, deformed steel tube shall be used. The prestressing steel can be grouted inside the encapsulation prior to being placed.

- Centralizers or grouting techniques shall ensure a minimum of 0.5 inch of grout cover over the encapsulation.

vii. Epoxy

A fusion-bonded epoxy may be used to provide a layer of protection for the steel tendon in addition to the cement grout.

viii. Coupler Protection

- On encapsulated bar tendons (Class I), the coupler and any adjacent exposed bar sections shall be covered with a corrosion-proof compound or wax-impregnated cloth tape. The coupler area shall be covered by a smooth plastic tube, complying with the requirements set forth in 4.9, overlapping the adjacent sheathed tendon by at least 1 inch. The two joints shall be sealed each by a coated heat shrink sleeve of at least 6 inches in length, or approved equal. The corrosion-proof compound shall completely fill the space inside the cover tube.

- Corrosion protection details for strand couplers, if specifically permitted, shall be submitted for approval of the Engineer.

h. Stressing, Load Testing, and Acceptance

i. General

Each ground anchor shall be tested. No load greater than ten (10) percent of the design load can be applied to the ground anchor prior to testing. The maximum test load shall be no less than 1.33 times the design load and shall not exceed 80 percent of the specified minimum ultimate tensile strength of the prestressing steel of the tendon. The test load shall be simultaneously applied to the entire tendon. Stressing of single-element tendons shall not be permitted.

ii. Stressing Equipment

- The testing equipment shall consist of:

  - A dial or vernier scale capable of measuring to the nearest .001 inch shall be used to measure the ground anchor movement. The movement measuring device shall have a minimum travel equal to the theoretical elastic elongation of the total anchor length at the maximum test load and it shall have adequate travel so the ground anchor movement can be measured without resetting the device at an interim point.

SP624

- A hydraulic jack and pump shall be used to apply the test load. The jack and a calibrated primary pressure gauge shall be used to measure the applied load. The jack and primary pressure gauge shall be calibrated by an independent firm as a unit. The calibration shall have been performed within forty-five (45) working days of the date when the calibration submittals are provided to the Engineer. Testing cannot commence until the Engineer has approved the calibration. The primary pressure gauge shall be graduated in 100 psi increments or less. The ram travel shall be at least 6 inches and preferably not be less than the theoretical elongation of the tendon at the maximum test load. If elongations greater than 6 inches are required, restroking can be allowed.

- A calibrated reference pressure gauge shall also be kept at the site to periodically check the production (i.e. primary pressure) gauge. The reference gauge shall be calibrated with the test jack and primary pressure gauge. The reference pressure gauge shall be stored indoors and not subjected to rough treatment.

- The Contractor shall provide an electrical resistance load cell and readout to be used when performing an extended creep test.

- The stressing equipment shall be placed over the ground anchor tendon in such a manner that the jack, bearing plates, load cells and stressing anchorage are axially aligned with the tendon and the tendon is centered within the equipment.

- The stressing equipment, the sequence of stressing and the procedure to be used for each stressing operation shall be determined at the planning stage of the project. The equipment shall be used strictly in accordance with the manufacturer's operating instructions.

- Stressing equipment shall preferably be capable of stressing the whole tendon in one stroke to the specified test load and the equipment shall be capable of stressing the tendon to the maximum specified test load within 75 percent of the rated capacity. The pump shall be capable of applying each load increment in less than 60 seconds.

- The equipment shall permit the tendon to be stressed in increments so that the load in the tendon can be raised or lowered in accordance with the test specifications, and allow the anchor to be lift-off tested to confirm the lock off load.

- Stressing equipment shall have been calibrated, within an accuracy of plus or minus two (2) percent, a maximum of 45 days prior to use. The calibration certificate and graph shall be available on site at all times. The calibration shall be traceable to the National Institute of Standards and Technology (NIST).

iii. Load Test Setup

- Dial gauges shall bear on the pulling head of the jack and their stems shall be coaxial with the tendon direction. The gauges shall be supported on an independent, fixed frame, such as a tripod, which will not move as a result of stressing or other construction activities during the operation.

- Prior to setting the dial gauges, the Alignment Load (AL) shall be accurately placed on the tendon. The magnitude of the AL depends on the type and length of the tendon.

- Regripping of strands, which would cause overlap wedge bites, or wedge bites on the tendon below the anchor head, shall be avoided.

- Stressing and testing of multiple element tendons with single element jacks is not permitted.

- Stressing shall not begin until the grout has reached adequate strength.

iv. Performance Tests

- Five (5) percent of the ground anchors or a minimum of three (3) ground anchors, whichever is greater, shall be performance tested in accordance with the procedures described in this section. The Engineer shall select the ground anchors to be performance tested. The remaining ground anchors shall be tested in accordance with the proof test procedures as outlined in 5.h. below.

- The performance test shall be made by incrementally loading and unloading the ground anchor in accordance with the schedule provided in section 5.h. The load shall be raised from one increment to another immediately after recording the ground anchor movement. The ground anchor movement shall be measured and recorded to the nearest 0.001 inch with respect to an independent fixed reference point at the alignment load and at each increment of load. The load shall be monitored with the primary pressure gauge. The reference pressure gauge shall be placed in series with the primary pressure gauge during each performance test. If the load determined by the reference pressure gauge and the load determined by the primary pressure gauge differ by more than ten (10) percent, the jack, primary pressure gauge and reference pressure gauge shall be recalibrated at no expense to the Department. At load increments other than the maximum test load, the load shall be held just long enough to obtain the movement reading.

- The maximum test load in a performance test shall be held for ten (10) minutes. A load cell shall be used to monitor small changes in load during constant load-hold periods.

- The jack shall be adjusted as necessary in order to maintain a constant load. The load-hold period shall start as soon as the maximum test load is applied and the ground anchor movement, with respect to a fixed reference, shall be measured and recorded at 1 minute, 2, 3, 4, 5, 6, and 10 minutes. If the ground anchor movement between one (1) minute and ten (10) minutes exceeds .04 inch, the maximum test load shall be held for an additional 50 minutes. If the load hold is extended, the ground anchor movement shall be recorded at 15, 20, 30, 40, 50 and 60 minutes.

v. Steps for the Performance Test – The steps for the performance test are detailed in the table on the following page:

Step	Loading	Applied Load	Record and Plot Total Movement (d_{ti})	Record and Plot Residual Movement (d_{ri})	Calculate Elastic Movement (d_{ei})
1	Apply alightment load (AL)				
2	Cycle 1	0.25DL	d_{t1}		$d_{t1} - d_{r1} = d_{e1}$
		AL		d_r	
3	Cycle 2	0.25AL	d_2		$d_{t2} - d_{r2} = d_{e2}$
		0.50DL	d_{t2}		
		AL		d_{r2}	

4	Cycle 3	0.25DL	d_3		$d_{t3} - d_{r3} = d_{e3}$
		0.50DL	d_3		
		0.75FL	d_3		
		AL		d_{r3}	
5	Cycle 4	0.25DL	d_4		$d_{t4} - d_{r4} = d_{e4}$
		0.50DL	d_4		
		0.75DL	d_4		
		1.00DL	d_{t4}		
		AL		d_{r4}	
6	Cycle 5	0.25DL	d_5		$d_{t5} - d_{r5} = d_{e5}$
		0.50DL	d_5		
		0.75DL	d_5		
		1.00DL	d_5		
		1.2DL	d_5		
		AL		d_{r5}	
7	Cycle 6	0.25DL	d_6		
		0.50DL	d_6		
		0.75DL	d_6		
		1.00DL	d_6		
		1.2DL	d_6		
		1.33DL	d_{t6} **, zero reading for creep test**		
8	Hold load for 10 minutes while recording movement at specified times. If the total movement measured during the load hold exceeds the specified maximum value then the load hold should be extended to a total of 60 minutes.				
9	Cycle 6 cont=d	AL		d_{r6}	Cycle 6: $d_m - d_{r6} = d_{e6}$

Notes: AL = Alignment Load, DL = Design Load, d_i = total movement at a load other than maximum for cycle, i = number identifying a specific load cycle.

vi. Proof Tests

The proof test shall be performed by incrementally loading the ground anchor in accordance with the following schedule. The load shall be raised from one increment to another immediately after recording the ground anchor movement. The ground anchor movement shall be measured and recorded to the nearest 0.001 inch with respect to an independent fixed reference point at the alignment load and at each increment load. The load shall be monitored with the primary pressure gauge. At load increments

SP624

other than the maximum test load, the load shall be held just long enough to obtain the movement reading.

Proof Test Schedule

Step	Load
1	AL
2	0.25DL
3	0.50DL
4	0.75DL
5	1.00DL
6	1.20DL
7	1.33DL
8	Reduce to lock-off load
9	AL (optional)
10	Adjust to lock-off load

vii. The maximum test load in a proof test shall be held for (10) minutes. The jack shall be adjusted as necessary in order to maintain a constant load. The load-hold period shall start as soon as the maximum test load is applied and the ground anchor movement with respect to a fixed reference shall be measured and recorded at 1, 2, 3, 4, 5, 6, and 10 minutes. If the ground anchor movement between one (1) minute and ten (10) minutes exceeds 0.04 inch, the maximum test load shall be held for an additional 50 minutes. If the load hold is extended, the ground anchor movements shall be recorded at 15, 20, 30, 40, 50, and 60 minutes.

viii. Extended Creep Tests

- The Department shall determine if extended creep testing is required and select those ground anchors that are to be creep tested. If creep tests are required, at least two (2) ground anchors shall be tested. The stressing equipment shall be capable of measuring and maintaining the hydraulic pressure within 50 psi.

