**STATE OF TENNESSEE**
**DEPARTMENT OF TRANSPORTATION**
**Construction division**
**SUITE 700, JAMES K. POLK BUILDING**
**505 DEADERICK STREET**
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**JOHN C. SCHROER**
COMMISSIONER

**BILL HASLAM**
GOVERNOR

November 13, 2018

# ADDENDUM #3

**Re: I- 75 Interchange @I-24**
**Hamilton County**
**Contract No. DB1801**

**To Whom It May Concern:**
This addendum revises the RFP Contract Book 1, Book 2, and Book 3. Attached are the revised sheets.

You must acknowledge this addendum by completing the "Addendum Letter Acknowledgement form C and the Technical Proposal Signature Page (Form TPSP) within your Technical Proposal. It is the bidder's responsibility to notify all affected manufacturers, suppliers and subcontractors of this change.

Sincerelv.

Lia Baird

Assistant Director of Construction
Construction Division

# DESIGN-BUILD
# RFP CONTRACT BOOK 1
# INSTRUCTIONS TO
# DESIGN-BUILDERS (ITDB)

**TENNESSEE DEPARTMENT OF TRANSPORTATION**

**Interstate I-75 at Interstate I-24 Interchange Modification**

**Hamilton County- TENNESSEE**

**CONTRACT NUMBER: DB1801**

**July 27, 2018**

**Addendum #1 August 24, 2018**

**Addendum #2 September 26, 2018**

**Addendum #3 November 13, 2018**

## *4. RESPONSE CATEGORY IV: TECHNICAL SOLUTIONS*

Submit as much of the following for Evaluation on form Response Category IV form in **Appendix A**(be as specific as possible):

a. It is not the intent of the Department for the Design-Builder to submit design plans. The details submitted shall be of sufficient detail to illustrate color, texture, pattern, emblems, proportion, corridor consistency, complementing details, or other such visual effects. For those details used in multiple locations, typical details will suffice with the locations for their use noted in narrative or graphic form.

b. Conceptual plans, drawings, etc. within the Technical Proposal (these plans are in addition to and are separate from the ROW Acquisition sheets required in **Contract Book 3 (Project Specific Information)**) shall include at a minimum the following:
   - Show plan view of design concepts with key elements noted.
   - Show preliminary drawing of bridge elements.
   - Identify preliminary horizontal and vertical alignments of all roadway elements.
   - Show typical sections for the mainline of the Project.
   - Identify drainage modifications and designs to be implemented.
   - Identify the appropriate design criteria for each feature if not provided.
   - Identify all bridge types to be constructed, including any special design features or construction techniques needed.
   - Identify any deviations or proposed design exceptions, from the established design criteria that will be utilized. Explain why the deviation is necessary.
   - Describe any geotechnical investigations to be performed by the Design-Builder.
   - Describe how any utility conflicts will be addressed and any special utility design considerations. Describe how the design and construction methods minimize the Department's utility relocation costs.
   - Describe how the design will affect the right-of-way costs.
   - Identify types of any retaining walls and /or noise walls if applicable.

c. The Technical Proposal shall include half-size plan sheets depicting those elements required by the RFP.

d. Describe any traffic control requirements that will be used for each construction phase.

e. Describe how traffic will be maintained as appropriate and describe understanding of any time restrictions noted in the RFP.

f. Describe the safety considerations specific to the Project.

g. Discuss overall approach to safety.

h. Describe any proposed improvements that will be made prior to or during construction that will enhance the safety of the work force and/or traveling public both during and after the construction of the Project.

~~i. Provide detailed Traffic Analysis and Mitigation Report as described in RFP Form Response Category IV: Technical Solution.~~

# DESIGN-BUILD
# RFP CONTRACT BOOK 2
# CONTRACT

## TENNESSEE DEPARTMENT OF TRANSPORTATION

**Interstate 75 at Interstate 24 Interchange Modification**

**Hamilton County - TENNESSEE**

**CONTRACT NUMBER: DB1801**

**July 27, 2018**

**Addendum #2 September 26, 2018**

**Addendum #3 November 13, 2018**

# APPENDIX B

## *SPECIAL PROVISIONS*

| TITLE | SP# |
|---|---|
| EMPLOYING AND CONTRACTING WITH ILLEGAL IMMIGRANTS | 102I |
| SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION | 102LC |
| BUY AMERICAN REQUIREMENTS | 106A |
| AIR QUALITY FOR MOWING | 107AQ |
| WATER QUALITY AND STORM WATER PERMITS | 107FP |
| PROJECT COMPLETION AND LIQUIDATED DAMAGES | 108B |
| PAYMENT ADJUSTMENT FOR FUEL | 109A |
| PRICE ADJUSTMENT FOR BITUMINOUS MATERIAL | 109B |
| MOWING PAYMENT ADJUSTMENT FOR FUEL | 109MA |
| BITUMINOUS PLANT MIX ROADWAY DENSITY | 407DEN |
| INTELLEGENT COMPACTION (IC) FOR HOT MIX ASPHALT (HMA) | 407IC |
| SECTION 411-ASPHALT CONCRETE SURFACE (HOT MIX) | 411B |
| FULL DEPTH AND PARTIAL DEPTH CONCRETE PAVEMENT REPAIR | 502A |
| FULL DEPTH AND PARTIAL DEPTH CONCRETE PAVEMENT REPAIR (HIGH EARLY STRENGTH) | 502C |
| DOWEL BAR RETROFITTING | 503DB |
| SECTION 602 – STEEL STRUCTURES (INSPECTION COST ONLY) | 602 |
| CLEANING AND RESEALING TRANSVERSE AND LONGITUDINAL JOINTS AND RANDOM CRACKS | 502J |
| GRINDING CONCRETE PAVEMENT | 503 |
| REPAIR OF BRIDGE DECK CRACKS | 604CR |
| BRIDGE DECK PREPARATION USING HYDRODEMOLITION | 604H |
| BRIDGE DECK PREPARATION REPAIR & CONCRETE OVERLAY, USING HYDRODEMOLITION | 604HD |
| RETAINING WALLS | 624 |
| DRILLED SHAFT SPECIFICATIONS | 625 |
| AGGREGATE FOUNDATION SYSTEMS | 626 |
| PREFABRICATED VERTICAL DRAINS | 627PVD |

| TITLE | SP# |
|---|---|
| HIGHWAY SIGNS, LUMINAIRES & TRAFFIC SIGNALS | 700SIG |
| TRAFFIC CONTROL SUPERVISOR | 712B |
| CONTRACTOR PROVIDED UNIFORMED POLICE OFFICER | 712PO-DB |
| TRAFFIC QUEUE PROTECTION | 712PTQ |
| CONTRAST PAVEMENT MARKINGS | 716DB |
| ~~SOUND-ABSORBING NOISE BARRIERS~~ | ~~718NB~~ |
| REMOVAL AND DISPOSAL OF LITTER | 719A |
| ITS SPECIAL PROVISION | 725 |
| RIGHT-OF-WAY MOWING | 806 |
| EQUAL EMPLOYMENT OPPORTUNITY | 1230 |
| STANDARD FEDERAL EQUAL EMPLOYMENT OPPORTUNITY CONSTRUCTION CONTRACT SPECIFICATIONS (EXECUTIVE ORDER 11246) | 1231 |
| NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION TO ENSURE EQUAL EMPLOYMENT OPPORTUNITY (EXECUTIVE ORDER 11246) | 1232 |
| TRAINING PROGRAM REQUIREMENTS | 1240 |
| DISADVANTAGED BUSINESS ENTERPRISE PARTICIPATION | 1246 |
| DBE CONTRACT GOALS | 1247 |
| REQUIRED CONTRACT PROVISIONS (FEDERAL-AID CONSTRUCTION CONTRACTS) | FHWA 1273 |
| TENNESSEE DEPARTMENT OF TRANSPORTATION MINIMUM WAGE SCALES FOR FEDERAL-AID CONSTRUCTION AND STATE FUNDED CONSTRUCTION | 1320 |
| FEDERAL WAGE RATES | AA-FED RATES |
| STATE WAGE RATES | AA-ST RATES |

July 27, 2018

**STATE OF TENNESSEE**

I-75/I-24
Hamilton County
Contract #: DB1801

**SPECIAL PROVISION**

**REGARDING**

**PROJECT COMPLETION AND LIQUIDATED DAMAGES**

The project shall be completed in its entirety as set forth in the Contract.

Daytime lane closures shall not be allowed at any time, unless otherwise specified herein or as directed by the Engineer.

Temporary lane closures on I-24, I-75 and Spring Creek Road will be allowed Sunday through Thursday nights between 9:00 P.M. and 6:00 A.M as described in RFP Book 3. Construction, Maintenance of Traffic. For each hour, or portion thereof, in which the temporary lane closure is not completed and open to traffic, the sum of **$6,000** per hour per lane shall be deducted from the monies due the Design-Builder, not as a penalty, but as liquidated damages.

Temporary lane closures on local streets shall only be allowed nightly between 9:00 p.m. and 6:00 a.m. For each hour, or portion thereof, in which the temporary lane closure is not completed and open to traffic, the sum of **$1,800** per hour per lane shall be deducted from the monies due the Design-Builder, not as a penalty, but as liquidated damages.

In addition to temporary lane closures, the Design-Builder will be allowed up to four (4) weekend closures of interstate-to-interstate ramps within the interchange. The Design-Builder will be allowed up to two (2) weekend closures of the Spring Creek Road over I-24 bridges. A weekend is defined as between Friday at 10:00 P.M. to Monday at 4:00 A.M. outside of the holidays, and major events discussed in RFP Book 3.

For each hour, or portion thereof, in which a full weekend closure is not completed and open to traffic, the sum of **$6,000** per hour per lane shall be deducted from the monies due the Design-Builder, not as a penalty, but as liquidated damages.

Rolling roadblocks are permitted during blasting operations, the erection/construction of overhead signs and setting of bridge beams. These roadblocks shall be conducted by law enforcement agencies specified in Special Provision 712PO – DB. Rolling roadblocks will only be allowed at night between 9:00 P.M. and 6:00 A.M. with a maximum duration of 30 minutes. For each 15-minute period, or portion thereof, in excess of the allotted 30-minute period that any traffic lane remains closed, the sum of $3,000 per lane shall be deducted from the monies due the Design-Builder, not as a penalty, but as liquidated damages.

Blasting within the project limits shall not occur on a Sunday. Blasting shall be permitted between 9:00 A.M. and 2:00 P.M. If necessary for the public's protection from blasting, the Design-Builder may close traffic lanes in the vicinity of blasting site up to 15 minutes in any one-hour period. For each **15-minute** period, or portion thereof, in excess of the allotted 15-minute period that any traffic lane remains closed, the sum of **$3,000** per lane shall be deducted from the monies due the Design-Builder, not as a penalty,

but as liquidated damages.

The table below summarizes the liquidated damages referenced above.

| Route Name/Type | Temporary Lane Closures Liquidated Damages | Full Weekend Closure Liquidated Damages | Rolling Roadblock/Blasting Liquidated Damages |
|---|---|---|---|
| I-24, I-75, including ramps | $6,000 per hour per lane | $6,000 per hour per lane | $3,000 per 15 min. per lane |
| Spring Creek Road | $6,000 per hour per lane | $6,000 per hour per lane | N/A |
| Local Streets including State Routes | $1,800 per hour per lane | N/A | N/A |

**Welcome Center**

The Design-Builder shall minimize disruptions to the normal operations of the Welcome Center located on I-75 north of the Ringgold Road interchange. The Design-Builder will be allowed to close the Welcome Center as detailed in RFP Book 3. Failure to restore full access to and normal operations of the Welcome Center within the allowed times will result in liquidated damages of $1,200 per calendar day until full access and normal operations are restored. Additionally, RFP Book 3 contains additional information regarding mandatory advance notice.

**Noise Barriers**

The Design-Builder shall complete construction of the new noise barrier east of Spring Creek Road prior to any work on the I-75 to I-24 ramps. Once work begins, the noise barrier shall be completed within 90 days. Failure to complete construction within the allowed 90 calendar days will result in liquidated damages of **$1,000** per day until noise barrier construction is complete. Noise barrier construction and/or repairs shall only be conducted during daytime hours not earlier than 8:00 A.M. and no later than 7:00 P.M. For each hour, or portion thereof, in which the noise barrier construction and/or repairs continue (outside the daytime hours allotted), the sum of **$500** per hour per noise barrier shall be deducted from the monies due the Design-Builder, not as a penalty, but as liquidated damages.

**Potholes**

The Design-Builder shall mitigate potholes greater than or equal to 1 square foot and 1.25 inches deep or an equivalent volume of size, shape and location that presents a hazard to the traveling public within 24 hours of discovery or notification. Failure to complete pothole mitigation within the 24-hour period will result in the sum of **$1,000** per occurrence per day (or portion thereof) until pothole mitigation is complete. These deductions are not penalties but are liquidated damages.

The following sections summarize the liquidated damages associated with ITS field device and supporting infrastructure downtime.

**Fiber Network**

The Design-Builder shall ensure continuous operation of the fiber optic lines within construction limits. Temporary disconnect of communication shall not exceed forty-eight hours. Failure to restore

communication within the allowed forty-eight hours will result in liquidated damages of **$500** per hour until communication is restored.

**Dynamic Message Signs (DMS)**

The Design-Builder shall ensure continuous operation of the dynamic message signs (DMS) within construction limits. Temporary loss of DMS operation during construction activities shall not exceed thirty calendar days. Failure to restore full operation within the allowed thirty calendar days will result in liquidated damages of **$500** per day/per DMS until full operation of the DMS is restored. Full operation is defined as the DMS being installed, integrated with TMC software, and accessible/controllable by TMC personnel. ~~If necessary, multiple DMS may be down at the same time.~~

**CCTV Cameras**

The Design-Builder shall ensure continuous operation of the all CCTV cameras affected by construction activities. Temporary loss of CCTV camera operation during construction activities shall not exceed forty-eight hours. Failure to restore full operation within the allowed forty-eight hours will result in liquidated damages of **$500** per hour/per CCTV camera until full operation of the camera is restored. Full operation is defined as the CCTV camera being installed, integrated with TMC software, and accessible/controllable by TMC personnel. ~~If necessary, multiple CCTV cameras may be down at the same time.~~

**Radar Detection System (RDS)**

The Design-Builder shall ensure continuous operation of the radar detection systems (RDS) within the construction limits. Temporary loss of RDS operation during construction activities shall not exceed fourteen calendar days. Failure to restore full operation within the allowed fourteen (14) calendar days will result in liquidated damages of **$500** per day/per RDS until full operation of the RDS is restored. Full operation is defined as the RDS being installed, integrated with TMC software, and accessible/controllable by TMC personnel. ~~If necessary, multiple RDS may be down at the same time.~~

The table below summarizes the liquidated ITS-related damages referenced above.

| ITS Device Type | Allowable Down Time | Liquidated Damages |
|---|---|---|
| Fiber Network | 48-Hours | $500 per hour |
| DMS | 30 Calendar Days | $500 per day per DMS |
| CCTV | 48-Hours | $500 per hour per CCTV |
| RDS | 14 Calendar Days | $500 per day per RDS |

**Project Completion Date**

The Design-Builder shall complete all work to be done under the Contract on or before the Design-Builder's completion date, set forth in RFP Book 2 Section D.3. If the Design-Builder fails to complete all work specified in the Contract, except for plant/vegetation establishment and punch list items, on or before the Design-Builder's completion date, a sum of money equal to **$30,000** per Calendar Day, for the first 30 calendar days after the Design-Builder's completion date, shall be deducted from monies due to the Design-Builder, not as penalty, but as liquidated damages. For each calendar day thereafter, a sum of money equal to **$100,000** shall be deducted from monies due to the Design-Builder, not as a penalty, but

as liquidated damages.

~~Failure to complete the project on or before the Design-Builders established number of Calendar Days set forth in the Contract, shall apply for the project. For each calendar day after this established date, that all work specified in the contract; except for vegetation establishment and punch list items; is not complete, a sum of money equal to **$100,000** per Calendar Day shall be deducted from monies due to the Design-Builder, not as a penalty, but as agreed compensation for damages resulting from the Design-Builder's delay in completion of construction operations on the Department and road users.~~

Where provisions of this Special Provision conflict with Subsection 108.09 of the Standard Specifications, as amended, this Special Provision prevails. Additionally, RFP Book 3 contains additional information regarding mandatory closure concurrence and advance notice.

**S T A T E** **O F** **T E N N E S S E E**

January 1, 2015

# SPECIAL PROVISION

# REGARDING

# DOWEL BAR RETROFITTING

DESCRIPTION

The work consists of installing epoxy coated 1-1/2 inch diameter by 18 inch long plain round dowel bars into existing concrete pavement. The existing Portland Cement Concrete pavement shall be slotted and the dowel bars shall be retrofit across pavement cracks and/or joints.

MATERIALS (See Standard Specifications for other details)

Dowel bars, including the ends, shall be epoxy coated. The dowel bars shall also be further coated prior to installation with a bond breaking compound. The bond breaking coating shall be one of the approved products appearing on the Department's Qualified Products List.

The dowel bars shall have tight fitting end caps made of nonmetallic material that allows for 1/4 inch bar movement at each end of the bar. The Contractor shall submit an end cap sample to the Engineer for approval prior to installation.

Chair devices for supporting and holding the dowel bar in place during placement of the patching material shall be completely epoxy coated and made of nonmetallic material. The Contractor shall submit a chair sample to the Engineer for approval prior to installation.

The foam core board filler material shall be 1/4 inch thick, constructed of closed cell foam and faced with poster board material on each side. The foam core board is to be used when existing transverse joints are being retrofitted.

The caulk for sealing the existing crack/joint at the bottom and sides of the slot shall be a commercial grade of silicone caulk containing a minimum of 50 percent silicone.

The Portland cement concrete pavement that is removed to install the dowel bars shall be replaced with one of the following approved patching products: Patchroc 1060, Five Star Highway Patch, Burke 928 Fast Patch, or an approved equal. The use of Set 45 will not be allowed.

The patching material may be extended with aggregate meeting the manufacturer's recommendations. The Contractor shall provide a concrete mix design, including all additives, to meet a minimum compressive strength of 4,000 psi in 6 hours.

The Contractor shall verify the results of the mix design prior to beginning work. If the mix design is not satisfactory, the Contractor shall provide the Department with a mix design that meets the requirement

prior to the beginning of work.

CONSTRUCTION REQUIREMENTS

The Contractor shall install the dowel bars in the existing Portland cement concrete pavement as shown in the plans and according to the following requirements:

1. Diamond saw cut the pavement to place the center of the dowel bar at mid-depth in the pavement. Multiple saw cuts parallel to the center line may be required to properly remove the waste material from the slot. The saw cuts for the six slots at each transverse crack/joint shall be made such that the dowel bars are placed within the following tolerances:

   Centerline of individual dowel bars shall be parallel to the top of pavement, parallel to the ether dowel bars, and parallel to the roadway centerline within + or - 1/4 inch in 18 inches.

2. Any jackhammers used to break loose the concrete shall net be larger than the 30 pound class. If the pavement is damaged by the 30 pound jackhammer, the engineer will require the Contractor to use a 15 pound hammer.

3. All surfaces exposed and cracks in the slot shall be sand blasted and cleaned prior to bar installation.

4. The crack/joint on the bottom and the sides of the slot shall be filled with silicone caulk.

5. The dowel bars shall be lightly coated with the bond breaking compound prior to placement. The bar chairs shall provide a minimum of 1/2 inch clearance between the bottom of the dowel bar and the bottom of the slot. The dowel bar shall be placed to the depth shown on the plans, parallel to centerline and the top of the roadway surface, and at the middle of the slot, all within the specified tolerances. The chairs shall hold the dowel bar securely in place during placement of the patching mix.

   Longitudinal dowel bar placement for skewed joints or cracks shall be within + or - 2 inches. Longitudinal dowel bar placement for perpendicular joints shall be within + or - 1 inch.

6. The 1/4 inch thick foam core board shall be placed at the middle of the dowel bar to maintain a transverse contraction joint. The existing joint sealant may need to be cut or removed to accommodate the 1/4 inch thick foam core board with 1/2 inch by 1 inch tabs. The tabs are required to stabilize the foam core board during patching material placement. The foam core board shall fit tightly around the dowel bar and to the bottom and edges of the slot. The top of the foam core board shall be flush with the top surface of the concrete pavement.

   The Contractor may need to increase the width of the foam core board for pavements with skewed joints. The skew angle may vary for different pavement sections.

   The Contractor shall caulk the transverse joint crack at the bottom and the sides of the slot on both sides of the 1/4 inch thick foam core board. The foam core board shall be capable of remaining in a vertical position and tight to all edges during the placement of the patching material.

If for any reason the foam core board shifts during the placement of the patching material, the work shall be rejected and replaced at the Contractor's expense.

7. The Contractor shall thoroughly moisten all surfaces on the sawed slot immediately prier to filling with patching compound. Care shall be taken to prevent standing water in the slot. All excess water shall be removed with compressed air.

   The Contractor shall fill the slot (with the installed dowel bar, chairs, foam core board where used, and silicone in place) with an approved patching material. The patching material shall be vibrated with a small hand held vibrator capable of thoroughly consolidating the patching material into the slot and around the dowel bar. The top surface of the filled slot shall be trowel finished and cured immediately after each group of three dowels are installed. The curing compound shall meet the requirements of the Standard Specifications.

   The patching material shall be mixed with a hand mixer. The Engineer will test the patching material once every four hours of production. The patching material shall have a minimum compressive strength of 4,000 psi in 6 hours. Department compression testing may be performed up to 24 hours after the cylinders are made. If the compressive strengths are not being met, production shall cease and the Contractor shall resubmit a concrete mix design correcting the strength problems.

8. The transverse contraction joints shall be sawed and sealed as required in the Standard Drawings within 24 hours after placement of the patching material.

9. Any damage to the pavement due to the Contractor's operation shall be repaired or replaced at the expense of the Contractor.

MEASUREMENT

Dowel bar retrofit will be measured by each dowel bar installed and accepted.