- The extended creep test shall be made by incrementally loading and unloading the ground anchor in accordance with the performance test schedule provided in 5.8.5. At the end of each loading cycle, the load shall be held constant for the observation period indicated in the creep test schedule below. The times for reading and recording the ground anchor movement during each observation period shall be 1, 2, 3, 4, 5, 6, 10, 15, 20, 25, 30 , 45, 60, 75, 90, 100, 120, 150, 180, 210, 240, 270 and 300 minutes as appropriate for the load increment. Each load-hold period shall start as soon as the test load is applied. In a creep test, the primary pressure gauge and reference pressure gauge will be used to measure the applied load and the load cell will be used to monitor small changes in load during constant load-hold periods. The jack shall be adjusted as necessary in order to maintain a constant load.

- The Contractor shall plot the ground anchor movement and the residual movement measured in an extended creep test. The Contractor shall also plot the creep movement for each load hold as a function of the logarithm of time.

Extended Creep Test Schedule

Load	**Observation period (min)**
AL	
0.25DL	10
0.50DL	30
0.75DL	30
1.00DL	45
1.20DL	60
1.33DL	300

ix. Ground Anchor Acceptance Criteria

- A performance-tested or proof-tested ground anchor with a 10 minute load hold shall be acceptable if the: (1) ground anchor resists the maximum test load with less than 0.04 inch of

movement between 1 minute and 10 minutes; and (2) total elastic movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the unbonded length.

- A performance-tested or proof-tested ground anchor with a 60 minute load hold shall be acceptable if the: (1) ground anchor resists the maximum test load with a creep rate that does not exceed 0.08 inch in the last log cycle of time; and (2) total elastic movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the unbonded length.

- A ground anchor subjected to extended creep testing is acceptable if the: (1) ground anchor resists the maximum test load with a creep rate that does not exceed 0.08 inch in the last log cycle of time; and (2) total elastic movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the unbonded length.

- The initial lift-off reading shall be within plus or minus five (5) percent of the designated lock-off load. If this criterion is not met, then the tendon load shall be adjusted accordingly and the initial lift-off reading repeated.

x. Procedures for Anchors Failing Acceptance Criteria

- Anchors that do not satisfy the minimum apparent free length criteria shall be either rejected and replaced at no additional cost to the Department or locked off at no more than 50 percent of the maximum acceptable load attained. In this event, no further acceptance criteria are applied.

- Regroutable anchors which satisfy the minimum apparent free length criteria but which fail the extended creep test at the test load may be post grouted and subjected to an enhanced creep criterion. This enhance criterion requires a creep movement of not more than 0.04 inch between 1 and 60 minutes at test load. Anchors which satisfy the enhanced creep criterion shall be locked off at the design lock-off load. Anchors which cannot be post grouted or regroutable anchors that do not satisfy the enhanced creep criterion shall be either rejected or locked off at 50 % of the maximum acceptable test load attained. In this event, no further acceptance criteria are applied. The maximum acceptable test load with respect to creep shall correspond to that where acceptable creep movements are measured over the final log cycle of time.

- In the event that the anchor fails, the Contractor shall modify the design and/or construction procedures. These modifications may include, but are not limited to, installing additional anchors, modifying the installation methods, reducing the anchor design load by increasing the number of anchors, increasing the anchor length, or changing the anchor type. Any modification of design or construction procedures shall be at no change in the contract price. A description of any proposed modifications must be submitted to the Engineer in writing. Proposed modifications shall not be implemented until the Contractor receives written approval from the Engineer.

xi. Anchor Lock-Off

- After testing has been completed, the load in the tendon shall be such that after seating losses (i.e. wedge seating); the specified lock-off load has been applied to the anchor tendon.

- The magnitude of the lock-off load shall be specified in the approved working drawings, or as determined by the designer.

- The wedges shall be seated at a minimum load of 50% F_{pu}. If the lock-off load is less than 50% F_{pu}, shims shall be used under the wedge plate and the wedges seated at 50% F_{pu}. The shims shall then be removed to reduce the load in the tendon to the desired lock-off load. Bar tendons may be locked off at any load less than 70% F_{pu}.

xii. Anchor Lift-Off Test

After transferring the load to the anchorage, and prior to removing the jack, a lift-off test shall be conducted to confirm the magnitude of the load in the anchor tendon. This load is determined by reapplying load to the tendon to lift off the wedge plate (or anchor nut) without unseating the wedges (or turning the anchor nut). This moment represents zero time for any long time monitoring.

Method of Measurement

The method of measurement shall be square foot area of the wall face, measured from the top of footing (or bottom of wall for walls without footings) to the top of the wall excluding any appurtenances.

Basis of Payment

The earth retaining wall, complete in place and accepted, shall be paid for at the contract square foot bid price. The bid price for walls shall include as required: grading and compaction of the wall foundation, undercutting and backfilling of weak surficial zones, installation of ground improvement, footing excavation, presplitting, sheeting, shoring, drilling, piles, lagging, grouting, concrete, reinforcing steel, reinforcement strips or mesh, tie strips or rods, fasteners, connectors, wire mesh baskets, prefabricated modular components, post tensioning, performance testing and evaluation, architectural treatment and/or texture finish, drainage system, water-stops and joint sealing material, and all miscellaneous material and labor for the complete installation of the wall. If the contractor's design requires the use of select granular backfill, the unit price bid for the wall shall be full compensation for any additional backfill costs due to the use of select backfill material.

If required for retaining wall protection against vehicle impact, the cost of the barrier wall and end terminals shall be included in the square foot cost of the wall.

Additional area of wall required due to unforeseen foundation conditions or other reasons and approved by the Engineer will be paid for on the basis of the unit price bid except as noted below.

The mechanically stabilized earth wall, complete in place and accepted as noted above, shall be paid for at the contract square foot bid price. No increase in unit price will be paid for increases in wall height less than or equal to 10 feet as compared to the contract plans and wall heights. Wall height increases greater than 10 feet will be paid for by supplemental agreement.

The cast-in-place concrete cantilever or counterfort retaining wall, complete in place and accepted shall be paid for at the contract square foot bid price except as noted below.

If the actual driven quantity of concrete piles varies more than 10% from the estimated quantity based on the estimated lengths, an increase or decrease based on the contract bid price, or in the absence of a bid item, a price of twenty eight (28) dollars, per linear foot of additional or reduced pile length will be added or deducted accordingly from the price paid for the retaining wall. If the Engineer orders additional test piles, they will be paid for at the contract bid price, or in the absence of a bid item, a price of forty (40) dollars per linear foot. If the contractor changes friction pile types or sizes, additional load test(s) may be required at the Engineer's discretion and at the contractor's expense.

If the contractor uses a different type of pile than those that have estimated lengths shown on the contract plans, the price of the wall shall include all costs associated with piles and pile installation with no additional payment for any variation in pile lengths. All pile types and pile driving procedures, lengths, and bearings shall be in accordance with the Standard Specifications and shall be approved by the Engineer

The contractor shall show the estimated quantity of point bearing steel piles on the design drawings submitted for approval. If the actual quantity of steel piles driven differs more than 10% from this approved quantity because of variation in the rock line, the cost of the retaining wall will be increased or decreased accordingly based on the contract bid price,

or in the absence of a bid item, a unit price of thirty five (35) dollars per linear foot, for the adjusted piling quantity.

If the Engineer orders changes in the work which alters the exposed surface area of the wall without increasing the height of the wall, payment will be increased or decreased accordingly based on the square foot bid price. If the Engineer orders changes in the work which increases the height of the wall, the unit price bid for the wall sections that were increased up to a maximum of 10 feet will be adjusted according the following tables. Adjustments exceeding 10 feet will be made by supplemental agreement.

RETAINING WALL COST ADJUSTMENT FACTORS

Level Backfill with Slope <= 3 : 1 (Run : Rise)

Original Height (ft.) \ Height Increase (ft.)	1	2	3	4	5	6	7	8	9	10
10	1.01	1.02	1.04	1.06	1.08	1.10	1.13	1.16	1.20	1.24
11	1.01	1.03	1.05	1.07	1.09	1.12	1.16	1.19	1.22	1.26
12	1.02	1.03	1.06	1.08	1.11	1.14	1.17	1.21	1.25	1.29
13	1.02	1.04	1.06	1.09	1.12	1.15	1.19	1.23	1.27	1.31
14	1.02	1.04	1.07	1.10	1.13	1.17	1.21	1.25	1.29	1.34
15	1.02	1.05	1.08	1.11	1.14	1.19	1.22	1.26	1.31	1.36
16	1.03	1.05	1.08	1.12	1.16	1.19	1.24	1.28	1.33	1.38
17	1.03	1.05	1.09	1.13	1.16	1.21	1.25	1.29	1.34	1.40
18	1.03	1.06	1.10	1.13	1.17	1.22	1.26	1.31	1.36	1.41
19	1.03	1.06	1.10	1.14	1.18	1.22	1.27	1.32	1.37	1.42
20	1.03	1.07	1.11	1.15	1.19	1.23	1.28	1.33	1.38	1.44
21	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.34	1.39	1.45
22	1.04	1.07	1.11	1.15	1.20	1.25	1.29	1.35	1.40	1.45
23	1.04	1.07	1.12	1.16	1.20	1.25	1.30	1.35	1.41	1.46
24	1.04	1.08	1.12	1.16	1.21	1.25	1.30	1.36	1.41	1.47
25	1.04	1.08	1.12	1.16	1.21	1.26	1.31	1.36	1.41	1.47
26	1.04	1.08	1.12	1.17	1.21	1.26	1.31	1.36	1.42	1.47
27	1.04	1.08	1.12	1.17	1.21	1.26	1.31	1.37	1.42	1.48
28	1.04	1.08	1.12	1.17	1.22	1.26	1.31	1.37	1.42	1.48
29	1.04	1.08	1.12	1.17	1.22	1.26	1.31	1.37	1.42	1.48
30	1.04	1.08	1.12	1.17	1.22	1.26	1.31	1.37	1.42	1.48
31	1.04	1.08	1.12	1.17	1.22	1.26	1.31	1.37	1.42	
32	1.04	1.08	1.12	1.17	1.22	1.26	1.31	1.36		
33	1.04	1.08	1.12	1.17	1.22	1.26	1.31			
34	1.04	1.08	1.12	1.17	1.21	1.26				
35	1.04	1.08	1.12	1.17	1.21					
36	1.04	1.08	1.12	1.17						
37	1.04	1.08	1.12							
38	1.04	1.08								
39	1.04									

RETAINING WALL COST ADJUSTMENT FACTORS

Sloping Backfill with Slope > 3 : 1 (Run : Rise)

Original Height (ft.) \ Height Increase (ft.)	1	2	3	4	5	6	7	8	9	10
10	1.03	1.07	1.11	1.16	1.22	1.28	1.35	1.43	1.51	1.60
11	1.04	1.08	1.13	1.18	1.25	1.31	1.39	1.47	1.56	1.65
12	1.04	1.09	1.14	1.20	1.27	1.34	1.42	1.50	1.59	1.69
13	1.05	1.10	1.15	1.22	1.29	1.36	1.44	1.53	1.62	1.72
14	1.05	1.10	1.16	1.23	1.30	1.38	1.46	1.55	1.65	1.75
15	1.05	1.11	1.17	1.24	1.32	1.40	1.48	1.57	1.67	1.77
16	1.06	1.12	1.18	1.25	1.33	1.41	1.49	1.59	1.68	1.78
17	1.06	1.12	1.19	1.26	1.33	1.42	1.50	1.59	1.69	1.79
18	1.06	1.12	1.19	1.26	1.34	1.42	1.51	1.60	1.70	1.80
19	1.06	1.12	1.19	1.27	1.34	1.42	1.51	1.60	1.70	1.80
20	1.06	1.13	1.19	1.27	1.34	1.43	1.51	1.60	1.69	1.79
21	1.06	1.13	1.19	1.27	1.34	1.42	1.51	1.60	1.69	1.79
22	1.06	1.13	1.19	1.27	1.34	1.42	1.51	1.59	1.68	1.78
23	1.06	1.13	1.19	1.27	1.34	1.42	1.50	1.59	1.68	1.77
24	1.06	1.13	1.19	1.26	1.34	1.41	1.50	1.58	1.67	1.76
25	1.06	1.12	1.19	1.26	1.33	1.41	1.49	1.57	1.66	1.74
26	1.06	1.12	1.19	1.26	1.33	1.40	1.48	1.56	1.64	1.73
27	1.06	1.12	1.19	1.26	1.32	1.40	1.47	1.56	1.63	1.72
28	1.06	1.12	1.18	1.25	1.32	1.39	1.46	1.54	1.62	1.70
29	1.06	1.12	1.18	1.25	1.31	1.39	1.46	1.53	1.61	1.69
30	1.06	1.12	1.18	1.24	1.31	1.38	1.45	1.52	1.60	1.67
31	1.06	1.11	1.17	1.24	1.30	1.37	1.44	1.51	1.58	
32	1.06	1.11	1.17	1.23	1.30	1.36	1.43	1.50		
33	1.05	1.11	1.17	1.23	1.29	1.36	1.42			
34	1.05	1.11	1.17	1.22	1.29	1.35				
35	1.05	1.11	1.16	1.22	1.28					
36	1.05	1.10	1.16	1.22						
37	1.05	1.10	1.16							
38	1.05	1.10								
39	1.05									

Appendix A
Approved Systems

The following wall systems/suppliers have been approved for use on TDOT projects. All approved systems are also found in QPL 38 Retaining Wall Systems:

SECTION A BIN/CRIB/PRECAST GRAVITY WALLS

Doublewal Corporation
7 West Main Street
Plainville, CT 06062
Telephone: (860) 793-0295
Fax: (860) 793-2119
Website: www.doublewal.com

Evergreen Wall
Permatile Concrete Products
P.O. Box 2049
100 Beacon Road
Bristol, VA/TN 24203
Telephone: 1 (800) 662-5332
Fax: 1 (276) 669-2120
Website: www.permatile.com

PRECAST CONCRETE GRAVITY WALL
Redi-Rock Retaining Wall (Unreinforced only)
Redi-Rock International
05481 US 31 South
Charlevoix, MI 49720
Telephone: (866) 222-8400
Fax : (231) 237-9521
Website: www.redi-rock.com or www.redi-rocktn.com for Tennessee contact info

SECTION B GABION WALLS

MANUFACTURER

MACCAFERRI-USA
10303 Governor Lane Boulevard
Williamsport, MD 21795-3116
Telephone: (301)223-6910
Fax: (301)223-6134
Website: www.macaferri-northamerica.com

TERRA AQUA
1415 North 32nd Street
Fort Smith, AR 72904
Telephone: (800) 736-9089
Fax: (775) 828-1394
Website: www.terraaqua.com

SECTION C MECHANICALLY STABILIZED EARTH WALL (SEGMENTAL, PRECAST FACING)

MANUFACTURER

REINFORCED EARTH WALL
Retained Earth Wall (Formerly by Foster Geotechnical)
Reinforced Earth Company
25 Technology Parkway South, Suite 100
Norcross, GA 30092
Telephone: (770) 242-9415
Fax: (770) 242-9758
Website www.reinforcedearth.com

ARES SEGMENTAL PRECAST RETAINING WALL SYSTEM
Tensar Earth Technologies, Inc.
5883 Glenridge Drive
Suite 200
Atlanta, GA 30328
Telephone (404) 250-1290
Fax (404) 250-0461
Website www.tensarcorp.com

SineWall
SineWall, LLC
7162 Liberty Centre Drive, Suite 105
West Chester, Ohio 45069
Contact: Tim Brereton
Phone: 513 759-2345
Fax: 513 297-7930
Email: breretont@sinewall.com,
Web site: www.sinewall.com
Note: SineWall is currently conditionally approved for use on TDOT projects for retaining walls where an MSE Segmental Facing is an acceptable wall type and the wall(s) for the project are less than 25 feet in height (measured from top of wall to front of wall finished ground line) and the total estimated wall surface area for all MSE wall(s) for the project totals less than 10,000 square feet.

SSL MSE PLUS™ RETAINING WALL SYSTEM
SSL, LLC
4740 Scotts Valley Drive, Suite E
Scotts Valley, CA 95066
Telephone: (831) 430-9300
Fax: (831) 430-9340
Website www.mseplus.com

TRICON RETAINED SOIL WALL SYSTEM
TRICON Precast, LTD
15055 Henry Road
Houston, Texas 77060
Telephone: (281) 931-9832
Fax: (281) 931-0061
Website: www.triconprecast.com

SECTION D MECHANICALLY STABILIZED EARTH WALL (MODULAR BLOCK FACING)

MANUFACTURER

Allan Block AB Commercial Wall
Red River Concrete Products
4235 Guthrie Highway
P.O. Box 30399
Clarksville, Tn. 37040
Contact: Mike Brewer
Phone: 931 647-3308
Fax: 931 553-0534

Email: mbrewer@redriverproducts.com
Website: www.allanblock.com
Note: Allan Block AB Commercial Wall is currently conditionally approved for use on TDOT projects for retaining walls where an MSE Modular Block Facing is an acceptable wall type and the wall(s) for the project are less than 25 feet in height (measured from top of wall to front of wall finished ground line) and the total estimated wall surface area for all MSE wall(s) for the project totals less than 10,000 square feet.

MESA Wall System
Tensar Earth Technologies, Inc.
5883 Glenridge Drive
Suite 200
Atlanta, GA 30328
Telephone (404) 250-1290
Fax (404) 250-0461
Website: www.tensarcorp.com

KEYSYSTEM I
Contech Construction Products
9025 Centre Pointe Drive, Suite 400
Westchester, OH 45069
Telephone: 1(800) 338-1122
Website: www.contech-cpi.com

LANDMARK REINFORCED WALL SYSTEM
Anchor Wall Systems
5959 Baker Road, Suite 390
Minnetonka, Minnesota 55345-5996
Telephone: (952) 933-8855
Website: www.anchorwall.com

VERSA-LOK RETAINING WALL SYSTEM
Kiltie Corporation
6348 Highway 36 Blvd., Suite 1
Oakdale, MN 55128
Telephone: (651) 770-3166
Local Contact – Chris Lazarides – (865) 363-5052
Website: www.versa-lok.com

SECTION E ANCHOR WALLS

MANUFACTURER

Berkle & Company Contractors, Inc.
Atlanta Regional Office
7300 Marks Lane
Austell, GA 30168
Telephone: (770) 941-5100
Fax: (770) 941-6300

Coastal Drilling East, LLC
70 Gum Springs Road
Morgantown, WV 26508
Telephone: (304) 296-1120
Fax: (304) 296-1569

F & W Construction
1225 Johnson Ferry Road, Suite 230
Marietta, GA 30068
Telephone: (770) 973-9091
Fax: (770) 973-9015

Goettle
12071 Hamilton Ave.
Cincinnati, OH 45231
Telephone: (513) 825-8100
Fax: (513) 825-8107