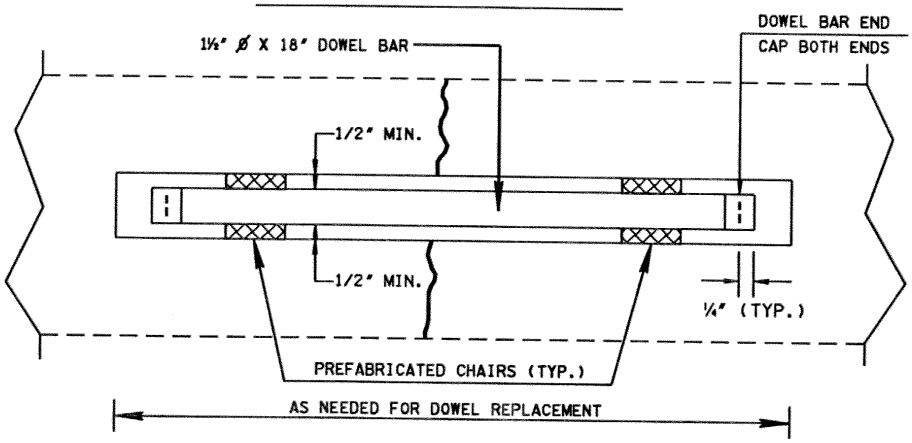
PAYMENT

Dowel bar retrofit will be paid at the contract unit price bid per each dowel bar. Payment shall be full compensation for equipment, materials, labor, and all incidentals required.

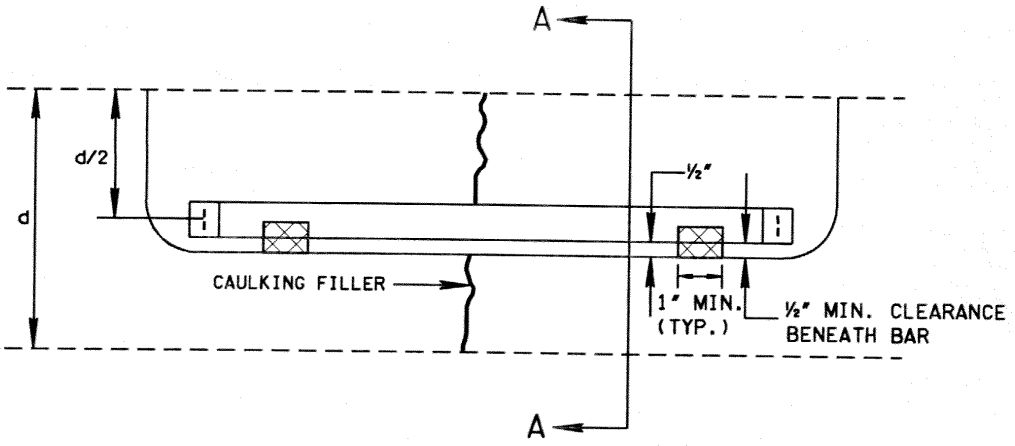
SP503DB

## DOWEL BAR RETROFIT DETAILS

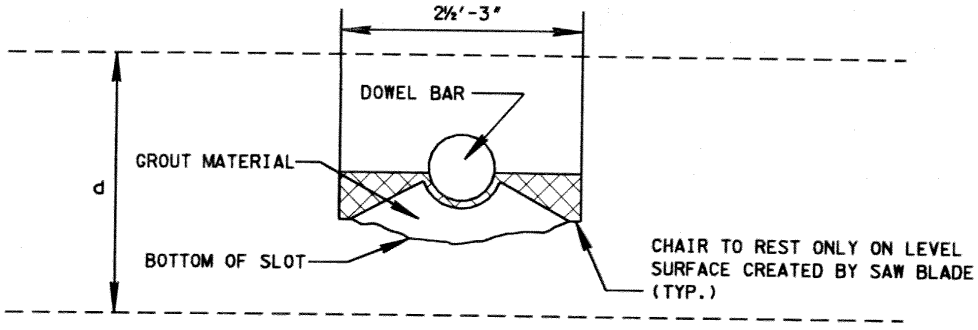
SP503DB




PLAN

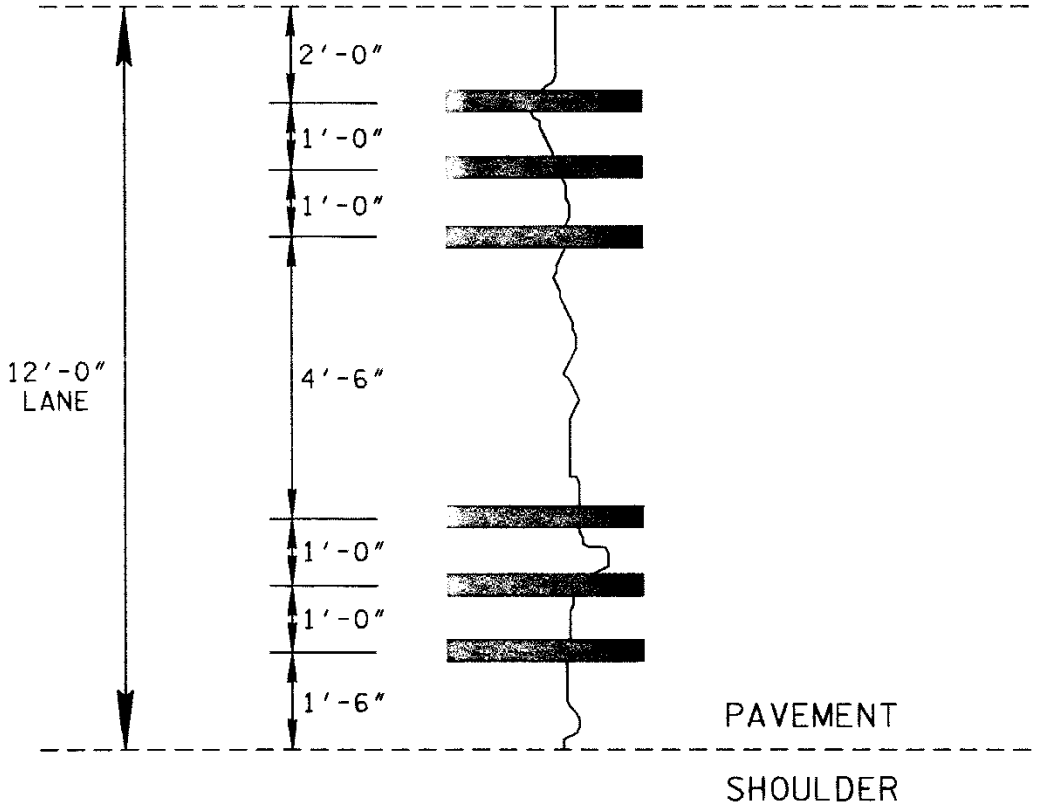



ELEVATION




SECTION A-A

SP503DB SP503DB




DOWEL BAR PLACEMENT

**S T A T E** **O F** **T E N N E S S E E**

(Rev. 2-19-96) January 1, 2015

## SPECIAL PROVISION

## REGARDING

## REPAIR OF BRIDGE DECK CRACKS

**Description.** This work shall consist of the cleaning and repairing of all visible bridge deck cracks in accordance with these specifications, the Standard Specifications, the contract plans or as directed by the Engineer. Cracks shall be repaired using a High Molecular Weight Methacrylate (HMWM).

**Materials**. The material used for treating cracks shall be a low viscosity, non-fuming, high molecular weight methacrylate resin listed on the Department's approved products list and conforming to the following:

| Physical Property | Requirement |
|---|---|
| Viscosity | 25 cps, maximum (Brookfield RVT with UL adaptor, 50 RPM at 25°C (77°F)) |
| Density | 0.9 kg/L (7.5 lbs/gal), minimum, at 25°C (77°F) |
| Flash Point | 82°C (180°F), minimum |
| Vapor Pressure | 1.0 mm Hg, maximum at 25°C (77°F) |
| Gel Time | 20 minutes minimum at application temperature |
| Tack Free Time | 6 hours maximum |
| Bond Strength | 10.3 MPa (1500 psi) minimum (ASTM C 882) |

The contractor shall have a qualified representative on site to provide expert assistance to the Contractor on storage, mixing, application, clean-up and disposal of materials.

The promoter and initiator, if supplied separately, shall not contact each other directly. Containers of promoters and initiators shall not be stored together in a manner that will allow leakage or spillage from one to contact the containers or material of the other.

The quantity of resin mixed with promoter and initiator shall be limited to 20 liters (5 gallons) at a time for manual application. A significant increase in viscosity shall be cause for rejection. The mixed resin shall be applied within 10 minutes after complete mixing.

A Material Safety Data Sheet (MSDS) shall be furnished for the HMWM resin promoter and initiator to be used. A certification showing conformance to these specifications shall be provided with each batch of resin.

Aggregate materials shall consist of clean, dry, fine grained sand as per resin manufacturer specifications.

**Surface Preparation.** Preparation of the concrete bridge deck surface shall consist of air blasting all visible cracks with oil free compressed air using sufficient air pressure to remove all loose or objectionable material from the cracks and bridge deck surface as approved by the Engineer The surface cracks shall be visually dry before treatment with HMWM is allowed to begin.

**Application of HMWM**. The contractor shall plan and prosecute his operations in such a manner as to protect persons and vehicles from injury or damage.

The concrete surface temperature shall not be less than 10°C (50° F) and not more than 38°C (100° F) at the time of resin application.

In applying to individual cracks on a linear foot basis the resin shall be applied at an average rate of one liter per 16 linear meters (one (1) gallon per 200 linear feet) or as directed by the Engineer. Large cracks (wider than 0.75 mm (0.03 inches)) should be pre-filled with sand before applying resin. Each crack shall be treated with resin by ponding the resin over the crack and allowing gravity to feed the material into the crack. The resin shall be ponded over each crack for 5-10 minutes. The ponding procedure shall be repeated until each crack is sealed.

If applying to the total deck surface on a square meter (square yard) basis, the deck surface shall be flooded with resin, allowing penetration into the concrete and filling of all cracks. The rate of application of promoted/initiated resin shall be approximately 2.2 square meters per liter (10 square yards per gallon), the exact rate shall be determined by the Engineer. Excess material shall be redistributed by squeegee or brooms within 10 minutes after application. The entire treated area of the bridge deck shall have sand broadcast by mechanical means to effect a uniform coverage of 0.14 to 0.16 kilograms per square meter (0.25 to 0.30 pounds per square yard).

Traffic shall not be permitted on the treated bridge deck until the treated cracks are tack free (non-oily).

Measurement and Payment. Bridge Deck Sealing shall be measured and paid for at the contract unit price per square meter (square yard) which price shall be full compensation for all labor, materials (except sealant), equipment, surface preparation and incidentals required for the satisfactory completion of the work.

Bridge Deck Crack Sealing shall be measured and paid for at the contract unit price per linear meter (linear foot) which price shall be full compensation for all labor, materials (except sealant), equipment, surface preparation and incidentals required for the satisfactory completion of the work.

Sealant shall be measured and paid for at the contract unit price per liter (gallon) which price shall be full compensation for furnishing the sealant material for individual crack sealing or sealing of areas by flooding.

**S T A T E** **O F** **T E N N E S S E E**

(Rev. 3-30-15) January 1, 2015

# SPECIAL PROVISION

## REGARDING

## BRIDGE DECK PREPARATION USING HYDRODEMOLITION

Description: This work shall consist of the removal of bridge deck concrete using hydrodemolition equipment as preparation for bridge deck repairs or overlay. All work shall be performed in accordance with the details shown on the plans or as directed by the Engineer.

Equipment and Materials. The hydrodemolition equipment shall be a self-propelled machine that utilizes a high pressure water jet stream capable of removing concrete to the depths shown on the plans or as directed by the Engineer and be capable of removing rust and concrete particles from reinforcing steel. Pneumatic hammers, 35 pound class maximum, may be used in areas that are inaccessible or inconvenient to the self-propelled machine such as, but not limited to, areas not to exceed one foot away from curbs or parapets.

Construction Requirements. Prior to the commencement of the removal operation, the hydrodemolition equipment shall be calibrated on an area of sound concrete approximately 2 ft. x 5 ft. as directed by the Engineer. The cost of the calibration procedure shall be included in the unit price bid for hydrodemolition. The Engineer shall verify the following settings:

1. Water pressure.
2. Machine staging control (step).
3. Nozzle size.
4. Nozzle speed (travel).

During the calibration, any or all of the above settings may be adjusted in order to achieve removal in accordance with the requirements of the plans. When the designated depth of removal is attained, the settings shall be recorded and maintained throughout the removal operation unless otherwise directed by the Engineer. The depth of removal shall be verified periodically and, if necessary, the equipment re-calibrated to insure the plans depth of removal.

After the hydrodemolition is completed, the deck shall be inspected (by sounding) to insure that all partial depth deteriorated concrete has been removed. Should deteriorated concrete be found, the Contractor shall remove the areas of deteriorated concrete by additional passes of the hydrodemolition equipment or jackhammers. No additional payment will be made for removal of these areas. The Contractor shall provide shielding, as necessary, to insure containment of all dislodged concrete within the removal area in order to protect the traveling public from flying debris both on and under the work site.

Waste water from the hydrodemolition process shall be controlled and filtered to produce a visibly clear water prior to releasing it to the surrounding environment. Sediment basins at the end of or outside of the structure shall be used if further filtration is required to produce visibly clear water. Bridge deck drains shall be plugged during the hydrodemolition process. The release of wastewater and solids generated by full depth hydrodemolition shall be minimized.

Cleaning of the bridge deck shall be performed with a vacuum system capable of removing wet debris and water. The deck shall then be blown dry with air to remove excess water and residual debris. Cleaning shall be done before debris and water are allowed to dry on the deck surface. All exposed reinforcing steel which is left unsupported by the hydrodemolition process shall be adequately supported and protected from bending by vacuum trucks or any other equipment. All reinforcing steel damaged or dislodged by these operations shall be replaced with epoxy coated bars of the same size at the expense of the Contractor.

When full depth repair is specified on plans, only those areas marked in the field by the Engineer as full depth repair will be paid for as full depth repair. Other areas where hydrodemolition equipment blows through the deck shall be the responsibility of the Contractor and will not be paid for as full depth repair.

Method of Measurement. Hydrodemolition shall be measured by the square yard of the total deck area regardless of depth.

Basis of Payment. The accepted quantity of hydrodemolition will be paid for at the contract unit price per square yard, which price will be full compensation for all materials, equipment and labor necessary to remove and dispose of all concrete and other debris to the depth shown on the plans or as directed by the Engineer. This item shall also include all rotomilling, vacuuming, shielding, containment and filtration of waste water, additional jackhammering and all other aspects of work necessary to remove bridge deck concrete by hydrodemolition.

Payment will be made under:

| Item No. | Description | Unit |
|---|---|---|
| 604-10.20 | Hydrodemolition | S. Y. |

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REV 1/31/06

**SPECIAL PROVISION**

**REGARDING**

**BRIDGE DECK PREPARATION, REPAIR, AND CONCRETE OVERLAY**

USING HYDRODEMOLITION

Description: This work shall consist of the removal of bridge deck concrete using hydrodemolition equipment as preparation for bridge deck repairs and concrete overlay. Rotomilling of the existing concrete deck prior to hydrodemolition will be allowed to a depth specified on the Plans. All work shall be performed in accordance with the details shown on the plans or as directed by the Engineer.

Equipment and Materials. The hydrodemolition equipment shall be a self-propelled machine that utilizes a high pressure water jet stream capable of removing concrete to the depths shown on the plans or as directed by the Engineer and be capable of removing rust and concrete particles from reinforcing steel. Pneumatic hammers, 35 pound class maximum, may be used in areas that are inaccessible or inconvenient to the self-propelled machine such as, but not limited to, areas not to exceed one foot away from curbs or parapets.

The concrete used to perform the deck repairs and overlay shall meet the requirements of the Standard Specifications for Class “D” concrete.

Construction Requirements. Prior to the commencement of the removal operation, the hydrodemolition equipment shall be calibrated on an area of sound concrete approximately (2 ft x 5 ft) as directed by the Engineer. The cost of the calibration procedure shall be included in the unit price bid for hydrodemolition. The Engineer shall verify the following settings:

1. Water pressure.
2. Machine staging control (step).
3. Nozzle size.
4. Nozzle speed (travel).

During the calibration, any or all of the above settings may be adjusted in order to achieve removal in accordance with the requirements of the plans. When the designated depth of removal is attained, the settings shall be recorded and maintained throughout the removal operation unless otherwise directed by the Engineer. The depth of removal shall be verified periodically and, if necessary, the equipment re-calibrated to insure the plans depth of removal.

After the hydrodemolition is completed, the deck shall be inspected (by sounding) to insure that all partial depth deteriorated concrete has been removed. Should deteriorated concrete be found, the Contractor shall remove the areas of deteriorated concrete by additional passes of the hydrodemolition equipment or jackhammers. No additional payment will be made for removal of these areas.

The Contractor shall provide shielding, as necessary, to insure containment of all dislodged concrete within the removal area in order to protect the traveling public from flying debris both on and under the work site.

Waste water from the hydrodemolition process shall be controlled and filtered to produce visibly clear water prior to releasing it to the surrounding environment. Sediment basins at the end of or outside of the structure shall be used if further filtration is required to produce visibly clear water. Bridge deck drains shall be plugged during the hydrodemolition process. The release of wastewater and solids generated by full depth hydrodemolition shall be minimized.

Cleaning of the bridge deck shall be performed with a vacuum system capable of removing wet debris and water. The deck shall then be blown dry with air to remove excess water and residual debris. Cleaning shall be done before debris and water are allowed to dry on the deck surface. All exposed reinforcing steel which is left unsupported by the hydrodemolition process shall be adequately supported and protected from bending by vacuum trucks or any other equipment. All reinforcing steel damaged or dislodged by these operations shall be replaced with epoxy coated bars of the same size at the expense of the Contractor.

When full depth repair is specified on plans, only those areas marked in the field by the Engineer as full depth repair will be paid for as full depth repair. Other areas where hydrodemolition equipment blows through the deck shall be the responsibility of the Contractor and will not be paid for as full depth repair.

Bridge deck repairs and concrete overlay shall be made as soon as practicable following removal by hydrodemolition and the subsequent cleaning of the deck as mentioned above. Traffic shall not be permitted on the bridge deck until curing time has elapsed in accordance with the Standard Specifications.

Method of Measurement. Hydrodemolition shall be measured by the square yard of the total deck area regardless of depth.

Full depth repair shall be measured by the square yards of deck surface area repaired.

Class D Concrete (Repair) shall be measured by the cubic yard. The number of cubic yards will be determined by deducting the theoretical quantity of class D concrete (overlay) from the number of cubic yards actually used as determined from invoices or conversion from batch weights then multiplying by a factor of 0.96 to allow for waste.

Class D Concrete (Overlay) shall be measured by the cubic yard based on the theoretical quantity required for the overlay shown in the plans.

Basis of Payment. The accepted quantity of hydrodemolition will be paid for at the contract unit price per square yard, which price will be full compensation for all materials, equipment and labor necessary to remove and dispose of all concrete and other debris to the depth shown on the plans or as directed by the Engineer. This item shall also include all rotomilling, vacuuming, shielding, containment and filtration of waste water, additional jackhammering and all other aspects of work necessary to prepare the deck for repair and concrete overlay.

The accepted quantity of Bridge Deck Repairs (Full Depth) will be paid for at the contract unit price per square yard, which price will be full compensation for full depth concrete removal including all materials, equipment and labor necessary to remove and dispose of all concrete and other debris as directed by the Engineer. This item shall also include any rotomilling, hydrodemolition, vacuuming, shielding, containment, additional jackhammering and all other aspects of work including forming and form removal necessary to prepare the deck for repair. Only those areas marked in the field by the Bridge Inspection and Repair Office as full depth repair will be paid under item 604-10.30.

The accepted quantity of Class D Concrete (Overlay) will be paid for at the contract unit price per cubic yard, which price will be full compensation for the placement and finishing of the concrete in accordance with the Standard Specifications and for any tools, labor, equipment or incidentals necessary for such placement.

The accepted quantity of Class D Concrete (Repair) will be paid for at the invoice price (including sales tax) of the concrete per cubic yard plus 15%.

Payment will be made under:

| Item No. | Pay Item | Pay Unit |
|---|---|---|
| 604-10.20 | Hydrodemolition | Square Yard |
| 604-10.30 | Bridge Deck Repairs (Full Depth) | Square Yard |
| 604-10.85 | Class D Concrete (Overlay) | Cubic Yard |
| 604-10.86 | Class D Concrete (Repairs) | Cubic Yard |

**S T A T E** **O F** **T E N N E S S E E**
Rev. 5/18/17 January 1, 2015

# SPECIAL PROVISION
# REGARDING
# DRILLED SHAFT SPECIFICATIONS

**625.01 Description.** This work shall consist of constructing cast-in-place reinforced concrete drilled shafts and rock sockets, as required, to serve as a structural foundation. This work shall provide reinforced concrete shafts cast in cylindrically excavated holes extending sufficiently into soil or sound rock to adequately support the structure and all externally applied loads for which the shaft was designed. The drilled shaft foundation, including the rock socket, where required, shall be constructed in accordance with these Specifications, as shown on the Plans and in accordance with other Specifications included in the contract documents.

**625.02 Qualifications of Drilled Shaft Contractor.** The Contractor/Subcontractor performing the work described herein shall have staff on-site (driller and/or foreman or superintendent) experienced in the drilled shaft specialty and have installed drilled shafts of both diameter and length similar to those shown on the Plans. The Contractor shall have staff (as defined above) on site that has a minimum of three years of experience in the geologic conditions associated with the project site prior to the bid date for this project. This work shall be performed under the supervision of the Contractor's/Subcontractor's superintendent, who is knowledgeable and experienced in the method of constructing drilled shafts as required by the project. The Contractor's/Subcontractor's equipment shall have the capacity to undertake the work and shall be sufficient to complete the work within the specified contract time. The Contractor shall furnish evidence of experience and expertise that the Contractor/Subcontractor meets the following requirements:

The Contractor's/Subcontractor's ability to construct the drilled shafts for this project shall be supported by a list containing a description of at least five projects either on-going or completed in the last two years on which the Contractor's/Subcontractor's staff (driller, foreman or superintendent), responsible for the drilled shaft construction, have installed drilled shafts of similar size as shown in the Plans and with similar excavation techniques anticipated for this project. This list of projects shall contain a brief description of the project as well as names and phone numbers of the project owner's representatives who can verify the Contractor's/Subcontractor's staff participation on the project.