Hayward-Baker, Inc.
P.O. Box 6
Hermitage, TN 37076
Telephone: (615) 883-6445
Fax: (615) 883-6418
Website: www.haywardbaker.com

The Judy Company
8334 Ruby Avenue
Kansas City, KS 66111
Telephone: (913) 422-5088
Fax: (913) 422-5307

Schnabel Foundation Company
1654 Lower Roswell Road
Marietta, GA 30068
Telephone: (770) 971-6455
Fax: (770)977-8530
Website: www.schnabel.com

Nicholson Construction Company
P.O. Box 7
2117 Immel Mine Road
Mascot, TN 37806
Telephone: (865) 933-3111
Fax: (865) 933-1652
Website: www.nicholsonconstruction.com

STATE OF TENNESSEE

(Rev. 12-18-1995) March 1, 2006

SPECIAL PROVISION

REGARDING

SECTION 730 – TRAFFIC SIGNALS

Delete Subsection 730.05 and add the following:

730.05-Working Drawings. The contractor shall provide detailed technical circuit description and circuit schematic information applicable to the operation and maintenance of the controller and associated auxiliary equipment. Cabinet wiring diagrams with interconnection details, schematics, and maintenance techniques shall be furnished. Information in manual form shall include a materials guide which shall contain the replacement part numbers and description of all components used. All solid-state devices shall be listed by their generic name or in lieu of this, a complete cross-index from manufacturers' numbers to generic number shall be provided and shall be identified on all printed circuit boards or other mounting locations. Parts lists shall be itemized with the respective chassis, module, or circuit wherein parts may be found. A total listing of parts without grouping shall not be acceptable. Schematic circuit drawings shall be furnished that are slow to fade when exposed to sunlight over long periods of time. A developed and fixed printing process, or one of the forms of printing by actual ink transfer, will be acceptable.

Two (2) copies of all the above information shall be provided with the controllers. In addition, three (3) copies of a cabinet wiring diagram, including all auxiliary equipment, shall be supplied with each controller unit. A clear, resealable plastic envelope shall be attached with screws to the inside of each cabinet door for storage of the cabinet wiring prints. This envelope shall be mounted so as to avoid restriction of the circulation of air into and out of the cabinet.

Delete Subsection 730.07 and add the following:

730.07-Training. The Contractor shall provide (with manufacturer personnel), as part of the contract of the signals, a minimum of twenty-four (24) hours of classroom and laboratory instruction on the operation and maintenance of each separate type of controller supplied for three (3) City of Memphis technicians. Instructions shall be on a highly technical level, describing the design and operation of electronic circuitry in great detail as well as demonstrating troubleshooting and repair techniques. The rudiments of dial systems and basic solid-state theory are below the level of the instruction required by this specification. This instruction shall begin at a time requested by the City and approved by the Engineer, and shall be conducted at facilities provided by the Contractor.

Add the following to Subsection 730.16:

Cable Hangers

All cable and conductors running in a pole shall be hung with a strain relief hanger-gripper from the "J" hook in the top of the pole before leaving or after entering the pole through a weatherhead, entering a Mast arm, signal head, push button, or controller cabinet. Cable(s) entering or leaving via the pole foundation shall be hung in a strain relief hanger-gripper if the cable(s) rises more than 2.5 meters (8 feet) above the foundation. The cable and conductors shall be in one or more hanger-grippers with the gripper distributing the weight over a minimum of 300 millimeters(one foot).

Entry Bushings

All entry or exit points through field-drilled holes in poles, pedestals, or mast arms at the point of attachment of vehicle or pedestrian heads shall be tapped and shall have a threaded PVC stub extending 50 millimeters (2 inches) beyond the outside surface to protect the cable and conductors from sharp edges or corners and to maintain cable alignment, in conformance with the Plans.

Delete Subsection 730.19 and substitute the following:

The sealant is intended to protect the detector loop wire against ambient environment and roadway conditions.

General:

1. The sealant shall be a one-part electrometric compound requiring no mixing, measuring or application of heat prior or during its installation.
2. The sealant must provide compressive yield strength to withstand normal vehicular traffic as well as sufficient flexibility to withstand normal movement in asphalt and concrete road pavement.
3. The sealant shall have flow characteristics which insure complete encapsulation of the wires.
4. The sealant shall not run out of the detector saw-cut in sloped areas during or after application.
5. The sealant shall enable vehicular traffic to pass over the properly filled saw-cut immediately after installation.
6. The cured sealant shall be landfill disposable in accordance with environmental protection agency requirements.
7. The sealant shall have the following physical properties:

Physical Properties of the Uncured (wet) Encapsulant

Property	Requirement	Test Procedure	ASTM Reference
a. Weight	1.2-1.27 kg/l (10.0-10.6 lbs/gal)	Kilograms/Liter (Weight/gallon)	D 1875
b. Total solids by Weight	75% min.	Determination of non-volatile content	D 2834
c. Viscosity	5,000-85,000 cps	Viscosity	D 1048B
d. Drying Time	Touch: 24 hrs. max.	Tack-Free Time	D 1640
e. Non-Flow	70% min.	Retention Test	---

Physical Properties of the Cured Encapsulant

Property	Requirement	Test Procedure	ASTM Reference
a. Hardness (Indentation)	60-85	Rex hardness	D 2240
b. Tensile Strength	5515 kPa min. (800 psi min.)	Tensile and Elongation	D 412A
c. Elongation at Break	400-700%	Tensile and Elongation	D 412A

Delete Subsection 730.24 and add the following:

730.24-Signal Heads. The Contractor shall provide and install vehicle and pedestrian signals as shown on the Plans. Each signal face shall consist of one or more signal sections, each containing an optical unit, lens, main housing, door and visor and designed and constructed so as to fit rigidly and securely together, one above the other to present a clean appearance and provide a weathertight enclosure for the optical and electrical equipment. These signal heads shall meet the requirements of the latest Institute of Transportation Engineers Standards for "Adjustable Face Vehicle Traffic Control Signal Heads," the "Adjustable Face Pedestrian Signal Head Standard," the National Electrical Code, and the Manual on Uniform Traffic Control Devices where applicable. Each signal head assembly shall be supplied complete with an incandescent traffic signal lamp bulb and ready for operation with the connection of field wiring. Signal heads shall be covered or "bagged" on installation until all work at the intersection has been completed, tested, accepted, and the signal turned on for traffic. At the time of turn-on of the signal, any old signals shall be covered or immediately removed.

Materials

The housing and door of each signal section shall be fabricated from corrosion-resistant U.V. stabilized Polycarbonate resin material. The moldings shall be a minimum of 2.3 millimeters (0.090 inches) thick and be ribbed for additional strength at point of high stress. Additional thickness shall be provided as necessary to eliminate light transmission through the housing, door, visor, or backplate.

Visors and backplates shall be fabricated from corrosion-resistant U.V. stabilized Polycarbonate resin material. Visors shall have a 2.5 millimeters (0.100-inch) minimum thickness. Backplates shall have a 3.2 millimeters (0.125-inch) minimum thickness.

Construction

Wiring. Signal head leads shall be 0.82 square millimeter (No. 18 AWG) stranded with 105 degrees C Thermoplastic insulation. A separate white (common) lead shall be wired to each socket shell; and a colored lead, corresponding to the color code specified in the Plans, shall be wired to each socket terminal. Leads shall be of sufficient length to allow connection to the terminal block specified herein. Each complete signal head shall be provided with a minimum 4-point terminal block, properly mounted in a signal section. Stud type terminal blocks shall have not less than 6 millimeters (1/4") edge clearance to any portion of the stud. Exterior wiring shall have a 360 degree drip loop in advance of entering the head.

Housing. The housing of each section shall be a one-piece, corrosion-resistant, Polycarbonate resin molding with integral sides; top and bottom; free of voids, cracks, inclusions, or blow holes; and furnished with provisions for mounting of a backplate. The top and bottom of the housing shall have an opening 50 millimeters (2-inches) in diameter to accommodate standard 38 millimeter (1-1/2 inch) pipe, with no other opening in the top or bottom of the housing. Individual signal sections shall be fastened together, one above the other into a complete signal face, by means of plated nuts, bolts, and washers in such a manner that any section may be rotated about a vertical axis and positioned at an angle with respect to an adjacent section. The opening hub shall have 72 circumferential serrations to secure each section in its orientation, adjustable in 5-degree increments, and prevent its inadvertent rotation. A six-position labeled barrier terminal block shall be provided in each signal face for the purpose of field connections. The barrier terminal shall be installed in the circular yellow or yellow arrow section of each signal face. If the face has neither of these sections, the terminal block shall be installed in the uppermost section of the head. There shall be provisions for the attachment of a 6 millimeters (1/4-inch) tether line to the bottom of each span wire-mounted signal head employing a wire rope clip (Crosby #G450, Oliver #9072, Chance #6480 or equal) attached to the pinnacle. A pinnacle shall be provided to close all 50 millimeter (2-inch) openings in each housing which will not otherwise be sealed from the weather when installed with the specified mounting hardware.

Door. The housing door of each signal section shall be a one-piece, corrosion-resistant Polycarbonate resin molding; free of voids, cracks, inclusions, or blow holes. The outer face of the door shall have four (4) holes equally spaced about the circumference of the lens opening to accommodate the secure mounting of the signal head tunnel visor. The visor shall fit flush against the door, and no light shall leak between the door and the visor. Two stainless-steel hinge pins shall attach the door to the housing, one in the upper left corner and one in the lower left corner of the door. To stainless-steel wing nuts or screws, one in the upper right corner and one in the lower right corner of the door, shall be used for opening the door and closing it tight against the housing. The wing screws or nuts shall be installed to prevent their accidental removal or falling out. The removal of the hinge pins and the operation of the wing nuts or screws shall not require the use of tools.