**625.03 Drilled Shaft Work Plan**. The Contractor shall develop a work plan for all the drilled shafts and submit the plan for review and acceptance by the Engineer 30 days prior to beginning construction of the drilled shafts. The Drilled Shaft Work Plan shall provide detailed project specific information, including the following:

1. Work experience in accordance with required qualifications mentioned in Subs**ection 625.02.**
2. List and size of proposed equipment including: cranes, kelly bars, drill rigs, vibratory hammers, augers, core barrels, cleanout buckets, airlifts and/or submersible pumps, tremies and/or concrete pumps, casing (diameters, thicknesses and lengths), etc.
3. Details of the sequence and proposed schedule of drilled shaft construction, including the anticipated order in which shafts will be constructed
4. Details of excavation methods
5. Details of proposed methods to clean the excavation bottom
6. Details of the method(s) to be used to ensure shaft stability (i.e., prevention of caving, bottom heave, etc. using temporary casing, slurry, or other means) during excavation and concrete placement. If appropriate, this shall include a review of method suitability to the anticipated site and subsurface geotechnical conditions
7. Details of reinforcement placement including support and method to center in the excavation
8. Details of concrete placement including proposed operational procedures for the concrete tremie or pump (if applicable); including initial placement, how the tremie or pump will be raised during concrete placement and what type of discharge control will be used to prevent concrete contamination when the tremie or pump is initially placed in the excavation.
9. If applicable, details of casing installation and temporary casing removal including order of telescoped casing removal and minimum concrete head in each casing during removal
10. Required submittals for concrete mix designs
11. Details on how drilling spoils will be handled including environmental control procedures used to prevent the loss of concrete and spoils
12. Detailed procedures for mixing, using, maintaining, and disposing of the slurry shall be provided. A detailed mix design (including all additives and their specific purpose in the slurry mix), and a discussion of its suitability to the anticipated subsurface geotechnical conditions, shall also be provided for the proposed slurry
13. Other information shown in the Plans or requested by the Engineer

The Engineer will review the Drilled Shaft Work Plan for conformance with the Plans and Specifications. Within 15 days of receiving the plan, the Engineer will notify the Contractor of any additional information required and/or changes that may be necessary to satisfy the Plans, Specifications and special provisions. Any part of the plan that is unsatisfactory will be rejected and the Contractor shall submit changes for re-evaluation. The Engineer will respond to the Contractor within 7 days after receiving the proposed changes.

Review of the Drilled Shaft Work Plan by the Engineer does not relieve the Contractor of the responsibility to perform the work in accordance with Plans and Specifications. The Drilled Shaft Work Plan is intended to provide an opportunity for the Contractor to explain his approach to the work and to allow the Engineer to comment on equipment and procedures before field operations begin.

**625.04 Preconstruction Conference.** After the Drilled Shaft Work Plan has been reviewed by the Project Supervisor, a drilled shaft preconstruction conference shall be scheduled with the Contractor/Drilling Subcontractor to discuss construction and inspection of the drilled shafts. At a minimum, the attendees should include the General Contractor's Superintendent, the Drilling Subcontractor's Superintendent, the State's representatives, the Geotechnical Engineer, the Structural Engineer and members of the Inspection Team. This conference shall be completed prior to beginning any drilled shaft work.

## Construction Requirements

**625.05 Material.** All material shall be in accordance with the Plans and in accordance with other Specifications included in the contract document.

**625.06 Self-Consolidating Concrete.** Drilled shafts shall be constructed of the class concrete and concrete strength specified on Plans, and all material, proportioning, mixing and transporting of concrete shall be in accordance with *TDOT Standard Specifications for Road and Bridge Construction* except as modified below. The concrete mix for drilled shafts shall be dense, homogeneous, fluid and resistant to segregation, and shall consolidate under self-weight such that vibrating or rodding will not be required as specified in **604.03 1b.** Self-Consolidating Concrete (SCC) Design and Production Parameters. The concrete mix shall have a set time that ensures that fluidity is maintained throughout the shaft concrete placement and removal of temporary casing, if used.

**625.07 Casing.** When applicable, the Contractor shall select the rigid casing used to stabilize shaft during construction unless casing is specified on Plans. A casing with sufficient strength to safely resist all imposed loads, including those from the soil and ground water, shall be used. The Contractor must insure the stability of casing during all drilled shaft operations.

Shop Drawings. Shop drawings for permanent steel casings shall be submitted to and approved by the Engineer prior to installation of the casings.

Condition of Casings. Casings shall be smooth, clean and watertight. Out-of-round tolerance shall not exceed one inch at any portion of the casing. The Contractor shall demonstrate the casing is within tolerance after installation. Telescoping casing shall not be allowed in bridges located in Seismic Zones 3 or 4.

Extent of Casing Length. Permanent casings, if required, shall be continuous wherever possible or practical. The permanent casing shall terminate at the specified elevation. Where drilled shafts are located in open water areas, casings shall be extended at least 18 inches above the datum defined water elevation as shown on the plans. Contractor shall be responsible for casing adjustments at the time of installation due to water fluctuations.

Use of Teeth or Cutting Edge. The casing may be fabricated with teeth or a cutting edge to facilitate insertion into the rock.

Splices. Splicing of permanent casings is not desirable and will only be permitted when approved by the Engineer. If splices are required, the welding process shall be in accordance

with the requirements specified in subsection **602.19**. The Contractor shall be fully responsible for the adequacy of welds during driving.

Welding. Welding of casings shall be in accordance with the current edition of *AASHTO/AWS Bridge Welding Code* and *TDOT Standard Specification for Road and Bridge Construction* and as specified in Plans, except that shop welding of casings will not require radiographic inspection. Inspection of welds will be of a visual nature. If evidence indicating poor welding is found, the Engineer may require ultrasonic testing at the contractor's expense.

**625.08 Slurry.** Drilling slurry will be defined as mineral slurry, polymer slurry, natural slurry formed during the drilling process, water or other fluids used to maintain stability of the drilled shaft excavation to aid in the drilling process or to maintain the quality of the rock socket. In addition, the terms mineral slurry and polymer slurry, as used herein, will be defined as the final mixed composite of all additives, including manufactured mineral or polymer slurry additives required to produce the acceptable drilling slurry.

Slurry Usage. Drilling slurry shall be used if detailed in the approved installation plan, if in accordance with the contract documents or if approved in writing by the Engineer. Drilling slurry may be used at the Contractor's option if the slurry is not in accordance with the contract documents; however, any slurry shall be approved by the Engineer prior to use. Drilling slurry, when used, will be non-compensable and effect on time of performance due to the use of the slurry will be non-excusable.

General Properties. The material used to make the slurry shall not be detrimental to the concrete or surrounding ground strata. Mineral slurries shall have both a mineral grain size that remains in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. Polymer slurries shall have sufficient viscosity and gel characteristics to transport excavated material to suitable screening systems or settling tanks. The percentage and specific gravity of the material used to make the slurry shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement. If approved by the Engineer, the Contractor may use water and on-site soils as drilling slurry. In that case, the range of acceptable values for density, viscosity and pH, as shown in the following table for bentonite slurry, shall be met, except that maximum density (unit weight) shall not exceed 70 pounds/cubic foot. When water is used as the drilling fluid to construct rock sockets in limestone, dolomite, sandstone or other formations that are not erodible, the requirements for slurry testing will not apply.

Preparation. Prior to introduction into the shaft excavation, the manufactured mineral or polymer slurry admixture shall be pre-mixed thoroughly with clean, fresh water and for adequate time in accordance with the slurry admixture manufacturer's recommendations allotted for hydration. Potable water can be used for mixing although stream or river water may be used when approved by the engineer. Slurry tanks of adequate capacity will be required for slurry mixing, circulation, storage and treatment. No excavated slurry pits will be allowed in lieu of slurry tanks without written approval from the Engineer. Adequate de-sanding equipment will be required as necessary to control slurry properties during the drilled shaft excavation in accordance with the values provided in the table below. De-sanding will not be required for signposts or lighting mast foundations unless specified in the contract documents.

Control Tests. Control tests using a suitable apparatus shall be performed by the Contractor on the slurry to determine density, viscosity, sand content and pH of freshly mixed slurry, recycled slurry and slurry in the excavation. Tests of slurry samples from within one foot of the bottom and at mid-height of the shaft shall be conducted in each shaft excavation during the excavation process to establish a consistent working pattern. A minimum of four sets of tests shall be conducted during the first eight hours of slurry use on the project. When the results show consistent behavior, the testing frequency may be decreased to one set every four hours of slurry use, or as otherwise approved by the Engineer. Reports of all tests, signed by an authorized representative of the Contractor, shall be furnished to the Engineer on completion of each drilled shaft. An acceptance range of values for the physical properties will be as shown in the table below.

Sampling. When slurry samples are found to be unacceptable, the Contractor shall bring the slurry in the shaft excavation to within specification requirements. Concrete shall not be poured until re-sampling and testing results produce acceptable values. Prior to placing shaft concrete, the Contractor shall take slurry samples from within one foot of the bottom and at mid-height of the shaft. Any heavily contaminated slurry that has accumulated at the bottom of the shaft shall be removed. Disposal of all slurry shall be done in areas approved by the Engineer. The Contractor shall perform final shaft bottom cleaning after suspended solids have settled from the slurry mix.

| **Range of Acceptable Values for Mineral and Polymer Slurries in Fresh Water Without Additives** | | | | | |
|---|---|---|---|---|---|
| Property | **Bentonite** | **Emulsified Polymer** | **Dry Polymer** | **Units** | **Test Method** |
| **Density (Unit Weight)** | | | | | |
| At Introduction | 63.5- 66.8 | < 63 | < 63 | lb/ft3 | Density Balance |
| Prior to Concreting | 63.5- 70.5 | < 63 | < 63 | | |
| **Marsh Funnel Viscosity** | | | | | |
| At Introduction | 32 – 60 | 33 – 43 **b** | 50 – 80 **b** | sec/qt | Marsh Funnel |
| Prior to Concreting | 32 – 60 | 33 – 43 **b** | 50 – 80 **b** | | |

| | | | | | |
|---|---|---|---|---|---|
| **pH** | | | | | pH |
| At Introduction | 8 – 10 | 8 – 11 | 7 – 11 | -- | Paper or |
| | | | | | pH |
| Prior to Concreting | 8 – 10 | 8 – 11 | 7 – 11 | -- | Meter |
| **Sand Content** | | | | | API Sand |
| At Introduction | < 4 | < 1 | < 1 | Percent by | Content |
| | | | | Volume | Kit |
| Prior to Concreting | < 2 | < 1 | < 1 | | |
| **Maximum Contact Time** [a] | 4 | 72 | 72 | Hours | |

a. Without agitation and sidewall cleaning.

b. Higher viscosities may be required to maintain excavation stability in loose or gravelly sand deposits.

**625.09 Protection of Existing Structures.** All precautions shall be taken to prevent damage to existing structures and utilities as stated in Standard Specifications for Road and Bridge Construction or plans general notes. These measures shall include, but are not limited to, monitoring and controlling the vibrations from the driving of casing or drilling of the shaft, and selecting construction methods and procedures that shall prevent excessive caving of the shaft excavation.

**625.10 Technique Shafts.** When required by the contract documents, the Contractor shall demonstrate the adequacy of methods and equipment used during construction of the first drilled shaft, which shall be an out of position technique shaft, constructed with reinforcement as identified for production shafts on the Plans. This technique shaft shall be drilled in the position as directed by the Engineer and drilled to the maximum depth for any production shaft shown on the Plans. If at any time the Contractor is unable to demonstrate, to the satisfaction of the Engineer, the adequacy of methods or equipment and alterations required, an additional technique shaft(s) may be required. Technique shafts shall be cut off three feet below ground line, buried or otherwise disposed of as specified in the contract documents or as directed by the Engineer. Once approval has been given to construct production shafts, no changes will be permitted in the methods of equipment used to construct the shaft without approval from the Engineer. When a technique shaft is not required, construction of the first production shaft will be used to determine if the methods and equipment used by the Contractor are acceptable. Failure at any time to demonstrate to the Engineer the adequacy of methods or equipment will be cause for the Engineer to require appropriate alterations in equipment or method by the Contractor to eliminate unsatisfactory results.

**625.11 Construction Sequence.** Where construction of a footing is applicable, excavation to footing elevation shall be completed before shaft construction begins, unless otherwise authorized by the Engineer. Any disturbance to the footing area caused by shaft installation shall be repaired by the Contractor prior to pouring the footing. When drilled shafts are to be installed

in conjunction with embankment placement, the Contractor shall construct drilled shafts after placement of fills. Drilled shafts constructed prior to the completion of fills shall not be capped until the fills have been placed as near to final grade as possible, leaving only the necessary work room for construction of the caps.

**625.12 General Equipment and Methods.** The Contractor shall perform excavations through whatever material is encountered to the dimensions and elevations shown on the Plans. The Contractor's methods and equipment shall be suitable for the intended purpose and for whatever material is encountered.

Equipment. The Contractor shall provide equipment capable of constructing shafts to a depth equal to the deepest shaft tip elevation shown on the Plans plus 15 feet, or as otherwise specified in the contract documents. When a rock socket is identified on the Plans at a shaft location, the definition of "shaft tip elevation", for the purposes of this subsection, shall be taken to refer to the bottom of the rock socket.

Excavation Methods. Excavations required for shafts and rock sockets shall be completed in a continuous operation. The Contractor shall be responsible for ensuring the stability of the shaft excavation and the surrounding soil. When obstructions, either expected or unexpected, are encountered, the Contractor shall notify the Engineer promptly. The dry method, wet method, temporary casing method, permanent casing method if specified, or combinations, as necessary, shall be used to produce sound, durable concrete drilled shafts free of defects. The permanent casing method shall be used only when required by the contract documents or approved by the Engineer. Blasting excavation methods will not be permitted. When a rock socket is required, the Engineer will be the sole judge as to what constitutes the top of sound rock. The Engineer may order in writing additional depths of rock socket below the top of sound rock as considered necessary to improve the foundation. If the top surface of the sound rock is found to be inclined across the width of the shaft, the Contractor shall immediately notify the Engineer. The Contractor shall use an airlift, or other method approved by the Engineer, to clean the bottom of the shaft excavation.

**625.13 Dry Construction Method.** The dry construction method shall be used only at sites where the groundwater table and site conditions, generally stiff to hard clays or rock above the water table, are suitable to permit construction of the shaft in a relatively dry excavation and where the sides and bottom of the shaft remain stable without any caving, sloughing or swelling and allow visual inspection prior to concrete placement. The dry method shall consist of drilling the shaft excavation, removing accumulated seepage water and loose material from the excavation and placing the shaft reinforcing and concrete in a relatively dry excavation. The dry construction method shall be used only when shaft excavations have 12 inches per hour or less of seepage and less than 3" of standing water.

**625.14 Wet Construction Method.** The wet construction method shall be used at sites where a dry excavation cannot be maintained for placement of the shaft concrete. This method shall consist of drilling the shaft excavation below the water table, keeping the shaft filled with water, natural slurry formed during the drilling process, mineral slurry or polymer slurry to control seepage, groundwater movement and stability of the hole perimeter until excavation to the final depth and placement of the reinforcing cage and concrete has been completed. This procedure

will require placing the shaft concrete with either a tremie or concrete pump beginning at the shaft bottom, and displacing the water or slurry as concrete is placed. Temporary partial depth casings near the ground surface shall be provided to aid shaft alignment and position and to prevent sloughing of the top of the shaft excavation. Where drilled shafts are located in open water areas, shafts shall be constructed by the wet method using casings extending from above the water elevation to the Plans casing tip elevation or top of rock socket to protect the shaft concrete from water action during placement and curing. The casing shall be installed in a manner that produces a positive seal at the bottom of the casing.

**625.15 Temporary Casing Construction Method.** The temporary casing construction method shall be used at all sites where the stability of the excavated hole, the effects of groundwater cannot be controlled by other means, or other conditions exist in which the Engineer deems it necessary. In this method, the hole shall be advanced through caving material by the wet method in accordance with Subs**ection 625.14**. When a formation is reached that is nearly impervious, a casing shall be placed in the hole and sealed. Drilling may proceed by the dry method to the projected depth. The placement of concrete shall proceed by the dry or wet method, except that the casing shall be withdrawn after the concrete is placed. In the event seepage conditions prevent use of the dry method, excavation shall be completed by the wet method. Before and during casing withdrawal, a 5-foot minimum head of fresh concrete above the bottom of the casing shall be maintained at such a level that fluid trapped behind the casing is displaced upward out of the shaft excavation without mixing with or displacing the shaft concrete. Casing extraction shall be at a slow, uniform rate with the pull in line with the axis of the shaft. Temporary casings shall be removed while the concrete is still workable and the slump of the concrete is between four and eight inches. Vibratory hammers shall not be used for casing installation or removal within 50 feet of other shafts that have been completed less than 24 hours earlier. The reinforcing cage shall not be damaged or displaced when withdrawing the temporary casing.

**625.16 Permanent Casing Construction Method.** The permanent casing construction method shall be used only when required by the contract documents or authorized by the Engineer. The casing shall be continuous between top and bottom elevations shown on the Plans. Vibratory hammers shall not be used for casing installation within 50 feet of shafts which have had concrete poured within the past 24 hours

**625.17 Time Limitations.** When bentonite slurry is used, the Contractor shall adjust construction operations such that the maximum time that slurry is in contact with the bottom five feet of the shaft, the time from the end of drilling to the beginning of concrete placement, does not exceed four hours without agitation. If the four-hour limit is exceeded, the bottom five feet of the shaft shall be over reamed prior to performing other operations in the shaft. For rock sockets constructed in shale using polymer slurry, concrete placement shall begin within 72 hours of starting the rock socket excavation to avoid degradation of the shaft sidewall. Before concrete placement begins, foundation inspection, when required, cleaning operations and reinforcing steel placement shall be completed and approved by the Engineer. These operations will be included in the 72 hour time limit. If concrete placement is not begun within the time limit, the Contractor shall take corrective measures to the satisfaction of the Engineer.

**625.18 Level of Slurry.** During construction, the level of slurry not be less than five feet above the water table and shall be maintained at a height sufficient to prevent caving of the excavation. If the Engineer determines that the slurry construction method is failing to produce the desired final results, the Contractor shall discontinue operations and propose an alternate method for approval from the Engineer. Correction for a failed slurry construction method will be non-compensable and any effect on time of performance non-excusable.

**625.19 Slurry Manufacturer's Representative.** When manufactured mineral or polymer slurry additives are to be incorporated into the drilling slurry mix, the Contractor shall provide the technical assistance of a representative of the mineral or polymer slurry additive manufacturer at the site prior to introduction of the slurry into the first shaft where slurry use will be required, and during drilling and completion of a minimum of one shaft to adjust the slurry mix to the specific site conditions.

**625.20 Cleaning of Shaft or Casing Sidewalls.** Cleaning of the shaft or casing sidewalls shall occur by a method approved by the Engineer as necessary to remove the depth of softening or to remove excessive slurry cake buildup.

**625.21 General Excavation Considerations.** The Plans will indicate the top of shaft elevations and the estimated bottom of shaft elevations between which the drilled shaft shall be constructed. Drilled shafts may be extended or shortened as approved by TDOT Soils and Geology and TDOT Structures if the foundation material encountered is unsuitable or better than anticipated, or based on the results of load tests.

**625.22 Time Restrictions.** Drilled shaft excavation shall begin only if the Contractor can complete the excavation, perform foundation inspection and testing, and place the reinforcement and concrete as a continuous daily operation. No two shaft within 50 feet of another shaft shall be excavated at the same time. Shafts shall not be constructed within 24 hours of the completion of an adjacent shaft if the center-to-center spacing is less than three shaft diameters.

**625.23 Disposal of Excavated Material.** Excavated material removed from the shaft and any drilling fluids used shall be disposed of in accordance with the contract documents, as directed by the Engineer, and in compliance with federal and state regulatory requirements

**625.24 Worker Entry Into Shaft Excavation.** The Contractor shall not allow workers to enter the shaft excavation for any reason, unless both a suitable casing has been installed and adequate safety equipment and procedures have been provided to workers entering the excavation.

**625.25 Rock and Obstructions.** Subsurface obstructions at drilled shaft locations shall be removed by the Contractor. The Contractor shall employ special procedures or tools when the hole cannot be advanced using conventional equipment. Blasting will not be permitted. Any man-made material that significantly limits excavation advancement such as concrete, steel, timber, etc. will be classified as an "obstruction". Drilling tools lost in the excavation will not be considered obstructions and shall be promptly removed by the Contractor. The presence of an obstruction for pay purposes must be verified by the Engineer or his representative. Removal of obstruction(s) will be paid at two times the unit price bid for Item Drilled Caisson (Rock) L.F.

for the shaft length from the first occurrence of the obstruction until such depth that the shaft is advanced to the point of removal of the obstruction and normal shaft excavation methods can resume. Boulders or rock layers of such size that do not allow the use of soil excavation tools as described above will not be considered an obstruction but will be considered Drilled Caisson Rock as described above.

**625.26 Inspection Equipment.** The Contractor shall maintain at the job at all times, all equipment suitable for use in the shaft inspection.

**625.27 Removal of Excess Sediment.** Final shaft depth shall be measured with approved methods after final cleaning by airlift, or other method approved by the Engineer. Unless otherwise stated in the contract documents, a minimum of 50 percent of the base of each shaft shall have less than ½ inch of sediment at the time of concrete placement. The maximum depth of sediment or any debris at any place on the base of the shaft shall not exceed 1 ½ inches. Shaft cleanliness will be verified by the Engineer for wet or dry shafts.

**625.28 Inspection, Supervision, and Records.** The Contractor shall provide aid to the Engineer in maintaining accurate records during all phases of the drilled shaft installation. The Contractor's supervisor shall provide the Engineer with any information required for the drilled shaft inspection reports. The Contractor shall provide bosun chairs, gas meters, safety equipment, lights, mirrors, weighted tape measures, steel probes, cameras, personnel and all assistance that may be required for the Engineer to inspect the drilled shaft excavations. Contractor shall perform any corrective work found necessary as a result of inspections. Necessary time shall be allowed for performance of these inspections.

**625.29 Inspection for Side Walls.** At the Engineer’s request, the Contractor will lower the Inspector to the level of the bottom of the casing and allow visual examination of the side walls of the rock socket to confirm the top of rock socket has been reached once the casing has been extended to the top of rock. Preferably, the sidewall inspection should not be performed until the drilled shaft excavation has extended to the anticipated base of rock socket and before any inner casing is set below the top of rock. Should the observed rock excavation reveal soil inclusions or voids, the drilled shaft excavation shall be extended as directed by the Engineer. Where groundwater cannot be controlled or other conditions prevent safe down-hole entry, side wall inspection will be performed using a camera. The camera should include any light source needed to allow for clear imaging. The Contractor will be responsible for providing sufficient proof that casing has been properly seated into rock and that side walls are free from soil inclusions or voids.

**625.30 Inspection of Bottom of Shaft.** Where groundwater can be effectively controlled (that is, less than one foot of standing water is maintained in excavation bottom) after reaching the anticipated base of rock socket, the Contractor will lower the Inspector to the level of the bottom of the socket and allow visual examination of the bottom of the shaft. Temporary casing should extend to the base of the rock socket to allow the Inspector to safely enter the excavation. Where groundwater cannot be controlled or other conditions prevent safe down-hole entry, bottom of shaft inspection will be performed using a camera. The camera should include any light source needed to allow for clear imaging. The Contractor will be responsible for providing sufficient

proof that excess sediment has been removed in accordance with Subsection 625.27. The determination of the shaft's tip elevation after excavation to the anticipated base of rock socket will either be made by the Engineer's judgment of conditions found in previously performed test borings drilled within the dimensions of the rock socket, examination of rock socket shaft excavation results (recovered cores or observation of shaft drilling response) or by examination of rock cores taken at least 8 feet below the shaft bottom as discussed in **Subsection 625.31**.

**625.31 Core Drilling**. When required by contract documents, core drilling shall be performed as described in the contract plans and paid for under Core Drilling and Sampling at the contract unit price. When core drilling is not included in the contract documents and is required by site conditions and directed by the Engineer, core drilling shall be paid at the contract unit price for Concrete Coring. The Engineer may require rock core samples to be taken a minimum depth of 8 feet and up to a maximum depth of 20 feet below the bottom of the drilled shaft excavation to either aid in predetermining acceptable rock socket elevations prior to beginning of shaft excavation or to provide information to determine the acceptability of a completed rock socket. Core sampling should be performed in accordance with ASTM D 2113 using a double or triple wall core barrel of NX (54.7 mm / 2.16 in.) or NQ (47.5 mm / 1.87 in.) size. The Contractor will perform this core sampling or schedule his qualified representative to do this work.

**625.32 Log of Excavated Material.** The Contractor shall maintain a log of cored material for each foundation inspection hole, and such logs shall be delivered to the Project Supervisor within 24 hours of completion of the boring. The log shall include the following:

(a) The amount of NX or NQ cored per run and the amount recovered. All core loss shall be noted and explained. Clay layers shall be noted and located on the log by depth.

(b) The Rock Quality Designation (RQD) for the NX or NQ core. The bedding thickness and degree of weathering shall also be noted.

(c) Location and elevation of holes.

**625.33 Storage and Labeling of Rock Cores.** Rock cores shall be stored in structurally sound core boxes and shall be protected from the elements. The core boxes shall be properly labeled to indicate location, depth, beginning elevation, Contractor and date, and shall be delivered to the Engineer.

**625.34 Reinforcing Steel Cage Fabrication and Placement.** The reinforcing steel cage, consisting of the longitudinal bars, ties, spirals, cage stiffener bars, spacers, centering devices, and other necessary appurtenances, shall be completely assembled as a unit, and shall be placed immediately after the shaft excavation is inspected and accepted, and just prior to shaft concrete placement. Temporary internal cage stiffeners shall be removed as the cage is placed in the shaft such that interference with the placement of concrete does not occur. The Contractor shall verify the stability of the reinforcing steel cage. The Contractor shall submit verification calculations to the Engineer for review and approval. Calculations shall be sealed by an engineer licensed in the State of Tennessee.

**625.35 Reinforcing Ties, Splices and Clearances.** All reinforcing steel in the shaft shall be tied at every intersection and supported such that the steel remains within the allowable tolerances specified herein during placement of concrete or casing removal. The reinforcing steel cage shall have sufficient rigidity to prevent racking or permanent deformations during delivery or installation.

| Concrete Cover | | | |
|---|---|---|---|
| **Shaft Diameter** | **Uncased** | **Casing Remains** | **Casing Withdrawn** |
| 3'-0" or less | 3" | 3" | 4" |
| >3'-0" & <5'-0" | 4" | 4" | 4" |
| 5'-0" or larger | 6" | 6" | 6" |

**625.36 Spacers.** Rolling spacers for reinforcing steel shall be used to minimize disturbance of the shaft sidewalls and to facilitate removal of the casing during concrete placement. Sets of concrete spacers or other approved non-corrosive spacing devices shall be used at sufficient vertical intervals, near the bottom and along the shaft at intervals not exceeding five feet, to ensure concentric location of the cage within the shaft excavation. When the vertical steel is greater than one inch in diameter, the maximum spacing may be increased to 10 feet. As a minimum, a set of spacers shall be provided within two feet of both the top and bottom of the shaft. In addition, one set of spacers shall be provided at both two feet above and below each change in shaft diameter. Non-corrosive spacers shall be provided at a minimum of one spacer per 30 inches of circumference of cage with a minimum of three at each vertical level to maintain the required reinforcement clearances. The spacers shall be of adequate dimension to maintain the specified clearance between the outside of the reinforcing cage and the side of the excavated hole or casing.

**625.37 General Considerations.** Accumulations of water in casings and excess sediment at the base shall be removed as described herein before the concrete is placed. No concrete shall be placed until all casings, if used, within a 15 foot radius have been installed. Within the 15-foot radius, all driving or vibratory installation methods shall be discontinued until the concrete in the last shaft has set at least five days. Concrete placement shall begin as soon as possible after completion of the excavation, inspection and setting of the reinforcing cage, and shall proceed in a continuous operation from the bottom of the shaft to the Plans construction joint or above as specified herein. An unplanned stoppage of work may require an emergency construction joint during the shaft construction.

**625.38 Placement of Concrete in the Shaft.** Concrete shall be placed for each shaft with the flow of concrete directed down the center of the shaft. Concrete shall be placed by free fall or through a tremie or concrete pump. The free fall placement method will only be permitted in dry holes. Concrete placed by free fall shall fall directly to the base without contacting either the reinforcing cage or hole sidewall. Drop chutes may be used to direct concrete to the base during free fall placement.

**625.39 Time Limitations.** The Contractor shall maintain a continuous pour until shaft is complete. All admixtures shall be adjusted for the conditions encountered on the job so the concrete remains in a workable plastic state throughout the two-hour placement limit. Prior to concrete placement, the Contractor shall provide test results of both a trial mix and a slump loss test conducted by an approved testing laboratory using approved methods to demonstrate that the concrete meets the two-hour requirement. The Contractor may request a longer placement time if a concrete mix is provided that will maintain a slump of 4 inches or greater over the longer placement time in the entire shaft as demonstrated by trial mix and slump loss tests. The trial mix and slump loss tests shall be conducted using concrete and ambient temperatures approved for site conditions.

**625.40 Concrete Placement by Tremie.** Tremies used to place concrete shall consist of a tube of sufficient length to discharge concrete at the shaft base elevation. The tremie shall have sufficient weight to rest on the shaft bottom before the start of concrete placement and to prevent curling of the tremie line during placement of the concrete. The tremie shall not contain aluminum parts that may come in contact with the concrete. A tremie shall consist of a watertight tube having an inside diameter of no less than 10 inches and fitted with a hopper at the top. The inside and outside surfaces of the tremie shall be clean and smooth to permit both flow of concrete and unimpeded withdrawal during concrete placement. The tremie wall thickness shall be adequate to prevent crimping or sharp bends that restrict concrete placement.

**625.41 Tremie Operation.** Underwater placement of concrete shall not begin until the tremie is at the shaft base elevation. The discharge end of the tremie shall be constructed to permit the free radial flow of concrete during placement operations. The tremie discharge end shall remain immersed as deep as practical in the concrete, but shall be no less than five feet at all times. The tremie shall be supported such as to permit free movement of the discharge end over the entire top surface of the work and to permit rapid lowering when necessary to retard or stop the flow of concrete. The discharge end shall be sealed closed at the start of work to prevent water from entering the tube before the tube is filled with concrete. After placement has started, the level of the concrete in the tremie shall be maintained above the level of slurry or water in the borehole at all times to prevent water or slurry intrusion into the shaft concrete. If water enters the tube after placement is started, the tremie shall be withdrawn, the discharge end resealed, and the placement restarted. The flow of concrete shall be continuous until the work is completed.

**625.42 Removal of Tremie Orifice From Concrete.** If at any time during the concrete pour, when using the wet construction method, the tremie line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete surface, the entire drilled shaft will be considered defective. Corrections made by the Contractor will be non-compensable and any effect on time of performance non-excusable.

**625.43 Concrete Placement by Pump.** Concrete pumps and lines may be used for concrete placement by either the wet or dry construction method. All pump lines shall have a minimum diameter of 5 inches and shall be constructed with watertight joints. Concrete placement shall not begin until the pump line discharge orifice is at the shaft base elevation. For the wet construction method, a plug or similar device shall be used to separate the concrete from the fluid in the hole until pumping begins. The plug shall either be removed from the excavation or

shall be of a material that does not cause a defect in the shaft if the plug is not removed. The discharge orifice shall remain at least 5 feet below the surface of the fluid concrete. If at any time during the concrete pour the pump line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete level, the shaft will be considered defective. . Corrections made by the Contractor will be non-compensable and any effect on time of performance non-excusable.

**625.44 Adjustment of Concrete Free Fall or Rate of Concrete Flow.** If the free fall concrete causes the shaft excavation to cave, the Contractor shall control the movement of concrete by reducing the free fall of the concrete or the rate of flow of concrete into the excavation. The Contractor shall be responsible for proposing, developing, and after approval from the Engineer, implementing corrective work.

**625.45 Drop Chutes.** Drop chutes may be used to direct placement of free fall concrete down the center of the shaft excavations. Drop chutes shall be a smooth tube constructed either as a continuous one-piece unit or as removable sections. Aluminum drop chutes will not be permitted. Concrete may be placed through either a hopper at the top of the tube or side openings as the drop chute is retrieved during concrete placement

**625.46 Construction Joints.** Construction joints shall not be utilized unless otherwise approved by the structural Engineer. All planned reinforcing steel shall extend uninterrupted through joints. Surfaces of fresh concrete at horizontal construction joints shall be rough floated sufficiently to thoroughly consolidate the surface and to intentionally leave the surface in a roughened condition.

**625.47 Concrete Curing.** Portions of drilled shafts exposed to a body of water shall be protected from the action of water by leaving the forms in place for at least seven days after concrete placement or until the shaft concrete reaches a minimum strength of 3,375 psi. After placement, the temporarily exposed surfaces of the shaft concrete shall be cured to prevent loss of water.

**625.48 Construction Tolerances.** During excavation of the shaft, the Contractor shall monitor the plumbness, alignment and dimensions of the shaft. Any deviation exceeding the allowable construction tolerances specified herein shall be corrected with a procedure approved by the Engineer. Drilled shaft excavations constructed in such a manner that the concrete shaft cannot be completed within the required tolerances will not be accepted. Correction methods shall be submitted by the Contractor for the Engineer's approval. Drilled shaft construction shall not begin until approval has been obtained. When a shaft excavation is completed with unacceptable tolerances, the Contractor shall propose, develop and, after approval from the Engineer, implement corrective work. Redesign drawings and computations submitted by the Contractor shall be signed by a professional Engineer registered to practice in the State of Tennessee. The following construction tolerances will apply to drilled shafts unless stated otherwise in the contract documents:

(a) Temporary casing diameters shall provide a final shaft diameter as shown on the Plans. When approved by the Engineer, the Contractor may provide a larger casing at the

Contractor's expense.

(b) Shafts shall be constructed such that the center of the top of the shaft is within 3 inches of Plans position in the horizontal plane at the plan elevation for the top of the shaft.

(c) For shafts in rock, the vertical alignment of a vertical shaft excavation shall not vary from the Plans alignment by more than ¼ inch per foot of depth. For shafts in soil, the vertical alignment of a vertical shaft excavation shall not vary from the Plans alignment by more than 3/16 inch per foot of depth.

(d) The bottom of the shaft excavation shall be normal to the axis of the shaft within a tolerance of 3/8 inch per foot of shaft diameter.

(e) Shaft steel reinforcing bar shall be no higher than six inches above Plans location or three inches below Plans elevation.

**625.49 Integrity Testing.** The completed shaft shall be subjected to the testing methods, specified by Plans, such as concrete coring or sonic logging testing, to determine the extent of any defects that may be present. If CSL testing is indicated in the plans, TDOT will supply a CSL consultant to perform the testing. If testing reveals voids or discontinuities in the concrete which indicate that the shaft is not structurally adequate, the shaft will be retested within 3 to 7 days of receiving the initial testing report. In the event retesting confirms the initial test, further measures as specified in **625.50** shall be conducted at the Contractor's expense.

The placement of concrete in additional drilled shafts shall be discontinued until the Contractor demonstrates the adequacy of the shaft construction method to the satisfaction of the Engineer. Any additional work required by the Contractor as a result of shaft defects will be non-compensable and any effect on time of performance non-excusable.

**625.50 Concrete Coring.** At locations where concrete coring is to be provided, as indicated in the contract documents or as directed by the Engineer, the following will apply. Upon completion of placing concrete and after waiting a minimum of 48 hours, the top surface of concrete shall be cleaned of laitance and any unsound concrete, and then one core hole, or as specified on the plans, shall be drilled completely through the shaft concrete and the rock socket to approximately one foot below the bottom of the rock socket of each shaft. Provisions for the inspection of the concrete surface shall be in accordance with the applicable requirements described herein. Core holes shall be drilled at locations specified by the Engineer. The holes shall be drilled to recover NX (54.7 mm / 2.16 in.) or NQ (47.5 mm / 1.87 in.) size cores. The core samples recovered shall be labeled as to the location from which the samples were taken. The samples shall be delivered to the Engineer for examination. If the cores indicate defective concrete in the shaft, which in the judgment of the Engineer impairs the strength of the completed shaft, the Contractor shall drill additional cores as directed by the Engineer. If the concrete is found to be defective, the Contractor shall submit to the Engineer in writing a proposal for correction, and those corrective procedures shall be approved by the Engineer before such corrective work is undertaken. The cored holes in non-defective concrete shall be filled with grout such that all voids are filled. Grout shall be non-shrink and obtain a

compressive strength equal to or in excess of that specified for the drilled shaft concrete. Grout shall be selected from TDOT Qualified Products List or alternate submitted for TDOT approval. No direct payment will be made for grout and grouting.

**625.51 Sonic Logging Testing.**

If CSL testing is indicated on a project with CEI oversight, the CEI shall supply a CSL consultant to perform the testing. Shafts six feet in diameter and larger require the addition of 3D tomography. Testing will be performed after the shaft concrete has cured as specified in Table 625.51 – 1. The Contractor shall provide reasonable access to the shaft top for performance of the sonic logging testing.

**Table 625.51 Sonic Logging Time Requirements**

| Shaft Diameter | Minimum Cure Time (prior to testing) |
|---|---|
| 4 to 6 ft. | 72 hours |
| 6 to 8 ft. | 96 hours |
| >8 ft. | 120 hours |

Installation of Pipes. The Contractor shall furnish and install ≥1 ½" nominal inside diameter steel pipes with 0.145" minimum wall thickness, ASTM A 53, Standard Weight, for use in sonic testing of each drilled shaft. Pipes shall be installed in each drilled shaft at the locations shown on the Plans, as required by the testing agency or as directed by the Engineer. The pipes shall be sufficiently regular and free from defects to permit the free and unobstructed passage of the probes. The pipe shall be installed such that all internal joints are flush. Stiffening devices such as mandrels, tape or similar material to seal the joints shall not be used. Pipe shall be watertight with clean internal and external faces, the latter to ensure a good bond between the concrete and the pipes. The pipes shall be fitted with a screw-on watertight shoe and cap and shall be securely fixed to the interior of the reinforcement cage with a minimum cover of three inches from the shaft periphery. The pipes shall be as near to parallel as possible, equally spaced and vertical. Where several sections of pipe are required to reach the full length, joints shall be made watertight. The pipes shall be filled with water and plugged or capped before shaft concrete is poured. The upper end of the pipe shall not be left open after the pour. The pipes shall extend at least three feet above the top of the concrete in the shaft to compensate for water displaced by insertion and removal of the transmitter, receiver, and cable. For shafts with a rock socket, the lower end of the pipes shall extend to the bottom of the rock socket. Care shall be taken during the drilled shaft concrete pour to not damage the pipes. If a tremie is used, the tremie shall not be permitted to rest on top of the pipes during the pour. After completion of the sonic logging and final acceptance of the drilled shaft, the Contractor shall fill the access pipes with grout. All cost associated with materials and installation of steel pipes for sonic logging testing shall be included in the cost of Drilled Shaft Concrete.

Sonic Logging Equipment. The sonic logging equipment furnished by the CSL consultant shall consist of all necessary supplies, support equipment and power to perform the sonic logging testing requirements as described herein.

Sonic Logging Test Procedure. The drilled shaft shall be tested between three and 7 days after concrete placement. The following procedures shall apply:

(a) Pipes shall be checked to ensure the pipes are free from blockages and are filled with water.

(b) Levels shall be taken on top of each pipe, each pipe shall be plumbed and the length shall be recorded.

(c) Testing shall be performed between each pair of adjacent pipes around the shaft perimeter and also in pairing combinations between each pipe with all other pipes in the shaft.

(d) All tests shall be carried out with the probes in the same horizontal plane unless the Engineer directs that defects be further evaluated with the probes on different horizontal planes.

(e) The probes shall be raised simultaneously from the bottom of the pipes ensuring that all slack is taken out of the cables before the analyzer is switched on, and that the distance between transducers remains constant during the course of the test. The speed of ascent shall be less than 12 inches per second. Measurements shall be taken at three inch intervals or less. Anomalies indicated by longer pulse first-arrival times (FAT) and significantly lower amplitude per energy signals shall be reported. If anomalies are detected, additional tests with two or more sources per receiver vertical offsets of greater than or equal to 20 inches shall be conducted between the same tubes unless the anomaly is within 20 inches of the bottom of the shaft.

(f) The CSL Consultant shall provide accurate measurements of probe depths on the logs.

Record of Testing. Preliminary results of the testing shall be provided on site prior to the CSL consultant leaving the site. A detailed CSL report and test data shall be submitted to the Engineer within seven days. The CSL report shall be signed and sealed by a Professional Engineer. The CSL report shall include, but is not limited to, the following: project identification and dates of testing, a table and schematic showing shafts tested with accurate identification of tube coordinates and collar elevation, name of personnel that performed the tests and interpretation and those personnel's affiliation, equipment used, data logs, interpretation, analysis, and results. The data logs shall include XY plots of FAT, amplitude and velocity versus depth. CSL data shall be processed to provide easy to understand 2D cross-sections between tubes for all tube pair combinations. These plots shall be annotated by the CSL consultant as appropriate to delineate anomalous results. For shafts six feet in diameter and larger, 3D tomography will be required along with CSL testing. If 3D tomography is requested, the data shall be submitted to the Engineer within ten days. If offset surveys are performed as part of 3D tomography, data plots shall include 3D volumetric images for the entire shaft, color-coded, to indicate velocity variations along the shaft. Locations and geometry of anomalies or unconsolidated zones shall be identified in 3D color images with detailed discussion. The results for CSL and 3D surveys shall be based on the percentage decrease in velocity as correlated to the

following Concrete Condition Rating Criteria (CCRC). The velocity datum of good concrete shall be established by averaging the velocities in the good concrete along the drilled shaft. Deviations from the velocity datum shall be used for determining the Concrete Condition Rating.

| Concrete Condition Rating Criteria | | | | |
|---|---|---|---|---|
| | | Overall Rating shall be the lower of the two criteria | | |
| **Concrete Condition Rating** | **Rating Symbol** | **Velocity Reduction** | **Signal Distortion/Strength** | **Indicative Results** |
| Good | G | 0 to 10% | None / normal Energy Reduction ≤ 6 dB | Acceptable concrete |
| Questionable | Q | 10% to 20% | Minor / lower Energy reduction = 6.1 to 9 dB | Minor concrete contamination or intrusion. Questionable quality concrete. |
| Poor | P/D | > 20% | Severe / much lower Energy reduction > 9 dB | Defects exist, possible water slurry contamination, soil intrusion, and or poor quality concrete. |
| Water | W | V= 4760 to 5005 ft/sec (≈60% reduction) | Severe / much lower Energy reduction > 12 dB | Water intrusion, or water filled gravel intrusion with few or no fines present. |
| No Signal | NS | No signal received | None | Soil intrusion or other severe defect absorbed the signal, tube debonding if near top. |

[a] The baseline velocity shall be 13,000 feet per second for normal weight concrete with f'c = 3 to 5 ksi.

Correction of Unacceptable Results. The CSL consultant shall immediately inform the Engineer of any suspected anomalies, honeycombing or poor concrete quality detected by testing. The Contractor and CSL consultant shall duly perform further tests as directed by the Engineer to evaluate the extent of any detected anomalies. Core drilling, or other investigative methods as approved by the Engineer, shall be performed to further investigate the anomaly. If a defect is confirmed, the Contractor shall bear all costs involved with the shaft coring, grouting and remediation. Within 14 days of the completion of testing, the Contractor shall provide a report signed and sealed by a Professional Engineer registered in the State of Tennessee providing the results of the additional investigations and recommendations to accept or repair the shaft. The report shall also contain recommendations for modification of construction procedures to prevent defects for subsequent shaft installations. The dates of the completion of drilling, cleaning, steel placement and concrete pour shall also be provided. Construction above the top of shaft shall not be performed until the shaft has been accepted by the Engineer.

**625.52 Drilled Shaft Load Tests.** All load tests, when required by the contract documents, shall be completed and submitted to the Engineer for review and approval before construction of any production drilled shafts. The locations of load test shafts, the maximum loads to be applied, the test equipment to be furnished by the Contractor, and the actual sequence of the load testing shall be as shown on the Plans or as specified in the contract documents. After completion of testing, test shafts not used as production shafts shall be cut off at an elevation three feet below the finished ground line. The portion of shafts cut off shall be disposed of by the Contractor, at the Contractor's expense, in a manner approved by the Engineer.

## Compensation

**625.53 Method of Measurement.**

Drilled Shaft Excavation (Soil). Accepted drilled shafts will be measured for payment to the nearest 0.10 vertical foot of length along the axis of each shaft. For shafts without a rock socket, measurement will be from the Plans elevation for the top of shaft to the bottom of the shaft. For shafts with a rock socket, measurement will be from the Plans elevation for the top of shaft to the top of the rock socket as defined in section "Drilled Shaft Excavation (Rock)".