Optical System. The optical system shall consist of a lens, reflector, and lamp socket. The system shall be designed to minimize sun phantom and eliminate light spillover. Prefocused, incandescent lamps shall be the light source for all signals. Signal lamps for 200 millimeter (8 inch) lenses shall be clear, 595 rated initial lumen output, with a minimum life of 6,000 hours. Signal lamps for 300 millimeter (12 inch) lenses shall be clear, 1750 rated initial lumen output, with a minimum life of 6,000 hours. All vehicle signal lenses shall be glass and shall conform to the latest standards of the Institute of Transportation Engineers and American National Standards Institute optical specification. All reflectors shall be of ALZAK aluminum construction. The lamp socket shall be of Bakelite construction. Lamp replacement shall be accomplished without the use of tool or the removal of the lens or reflector. The socket shall be fixed-focus and permit its rotation a full 360 degrees to any position to orient bulb filament openings. The socket shall be securely held in the reflector so as not to loosen, rotate, or fall out under vibration of traffic and wind movement of the signal head. The lamp socket shall be provided with two coded 0.82 square millimeter (#18 AWG) copper wire leads. The leads shall be fitted with insulated spade wire terminals and be of sufficient length to make field connections at the barrier terminal block.

The vehicular and pedestrian signal lens, signal lamp socket, and reflector shall form a sealed module with molded neoprene gaskets holding the sealed optical module securely in the signal door. The gasket shall provide a seal to prevent moisture, dust, and road film contamination from entering the optical module and the signal housing.

Visors. Each signal door shall be fitted with a corrosion-resistant Polycarbonate resin tunnel visor. 200 millimeter (eight-inch) signals shall have visors a minimum of 175 millimeters (7-inches) long; 300 millimeter (12-inch) signals shall have visors a minimum of 240 millimeters (9-1/2 inches) long. The visor shall be flat black inside and outside. The visors shall be attached to the door at four equally spaced locations with four plated screws or four bayonet-type self-locking tabs integrally formed with the visor. The visor shall be preformed into a fixed cylindrical shape of the proper diameter to be installed around the lens.

Directional Louvers. Where shown on the Plans, louvers shall be furnished and installed in the hoods of the signal head sections designated.

Directional louvers shall be so constructed as to have a snug fit in the signal hoods. The outside cylinder and vanes shall be constructed of a non-ferrous metal or galvanized sheet steel. Louvers shall be painted with two coats of black enamel as specified in these specifications.

Backplate. Each signal head assembly, so required by the Plans, shall be equipped with a backplate with a minimum width of 125 millimeters (5-inches) with rounded corners. Stainless-steel screws shall be provided for mounting to the signal housing. The backplate shall consist of one or more pieces fabricated from corrosion-resistant, flat Polycarbonate resin material colored flat black front and back.

Legends. Pedestrian heads shall be fitted with lenses that, when illuminated, shall provide a Portland Orange "DONT WALK" in the top section and a Lunar White "WALK" in the bottom section, all conforming to the I.T.E. Standard for "Adjustable Face Pedestrian Signal Heads." The remainder of the lens shall be black and opaque. When not illuminated, the legends shall not be distinguishable.

Traffic signal lenses shall be circular, red, yellow, or green in color and 200 or 300 millimeter (8-inch or 12-inch) nominal diameter, as specified. No legend shall be permitted. Arrow lenses shall be circular, 300 millimeters (12-inches) in diameter, green or yellow in color, and be opaque except for the arrow legend. If an arrow lens is only applicable for one orientation; i.e., left, straight, or right, this information shall be indicated in a permanent and appropriate manner on the lens but without impairing the optical properties of the lens.

Mounting Hardware. Spanwire suspension fitting with cable entrance shall be a one piece malleable iron casting, minimum wall thickness 5 millimeters (3/16-inch), and free of flash and voids. The cable entrance shall have a plastic bushing with a minimum inside diameter of 32 millimeters (1-1/4 inches). The suspension fitting shall provide six separate, clevis pin positions for balancing the signal assembly. The thickness of the solid casting in this suspension area shall be a minimum of 16 millimeters (5/8-inch). A hex head threaded malleable iron lock nipple shall be provided for attaching the signal head to the bottom of the suspension fitting for one-face signals or to the top bracket of multiface signal brackets.

The mounting hardware for each signal face shall include a nylon, serrated, 72-tooth lock ring with full locking pins and a circular neoprene gasket for weather sealing.

All openings in signal heads, top or bottom which are not otherwise utilized for signal mounting, shall be closed with a hex ornamental pinnacle assembly complete with circular neoprene gasket and malleable iron hex lock nut. No conduit lock nuts are permitted.

Spanwire Suspension Clamp Assembly, where required, shall consist of a galvanized, malleable iron spanwire clevis saddle, 16 millimeters (5/8-inch) diameter plated steel clevis pin with cotter key, two 13 millimeters (1/2-inch) plated steel "U" bolts with nuts and washers (no "J" bolts are permitted), and a galvanized malleable iron cable locking bar, all fitted to the diameter of the guy span as specified in the Plans. Galvanizing to meet ASTM A 153.

Balance Adjustor required for each spanwire suspended signal head shall be supplied with a malleable iron balance adjustor complete with steel I-bolt and steel clevis pin with cotter key to be installed between the spanwire suspension clamp and the suspension fitting with cable entrance.

Brackets, where required, shall consist of a malleable iron center outlet body, schedule 40 pipe, elbows, serrated fittings, and other hardware as required to provide a multiface signal head assembly with internal wiring raceways to each face as specified.

Spanwire Bottom Bracket, where required, shall consist of 65 x 3 millimeter (2-5/8" x 1/8") steel brace with an arm fitted with a pinnacle, neoprene washer, and malleable iron hex lock nut for each signal face to be accommodated (conduit lock nuts not acceptable). An attachment fitting for 6 millimeter (1/4-inch) tetherwire shall be mounted at the center of the bracket.

Polycarbonate Side of Pole Bracket, where required, shall be one-piece molding with internal wiring raceway for banding or lag screw attachment to steel or wood poles. Brackets shall be designed to withstand 160 km per hour (100 mph) wind loading on it and the signal head. Each bracket shall have an integrally molded 72-tooth serrated ring for signal head positioning and come complete with 38 millimeter (1-1/2 inch) nipple, hex lock nut, pinnacle, neoprene washer, and one 1/4-inch interlocking shim for plumbing signals.

Elevator Plumbizer, where required, shall be malleable iron or bronze alloy for mast arm installation, with internal wire raceway, sized to fit a 38 millimeter (1-1/2 inch) tenon, complete with three set screws and one through bolt with nuts and lock washer, complete with serrations to lock signal position to be installed between the red and yellow signal sections.

Slip Fitter Collar, where required, for top post mounting shall be malleable iron, including one vertical 38 millimeter (1-1/2 inch) nipple with hex lock nut; two 38 millimeter (1-1/2 inch) threaded horizontal entrances; and three set screws for attachment to the post. All horizontal entrances not used for attaching signal brackets shall be closed with a pinnacle and neoprene washer.

Color, Finish, and Painting

Polycarbonate resin hardware shall have color impregnated throughout the material. The finish shall be smooth and unflawed. Signal head parts shall be colored as follows:

a. Vehicle Head:

Housing - Federal Yellow
Door - Flat Black
Tunnel Visor - Flat Black inside and out
Backplate - Flat Black front and back
Pole Bracket - Federal Yellow

b. Pedestrian Head:

Housing - Federal Yellow
Door - Black
Tunnel Visor - Flat Black inside and out
Pole Bracket - Federal Yellow

All metal hardware, except those specified as galvanized, plated, or stainless steel shall be painted Federal Yellow. The metal parts shall be painted with a primer coat and a finish coat of the best quality oven-baked enamel. Lenses, reflectors, gaskets, and Polycarbonate parts shall not be painted.

Signal Head Installation - Signal heads shall be installed with the faces completely covered until the entire installation is ready for operation.

Delete the section under Controller Cabinets in Subsection 730.25 and substitute the following:

Cabinet

Cabinets shall be provided for each controller installed by the Contractor. The cabinet Installed by the Contractor shall be equipped with a radio interference filter installed at the electric service line input. The filter shall provide a minimum electrical noise attenuation of 50 decibels over the range of 200 kilohertz to 75 megahertz.

Surge Protection. The controller assembly shall conform to requirements of NEMA TS 1, part 2 - "Environmental Standards and Test Procedures". No cabinet surge protection or line filters shall be considered in providing the required transient protection of NEMA Part 2 (Reference note on NEMA Part 2, Page 6, Figure 2-2). Each 120 VAC electromechanical relay in the cabinet, flash transfer, signal monitor, etc., shall be suppressed with a 150-volt, 20-amp Varistor across it to ground.