Drilled Shaft Excavation (Rock). For pay purposes Drilled Shaft Excavation (Rock), the "top of rock" is defined as the elevation at which natural material cannot be drilled by conventional drilling tools and requires the use of special rock augers, core barrels, air tools, or specialized removal methods. The accepted rock sockets and drilling through rock will be measured for payment to the nearest 0.10 vertical foot of length along the axis of the shaft for the cumulative length of rock, as determined by the Engineer.

Drilled Shaft Concrete. Drilled shaft concrete shall include all cost for materials, placement concrete, and installation of steel pipes, as required by contract documents, for Sonic Logging Testing. Drilled shaft concrete will be measured by the cubic yard and computed from the dimensions indicated on the Plans or ordered in writing by the Engineer.

Drilled Shaft Reinforcing Steel. Drilled shaft reinforcing steel will be measured and computed for payment by the pound, unless otherwise stipulated in the Plans, in accordance with **subsection 604.30** of the Standard Specifications for Road and Bridge Construction .

Drilled Shaft Casing (Permanent). Permanent drilled shaft casing will be measured by the vertical foot of permanent casing installed. Additional permanent drilled shaft casing installed for the convenience of the Contractor will not be measured for payment.

Drilled Shaft Casing (Temporary). Temporary Drilled shaft Casing will not be measured for payment and shall be incidental to the work.

Foundation Probe Holes. Foundation probe holes will be measured for payment to the nearest 0.10 linear foot of length along the axis of each hole and paid for as Item Rock Drilling Bridges.

Foundation Core Holes. Measurement for payment for foundation core holes will be to the nearest 0.10 linear foot of length along the axis of each hole.

Concrete Coring. Measurement for payment for concrete cores will be to the nearest 0.10 vertical foot of length along the axis of the shaft from the top of concrete to a point determined

by the Engineer, and may extend the entire length of the shaft plus one foot below the bottom of the rock socket.

Sonic Logging Testing. When testing is not performed by the CEI, sonic logging testing of drilled shafts, as required, will be measured for payment per each drilled shaft.

Drilled Shaft Load Tests. Load tests will be measured for payment per each load test performed.

**625.54 Basis of Payment.**

Drilled Shaft (Soil). Payment will be considered full compensation for all temporary steel casing required, costs of drilling, excavation, slurry, dewatering, cleaning, and incidental work and materials required to complete the excavation. Payment for any drilled shaft excavation will be at the contract unit price per vertical foot for the diameter of the drilled shafts specified. No additional compensation will be made for concrete required to fill an oversized casing or for oversized excavation.

Drilled Shaft (Rock). Payment will be considered full compensation for drilling, excavation, slurry, cleaning, dewatering, and incidental work and material required to complete the excavation. For payment purposes the length of any rock socket installed and accepted shall be paid for at the contract unit price per vertical foot for the diameter of the rock socket specified. If the method of construction requires that drilled shaft casing be seated into the sound rock such that the bottom of the casing is below the determined top of sound rock elevation, payment for excavation below the top of the sound rock layer (top of the rock socket) will be included in the payment for the rock socket. In the event that the Engineer orders additional rock socket construction, payment for the additional length will be at the contract unit price per vertical foot of rock socket. Payment will be considered full compensation for the additional excavation into rock including all incidentals necessary to complete the work down to the elevation designated by the Engineer. Additional reinforcing steel and concrete shall be paid for at the contract unit bid price.

Obstructions. Removal of obstruction(s) will be paid at two times the unit price bid for Item Drilled Shaft (Rock) V.F. for the shaft length from the first occurrence of the obstruction until such depth that the shaft is advanced to the point of removal of the obstruction and normal shaft excavation methods can resume.

Drilled Shaft Concrete. Include all costs associated with furnishing and placing concrete in the drilled shaft in the unit price bid per cubic yard for Drilled Shaft Concrete in accordance with the Contract Plans. Include all costs associated with furnishing and installing Sonic logging access tubes and any required extensions in the unit price bid per cubic yard for Item Drilled Shaft Concrete. No payment will be made for construction delays resulting from the initial sonic logging testing of the drilled shaft. The Department will pay the costs for the initial sonic logging testing. The Contractor shall pay for all costs associated with coring, engineering design, cost required to correct defects and any construction delay costs, if a defect is found based on the sonic logging. The Contractor shall pay the costs of sonic logging testing to re-test the repaired drilled shafts.

Drilled Shaft Reinforcing Steel. Include all costs associated with furnishing and placing reinforcing steel, including but not limited to spacers, ties, and splices, in the drilled shaft at the

unit price bid per pound for Reinforcing Steel in accordance with Subsection **604.31** of the Standard Specifications.

Drilled Shaft Casing (Permanent). Include all costs associated with furnishing and installing permanent casing in the drilled shaft in the unit price bid per vertical foot of Drilled Shaft Casing. Temporary Casing, including all costs associated with installation and removal, shall be included in the bid price for item Drilled Shaft Excavation.

Foundation Core Holes. When core drilling is required by contract documents, payment will be at the contract unit price per linear foot for Item Core Drilling and Sampling. Payment will be considered full compensation for drilling or coring the holes, extracting and packaging the samples or cores, laboratory testing, delivering the samples or cores to the specified TDOT location and for all other expenses necessary to complete the work. When Core Drilling is not included in the contract documents and is required by site conditions and directed by the Engineer, Core Drilling shall be paid at the contract unit price for Item Concrete Coring. Payment shall be full compensation for completing the core drilling as specified above.

Concrete Coring. Payment for concrete coring will be considered full compensation for all material, labor, tools, equipment, grouting and incidentals necessary to complete the work. The field measured quantity shall be paid at the contract unit price per vertical foot for Item Concrete Coring.

Sonic Logging Testing. When testing is not performed by the CEI, payment for sonic logging testing of drilled shafts, when required by contract documents, or directed by the Engineer, will be made at the contract unit price per each drilled shaft for sonic logging testing. No payment will be made for supplementary sonic logging testing to evaluate defects. Payment for sonic logging testing will be considered full compensation for providing all equipment, conducting the actual probing measurements as specified, furnishing reports, removing equipment, and all tools, labor and any incidentals necessary to complete the work. The number of sonic logging inspections may vary from the estimated quantities, but the contract unit price shall prevail regardless of the variation.

Drilled Shaft Load Tests. When required by contract documents, drilled shaft load test will be paid at the contract unit price per each and will be considered full compensation for all costs related to performing and reporting load tests as specified.

**S T A T E** **O F** **T E N N E S S E E**

Rev. 8-21-17 January 1, 2015

# SPECIAL PROVISION
# REGARDING
# AGGREGATE FOUNDATION SYSTEMS

**626.01 Description –** This work shall consist of the design, furnishing of materials and the construction/installation and testing of aggregate foundations, consisting of either stone columns or aggregate piers. The intent of the aggregate foundations specified herein is to provide sufficient soil reinforcement and/or soil densification (i.e. global slope stability, bearing capacity, settlement) within the limits indicated on the contract documents to achieve the degree of improvements required to meet the performance criteria stated in the contract documents.

**626.02 Method –** Stone columns or aggregate piers shall be designed and constructed for the aggregate foundations based upon the soil information provided in the contract documents, the Contractors expertise, and other factors. The Contractor shall be responsible for all aspects of the design of the aggregate foundation system selected and meeting the performance requirements specified in the contract documents, including any grading deemed necessary by the contractor to prepare the project site for the aggregate foundations.

If the Prime Contractor does not possess the capability or expertise to design and/or install the aggregate foundations, as stated herein, or they select a system that is considered proprietary, they shall make arrangements to contract the services of a licensed Contractor or other qualified personnel, who meet the requirements stated herein, to perform the design and/or installation. All aggregate foundation improvement documents shall be signed and sealed by a Professional Engineer licensed in the State of Tennessee. The procurement of any permits required for the installation of the aggregate foundations, including the disposal of any water or spoils, shall be the sole responsibility of the Contractor.

**626.03 Qualifications of Designer/Installer –** The Contractor performing the work described herein shall have personnel on-site (engineer, operator, and/or foreman or superintendent) experienced in the aggregate foundations being installed. This work shall be performed under the supervision of the Contractors superintendent, who is knowledgeable and experienced in the method of constructing

aggregate foundations as required by the project. The Contractors equipment shall have the capacity to undertake the work and shall be sufficient to complete the work within the specified contract time.

The Contractor selected for this project shall meet the following criteria:

1. A minimum of five (5) years of experience in the selected aggregate foundation system design and installations.
2. At least one (1) registered Professional Engineer licensed to perform work in the State of Tennessee. The Contractor shall assign an engineer to supervise the work with at least (3) years of experience in the design and installation of the selected aggregate foundations.
3. A superintendent or foreman with a minimum of two (2) years of experience in the supervision of the aggregate foundation. The contractor may not use consultants or manufacturers' representatives in order to meet the requirement of this section.
4. Evidence of successful design and installation of the selected aggregate foundation system, within the United States of America, under similar conditions on at least three (3) projects in the last three (3) years. This documentation shall contain at a minimum: name of client contact, address, and telephone number; location of project; contract value, description of aggregate foundations and use (i.e. slope stability, settlement, bearing capacity, etc.)

**626.04 Design Requirements** – The Contractor shall be responsible for ensuring that the size, pattern, depth and spacing of the aggregate foundations are adequate to provide the required global slope stability, bearing capacity and/or settlement. The contractor shall be fully responsible for all assumptions, made by the contractor in regard to the aggregate foundation system, the strength of the soil and rock, and all implications that the properties of the soil and rock have on the design, constructability and stability.

The design of the aggregate foundation system shall meet all requirements contained within the contract documents.

**626.05 Submittal of Designs and Details**– The Contractor shall submit the designs and details (Design Packet) for review and acceptance by the Engineer (Materials and Test Division) no less than sixty (60) calendar days prior to beginning construction of the aggregate foundations.

INITIAL SUBMITTAL

1. Work experience in accordance with required qualifications mentioned in Subsection 625.03 of this Special Provision.
2. The Contractor shall submit one (1) full size plan set and one (1) electronic copy (PDF) of the

design packet to the Engineer as an initial submittal. If clarifications are required, an email with an accompanying electronic file (PDF) will be sent to the Contractor for clarifications within 15 business days after the receipt of the initial submittal.

3. The Contractor will be allowed 5 business days for comments clarification after the initial comments have been received. The Engineer will be allowed 5 business days following the Contractors response to determine if further clarification is needed.
4. The Engineer will not approve the submittal of the design packet but will review the submittal for completeness.
5. The initial submittal shall be signed and sealed by a registered Professional Engineer licensed to perform work in the State of Tennessee.

FINAL SUBMITTAL

1. Once the Engineer informs the Contractor that the design packet is complete, the Contractor shall submit one (1) full size set and one (1) electronic copy (PDF) of the final approved set of plans.
2. The final submittal shall be signed and sealed by a registered Professional Engineer licensed to perform work in the State of Tennessee.

MINIMUM REQUIREMENTS OF THE SUBMITTAL OF DESIGN CALCULATIONS

1. Configuration of the Design Submittal
    a. The design packet shall contain in the title block the project number, county, foundation locations, initials of the preparer, contract number and page number. An index page shall be included to provide a list of the pages of the submitted design packet.
    b. The design packet shall include an explanation of the symbols on the calculations, a description of the computer program(s) used in the design, and at least one hand calculation documenting the computer program results. The design calculations shall indicate the target minimum replacement ratio and target minimum composite angle of internal friction at each section.
2. Diagrams of Critical Cross Sections
    a. The design packet shall include diagrams of the critical design cross section geometry including soils and rock strata, along with the locations, size and depths of the aggregate foundations.
    b. The design cross sections shall also include the critical slip surface shown where it will result with the minimum factor of safety.

3. Physical Properties of Rock and Soil

    a. The soil and rock properties, including shear strength, friction angle, cohesion and unit weights shall be shown for each soil and rock strata. Geotechnical information is provided in the contract documents.

4. Factor of Safety

    a. The comparison of the calculated factor of safety and the minimum required factor of safety shall be clearly shown in the design packet.

MINIMUM REQUIREMENTS OF THE SUBMITTAL OF AGGREGATE FOUNDATION DETAILS

1. Plan View of the Aggregate Foundations

    a. A plan view of the aggregate foundations shall be submitted. The following details shall be shown in the plan view:

        i. Identification numbers of the aggregate foundations;

        ii. A reference baseline;

        iii. Offset from the construction centerline or baseline to the aggregate foundations;

        iv. Size and alignment of aggregate foundations;

        v. Right-of-way and permanent or temporary construction easement limits, location of all known active and abandoned existing utilities, adjacent structures and other potential interferences;

        vi. The centerline of any drainage structures or drainage pipes located behind, within, or under the foundations.

2. Elevation View of Aggregate Foundations

    a. A drawing of the elevation view of the aggregate foundations shall be submitted. The following details shall be shown in the elevation view:

        i. Identification numbers of the aggregate foundations;

        ii. The elevation at the top and bottom of the aggregate foundations;

        iii. Size and alignment of the aggregate foundations;

        iv. Schematic and elevations of the structure, slope, etc. being supported by the aggregate foundation.

        v. The centerline of any drainage structures or drainage pipes located behind, within, or under the foundations.

**626.06 Work Plan** – The Contractor shall develop a work plan and submit the plan for review and acceptance to the Engineer no less than sixty (60) days prior to beginning construction of the aggregate foundations. The Contractor shall submit one (1) paper copy set and one (1) electronic copy (PDF) of the Quality Control Plan to the Engineer as an initial submittal. If clarifications are required, an email with an accompanying electronic file (PDF) will be sent to the Contractor for clarifications. Submittal clarifications and responses will follow same process as outlined in Subsection "626.05 Submittal of Designs and Details" The Work Plan shall provide detailed project specific information, including the following:

1. Work experience in accordance with required qualifications mentioned in Subsection 625.03 of this Special Provision, SP626.
2. List and size of all equipment and construction procedures to be used during installation;
3. The source of the proposed aggregate foundation backfill material and the gradation with tolerances the Contractor proposes to use. Upon approval of the backfill source and gradation, the contractor shall maintain this gradation throughout the aggregate foundation installation;
4. Details of the sequence and proposed schedule of aggregate foundation installation, including the anticipated order in which aggregate foundations will be constructed;
5. Details of excavation methods;
6. Designs of temporary embankment slopes and/or shoring deemed necessary by the Contractor;
7. Details on how water and spoils will be handled;
8. Other information shown in the Plans or requested by the Engineer.

**626.07 Quality Control Plan** – The Contractor shall develop a Quality Control Plan and submit the plan for review and acceptance to the Engineer no less than sixty (60) days prior to beginning construction of the aggregate foundations. The Contractor shall submit one (1) set and one (1) electronic copy (PDF) of Quality Control Plan to the Engineer as an initial submittal. If clarifications are required, an email with an accompanying electronic file (PDF) will be sent to the Contractor for clarifications. Submittal clarifications and responses will follow the same process as outlined in Subsection "626.05 Submittal of Designs and Details" The quality control plan shall include the following:

1. A proposed plan for quality control throughout the installation process;
2. Controls and measurements of the aggregate foundations;
3. A proposed verification program, including proposed independent testing agency to be used;
4. Copies of forms to be used for daily reports, testing reports and other pertinent reports;

5. Copies of testing methods to be used;
6. Copy of written Verification Program.

**626.08 Verification Program –** A verification plan designed, accomplished and reported by the Contractor is required to measure the quality of the installed aggregate foundations. The proposed verification program is subject to approval by the Engineer. As a minimum, the verification program shall include the following:

1. Proposed means and methods for verification that design and performance criteria, as stated in contract documents, has been satisfied. This may include but shall not be limited to modulus testing on individual elements and/or groups, soil borings, and other methods as required by the aggregate foundation system designer and approved by the Engineer.
2. Quality control program to verify that aggregate foundation elements are installed in accordance with the specifications and requirements as outlined in this Special Provision. The quality control program shall include testing and/or observations by an independent testing agency.
3. Program to monitor performance of the aggregate foundation system during and after construction of the overlying embankment. This procedure may include the installation of instrumentation. Instrumentation installed to monitor performance may also be used to aid in the verification that design and performance criteria have been satisfied.

**626.09 Daily Progress Reports and Final Reports –** During construction the Contractor shall submit an electronic file (PDF) copy of daily progress reports to the Engineer. Daily reports shall contain (if applicable) but shall not be limited to, element identified by location number, date constructed, drilled diameter, elevation of top and bottom of element, average lift thickness, the type and size of equipment used, description of soil and ground water conditions, quantity of aggregate used per element, results of quality control testing, and other pertinent daily activity information. The Contractor shall immediately report any unusual conditions encountered during aggregate foundation installation to the Engineer.

At the completion of the installation of the aggregate foundations, the Contractor shall submit a final report to the Engineer detailing the equipment and methods used, production rates, the performance of the site during treatment, and that the site meets the established criteria set forth in the contract documents. This report shall include a summary of all verification testing performed.

**626.10 Pre Construction Conference –** A pre-construction conference shall be held a minimum of 14 calendar days prior to the Contractor beginning any aggregate foundation installation work at the site to

discuss construction procedures, personnel, verification program, quality control and equipment to be used. Those in attendance shall include:

1. The superintendent and/or foreman, on-site supervisors, and the independent testing agency representative.
2. The Engineer, key inspection personnel, and representatives of the Contracting Authority.

If significant changes are made to the Contractors personnel, or significant revisions are made to the Contractors Design Packet and Work Plan, an additional conference shall be held before any additional work is performed.

**626.11 Materials –** Aggregate foundation backfill materials shall be furnished by the Contractor. Aggregates used for the construction of aggregate foundations shall be relatively clean crushed stone, meeting the requirements of Section 903 of the Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction for abrasion loss and sodium soundness.

Gradations for aggregate foundations shall be Type I, Grade B in accordance with ASTM D1241, ASTM C33 sizes No. 57, No. 67, or shall be a graded aggregate selected by the installer and approved by the Designer and Engineer. For aggregate foundation elements that extend below the water table, the gradation shall be the same as ASTM D1241 Type I, Grade B, except that particles passing the number 40 sieve shall be eliminated. Alternatively, ASTM C33 size No. 57 stone or other stone selected by the installer and approved by the Designer and Engineer. The aggregate shall have been successfully used in the modulus test.

**626.12 Installation –** The excavation, installation and testing shall be performed in accordance with the requirements shown on the submittals outlined in Subsection “626.05 Submittal of Designs and Details” and “Subsection 626.06 Work Plan”.

1. Excavation and Shoring
    a. The site shall be graded and leveled as needed for proper installation of the aggregate foundation system selected by the Contractor. The Contractor is also responsible for determining the need for and consequently designing any temporary embankment slopes and/or types of temporary shoring used to ensure proper installation. Any designs of temporary embankment slopes and/or types of temporary shoring shall be signed and sealed by a registered Professional Engineer licensed to perform work in the State of Tennessee.

**626.13 Tolerances –** Aggregate foundations shall be installed so that each completed element will be

continuous throughout its length. Aggregate foundations shall be installed in a sequence that will minimize ground heave. Any heaving shall be re-compacted or excavated as directed by the Engineer, and be considered incidental to aggregate foundation installation.

1. The center of the completed element shall be within 6 inches of the required horizontal location as shown on the approved details.
2. The completed element shall be out of plumb no more than 2 inches horizontal for every 10 feet vertical of depth as shown on the approved details.
3. The diameter of the completed element shall not be less than 10% of the required diameter as shown on the approved details
4. The centerline of the top of the ground improvement provided by the completed element shall be within 6 inches of the required elevation.

If the aggregate foundation elements are determined to be out of one of more of these tolerances, installation of an additional element may be required at the Contractors expense. The Engineer may require additional aggregate foundation elements to be installed at the Contractors expense if the average effective diameter of any group of 40 consecutively installed elements is less than the plan diameter as shown on the approved design and details.

**626.14 Modulus Testing –** Testing to evaluate performance values selected for design will be provided by the Contractor. A telltale shall be installed at the bottom of the test foundation so that the deflection at the bottom of the element can be measured. The modulus test shall be conducted at a location where the bottom of the element terminates in soil. ASTM D1143 general test procedures shall be used to establish load increments, load increment duration, and load decrements. Performance will be deemed acceptable when the deflection at the bottom of the element does not exceed 20% of the deflection at the top of the element.

1. The minimum number of modulus tests required will be presented in the contract documents, if not specified in the contract documents a minimum of one modulus test shall be required.
2. The location(s) of the modulus test(s) shall be determined by the Engineer.
3. A seating load of approximately 5% to 9% of the design load shall be applied prior to application of load increments and prior to the measurement of deflection.
4. With the exception of the load increment representing approximately 115% of the design maximum foundation stress, all load increments shall be held for a minimum of 15 minutes and a maximum of 1 hour, and until the rate of deflection reduces to 0.01 inches per hour or less.
5. The load increment that represents approximately 115% of the design maximum on the foundation shall be held for a minimum of 15 minutes, a maximum of 4 hours and until the rate

of deflection reduces to 0.01 inches per hour or less.

6. The modulus testing shall be performed as described in the design packet.

**626.15 SPT Verification Testing –** Testing to evaluate performance values selected for design will be provided by the Contractor. SPT verification testing parameters will be given in the contract documents. The SPT verification testing shall be conducted in compliance with the following criteria;

1. Testing at each SPT location shall be performed at 2.5 ft. intervals through the entire depth of the improved soil zone.
2. The normalized SPT blow count shall be equal to the sum of the hammer blows required to drive the sample from 6 to 18 inches below the cleanout depth adjusted to an overburden pressure of 1 tsf and for a hammer efficiency of 60%.
3. SPT testing shall be conducted in accordance with ASTM D1586.
4. SPT testing shall be conducted at midpoint locations between the column patterns.
5. Failure to satisfy the minimum normalized SPT blow count criterion given in the contract documents shall require the installation of additional aggregate columns at the Contractors expense. The Engineer may elect to perform additional SPT verification testing.

**626.16 Rejection of Aggregate Foundation Elements –** If an aggregate foundation element is installed in an incorrect location or does not satisfy the specified tolerances, the Contractor shall install an additional element near the rejected element at a location approved and agreed upon by both the Designer and the Engineer. Alternate remedial procedures will be accepted only if they are approved by the Engineer. Unless the rejection is caused by an obstruction, refusal in rock, dense soil or errors in the project drawings, the cost of all labor and materials required for the additional element shall be the responsibility of the Contractor.

**626.17 Method of Measurement –** Aggregate Foundation Improvements will be measured as Lump Sum.

**626.18 Basis of Payment –** The Contractor will be paid the contract Lump Sum price for the aggregate foundation improvements. This payment shall be full compensation for all submittals, labor, equipment, tools, materials, material tests, field tests, verification program, and incidentals necessary to acceptably construct the foundations.