The Cabinet AC service must be provided with the following surge protection:

1. Unit must be a series hybrid type rated at 20,000 amps (8 x 20 microsecond) 20 times.
2. The protector must be provided with terminals as defined below:

   a. Main line (AC line first stage terminal)
   b. Main neutral (AC neutral input terminal)
   c. Equip line in (AC line second stage input terminal, 10 amps)
   d. Equip line out (AC line second stage output terminal, 10 amps)
   e. Equip neutral out (neutral terminal to protected equipment)
   f. GND (earth connection)

3. The equip line in and quip line out terminals must be separated by a 200 microhenry (minimum) inductor rated to handle 10 amps AC service.
4. The first stage clamp must be between main line and GND terminals.
5. The second stage clamp must be between equip line out and equip neutral.
6. Main neutral and equip neutral out are connected together internally and must have a gas discharge tube rated at 20 KA between main neutral and GND terminals.
7. Main line and equip line terminals are isolated internally.
8. If gas discharge tubes are utilized for the first stage clamps, each tube must have a minimum of 0.15 OHM follow-current limiters in series.
9. Peak clamp voltage; 350 volts at 20 KA (voltage measured between equip line out and equip neutral out terminals. Current applied between main line and GND terminals with GND and main neutral terminals externally tied together).
10. Response time: voltage in 9 above can never exceed 350 volts.
11. Protector must be epoxy encapsulated in a flame retardant material.
12. Continuous service current: 10 amps @ 120 VAC RMS.

Pin Connectors. Electrical connections between the control unit and the cabinet wiring harness(es) shall be accomplished using one or more "MS" type multiple pin connectors at the controller (NEMA type) and insulated spade wire terminal connectors at the cabinet terminal blocks. The pin connectors and function pin assignments shall be in accordance with Tables 1, 2, and 3. All functions developed within the control unit for existing or future expanded phasing, up to the maximum capability of the controller, shall be available at the cabinet terminals for greatest operational flexibility. All functions and pin assignments required by NEMA shall be provided as a minimum. Additional functions and features, either required by these specifications or offered by the manufacturer, shall be provided through the pin connector on otherwise spare positions.

TABLE 1

CONNECTOR A

Alphabetical Listing of Pin Assignments

Pin	Function	Pin	Function
A	Spare 1	f	Phase 1 Vehicle Call Det
B	+24V DC External	g	Phase 1 Ped Call Det
C	Voltage Monitor Output	h	Phase 1 Hold
D	Phase 1 Red Driver	i	Force Off Ring 1
E	Phase 1 Don't Walk Driver	j	Ext Min Recall All Phases
F	Phase 2 Red Driver	k	Manual Control Enable
G	Phase 2 Don't Walk	m	Call to Nonactuated I
H	Phase 2 Ped Clear	n	Test Input A
J	Phase 2 Walk	p	AC+
K	Phase 2 Vehicle Call Det	q	Spare 3
L	Phase 2 Ped Call Det	r	Coded Status Bit B Ring 1
M	Phase 2 Hold	s	Phase 1 Green
N	Stop Timing Ring 1	t	Phase 1 Walk
P	Inhibit Max Term Ring 1	u	Phase 1 Check
R	External Start	v	Phase 2 Ped Omit
S	Interval Advance	w	Omit All Red Clear Ring 1
T	Spare 2	x	Red Rest Mode Ring 1
U	AC-	y	Spare 4
V	Chassis Ground	z	Call to Nonactuated II
W	Logic Ground	AA	Test Input B
X	Flashing Logic Output	BB	Walk Rest Modifier
Y	Coded Status Bit C Ring 1	CC	Coded Status Bit A Ring 1
Z	Phase 1 Yellow	DD	Phase 1 On
a	Phase 1 Ped Clear	EE	Phase 1 Ped Omit
b	Phase 2 Yellow	FF	Ped Recycle Ring 1
c	Phase 2 Green	GG	Max 2 Selection - Ring 1
d	Phase 2 Check	HH	Spare 5
e	Phase 2 On		

TABLE 2

CONNECTOR B

Alphabetical Listing of Pin Assignments

Pin	Function	Pin	Function
A	Phase 1 Next	f	Phase 4 Next
B	Spare 1	g	Phase 4 Omit
C	Phase 2 Next	h	Phase 4 Hold
D	Phase 3 Green Driver	i	Phase 3 Hold
E	Phase 3 Yellow Driver	j	Phase 3 Ped Omit
F	Phase 3 Red Driver	k	Phase 6 Ped Omit
G	Phase 4 Red Driver	m	Phase 7 Ped Omit
H	Phase 4 Ped Clear Driver	n	Phase 8 Ped Omit
J	Phase 4 Don't Walk Driver	p	Overlap A Yellow Driver
K	Phase 4 Check	q	Overlap A Red Driver
L	Phase 4 Veh Call Det	r	Phase 3 Check
M	Phase 4 Ped Call Det	s	Phase 3 On
N	Phase 3 Veh Call Det	t	Phase 3 Next
P	Phase 3 Ped Call Det	u	Overlap D Red Driver
R	Phase 3 Omit	v	Spare 4
S	Phase 2 Omit	w	Overlap D Green Driver
T	Phase 5 Ped Omit	x	Phase 4 Ped Omit
U	Phase 1 Omit	y	Spare 5
V	Ped Recycle Ring 2	z	Max 2 Selection - Ring 2
W	Spare 2	AA	Overlap A Green Driver
X	Spare 3	BB	Overlap B Yellow Driver
Y	Phase 3 Walk Driver	CC	Overlap B Red Driver
Z	Phase 3 Ped Clear Driver	DD	Overlap C Red Driver
a	Phase 3 Don't Walk Driver	EE	Overlap D Yellow Driver
b	Phase 4 Green Driver	FF	Overlap C Green Driver
c	Phase 4 Yellow Driver	GG	Overlap B Green Driver
d	Phase 4 Walk Driver	HH	Overlap C Yellow Driver
e	Phase 4 On		

TABLE 3

CONNECTOR C

Alphabetical Listing of Pin Assignments

Pin	Function	Pin	Function
A	Coded Status Bit A Ring 2	i	Phase 5 Green Driver
B	Coded Status Bit B Ring 2	j	Phase 5 Walk Driver
C	Phase 8 Don't Walk Driver	k	Phase 5 Check
D	Phase 8 Red Driver	m	Phase 5 Hold
E	Phase 7 Yellow Driver	n	Phase 5 Omit
F	Phase 7 Red Driver	p	Phase 6 Hold
G	Phase 6 Red Driver	q	Phase 6 Omit
H	Phase 5 Red Driver	r	Phase 7 Omit
J	Phase 5 Yellow Driver	s	Phase 8 Omit
K	Phase 5 Ped Clear Driver	t	Phase 8 Veh Call Det
L	Phase 5 Don't Walk Driver	u	Red Rest Mode Ring 2
M	Phase 5 Next	v	Omit All Red Ring 2
N	Phase 5 On	w	Phase 8 Ped Clear Driver
P	Phase 5 Veh Call Det	x	Phase 8 Ped Green Clear Driver
R	Phase 5 Ped Call Det	y	Phase 7 Don't Walk Driver
S	Phase 6 Veh Call Det	z	Phase 6 Don't Walk Driver
T	Phase 6 Ped Call Det	AA	Phase 6 Ped Clear Driver
U	Phase 7 Ped Call Det	BB	Phase 6 Check
V	Phase 7 Veh Call Det	CC	Phase 6 On
W	Phase 8 Ped Call Det	DD	Phase 6 Next
X	Phase 8 Hold	EE	Phase 7 Hold
Y	Force Off Ring 2	FF	Phase 8 Check
Z	Stop Timing Ring 2	GG	Phase 8 On
a	Inhibit Max Termination Ring 2	HH	Phase 8 Next
b	Spare 1	JJ	Phase 7 Walk Driver
c	Coded Status Bit C Ring 2	KK	Phase 7 Ped Clear Driver
d	Phase 8 Walk Driver	LL	Phase 6 Walk Driver
e	Phase 8 Yellow Driver	MM	Phase 7 Check
f	Phase 7 Green Driver	NN	Phase 7 On
g	Phase 6 Green Driver	PP	Phase 7 Next
h	Phase 6 Yellow Driver		

TABLE 4

CONNECTOR D

Alphabetical Listing of Pin Assignments

Pin	Function	Pin	Function
1	TBC On Line (Sys Det #1)	20	Set Clock (Sp Status #5)
2	Dial A (Sys Det #7)	21	Dimmer (Sp Status #6)
3	Dial B (Sys Det #8)	22	Dial A (Sys Out 7)
4	Split A (Sys Det #5)	23	Dial B (Sys Out 8)
5	Split B (Sys Det #6)	24	Split A (Sys Out 5)
6	Offset 1 (Sys Det #2)	25	Split B (Sys Out 6)
7	Offset 2 (Sys Det #3)	26	Offset 1 (Sys Out 2)
8	Offset 3 (Sys Det #4)	27	Offset 2 (Sys Out 3)
9	Remote Flash	28	Offset 3 (Sys Out 4)
10	Preempt 1	29	Flash (Sys Out 1)
11	Preempt 2	30	Auxiliary 1
12	Preempt 3	31	Auxiliary 2 or any Preempt
13	Preempt 4	32	Auxiliary 3 or Det Reset
14	Conflict Flash Status	33	Logic Ground
15	Manual Flash Status	34	Optional Serial Comm. 1
16	Alt Seq A (Sp Status #1)	35	Optional Serial Comm. 1
17	Alt Seq B (Sp Status #2)	36	Optional Serial Comm. 2 Reserved-1
18	Alt Seq C (Sp Status #3)	37	Optional Serial Comm. 2 Reserved
19	Alt Seq D (Sp Status #4)		

Signal Conflict Monitor

All cabinets shall be supplied with a Signal Conflict Monitor (SCM) which meets the NEMA Standards. The SCM for all controller cabinets with three or more phases shall be the 12-channel type, and shall have the following features:

1. Liquid Crystal Display to show all data in English language format.
2. Shall monitor all Green/Yellow/Red/Walk field display outputs.
3. Shall monitor the Controller 24 VDC output and be user programmable to have this monitor function Latch on.
4. Shall monitor the Controller Voltage Monitor output, and be user programmable to have this monitor function Latch On.
5. Per Channel monitoring of Phase Yellow Clearance Interval, and shall cause flash operation if Yellow Clearance is less than the SCM programmed time (2.7 - 9 seconds).

6. Front panel mounted over-current protection (no internally mounted fuses are acceptable).
7. Front panel mounted reset switch.
8. Fault logging features:
   The SCM shall log all faults as to the:

   a. Date of fault
   b. Time of fault
   c. The fault condition
   d. Power failure

   and store these fault conditions in no-volatile memory for user retrieval. The monitor shall be able to store at least 9 such faults. The internal time clock shall automatically adjust for Daylight Savings Time changes. There shall be a keyboard method for the user to display and clear the stored event log.
9. There shall be an RS-232 port on the SCM to allow the user to print all data stored in the SCM. The printer shall interface with the SCM via a standard RS-232 cable. Printer to be supplied by others.
10. The SCM shall detect the following conditions and place the cabinet in the flash mode by De-energizing the Flash Transfer Relays:

    a. Absence of an active AC input on a channel
    b. Green/Yellow both active on a channel
    c. Yellow/Red both active on a channel
    d. Green/Red both active on a channel
    e. Green/Green active on conflicting channels
    f. Green/Yellow active on conflicting channels
    g. Green/Walk active on conflicting channels
    h. Low 24 VDC sample
    i. Controller Voltage Monitor active
    j. Clearance time less than programmed

11. On circuits where all field outputs are not used (such as left-turn phases) unused circuits shall be terminated at a load resistor and the monitor plus features shall function
12. No functional field display shall be permitted unless monitored by the SCM
13. The SCM sampling inputs shall be terminated at the closest tie point to the field termination

Cabinet Material

Pole mounted cabinets (required for two and three phase non-expandable controllers) shall be fabricated from cast aluminum or welded sheet aluminum or a combination of both. All welds shall occur on the inside surfaces of the cabinet to maintain a clean appearance.

Base mounted controller cabinets shall be installed as shown and fabricated from welded sheet aluminum or welded, copper bearing, 14 gauge (min.) sheet steel painted inside and out with zinc chromate primer and two coats of high grade aluminum paint. All welds shall occur on the inside surfaces of the cabinet to maintain a clean appearance.

1. Front Door.

   The cabinets shall have a right-hinged front-opening door, which shall include substantially the full area of the cabinet front and one auxiliary police door-in-door for access to emergency controls. The main door shall be equipped with a positive hold-fast device to secure the door in at least two open positions--one position being approximately 90 degrees open and the other at 120 degrees or more. The hold-fast device shall be easily secured and released without the use of tools. Each door shall be furnished with a neoprene rubber door sealing gasket to assure the weatherproof integrity of the cabinet doors when closed. The main cabinet door shall employ two or three heavy duty hinges which shall be welded to the cabinet and door with hinge pins of 6 millimeter (1/4-inch) diameter (minimum) stainless steel. No "piano" hinges or riveted construction shall be acceptable. The police panel door shall employ hinges meeting the above requirements.

2. Front Door Lock.

   The main door shall have a pin-tumbler cylinder lock, conforming to the City of Memphis Master Key as registered with the Corbin Lock Company. The Memphis Key Code shall be furnished with the approval of the equipment. The auxiliary police door shall be furnished with a standard police subtreasury lock. One (1) key for each lock shall be provided with each controller cabinet.

3. Frame.

   a. Base mounted cabinets shall be furnished for multi-phase controllers which have a frame capable of providing four (4) to eight (8) phases. All controllers supplied with railroad preemption equipment shall be furnished in base mounted cabinets. All hardware for mounting on a concrete foundation shall be furnished including Hot Dip Galvanized anchor bolts, nuts, washers, and template. All other controllers shall be furnished in pole-mounted cabinets.

   b. Pole mounted cabinets for two phase and three phase non-expandable controllers shall be equipped with brackets for stainless steel banding to either wood or steel pole mounting.

4. Ventilation.

All cabinets shall be furnished with a thermostatically operated, roof mounted electric exhaust fan. Pole mounted cabinet fans shall be capable of moving 5.6 cubic meters (200 cubic feet) of air per minute at cabinet temperature above 37 degrees C (100 degrees Fahrenheit). Base mounted cabinets shall have fans rated at 5.6 cubic meter per minute at 37 degrees C (200 CFM at 100 F). The fan shall be equipped with long lasting permanently lubricated bearings for constant unattended operation. The exhaust fan shall be mounted in a rain-tight housing attached to the cabinet top. The thermostat shall be adjustable from 20° C to 70° C (70° F to 160° F).

For pole and base mounted cabinets the inlet ventilation openings, located in the lower part of the cabinet, shall be screened and fitted with a fiberglass, furnace-type, replaceable air filter of adequate size and capacity to pass a volume of air equal to or greater than the rated capacity of the fan. The air filter supplied shall be a type and size which is readily available commercially.

5. Dimensions.

All cabinets for the controllers shall be consistent with the following minimum and maximum dimensions and equipment locations:

a. Top Shelf positioned to allow a minimum of 100 millimeters (4-inches) above controller to top of cabinet and 100 millimeters (4-inches) on each side of controller to the sides of the cabinet.
b. Second Shelf positioned approximately 200 millimeters (8 inches) below the top shelf to allow for a 150 millimeter (6-inch) high amplifier with a 50 millimeter (2-inch) space between top of amplifier and bottom of top shelf
c. Width of Cabinet must allow at least 50 millimeters (2-inches) clearance on each side of the set of amplifiers from the terminal strips mounted on the sides of the cabinet.
d. Third Shelf (optional) required if the top and second shelves will not accommodate the conflict monitor, amplifiers, pre-emptor (if required), and other equipment as required. The third shelf shall allow for the same top and side clearances as on the second shelf.
e. Load Switches to be mounted below the bottom shelf at the left rear of the cabinet. With the load switches in their bases, a minimum clearance of 50 millimeters (2-inches) shall be maintained below the bottom shelf and from the terminal blocks mounted on the sides of the cabinet.
f. Field Connectors to be made at the bottom rear of the cabinet on horizontal terminal strips. Terminal strip blocks shall be positioned not less than 50 millimeters (2-inches) nor more than 100 millimeters (4-inches) from the cabinet bottom.

g. Field Loop Connections to be made on terminal strips located on the left wall of the cabinet below the bottom shelf.

h. Loop Amplifier Cabinet Connections to be made on terminal strips on the left watt of the cabinet at the same level as that of the loop amplifier shelf with connections available for AC+, AC-, logic common, and the appropriate input to the controller for each module.

i. Cabinet Power Connections to be made on the right wall of the cabinet below the bottom shelf and 50 to 100 millimeters (2 to 4-inches) above the bottom of the cabinet.

j. The Maximum Outside Dimensions of a base-mounted cabinet (exclusive of mounting flanges) shall not exceed 1425 millimeters (56-inches) in height, 1020 millimeters (40-inches) in width, and 760 millimeters (30-inches) in depth.

Other cabinet facilities shall be furnished as follows:

a. A minimum of two, fully adjustable metal shelves with brackets to support controller, signal monitor, detector amplifiers, and other accessory equipment. The shelves shall be capable of vertical adjustment through virtually the full height of the cabinet.

b. Electric service line terminals for 6-gauge copper with 30-ampere circuit breaker line protection.

c. 120-volt duplex convenience receptacle with separate 30- ampere circuit protection.

d. Insulated barrier terminals to be used for detector field connections, AC power supply for amplifiers, and controller inputs from amplifiers. Quantities of terminals shall be for the above connections as follows:

   2 phase controller - 24 terminal positions

   3 & 4 phase controllers - 36 terminal positions

   5 to 8 phase controllers - 48 terminal positions

e. Grounded neutral buss with multiple screw terminals for 12- gauge copper signal neutrals and 4-gauge copper earth connection.

f. Insulated barrier terminals (two positions per phase module) for connection of 12-gauge copper pedestrian detector field wires. A 36-volt ziner diode shall be installed across each pedestrian detector field terminal to ground.

g. Insulated barrier terminals (five positions per phase module) for connection of 12-gauge copper signal display field wires. A 150-volt, 20-amp Varistor shall be installed across each signal field terminal to ground.

h. Insulated barrier terminals (four positions) for connection of 12-gauge copper system interconnect lines. A 150-volt, 20-amp Varistor shall be installed across each system interconnect terminal to ground.

i. Insulated barrier terminals for internal wiring interconnection of all other cabinet accessories and circuitry.

j. All barrier terminal blocks shall consist of twelve (12) terminal pairs using a minimum ten 32-size screws with the minimum center-to-center distance between terminal pairs being 16 millimeters (5/8-inch). Terminal blocks shall be furnished with an engraved or indelibly printed numbering strip attached with screws to the terminal block. This type and size terminal block shall be provided for all applications including controller inputs and outputs, field connections, and detector connections.

k. A 120-vac, 20-watt, fluorescent Light fixture mounted on the cabinet ceiling at the front of the cabinet. Fixture shall employ #F20T12/CW20, 20-watt, fluorescent tube. An on-off switch for the light shall be mounted on the inside of the main cabinet door.

l. Detector micro-switches shall be provided for placing vehicular and pedestrian calls on each individual phase separately. A sufficient number of switches shall be provided to serve the maximum phase capability of the controller unit. All switches are to be permanently labeled and identified.

m. An on-off power switch shall be mounted on the inside of the main cabinet door to disconnect all equipment in the cabinet from the 120-vac service line current with the exception of the cabinet light and the duplex convenience receptacle.

n. An automatic/flashing switch shall be mounted on the inside of the main cabinet door to preempt the normal signal display and initiate the specified flashing display. The controller shall continue to operate during this flashing mode.

o. All cabinet wiring shall be neatly bundled and attached to the sides and back of the cabinet.

p. All cabinets shall be furnished with a police compartment accessible through the door-in-door. The back side of the compartment extending into the cabinet shall have all exposed electrical facilities enclosed in a protective housing. The police compartment shall be furnished as follows:

(1) On-off power switch to operate same as the main on-off switch, above.