Payment will be made under Item Number:

- 626-01.01 Aggregate Foundation Improvements – Lump Sum

**S T A T E** **O F** **T E N N E S S E E**

Rev. 5-14-18 January 1, 2015

# SPECIAL PROVISION

# REGARDING

# PREFABRICATED VERTICAL DRAINS

**627.01 Description –** The work shall consist of furnishing all necessary labor, equipment, materials, incidentals and transportation for the installation of Prefabricated Vertical Drains (PVDs) in accordance with the details shown on the Plans and the requirements of these Specifications.

**627.02 Testing Standards –** Use the latest edition of the testing standards indicated in this Special Provision. Substitution of standards will require the prior written approval of the Engineer. The Contractor or the PVD Installer is to provide copies of all substituted standards to the Engineer.

The most recent version of the following testing method(s) may be employed:

- Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method); ASTM D3884
- Grab Breaking Load and Elongation of Geotextiles; ASTM D4632
- Trapezoid Tearing Strength of Geotextiles; ASTM D4533
- Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products; ASTM D4833
- Mullen Burst Test; ASTM 3786
- Water Permeability of Geotextiles by Permittivity; ASTM D4491
- Apparent Opening Size of a Geotextile; ASTM D4751
- Tensile Properties of Geotextiles by the Wide-Width Strip Method; ASTM D4595
- (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head; ASTM D4716
- Particle-Size Analysis of Soils; ASTM D422

**627.03 Materials -** The PVDs shall consist of newly manufactured materials and shall consist of a continuous polymeric drainage core and nonwoven geotextile filter fabric (jacket). The jacket shall allow

free passage of pore water to the core without loss of soil material or piping. The core shall provide continuous vertical drainage. The core and jacket material may be either non-bonded or bonded. For non-bonded PVDs, the jacket material is wrapped around the core and seamed to itself. For bonded PVDs, the jacket material is fused to both faces of the core along the peaks of the corrugations.

JACKET MATERIALS – The jacket components shall conform to the following:

- The jacket material shall be a synthetic nonwoven polymeric geotextile meeting the criteria listed in Table 1.
- The jacket material shall not be subject to localized damage (e.g., punching through the filter fabric by sand/gravel particles).
- The jacket material shall be rigid enough to withstand lateral earth pressures due to embedment and surcharge so that the vertical flow capacity through the core will not be adversely affected.
- The jacket material shall be flexible enough to bend smoothly during installation and during any induced consolidation settlement without damage.
- The jacket material shall not undergo cracking and peeling during installation of the vertical drain.

## Table 1 – Jacket Material Properties

| PROPERTY[1] | TEST METHODS | UNITS | REQUIREMENTS |
|---|---|---|---|
| Mass | ASTM D5261 | oz./yd$^2$ | $\geq$ 4.0 |
| Grab Elongation | ASTM D4632 | % | $\geq$ 50 |
| Grab Strength[2] | ASTM D4632 | lbs. | $\geq$ 130 |
| Tear Strength[3] | ASTM D4533 | lbs. | $\geq$ 60 |
| Permittivity | ASTM D4491 | sec.$^{-1}$ | $\geq$ 0.5 |
| AOS | ASTM D4751 | Sieve Size (mm) | #100 ($\leq$ 0.15) |
| Ultraviolet Stability (Retained Strength) | ASTM D4355 | % | $\geq$ 50 after 500 hrs. of exposure |

Notes:

[1]All numeric values represent Minimum Average Roll Value (MARV) in the weaker principal direction. Provide geotextiles whose average test results from any roll sampled in a lot for conformance or quality assurance testing meets or exceeds minimum values provided in this Table.

[2]For bonded drains, grab tensile strength tests shall be conducted on the assembled drain using ASTM D4595.

[3]For bonded drains the trapezoidal tear strength test shall be waived.

CORE MATERIALS – The core materials shall conform to the following:

- The core material shall be continuous polymeric material fabricated with grooves to promote drainage along the axis of the vertical drain. Studded cores are not allowed.
- The core material shall meet the criteria listed in Table 2.

## Table 2 – Core Material Properties

| PROPERTY | TEST METHODS | UNITS | REQUIREMENTS |
|---|---|---|---|
| Thickness | ASTM D5199 | in. | 0.09375 (3/32) |
| Mass | ASTM D3776 | oz./ft. | ≥ 0.60 |
| Tensile Strength | ASTM D638 | lbs. | 300 |
| Crush Strength | ASTM D1621 | psi | 450 |
| Ultraviolet Stability (Retained Strength) | ASTM D4355 | % | ≥ 50 after 500 hrs. of exposure |

ASSEMBLED PVD – The assembled PVD shall conform to the following:

- The mechanical properties (strength and modulus) of the assembled drain shall equal those specified for the component jacket and core.
- The assembled PVDs shall be resistant against wet rot, mildew, bacterial action, insects, dissolved salts, acids, alkalis, solvents, and other components in the site ground water.
- Use only one single type of assembled PVD on the project.
- Provide an assembled PVD that meets the properties indicated in Table 3

## Table 3 – Assembled PVD Properties

| PROPERTY | TEST METHODS | UNITS | REQUIREMENTS |
|---|---|---|---|
| Perimeter | -- | in. | ≥ 7.75 |
| Width | Measure with caliper | in. | ≥ 3.75 |
| Thickness | ASTM D5199 | in. | ≥ 0.1250 (1/8) |
| Discharge Capacity | ASTM D4716 | gpm | 1.5 (at 50 psi) |
| | ASTM D6918 | | 1.5 (at 25% compression) |

TRANSPORTATION AND STORAGE OF ASSEMBLED PVD – The transportation and storage of the assembled PVD shall conform to the following:

- Label or tag the assembled PVDs in such a manner that the information for sample identification and other quality control purposes can be read from the label. As a minimum, identify each roll of assembled PVD by the manufacturer as to lot or control numbers, individual roll number, date of manufacture, manufacturer and product identification of the jacket and core.
- During shipment and storage, wrap the PVDs in burlap or similar heavy duty protective covering. Protect the PVDs from sunlight, mud, dirt, dust, debris, and other detrimental substances during shipping and on-site storage. The PVDs shall be free of defects, rips, holes, and/or flaws. Material which is damaged during shipment, unloading, storage, or handling, or which does not meet the requirements of the drain material will be rejected by the Engineer.

SPLICING PVD

- Non-bonded PVDs may be field spliced. Remove approximately 6 inches of the jacket material from the current assembled PVD roll exposing the core. Insert the exposed core into the new roll of assembled PVD and secure using methods approved by the PVD supplier and accepted by the Engineer. The core material shall not be exposed after splicing. The core materials from each roll should be in firm contact with the corrugated peaks of one core overlapping the corrugated valleys of the other core.
- For bonded PVDs, provide to the Engineer the PVD Manufacturer's splicing procedure for review and acceptance by the Engineer prior to any PVD material being installed.

PVD DRAINAGE LAYER – Unless otherwise stated in the Plans, the PVD drainage layer shall conform to the following:

- Place a drainage layer consisting of at least 24 inches, unless otherwise specified in the plans, prior to PVD installation.
- Unless otherwise specified in the plans, the drainage layer material shall conform to the following gradation requirements (ASTM D422), as shown in Table 4:

## Table 4 – Drainage Layer Gradation

| SIEVE | PERCENT PASSING |
|---|---|
| 2-inch | 100 |
| ½-inch | 65-100 |
| ¼-inch | 50-100 |
| No. 10 | 40-70 |
| No. 40 | 10-40 |
| No. 200 | 0-5 |

- Material not meeting the gradation defined above will be rejected. Acceptance of materials will be at the project site.

**627.04 Submittals** – At least 30 calendar days before the beginning of the PVD installation, the Contractor shall submit to the Engineer for review, full details of the materials, equipment, sequence and method of installation. Review by the Engineer of these items shall not relieve the Contractor of the responsibility to install PVDs in accordance with this Special Provision. As a minimum, the submittal shall contain the following:

PREFABRICATED VERTICAL DRAIN MATERIAL - Acceptance of the sample PVD material by the Engineer will be required prior to delivery of the PVD material to the Project. At least 30 calendar days before beginning PVD installation, the Contractor and PVD Installer shall:

- Identify the proposed source of the assembled PVDs prior to delivery to the site.
- Supply, to the Engineer, a manufacturer's material certification that the assembled PVD meets or exceeds the material requirements of this specification. The manufacturer's literature shall document the physical and mechanical properties of the PVD. The PVD Manufacturer shall be a specialist in the manufacture of PVDs and shall have produced a minimum of 5,000,000 linear feet of the PVD material similar to that proposed for the Project and that has been successfully used in similar applications within the past 5 years, including details on prior performance on these projects.
- Submit to the Engineer, for review and visual inspection, 3 samples of the un-spliced PVD to be used and 3 samples of proposed splices, if splices are allowed on the project. The samples of un-spliced PVD shall be at least 5 feet long. Samples of spliced PVD shall be long enough to include the splice plus 2 feet of un-spliced drain on both sides of the splice. The samples shall be stamped or labeled by the manufacturer as being representative of the PVD material having its specified trade name.
- Submit to the Engineer, for review and visual inspection, 3 samples of the proposed anchor plate to be used to anchor the PVDs at the design depth shown on the plans.

PREFABRICATED VERTICAL DRAIN INSTALLER - Provide proof to the Engineer of the experience of the PVD Installer for the work described at least 30 calendar days prior to PVD installation. The PVD Installer shall:

- Document successful installation of at least 5,000,000 linear feet of PVDs during the last 5 years and shall be a certified installer of the PVD Manufacturer.
- Document at least 5 successfully completed projects within the last 5 years of similar size and complexity to that of the Project. Document the PVD Installer's experience by providing a project summary that includes for each referenced project, the project start and completion dates, total quantity of PVDs installed, and a detailed description of the project, site conditions,

and subsurface conditions. Include in the project description details of the PVD materials, the equipment and technique used to install the PVDs, the average and maximum length of PVD installed, the client name and address, the name and telephone number of the representative of the consultant and owner for whom the work was performed and who can attest to the successful completion of the work, and any other information relevant to demonstrating the PVD Installer's qualifications.

- Identify a full-time supervisor who has been in responsible charge of supervising PVD installation operations for at least 5 projects in the last 5 years. The supervisor shall be present at the work site at all times during PVD installation operations. Provide a detailed resume of the supervisor's experience and qualifications. Provide a detailed resume for the replacement supervisor, if required.

PREFABRICATED VERTICAL DRAIN INSTALLATION PLAN - At least 30 calendar days prior to PVD installation, the Contractor shall submit to the Engineer, for review, a PVD Installation Plan that includes as a minimum the following information:

- The configuration of the installation equipment including size, type, weight, maximum pushing force, and vibratory hammer rated energy.
- Dimensions and length of the mandrel.
- Details of the PVD anchorage.
- Detailed description of proposed installation procedures.
- Proposed methods for securing splices in non-bonded PVDs or the manufacturers splicing procedure for bonded PVDs, if splicing is allowed.
- Proposed methods and equipment for pre-augering or spudding.
- Submit documentation of the successful application of the proposed PVD installation operations.
- Provide shop drawings showing the planned locations and bottom elevations of all PVDs, a unique identification number for each PVD, the proposed installation sequence, the location of all potential conflicts with the locations of the PVDs.

**627.05 Submittal Reviews** – Acceptance of the proposed materials, equipment, construction sequence, and installation method will be accepted by the Engineer. Acceptance of the PVD materials, equipment, construction sequence, or installation method does not relieve the Contractor and PVD Installer of its responsibility to install the PVDs in accordance with the plans and specifications. Acceptance by the Engineer of the method and equipment to be used to install the PVDs is contingent upon satisfactory demonstration of PVD installation at the project site. If, at any time, the Engineer

considers that the method of installation does not produce satisfactory PVDs, alter the method and/or equipment as necessary to comply with this Special Provision. The Engineer will determine the adequacy of the Contractor's methods and equipment.

**627.06 Installation Requirements**

- Install PVDs as indicated on the plans or as directed by the Engineer. Install the PVDs with equipment that will minimize the disturbance of the subsoil during the installation operation and maintain the mandrel in a vertical position. Size the equipment to minimize the disturbance of the subsoil during the installation operation. Provide equipment with sufficient push force to install the PVDs through all existing subsurface material to the depths shown on the plans. Size the equipment to have the capability of installing the PVDs to a depth of approximately 20 feet greater than the maximum PVD depth shown on the plans. Select equipment such that it will not force the fill soil into the existing soil, nor disturb the fill soil, nor cause any bearing capacity problems with the subgrade soils due to the weight of the equipment.
- Install the PVDs using a mandrel or sleeve that can be advanced through the soils to the required depth. The mandrel or sleeve shall protect the PVD material from tears, cuts, and abrasion during installation and shall be retracted after each PVD is installed. To minimize disturbance of the subsoil, the mandrel or sleeve shall have a maximum cross-sectional area of 10 square inches. The mandrel or sleeve shall be sufficiently stiff to prevent wobble or deflection during installation. In no case will alternative raising and lowering of the mandrel during advancement be permitted. Permit the raising of the mandrel only after completion of the PVD installation to the bottom PVD elevation shown on the plans or otherwise authorized by the Engineer.
- Install the PVDs using either a constant load or constant rate of advancement technique. Use a vibrator only when approved by the Engineer in areas where constant load or constant rate of advancement methods cannot install the PVDs to the design depths. Jetting or use of an impact hammer will not be allowed to install PVDs.
- Provide each PVD with an "anchor" plate or similar arrangement to anchor the bottom of the drain at the required depth during mandrel removal and to prevent soil from entering the bottom of the mandrel during PVD installation. The anchorage shall be adequate to keep the bottom of the PVD at the required depth subject to approval and field verification by the Engineer. The corresponding dimension of the anchor shall conform as closely as possible to the breadth dimensions of the mandrel to minimize soil disturbance. The projected cross-sectional area of the mandrel and anchor combination shall not be greater than 14 square inches.

- Notify the Engineer at least 3 working days prior to installation of the initial PVDs at the location(s) shown on the plans to allow the Engineer sufficient time to provide the necessary inspection for the initial PVD installation. Do not begin installation of the initial PVDs at the location(s) indicated without the presence of the Engineer or his/her representative. During the installation of the initial 10 PVDs at the indicated location(s), demonstrate that the equipment, method, and material produce a satisfactory installation, as determined by the Engineer. Following completion of the initial PVD installations at the indicated location(s), do not proceed with the installation of the remaining PVDs at the embankment location until authorized by the Engineer.
- If foundations have been previously installed, install the PVDs in a manner as to avoid these foundations. The location of the PVDs relative to the foundations shall be determined and staked out prior to the installation of the PVDs. In addition, take precautions to preserve the stake locations and re-stake PVD locations as necessary.
- Using a baseline and benchmark determined by the Contractor, locate, number, and stake out the PVDs. All other construction staking, for taking precautions to preserve the stake locations, and for re-staking, if necessary, is the responsibility of the Contractor. Do not vary the as-installed locations of the PVDs by more than 6 inches from the locations designated on the plans or approved shop drawings.
- PVDs that deviate from the plan locations by more than 6 inches, that are damaged, or improperly installed will be rejected. Abandon in place rejected PVDs. Replacement PVDs shall be placed as close as possible to the correct original locations.
- Provide the Engineer with a means of verifying the plumb-ness of the mandrel and determining the depth of the PVDs. Check the equipment for plumb-ness prior to installing each PVD. A deviation from the vertical of no more than 2 percent (2%) during installation is allowed.
- Splices, if allowed in the plans or by the Engineer, shall be done in accordance with approved PVD Installation plan.
- Cut off the PVDs neatly at least 6 inches above the working layer, unless otherwise shown on the plans.
- Provide the Engineer with a means of determining the depth of the advancing PVD at any given time and the length of the drain installed at each location. Submit a summary tabulation of the number and length (to nearest 1/2 foot) of acceptable PVD daily to the Engineer.
- Refusal is defined as the point where the soils resist a reasonable effort at further penetration of the PVDs. The Engineer will establish refusal criteria based on the existing soil borings and the initial PVD installations to be performed by the PVD Installer in the presence of the Engineer or his/her inspector, as specified herein. Terminate no PVDs above the design PVD bottom

elevations shown on the plans without the approval of the Engineer. The Engineer may vary the depths, spacing, and/or number of PVDs to be installed, and may revise the plan limits for this work based on the actual subsurface conditions encountered.

- Where obstructions are encountered below the working surface, install a new drain within a 1 foot radius of the original location of the obstructed PVD. As directed by the Engineer make a maximum of 2 additional installation attempts for each obstructed PVD. If the PVD still cannot be installed to the design bottom elevation, abandon the PVD location and install a new PVD at a location directed by the Engineer. Clearly mark in the field locations where PVDs do not meet the depth criteria due to obstructions. The Engineer will have the right to waive the replacement PVD requirement upon written notice to the Contactor and the PVD Installer.

- Pre-augering or spudding for the PVD installation shall be allowed to advance the PVDs through compacted fill material or other obstructions. Penetrate the overlying fill material or any dense layers or obstructions when encountered to satisfactorily install the PVDs. Obstructions are defined as any man-made or natural object or strata that prevents the proper insertion of the mandrel and installation of the PVD.

- The Contractor may use augering, spudding, or other approved methods to loosen the soil and obstructing material prior to the installation of the PVDs. The obstruction clearance procedure is subject to the approval of the Engineer; however, such approval shall not relieve the Contractor or PVD Installer of the responsibility to clear obstructions in accordance with the specifications.

- If augering is the selected method, the augers shall have a minimum outside diameter equal to the largest horizontal dimension of the mandrel, shoe, or anchor, whichever is greatest. The maximum outside diameter of the auger shall be no more than 3 inches greater than the maximum dimension of the mandrel.

- Limit the use of obstruction clearance procedures and use only when approved by the Engineer. Penetrate no more than 3 feet beneath the obstruction when using augering or other obstruction removal techniques.

- Provide the Engineer with “As-Built” plans of the PVD installation. Include in the plans the location, the date installed, and the length of each PVD below the fill soil surface elevation. In addition, include on the “As-Built” PVD plans the fill soil surface elevation at each location, the “As-Built” PVD bottom elevation, and identify any rejected or abandoned PVD installations. Submit “As-Built” plans at least weekly during PVD installation operations. Submit a final “As-Built” PVD plan within 7 calendar days of the completion of PVD installation in all embankment locations. The final “As-Built” plans will be subject to the approval of the Engineer.

**627.07 Method of Measurement** – Furnish all supervision, materials, equipment, mobilization, crews, tools, required permits, survey stake out of PVD locations, and other equipment and materials as necessary to properly execute the work. In addition, this item includes clearing of obstructions and the proper disposal of surplus materials brought to the ground surface by obstruction clearance, if required.

Mobilization will be paid for by lump sum.

PVDs will be measured and paid for as the number of linear feet satisfactorily installed, or abandoned as directed by the Engineer. Measure the length of acceptably installed PVDs to the nearest 1/2 foot. The length of the PVDs to be paid for shall be the distance the installation mandrel tip penetrates below the working grade plus the required cut-off length above the working surface. Payment will not be made for drains that are not anchored to the required depth, unless previously approved by the Engineer in writing.

The Engineer may vary the depths, spacing, or numbers of PVDs to be installed and may revise the PVD installation limits shown on the plans based on the actual subsurface conditions encountered. Such changes or revisions may increase or decrease the total quantity of the PVDs estimated based on the plans. In the event of such changes in required PVD quantity, the payment for PVDs shall be made on the basis of the contract unit price per linear foot.

Drainage Layer Material will be paid for in cubic yards of material, complete and in place.

**627.08 Basis of Payment** – Mobilization shall include the cost of furnishing of all equipment and materials necessary to properly execute the work.

PVD payment will be based on the sum total length of all acceptably installed. No payment will be made for PVDs, or for any delays or expenses incurred through changes necessitated by improper material, equipment, or installation. No payment will be made for PVDs placed deeper than the bottom elevation designated on the plans unless authorized in writing by the Engineer. The unit bid price for PVDs shall include the cost of survey and stakeout, installing PVDs, and furnishing all labor, tools, and incidentals necessary to complete the work.

Drainage layer material payment will be based on the sum total cubic yards of material in place. The unit bid price for the drainage layer material shall include the cost of furnishing all labor, tools, and incidentals necessary to complete the work.

Payment will be made under Item Number:

- 627-01.01 Mobilization Lump Sum
- 627-01.02 Prefabricated Vertical Drain Linear Feet
- 627-01.03 Drainage Layer Material Cubic Yard

# Chattanooga

# Hamilton County

# I-75/I-24 Interchange
# DESIGN-BUILD CONSTRUCTION

*Federal Project No.*
**State Project No.**
**PIN 114174.00**

# SPECIAL PROVISION (SP) 725

**July 27, 2018**

**Revised November 13, 2018**

Prepared For:

**Tennessee Department of Transportation**

Prepared by:

**TDOT ITS Office**

records of the system integration procedures. Provisions will be made to accommodate changes to the system both during and after construction.

## 1.10 Payment Terms for 725 Item Numbers

Stored Materials Payment will be made for all 725 Item Numbers per TDOT Standard Specifications. For 725 items that describe payment terms based on completing certain testing or installation requirements, those payment terms will apply only to the unit price amount that is in excess of the stored materials payment. For example, if an item says that 50 percent of the contract unit price will be paid upon approval of Bench Test results, this payment will only be applicable if the stored materials payment was not already in excess of 50 percent of contract unit price. At the point which the percentage associated with a testing requirement exceeds the amount previously paid for stored materials, the additional amount will be paid to the Design-Builder at the time of that particular test completion.

## 1.11 Liquidated Damages

See Special Provision 108B for liquidated damages related to the ITS infrastructure.

**Fiber Network**
The Design-Builder shall ensure continuous operation of the fiber optic lines affected by construction activities. Temporary disconnect of communication shall not exceed forty-eight hours. Failure to restore communication within the allowed forty-eight hours will result in liquidated damages of $500 per hour until communication is restored.