(2) An automatic/flashing switch with a flashing position to permit the normal red, yellow, and green signal display to be preempted to the flashing operation. Power shall be removed from the controller unit during this flashing mode. Upon resuming automatic operation, the controller display shall be in the pre-programmed start-up orientation.

(3) A normal/manual switch so that, when in manual position, this switch shall stop the automatic sequence of the controller and hold the then existing display until manually advanced into the next interval. When in normal position, the automatic controller sequence shall continue.

(4) A miniature panel connector for connecting a detachable hand-held push button for manual operation. The connector shall have three (3) male pins and mate with a screw on type, coarse threaded, female connector plug.

(5) A high quality retractile cord with molded hand-held push button with attached connector plug for engaging the connector described above. The retractile cord shall be capable of an extension of 2.1 meters (7-feet) (minimum) and shall be stored in the police compartment when not in use.

6. Expansion.

The cabinet for four to eight phase controllers shall be furnished of sufficient size to accommodate the control equipment described, a coordinating unit, and eighteen (18) loop detector amplifiers The cabinet for two and three phase controllers shall be sized as above for eight (8) loop detector amplifiers and a coordinating unit.

The cabinet shall have provisions for all additional equipment associated with the future expansion to full functional capability, including but not limited to load switch bases, complete cabinet wiring, field connection terminals, and detector terminals.

Add the following to the end of Subsection 730.37:

Removal and Salvable Equipment. Utility companies will be responsible for the relocation and/or removal of their poles and equipment. The poles and equipment to be removed by the Contractor have been generally noted on the Plans; however, it is the intent of these Specifications to have the Contractor remove any traffic control-related equipment that is in conflict with the installation of the proposed equipment and deliver to the City of Memphis Traffic Signal Shop. All new or temporary signals, shall be removed and stockpiled in such a manner that the removed equipment will not be damaged. Poles shall be removed complete and undamaged. The pole shall be cleaned of any concrete foundation material. Any damage due to negligence on the part of the Contractor because of lack of proper care of equipment shall be cause for the Contractor to replace in kind. The cost of such replacement shall be borne fully by the Contractor without extra compensation. All such removed and salvageable equipment is now and shall remain the property of the City of Memphis.

STATE OF TENNESSEE

March 15, 2006
Project No.:
County:
Contract No.:

SPECIAL PROVISION

REGARDING

SEEDING WITH WOOD CELLULOSE FIBER MULCH

Description: This work shall consist of furnishing and placing seed, agricultural limestone, and wood cellulose fiber mulch material in accordance with the Standard Specifications for Road and Bridge Construction except as modified herein.

Materials:

Seed: Include Seed Mixes containing plant species mixed in accordance with the drawings. Seed application rates vary by Mix. Install in accordance with the drawings.

Agricultural limestone as required to amend soil and bring soil into conformance with the Specifications.

Wood cellulose fiber mulch for hydraulic seeding shall consist of specifically prepared wood cellulose processed into a uniform fibrous physical state. Wood cellulose fiber mulch shall be dyed green or contain a green dye in the package that will provide an appropriate color to facilitate visual inspection of the uniformly spread slurry. The fiber mulch, including dye, shall contain no germination or growth inhibiting factors. The mulch material shall be manufactured and processed in such a manner that the wood cellulose fiber mulch will remain in uniform suspension in water under agitation and will blend with seed, fertilizer and other additives to form a homogeneous slurry.

The manufacturer shall provide certification the wood cellulose fiber mulch conforms to the following:

Fiber or Particle Size		
Length		10.0 mm Max.
Thickness of Diameter		1.0 mm Approx.
Net Dry Weight Content	See "B" below	Min. stated on bag
pH Range	ASTM D778	4.0 – 8.5
Ash Content	ASTM D586	3.0 Max.

Water Holding Capacity	See "A" below	90% Min.

The mulch material shall contain no elements or compounds at concentration levels that will be phytotoxic.

The mulch material shall form a blotter-like ground cover, on application, having moisture absorption and percolation properties and shall cover and hold grass seed in contact with the soil without inhibiting the growth of the grass seedlings. The material shall be delivered in packages of uniform weight and shall bear the name of the manufacturer, the net weight, and a supplemental statement of the net dry weight content.

Tests:

A. Water Holding Capacity of Fiber Mulch

1. Scope

This method covers the procedure to be used in determining the water holding capacity of fiber mulch.

2. Apparatus

a. Scale, capable of weighing to nearest 0.1 gram
b. 200 mesh sieve – 8 X 2 in.
c. Cover for sieve – may be aluminum foil
d. Two 1000 ml graduated glass beakers
e. Pan – used to partially submerge sieve
f. Demineralized water
g. Sink and/or area free of drafts to drain sample

3. Procedure

a. Determine the total moisture content of fiber according to the following formula:

$$\% \text{ Moist.} = \frac{\text{Wet Wt.} - \text{Dry Wt.}}{\text{Wet Wt.}} \times 100$$

b. Weigh duplicate sample of "as-is" material equivalent to 12.0 grams of oven-dry fiber. Weigh to nearest 0.1 gram and place into a 1000 ml beaker. The equivalent weight can be determined by the following formula:

$$\text{"As-is" weight} = \frac{12.0}{1 - \frac{\% \text{ Moist.}}{100}}$$

c. Add 800 ml demineralized water to sample, stir and/or shake until thoroughly mixed. Allow to stand for 30 minutes.

d. Wet 200 mesh sieve. Cover top of sieve with aluminum foil or other material to retard evaporation. Prop sieve up at an angle of 30° - 45° and drain for 10 minutes. Remove cover and wipe excess water from outside rim of sieve and weigh immediately.

e. Place sieve in pan and pour fiber onto screen. Add sufficient water to float fibers inside of sieve. Stir, so that the fiber will form a uniform mat over the screen area. Carefully lift the sieve and mat from the water. Cover top to retard evaporation. Prop sieve up at an angle of 30° - 45°and drain for 10 minutes. Remove cover and wipe excess water from outside rim of sieve and weigh immediately.

f. Obtain net weight of wet mat by subtracting the screen weight from the total weight.

g. Calculate and report the water holding capacity by use of the following formula:

$$\% \text{ Water holding capacity} = \frac{\text{Net Wt. Wet Mat} - 12.0}{\text{Net Wt. Wet Mat}} \times 100$$

B. Moisture Content and Dry Weight of Fiber Mulch

1. Scope

This method covers the procedure to be used in determining the moisture content and dry weight of fiber mulch as packaged.

2. Apparatus

a. Scale, capable of weighing 100 lbs. (to nearest 0.1 pound)
b. Scale, capable of weighing to nearest 0.1 gram
c. Oven, capable of maintaining 212 ± 4°F.
d. (3) One gallon containers (Paint cans may be used)
e. (3) 200 mesh screens to cover containers

3. Procedure

a. Weigh bag of mulch as received. Use this weigh in Step H.

b. The moisture content should be determined from the average results of three (3) separate samples. Take one (1) sample each from the top, center, and bottom portions of the bag.

c. For each sample, loosely fill a one gallon container of known weight with mulch to approximately one (1) inch from the top.

d. Weigh immediately and cover the can with 200 mesh screen.

e. Dry in oven for 24 hours @ 212°F.

f. Cool to room temperature. Remove screen and weigh can and mulch.

g. % moisture is determined by the following formula:

$$\% \text{ Moisture} = \frac{A - B}{A - C} \times 100$$

Where: A = Original weight of can and mulch, in lbs.
B = Weight of can and dry mulch, in lbs., and
C = Weight of can, in lbs.

h. The total dry weight of the packaged fiber mulch is determined from the following formula:

$$\text{Dry Wt. of packaged product} = X - (X \times Y)$$

Where: X = Actual Wt. of mulch as packaged (Step A) in lbs. and

$$Y = \frac{\text{Avg. \% Moisture}}{100}$$

Compare with dry weight printed on bag.

Construction Requirements: The wood cellulose fiber mulch shall satisfactorily perform in hydraulic seeding equipment without clogging or damaging the system.

Wood cellulose fiber mulch shall be applied at a rate of approximately 35 pounds net dry weight per unit and shall be sprayed uniformly on the surface of the prepared seedbed.

Wood cellulose fiber mulch shall be held in place by an approved mulch binder conforming to one of the following:

a. Emulsified asphalt applied at the approximate rate of 4 gallons per unit as required to hold the mulch in place.

b. A non-toxic, degradable additive that will disperse in cold water to provide a homogenous lump-free solution which after application will cure to form a water insoluble, porous binder for the hay or straw mulch. The proportions of the additive and water mixture and the application thereof to the mulch shall be in accordance with the recommendations of the manufacturer.

The Contractor shall submit a sample of the additive to the Division of Materials and Tests for approval prior to use. Upon receipt of approval, the additive may be incorporated into the work.

Compensation: Measurement and payment shall be made in accordance with Subsections 801.09 and 801.10 of the Standard Specifications except that payment will be made under:

Item No.	Description	Pay Unit
801-01.05	Seeding with Wood Cellulose Fiber Mulch	Unit