**Dynamic Message Signs (DMS)**
The Design-Builder shall ensure continuous operation of the dynamic message signs (DMS) affected by construction activities. Temporary loss of DMS operation during construction activities shall not exceed thirty calendar days. Failure to restore full operation within the allowed thirty calendar days will result in liquidated damages of $500 per day/per DMS until full operation of the DMS is restored. Full operation is defined as the DMS being installed, integrated with TMC software, and accessible/controllable by TMC personnel. ~~If necessary, multiple DMS may be down at the same time.~~

**CCTV Cameras (CCTV)**
The Design-Builder shall ensure continuous operation of the all CCTV cameras affected by construction activities. Temporary loss of CCTV camera operation during construction activities shall not exceed forty-eight hours. Failure to restore full operation within the allowed forty-eight hours will result in liquidated damages of $500 per hour/per CCTV camera until full operation of the camera is restored. Full operation is defined as the CCTV camera being installed, integrated with TMC software, and accessible/controllable by TMC personnel. ~~If necessary, multiple CCTV cameras may be down at the same time.~~

**Radar Detection System (RDS)**
The Design-Builder shall ensure continuous operation of the radar detection systems (RDS)

affected by construction activities. Temporary loss of RDS operation during construction activities shall not exceed fourteen calendar days. Failure to restore full operation within the allowed fourteen calendar days will result in liquidated damages of $500 per day/per RDS until full operation of the RDS is restored. Full operation is defined as the RDS being installed, integrated with TMC software, and accessible/controllable by TMC personnel. ~~If necessary, multiple RDS may be down at the same time.~~

The table below summarizes the liquidated ITS related damages referenced in the section.

| ITS Device Type | Allowable Down Time | Liquidated Damages |
|---|---|---|
| Fiber Network | 48-Hours | $500 per hour |
| DMS | 30 Calendar Days | $500 per day per DMS |
| CCTV | 48-Hours | $500 per hour per CCTV |
| RDS | 14 Calendar Days | $500 per day per RDS |

b. The CCTV Camera System components shall be compatible with each other and be of rugged design and suitable for reliable operation when mounted in the configuration as specified in this ~~T~~SP and the Plans.

c. The CCTV Camera System shall be capable of attended and unattended, continuous 24 hours per day operation at the sites as shown on the Plans.

d. The Design-Builder shall ensure that the installed equipment provides unobstructed video of the roadway, traffic, and other current conditions around a roadside CCTV field site; that it responds to camera control signals from an operator of the system; and that the video images can be transmitted to remote locations interfaced to the system for observation.

e. The camera shall be fully digital, IP addressable and compliant with the H.264 video encoding standard. Any deviation from a digitally encoded H.264 IP CCTV camera shall be at the approval of the Engineer.

f. The camera shall be fully compliant with all aspects of the full motion National Television Standards Committee (NTSC) specification, and produce NTSC quality video.

g. The camera shall operate over wide dynamic light conditions ranging from low light/dusk to full sunlight having day (color)/night (monochrome) switchover and iris control, with user-selectable manual and automatic control capabilities.

h. The CCTV Camera System shall be capable of being remotely controlled and programmed.

i. Dome type enclosures shall be provided with pressurized integrated optic cartridge (IOC) for environmental protection

j. The camera shall be mounted together with the zoom lens and integrated into the pan and tilt device within the dome enclosure forming a totally integrated, easily removable assembly.

k. The camera shall include a high quality integrated camera/lens combination.

l. The camera shall also be equipped with an auto-iris lens capability compatible with the zoom lens supplied.

m. Iris capability shall include a provision for manual override via software.

n. The camera shall be capable of auto-focus during zoom-in or zoom-out, with provisions for override via software.

o. Overexposure protection shall be provided - the camera shall not be degraded or damaged under normal reasonable operating conditions.

p. The capability for local control of pan, tilt and zoom functions shall be provided at the roadside cabinet using vendor-supplied software installed on a laptop computer.

q. CCTV cameras shall support the NTCIP 1205 v1.08 communication protocol.

r. The cameras shall have image stabilization to reduce image jitter during viewing of the video.

s. The Vendor shall provide a minimum three (3) year warranty that covers manufacturing defects and workmanship. The warranty shall cover complete replacement at no charge for the equipment.

### 8.2.2 *Camera Unit*

The minimum Camera Unit requirements include:

1. Image Sensor Size: Not less than Diagonal 6mm (1/3" type)
2. Image Resolution: Not less than ~~720 x 480~~ 1280 x 720
3. Picture Elements (total) Not less than 1348 (H) x 976 (V)
4. Video Output: 16 Bit Digital YUV: 4.2.0
5. Day/Night Operation: Adjustable (Auto, Color and Mono Modes) via removable IR cut filter
6. Maximum Lens Aperture: Not less than f/1.6 (wide) to f/2.8 (tele)
7. Optical Zoom Range: Not less than 35X, 4.7mm to 84.6mm
8. Optical Zoom Speed: Two speeds
9. Horizontal Angle of View: Optical: Not less than 55.2° to 3.2
10. Minimum Focus Distance: Not greater than 0.01m (w); 1.0m (t)
11. Auto Focus: Selectable Auto/Manual; Minimum Scene Illumination for Reliable Auto Focus shall be no more than 50% video output.
12. Manual Shutter: Selectable
13. Auto Iris; Selectable auto/manual; Iris shall automatically adjust to compensate for

changes in scene illumination to maintain constant video level output within sensitivity specifications.

14. Sensitivity: Scene Illumination minimums ; F1.6 @ 50% Video

    a. 1.8 Lux (0.18 fc) @ 1/30 shutter, color mode

    b. 0.1 Lux (0.01 fc) @ 1/30 shutter, mono mode

### 8.2.3 *H.264/MJPEG Encoding Engine*

The IP Camera Positioning System (IPCPS) system shall fully integrate within its ~~positioning system~~ enclosure an H.264/MJPEG encoding component with functions as specified below. The Design-Builder may submit a nonintegrated solution installed in the traffic control cabinet or separate CCTV cabinet if it provides the same capabilities and is hardened for extreme temperatures, under approval by the Engineer.

1. Video Encoding: H.264 (Main Profile/Level 3.1) and MJPEG standards

2. Video Streams: Two independently configurable streams; (1) H.264 and (1) MJPEG

3. Video Stream Configuration Properties;

    a. Stream Settings

        i. Video Stream 1: H.264~~2~~.

        ii. Video Stream 2: MJPEG

    b. ~~Image~~Video Resolution: Not less than 480p and 720p~~, D1, VGA, CIF~~

    c. Streaming Mode: Capable of selectable CBR or VBR

    d. ~~Image Settings: (GOP (M, N)), Quality Value~~

    e. Frame Rates: 30, 15, 7, 4, 2, 1 fps

4. Data Rate: Adjustable in a range of not less than 256k up to 12Mb/sec for streaming video

5. Connection Types: Uni-cast~~, multi-Unicast~~ or multi-cast

6. IPCPS Video Latency: <150ms

7. Network Protocol Layers: RTP, RTSP, UDP, TCP, IP, DHCP, DNS, HTTP, HTTPS IGMPv2, ICMP, SMNPv2c/v3, and ARP as a minimum

### 8.2.4 *Positioning Drive*

1. Pan Movement; 360 degrees continuous rotation
2. Pan Speed; Variable from 0.1 to ~~80~~ 90 degrees/second or better.
3. Pan Repeatability; +/- 0.25 degree precision or better
4. Pan Preset Speed; 180 degree movement < 2 Seconds
5. Tilt Movement; Minimum of +90 to –90 degrees
6. Tilt Speed; Variable from 0.1 to ~~40~~45 degrees/second or better.
7. Tilt Repeatability; +/- 0.25 degree precision
8. Tilt Preset Speed; 180-degree movement < ~~2.5~~3 Seconds or better
9. ~~Pan/Tilt Modes; The DPS shall provide selectable modes of operation for user control flexibility:~~

    a. ~~Variable Proportional;~~

    b. ~~Proportional;~~

    c. ~~Fixed; Allows scaled fixed speed pan/tilt control based on level of zoom depth~~

### 8.2.5 *Operational*

The camera shall utilize NTCIP v1.08 communication protocol.

1. Presets; Minimum of 64, with each preset consisting of a pan, tilt, zoom and focus coordinate.

    a. Video Freeze between presets; Allow selection of freeze or live video during preset movements.

2. Preset Tours; Minimum 8 tours required, each tour shall consist of up to 32 pre-programmed presets, with individual dwell time property per preset per tour.

    a. Tour presets shall be useable in any order

    b. Presets may be used multiple times in tour

    c. Tours shall stop upon receipt of any pan/tilt positioning command.

d. Tour data shall be stored in non-volatile memory and shall not be lost if a power failure occurs.

3. Sector Zones; Provide a minimum of up to 16 user defined sector zones with each zone having a unique 24 character ASCII title programmed for description purposes.

4. Camera Site ID: Provide up to 2 lines of up to 24 ASCII characters each on video for user site description ID. If both lines are programmed, line 1 of ID shall always appear above line 2 regardless of top or bottom selection

5. Preset ID: Provide 1 line of up to 24 ASCII characters on video for Preset ID description. When a preset position is recalled the corresponding preset ID shall be displayed. The preset ID shall remain displayed until a pan, tilt, zoom, manual focus, auto focus select, or another preset command is received.

~~6. Compass/Direction ID; Provide ID on video for indication of viewing direction. User definable settings shall include;~~

~~a. 8 point or 16 point compass annotation from defined true north position.~~

~~i. Display shall include North, NE, East, SE, South, SW, West, and NW.~~

~~b. ID position shall group with the site location ID or separate from site location ID.~~

~~c. Provide for selectable 3-second time out or permanent display with global enable/disable setting of ID~~

~~7. Azimuth and Elevation ID: Provide ID on video for indication of absolute position of DPS positioning drive.~~

~~a. Position ID shall be displayed in 0 – 359 degrees for AZ position and +5 to -90 in EL elevation.~~

~~b. Provide for selectable 3-second time out or permanent display with global enable/disable setting of ID~~

8. Scalable Zoom; Variable speed pan/tilt ranges based off of zoom position. This adds the capability of limiting the maximum pan/tilt speed, while maintaining variable speed capability, throughout the zoom range of the camera.

~~a. Position ID shall be displayed in 0 – 359 degrees for AZ position and +5 to -90 in EL elevation.~~

~~b. Provide for selectable 3-second time out or permanent display with global enable/disable setting of ID~~

9. Updates: The IPCPS shall allow updates of firmware for new features via the Ethernet network communication channel. An internal IPCPS web server shall be provided for performing this task.

10. The IPCPS system shall return to previous position and state of operation upon power loss and restoration.

### 8.2.6 *IP Management*

The IPCPS shall provide at minimum the following network configuration properties;

1. IP Configuration: DHCP or Static IP address entry

2. Net mask address entry

3. Gateway address entry

### 8.2.7 *Power Input*

The IPCPS system shall fully comply with and include independent laboratory test results confirming compliance with the following electrical operating conditions;

1. Power; <100 Watts Maximum

2. Operating Voltage; ~~89 to 135Vac +/- 3hz, Per NEMA-TS2 para 2.1.2 and 2.1.3~~100-240 VAC

3. The nominal voltage shall be 120 VAC, Per NEMA-TS2 para 2.1.2

### 8.2.8 *Mechanical*

1. Connectors weatherproof non-corrosion type

2. Weight; Maximum 25lbs

3. Construction; Light Colored Powder Coated aluminum; all internal and external parts corrosion protected, stainless steel fasteners.

4. Faceplate shall be optically correct glass.

5. Camera Mount; provided to match pole locations on plans. See plans for variable types of poles.

6. Camera housing shall be equipped with a 1.5” NPT pipe thread to allow for connection to

the Camera Lowering Device connection box

### 8.2.9 *Environmental*

The IPCPS system shall fully comply with and include independent laboratory test results confirming compliance with the following environmental operating conditions;

1. Temperature; ~~-34C to 74C tested across low and high voltage ranges per Nema-TS2 paragraphs 2.1.2 and 2.1.3.~~ The operating ambient temperature range shall be from -34°C (-30°F) to +60°C (+140°F).

2. Vibration; Per Nema-TS2 paragraphs 2.1.9, 2.2.3, 5-30Hz sweep @ 0.5g applied in each of 3 mutually perpendicular planes.

3. Shock; Per Nema-TS2 paragraphs 2.1.10, 2.2.4, 10g applied in each of 3 mutually perpendicular planes.

4. Water Spray; Per IEC 60529+A1, 1999, Para 14.2.6, Solid water stream delivered thru 12.5mm nozzle @ 25 gallons/minute @ 9ft for 3 minutes

5. External Icing; Per Nema-TS2 250-2003, paragraphs 5.6

6. Corrosion Protection; Per NEMA 250-2003, paragraphs 5.10

7. Humidity; ~~0-100% NC per MIL-E-5400T, paragraphs 3.2.24.4~~ The IPCPS shall withstand the effects of humidity up to 100%, in accordance with MIL-E-5400T, paragraphs 3.2.24.4

8. Minimum Standards; IP66~~, IP67, ASTM-B117 Marine~~

### 8.2.10 *Certifications*

1. ~~Safety;~~ CE (24VAC~~ac~~)

2. ~~Emissions;~~ FCC Class A

### 8.2.11 *Surge Protection*

All CCTV Camera System electrical interconnects shall be protected from transient over-voltages (surges) including lightning and external electromagnetic fields coming into the cabinet. All cables shall be protected from a surge coming in on the ground and load side of the cabinet. The minimum surge protection requirements include:

1. Surge protectors shall be furnished for all non-dielectric cable and conductors (video, data/signal and device/assembly power) between the CCTV Camera System and the equipment cabinet.

d. Life Expectancy: Capable of surviving at a minimum of 25 occurrences at 2000-amperes.

e. Surge suppressor shall be self-resetting.

8. CCTV power surge protectors for power from equipment cabinet power distribution to the CCTV Camera System shall meet/provide the following functionality:

    a. Frequency: DC to 10MHz.

    b. Clamping Voltage: < 30VAC (rms) or 42VDC.

    c. Insertion Loss: < 0.2dB

    d. Input/Output Impedance: 75 ohms, typical.

    e. Peak Surge Current: 3000-amperes.

    f. Response Time: 1 nanosecond or less.

    g. Surge suppressor shall be self-resetting.

## 8.3 Installation Requirements

The following applies to both new CCTV sites and where an existing CCTV is being replaced under the contract. All equipment shall be installed according to the manufacturer's recommendations, the Plans and as follows:

1. Materials and associated accessories/adapters shall not be applied contrary to the manufacturer's recommendations and standard practices.

2. Shall include all materials needed to permanently mount the CCTV camera to the support structure as indicated in the plans.

3. Furnish and install power, video, and data cables, and any and all ancillary equipment required to provide a complete and fully operational CCTV system site.

4. Verify all wiring meets NEC requirements where applicable.

5. Cameras shall be mounted in positions which allow 360 degree continuous rotation and mounting arm position shall be approved by the Engineer prior to pole placement.

6. Furnish and install all appropriate field surge protection devices, and ensure proper ground per manufacturer recommendations.

# SECTION 10

# COLOR DYNAMIC MESSAGE SIGN

## 10.1 Description

This section describes furnishing, installing, and integrating a ~~stationary electronic~~ high resolution color electronic Dynamic Message Sign (DMS) assembly on a full span structure over the roadway and ground testing of signs. The Design-Builder shall supply a complete operating Light Emitting Diode (LED) sign including the sign case, sign controller unit (SCU), all cabling, conduits, electrical service, surge suppression, and all hardware associated with a complete installation as required by these Special Provisions. Note that the DMS item used to include a Roadside DMS Controller Cabinet. Now a separate Type C cabinet item is included in the plans and utilized as the Roadside DMS Controller Cabinet.

The DMS assemblies will provide TMC personnel with a means to visually communicate with motorists regarding any incidents, accidents, special events, travel times, graphical representations of the roadway during the roadway construction project. ~~etc. that may impact travel on the roadway network.~~ The DMS system shall also include manufacturer software that allows the creation, placement and display of graphics on the DMS. This software shall be installed in the Regional TMC with TMC operator access to the DMS field controller to allow display status and operational status.

## 10.2 Materials

### 10.2.1 *General*

1. Each DMS assembly shall consist of the following minimum components and general requirements:

    a. Full matrix LED sign with walk-in sign case.

    b. Mounting brackets.

    c. Associated SCU and software.

    d. Cabling between the various components.

    e. All electrical components shall be of the solid-state design. Use of vacuum or gaseous tube devices is not acceptable.

2. Provide door locks for all sign case and DMS cabinet doors, keyed to TDOT standard Corbin #2 that will be provided and confirmed during the submittal process. Provide two keys with each DMS location.

3. Provide a voltage label on all sign cases and DMS cabinets or enclosures in accordance with the NEC labeling requirements. Voltage labels shall meet the following minimum requirements:

    a. Labels shall be flat black lettering on a reflective yellow background. Lettering shall be a minimum of 1 inch in height.

    b. Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.

    c. Labels shall include the voltages entering the cabinet and shall be one continuous adhesive sheet. Examples are “120 VAC” or “120/240 VAC”.

    d. Labels shall be installed on all sign case and DMS cabinet doors.

### 10.2.2 *Sign Display*

The sign display shall meet the following requirements:

1. Each sign display shall have a single plane surface constructed of a single array of pixels.

2. The multi-color DMS system shall include manufacturer’s central control software.

~~3. Each sign display shall have a minimum of 125 columns and 27 rows of pixels.~~

3. Each sign display shall be able to display full color, a minimum of 24 bit displayable color.

4. Each full matrix sign display shall be able to display three (3) lines of twenty-one (21) - 18” tall characters that adhere to the respective MUTCD required NEMA TS 4 font sizes for electronics changeable massage signs.

5. Pixel columns and rows shall be perpendicular. The Pixel Matrix shall have a minimum of 96 rows x 400 columns.

6. Graphics shall be formed on the multi-color DMS.

7. Each sign shall be able to display graphic shapes including but not limited to arrows, roadway signs, and interstate shields, each of which can be designed and/or altered by the user through the supplied software.

8. Pixel spacing shall be such that three lines of text shall each have a nominal height of 18 inches.

9. Vertical and horizontal spacing between pixel centers shall be equal.

10. Each line shall contain a continuous matrix of pixels allowing the display of at least three (3) lines of 21 characters per line using a standard 18-inch font (23 X 15 pixel typical). Due to high-resolution aspect of the sign, pixel spacing between characters shall be determined as most compliant with latest version of MUTCD and NEMA TS 4 Hardware standard spacing.~~and one (1) pixel column as spacing between the characters.~~

11. ~~The spacing between lines shall be at least (3) pixels when 18-inch characters are displayed.~~

12. A minimum 12" border shall surround the LED pixel array.

13. Provide an automated light intensity measurement through electronic light sensors that can be easily maintained. The sensors shall be mounted in a manner to measure front, rear and ambient light conditions to set brightness levels.

11. The matrix shall be capable of double stroking all characters in an individual line.

### 10.2.4 *Physical Properties*

The sign physical properties shall meet the following requirements:

1. Access for all maintenance shall be from within the sign case and from the rear (i.e., the side opposite of the display surface) of the sign display.

2. The sign design shall allow unobstructed and convenient access to all non-structural components. Structural components are defined as the metal sign case and Lexan display cover.

3. All serviceable components shall be modular, interchangeable, and removable from within the sign case.

4. The sign display shall be composed of identical and readily interchangeable display modules and drivers.

5. Each display module shall contain one or more display pixels.

6. The replacement of any display module shall not require the use of any special tools.

7. All wiring interconnecting individual display modules shall be modular harness assemblies with latching push-on/pull-off or twist on/off connectors.

8. The removal of any combination of one or more display modules shall not alter the structural integrity of the sign display assembly, nor of the sign case.

9. The removal of any combination of display modules shall not affect the operation of the remaining operational modules in any way.

10. The performance of the sign shall not be impaired due to vibration caused by wind, traffic, or any other source.

11. All serviceable components shall weigh 50 pounds or less.

12. Mating connectors shall be designated by the connector number and male/female relationship. Connectors shall be keyed or pinned to prevent improper insertion of the wrong connector or PCB.

### 10.2.5 *Pixels*

Each pixel shall meet the following requirements:

1. Each pixel shall consist of the number of LED's needed to output white colored light at a minimum of 12,400 Candelas/m2 (white).~~produce a minimum of 40 candelas.~~

2. The number of necessary LED's shall be determined by the Vendor and be provided to the Engineer for approval.

3. Pixel to pixel luminous intensity shall not vary by more than a 2:1 ratio.

4. The optical axis of all pixels shall be perpendicular to the face of the sign display.

5. Pixels shall be replaceable either individually or in groupings. Groupings with three or more pixels shall be permitted only if bench level repairs and replacements to individual pixels are possible.

6. The failure of an LED in one string within a pixel shall not affect the operation of any other string or pixel.

7. Pixel Pitch shall be 20 mm (0.81 in).

8. Pixel power shall not exceed 1.5 watts per pixel, including the driving circuitry.

### 10.2.6 *LED Technology*

LEDs used to form a display pixel shall meet the following minimum requirements:

1. ~~The discrete, LED shall be un-tinted, non-diffused, solid-state lamps that use Aluminum Indium Gallium Phosphide (AlInGap) technology manufactured by Agilent Technologies, or functional equivalent.~~

2. ~~The manufacturer shall be the same for all LED's in all signs.~~

3. ~~The LED's shall display an amber color at a wavelength of 590 nm (± 5 nm).~~

4. ~~The LED shall have a 15o viewing angle with the half-power viewing angle defined such that at a given distance from the LED, luminous intensity measured at any point at an angle of 7.5o from the LED's center axis is no less than half the luminous intensity measured directly on the LED's center axis.~~

5. ~~The LED size shall be nominally 0.20 inches.~~

6. ~~The luminous output shall be a minimum of 3,000 mcd luminous intensity at 20 mA forward current.~~

7. ~~Current flow through any LED shall not exceed the following values under any light output level:~~

    a. ~~RMS current of 25 mA~~

b. ~~Peak current of 30 mA~~

1. The manufacturer shall be the same for all LED's in all signs.

2. The LED manufacturer shall perform color and intensity sorting to the bins. Each color and intensity of the LED's shall be obtained from no more than two (2) consecutive color 'bins' as defined by the LED manufacturer.

3. Each LED driver board shall be microprocessor controlled and shall communicate with the sign controller on a wire or fiber optic communications network using an addressable network protocol. The microprocessor shall process commands from the sign controller to display data, perform diagnostics, and report pixel status.

4. Red LEDs shall utilize AlInGaP semiconductor technology and shall display a red color at a wavelength of 615 nm – 630 nm (± 5 nm).

5. Green LEDs shall utilize InGaN semiconductor technology and shall display a green color at a wavelength of 520 nm – 530 nm (± 5 nm).

6. Blue LEDs shall utilize InGaN semiconductor technology and shall display a blue color at a wavelength of 465 nm – 470 nm (± 5 nm).

7. The LED shall have a nominal viewing cone of 30° with a half-power angle of 15° measured from the longitudinal axis of the LED. Viewing tolerances shall be a specified in the LED manufacturer's product specifications and shall not exceed ± 5°. Using optical enhancing lenses with 15° LED's will not conform to 30° half-power viewing cone specifications and will be cause for rejection.

8. The LED size shall be nominally 0.20 inches.

9. The luminous output shall be a minimum of 3,000 mcd luminous intensity at 20 mA forward current.

10. Current flow through any LED shall not exceed the following values under any light output level:

    a. RMS current of 25 mA

    b. Peak current of 30 mA

11. LED life shall be nominally rated for 100,000 hours of operation under field conditions, which shall include operating temperatures between -22° and +185°F (- 30° and +85°C).

12. LED life shall be defined as time it takes for the LED light output to degrade to half of the LED's initial light output.

13. To maximize LED service life, LED drive currents will not be allowed that exceed the

manufacturer's recommendations for the 100,000-hour life, but shall be sufficient to supply the required intensity.

14. The LED pixels shall be directly driven using pulse width modulation (PWM) of the drive current to control the display intensity. This LED driver circuitry shall vary the current pulse width to achieve the proper display intensity levels for all ambient light conditions. The drive current pulse shall be modulated at a frequency high enough to provide flicker-free operation and a minimum of 200 brightness levels.

### 10.2.7 *Sign Case*

The DMS Sign Case shall meet the following requirements:

1. Be a walk-in type, weatherproof enclosure that houses electrical, communication, and electronic control devices necessary for the operation of the sign. All steel components shall be stainless steel, unless otherwise noted in these specifications.

2. The sign case shall comply with AASHTO design standards for "Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals" and with the fatigue requirements of the National Cooperative Highway Research Program (NCHRP). All sign case and structural drawings shall be stamped by a Professional Engineer certified in the State of Tennessee.

3. Be attached to and become an integral part of the support structure.

4. The dimensions of the sign case (including walk-in cabinet) shall be as specified in this SP. Sign case dimensions shall be approved by Engineer.

5. The sign case shall present a clean, unbroken, neat appearance.

6. The front of the sign case shall not have any visible text or logos on it.

7. The sign case shall be weatherproof and protect the interior from moisture, dust, dirt and corrosion.

8. Positive corrosion protection shall be provided between dissimilar metals.

9. The angular alignment of the sign case shall be adjusted in the vertical direction down by three (3) degrees and be incorporated into the face of the display so as to leave the internal walkway as level as possible. If the sign can only be tilted using external brackets to the case, the provisions shall be made to make the internal walkway level.

10. The sign case shall be constructed of aluminum sheeting to be 5052-H32 and structural members to be 6061-T6.

11. Aluminum sheeting shall be not less than 1/8 inch thick with all seams continuously welded by the inert gas process.

12. The front of the sign case shall have a flat black matte finish applied in accordance with American Architectural Manufacturers Association (AAMA 2605) with an expected outdoor service life of 10 to 15 years.

13. All other surfaces shall have a bare aluminum mill finish.

14. Weep holes shall be provided to allow moisture to escape.

15. The sign case shall have an interior, non-skid walkway where the walkway shall extend the entire length of the sign case.

16. The unobstructed walkway shall be at least 24 inches wide and at least 75 inches high.

17. The interior walkway shall be capable of supporting a concentrated load of 300 pounds per square foot at any location, and a total load of 1000 pounds within any ten-foot section of the walkway.

18. Sign case shall have two (2) lifting eyes for placement of sign on structure.

19. Complete sign, including casing, all peripherals and electronics shall weigh no more than 4200 lbs.

20. Total sign case dimensions shall not exceed:

    a. Width: 31 feet (9.44 m)
    b. Height: 9 feet (2.74 m)
    c. Depth: 4.5 feet (1.4 m)

### 10.2.8 *Access Door*

The sign shall have an access door on the side of the sign case. The door shall meet the following requirements:

1. Access to the interior of the sign case shall be via a gasketed door that opens out. Door size should be no larger than 25 inches.

2. The door shall be located in the side of the sign case nearest the shoulder of the road and the catwalk when looking at the sign face.

3. The door, latches, and locks shall be engineered in such a way that the door can always be opened from inside of the sign to prevent a technician from being locked in the sign case.

4. The door latching mechanism shall be a three-point draw roller type.

5. The door latching pushrods shall be turned edgewise at the outward supports and have a

3. Ventilation openings shall be louvered or hooded.

4. Ventilation openings shall be covered with screens so as to prevent the entrance of birds or insects.

5. The number and size of louvered vents shall be determined by the DMS manufacturer to be of sufficient size to provide adequate ventilation.

6. Air filters shall be installed behind each vent and shall meet the following requirements:

    a. Replaceable industrial grade pleated.

    b. Shall completely cover the vent opening area.

    c. Shall be manufactured per ASHRAE Standard 52.2P or later version.

    d. Shall be of fire retardant and water resistant construction, able to withstand temperatures up to 300°F.

    e. Filter replacement is to be accomplished without tools with easy access.

7. The sign case shall be equipped with one or more fans that meet the following requirements:

    a. Positive pressure ventilation system.

    b. The continuous duty electric fans shall include ball or roller bearings.

    c. Sign case venting fan(s) shall have a minimum combined capacity to keep the signs housing internal temperature to a maximum of thirty (30) degrees Fahrenheit above external ambient temperature.

    d. LED cooling fans shall be provided to vent the air between the display module and the sign face cover.

    e. Sufficient LED cooling fans shall be provided to keep the air surrounding the LEDs to a maximum temperature not exceeding the rated temperature for the LEDs.

    f. The sign shall be equipped with a minimum of one (1) ambient temperature sensor, one (1) internal temperature sensor, and one (1) sensor that measures relative humidity of the air inside the housing. Mount the sensors such that they will never be in direct sunlight, and easy to maintain/replace. All sensors shall report data to the SCU.

    g. Provide sign case ventilation calculations and LED cooling calculations to show sufficient air circulation is provided to meet this SP requirements under worse case air humidity, solar loading, internal heat generation with 50% of all sign pixel

turned on at maximum light out level. All sign case temperatures shall be measured at ceiling level.

h. The fan(s) shall be mounted within the housing.

i. The fan(s) shall be downstream from the air filters.

j. The sign case venting fan(s) shall blow the air into the sign case.

k. The DMS manufacturer shall determine the number, placement, and size of the electric fans.

l. The fans shall be thermostatically controlled. The thermostat shall meet the following requirements:

   i. Shall be manually adjustable to turn off and on between ~~33°C~~ 91°F and ~~65°C~~149°F.

   ii. On and off hysteresis shall not exceed three (3) degrees Fahrenheit.

   iii. The manual adjustment shall be graded in five (5) degrees Fahrenheit increment scale.

   iv. Measure sign case temperature at ceiling level.

m. The fan circuit shall be protected at 125% of the fan motor capacity.

## 10.2.10 *Sign Face Cover*

The sign face display cover shall meet the following requirements:

1. The sign face cover shall be attached to the front of the sign case.

2. The sign face cover shall be a weatherproof, multi-window assembly, which allows an unobstructed view of the sign display.

3. The window material shall meet the following requirements;

   a. Be scratch resistant and ultraviolet stabilized polycarbonate plastic panels (Lexan with stabilizer or equivalent).

   b. Be not less than 1/8 inch.

   c. Shall not exhibit any flaws as a result of normal cleaning, installation or removal, ventilation, vibration and/or positive or negative pressure caused by wind or the passing of large vehicles.

4. Documentation shall be provided the Engineer showing the materials used in the manufacture of the window material.

5. The window attachment mechanism shall provide for the replacement of individual windows without disturbing adjacent windows.

6. The removal of any combination of windows shall not adversely affect the integrity of the sign display cover.

7. The attachment mechanism shall allow the windows to expand and contract with changes in the temperature.

8. A weatherproof seal shall be maintained when the window expands and contracts.

9. The windows shall be installed with a reusable gasket or caulking. The gasket or caulking shall meet the following requirements:

    a. Designed for outside plant use.

    b. Design life of at least ten (10) years.

    c. Remain flexible for at least ten (10) years.

10. Internal strip heaters shall be provided inside the sign case at the bottom of the sign face to prevent fogging of the sign face cover.

11. The internal axial or strip heaters shall be thermostatically controlled. The thermostat shall meet the following requirements:

    a. Shall be manually adjustable to turn on and off between –20 degrees Fahrenheit to 50 degrees Fahrenheit

    b. On and off hysteresis shall not exceed 3 degrees Fahrenheit.

    c. The manual adjustment shall be graded in 5 degrees Fahrenheit increment scale.

## 10.2.11 *Redundant Power Supply*

The DMS display power supply and driver electronics shall meet the following requirements:

1. Shall be auto-ranging regulated DC power source.

2. Operate from ~~120~~90 VAC, 60 Hz (or 240 VAC, 60 Hz). Require NEMA TS 2 voltage input requirements.

3. Have an output of less than 24 VDC.

## 10.2.12 *Sign Electrical Requirements*

1. The 120/240 Volt electrical service panel shall be rated for 100 amperes maximum.

2. The panel shall have an interrupt rating of not less than 10KA.

3. Internal sign case illumination shall meet the following minimum requirement:

   ~~a. Minimum of three (3) light fixtures.~~

   a. Mounted near the DMS ceiling.

   b. Provide uniform light distribution in the sign case.

   c. The lighting shall be via compact fluorescent lamps with a life of at least 10,000 hours of operation and a minimum 30 watt rating.

   d. A minimum of one (1) compact fluorescent light fixture shall be installed every eight (8') feet of DMS width. The lamps shall provide uniform light distribution throughout the inside of the assembly.

   ~~d. The lights shall be 4 feet, double bulb fluorescent fixtures, socketed florescent spiral bulbs, or approved equivalent.~~

   e. The lamps shall be self-ballasted and be rated for cold weather.

   f. The bulbs ~~will~~shall be shielded with a protective wire cage.

   g. The lights are to be controllable with a manual timer having an adjustable maximum on-time of four (4) hours.

   h. The light switch and timer shall be located near the entry door on the side away from the door hinges.

   i. Two of the light fixtures shall be located approximately two feet from each end of the sign case, and one fixture shall be located in the center of the sign case.

4. The sign case shall be constructed to prohibit any interior light from being visible from the outside when the door is shut.

5. The sign case shall be equipped with three, 15 amp, 120 VAC duplex GFCI (NEMA 15-R) AC receptacles.

6. Two AC receptacles shall be located approximately four feet from each end, and one receptacle shall be located in the center of the sign case.

7. The AC receptacle shall be mounted on the back wall of the sign case.

### 10.2.13 *Sign Controller Unit (SCU)*

The Sign Controller Unit (SCU) shall control the operation of all equipment housed at the Dynamic Message Sign site. The SCU shall meet the following requirements:

1. Shall include a front panel interface with graphical LCD and keypad for direct (local) operation and diagnostics.

2. Shall respond to the direct commands from the system computer and the portable, field-testing computer.

3. Shall be mounted in the roadside DMS cabinet and not in the sign enclosure.

4. Shall receive and interpret commands sent by the system computer and cause the immediate message to be displayed on the sign, and shall provide a return message to the computer that provides information concerning the status of the sign.

5. Shall continuously monitor command messages from the system computer.

6. Shall either blank the display, or continue to display a given message, depending on the option selected by the operator, when a computer system poll is not received within a user-definable threshold period.

7. Shall maintain a library of not less than 60 different display messages and related parameters. The SCU shall support uploading and downloading the message library.

8. Shall monitor and report internal sign case temperatures.

9. Shall be capable of detecting power failures. Power failure is defined when the power is out of limits for 3 or more cycles.

10. Shall include a battery backup that allows the controller to operate for a minimum of 30 minutes while the incoming AC power source has failed.

11. The battery backup circuit shall supply enough power capacity to operate the following equipment:

    e. SCU~~r~~

    f. All communication equipment within the DMS roadside cabinet

12. Shall perform the following function when power is restored after a power failure is detected:

    a. Display the same message prior to power failure if the outage is less than the user specified period.

## 10.2.14 *Communications*

The DMS controller shall provide interfaces for local and remote communications meeting the following minimum requirements:

1. Communication interface shall be 10/100 Base TX Ethernet for all DMS devices. No serial to Ethernet converters (i.e., terminal servers) are permitted either internal or external to the controller.

~~2. Remote communication interface shall be 3G wireless data communication platform using EV_DO Rev. A with fallback to CDMA 1X, CDMA 1xRTT, CDMA IS.95 (Airlink Raven X or equal).~~

2. Communication interface shall comply with NTCIP 1203 v03 or later version.
~~3. The sign controller local communication interfaces shall include at a minimum:~~

   a. ~~A serial RS-232 and 10/100 Base TX interface at the roadside cabinet.~~

   b. ~~A serial RS-232 and/or 10/100 Base TX interface inside the sign case.~~

## 10.2.15 *NTCIP Requirements*

This SP references several standards through their NTCIP designated names and numbers. Each NTCIP Component covered by these project specifications shall implement the most recent version of the standard that is available as of September 1, ~~2008~~2018, including any and all prepared Amendments to these standards as of the same date.

Profile Implementation Conformance Specifications (PICS) for each NTCIP standard required shall be submitted for review and approval to the Department.

1. Ethernet Interface

   Communication interfaces using Ethernet shall conform at a minimum with all mandatory objects of all mandatory Conformance Groups of the following standards:

   a. 1101 – NTCIP Simple Transportation Management Framework (STMF)

   b. 1203 – NTCIP Object Definition for Dynamic Message Signs

   c. 2301 – NTCIP AP-STMF

   d. 2202 – NTCIP TP-Internet

   e. 2104 – NTCIP SP-Ethernet

the requirements for Conformance Level 1 (NOTE - See Amendment to standard).

b. Optionally, the NTCIP Component may support SNMP traps.

c. A communication interface may support additional Application Profiles at the manufacturer's option.

d. Responses shall use the same Application Profile used by the request.

e. Each communication interface shall support the receipt of application data packets at any time allowed by the subject standards.

6. Information Level

All communication interfaces Information Level protocol shall meet the following minimum requirements:

a. All communication interfaces shall provide Full, Standardized Object Range Support of all objects required by these procurement specifications unless otherwise indicated below.

b. The maximum Response Time for any object or group of objects shall be 200 milliseconds.

c. All communication interfaces shall implement all mandatory objects of all mandatory Conformance Groups as defined in NTCIP 1203 and their respective Amendments.

~~d. Table 1 indicates the modified object requirements for these mandatory objects.~~

~~e. Table 2 shows the required minimum support of messages that are to be stored in permanent memory.~~

d. The sign shall blank if a command to display a message contains an invalid Message CRC value for the desired message and shall provide a return message.

~~d. Table 3 specifies the support of the required MULTI tags and their ranges.~~

e. Shall also implement all mandatory objects of the following optional conformance groups of NTCIP 1201.

i. Time Management Conformal Group

ii. Report Conformal Group. Table 4 indicates the modified object requirements.

f. Implement all objects of the Font Configuration Conformance Group, as defined in NTCIP 1203. ~~Table 5 indicates the modified object requirements for this conformance group.~~

g. Implement all objects of the DMS Configuration Conformance Group, as defined in NTCIP 1203.

h. Implement all objects of the Multi Configuration Conformance Group, as defined in NTCIP 1203. ~~Table 6 indicates the modified object requirements for this conformance group.~~

i. Implement all objects of the Multi Error Configuration, as defined in NTCIP 1203.

j. Implement all objects of the Illumination/Brightness.

k. Sign Status, as defined in NTCIP 1203.

l. Status Error, as defined in NTCIP 1203.

m. Pixel Error Status, as defined in NTCIP 1203.

n. Since the display of graphics is currently not defined within the NTCIP Standards or their amendments, the vendor shall propose, and provide detailed documentation (i.e., interface protocol description level), how the specified graphical shapes can be displayed.

~~o. Implement the optional objects listed in Table 7.~~

**~~Table 1: Modified Object Ranges for Mandatory Objects~~**

| **~~Object~~** | **~~Reference~~** | **~~Project Requirement~~** |
|---|---|---|
| ~~ModuleTableEntry~~ | ~~NTCIP 1201 Clause 2.2.3~~ | ~~Shall contain at least one row with moduleType equal to 3 (software). The moduleMake shall specify the name of the manufacturer, the moduleModel shall specify the manufacturer's name of the component and the modelVersion shall indicate the model version number of the component.~~ |
| ~~MaxGroupAddresses~~ | ~~NTCIP 1201 Clause 2.7.1~~ | ~~Shall be at least 1~~ |

| Object | Reference | Project Requirement |
|---|---|---|
| CommunityNamesMax | NTCIP 1201 Clause 2.8.2 | Shall be at least 3 |
| DmsNumPermanentMsg | NTCIP 1203 Clause 2.6.1.1.1.1 | Shall be at least 1* |
| DmsMaxChangeableMsg | NTCIP 1203 Clause 2.6.1.1.1.3 | Shall be at least 60. Each message shall support at least 3 pages per message. |
| DmsFreeChangeableMemory | NTCIP 1203 Clause 2.6.1.1.1.4 | Shall be at least 20 when no messages are stored. |
| DmsMessageMultiString | NTCIP 1203 Clause 2.6.1.1.1.8.3 | The DMS shall support any valid MULTI string containing any subset of those MULTI tags listed in Table 4 |
| DmsControlMode | NTCIP 1203 Clause 2.7.1.1.1.1 | Shall support at least the following modes: local external central centralOverride |

**Table 2: Content of Permanent Messages**

| Perm. Msg. Num. | Section 12 Description |
|---|---|
| 1 | Permanent Message #1 shall blank the display (i.e., command the sign to use dmsMessageType 7). It shall have a run-time priority of 50. |

**Table 3: Required MULTI Tags**

| Code | Feature |
|---|---|
| f1 | Field 1 – time (12hr) |
| f2 | Field 2 – time (24hr) |
| f8 | Field 8 – day of month |

| Code | Feature |
|---|---|
| f9 | Field 9 - month |
| f10 | Field 10 - 2 digit year |
| f11 | Field 11 - 4 digit year |
| Fl (and /fl) | flashing text on a line by line basis with flash rates controllable in 0.5 second increments. |
| Fo | Font |
| Jl2 | justification - line - left |
| Jl3 | justification - line - center |
| Jl4 | justification - line - right |
| Jl5 | justification - line - full |
| Jp2 | justification - page - top |
| Jp3 | justification - page - middle |
| Jp4 | justification - page - bottom |
| Mv | moving text |
| Nl | New line |
| Np | New page, up to 2 instances in a message (i.e., up to 4 pages/frames in a message counting first page) |
| Pt | page times controllable in 0.5 second increments. |

**Table 4: Modified Object Ranges for the Report Conformance Group**

| Object | Reference | Project Requirement |
|---|---|---|

| Object | Reference | Project Requirement |
|---|---|---|
| maxEventLogConfigs | NTCIP 1201 Clause 2.5.1 | Shall be at least 50 |
| eventConfigurationMode | NTCIP 1201 Clause 2.4.3.1 | The NTCIP Component shall support the following Event Configuration Modes: onChange greaterThanValue smallerThanValue |
| maxEventLogSize | NTCIP 1201 Clause 2.5.3 | Shall be at least 200 |
| maxEventClasses | NTCIP 1201 Clause 2.5.5 | Shall be at least 16 |

**Table 5: Modified Object Ranges for the Font Configuration Conformance Group**

| Object | Reference | Project Requirement |
|---|---|---|
| numFonts | NTCIP 1203 Clause 2.4.1.1.1.1 | Shall be at least 4* |
| maxFontCharacters | NTCIP 1203 Clause 2.4.1.1.1.3 | Shall be at least 127** |

*Upon delivery, the first font shall be a standard 18" font. The second font shall be a double-stroke 18" font. The third font shall be a 28" font. The fourth font shall be empty.

**Upon delivery, the first three font sets shall be configured in accordance with the ASCII character set for the following characters:

1. "A" thru "Z" - All upper case letters
2. "a" thru "z" - All lower case letters
3. "0" thru "9" - All decimal digits
4. Space (i.e., ASCII code 0x20)

5. Punctuation marks shown in brackets [. , ! ? - ‘ ’ “ ” / ( ) ]

6. Special characters shown in brackets [# & * +< >]

**Table 6: Modified Object Ranges for the MULTI Configuration Conformance Group**

| Object | Reference | Project Requirement |
|---|---|---|
| defaultBackgroundColor | NTCIP 1203 Clause 2.5.1.1.1.1 | The DMS shall support the following background colors: black |
| defaultForegroundColor | NTCIP 1203 Clause 2.5.1.1.1.2 | The DMS shall support the following foreground colors: amber |
| defaultJustificationLine | NTCIP 1203 Clause 2.5.1.1.1.6 | The DMS shall support the following forms of line justification: left<br>center right full |
| defaultJustificationPage | NTCIP 1203 Clause 2.5.1.1.1.7 | The DMS shall support the following forms of page justification:<br>top middle bottom |
| defaultPageOnTime | NTCIP 1203 Clause 2.5.1.1.1.8 | The DMS shall support the full range of these objects with step sizes no larger than 0.5 seconds |
| defaultPageOffTime | NTCIP 1203 Clause 2.5.1.1.1.9 | The DMS shall support the full range of these objects with step sizes no larger than 0.5 seconds |
| defaultCharacterSet | NTCIP 1203 Clause 2.5.1.1.1.10 | The DMS shall support the following character sets: eightBit |

**Table 7: Optional Object Requirements**

| Object | Reference | Project Requirement |
|---|---|---|

| Object | Reference | Project Requirement |
|---|---|---|
| globalSetIDParameter | NTCIP 1201 Clause 2.2.1 | |
| eventConfigLogOID | NTCIP 1201 Clause 2.5.2.7 | |
| eventConfigAction | NTCIP 1201 Clause 2.5.2.8 | |
| eventClassDescription | NTCIP 1201 Clause 2.5.6.4 | |
| defaultFlashOn | NTCIP 1203 Clause 2.5.1.1.1.3 | The DMS shall support the full range of these objects with step sizes no larger than |
| defaultFlashOff | NTCIP 1203 Clause 2.5.1.1.1.4 | The DMS shall support the full range of these objects with step sizes no larger than |
| dmsSWReset | NTCIP 1203 Clause 2.7.1.1.1.2 | |
| dmsMessageTimeRemaining | NTCIP 1203 Clause 2.7.1.1.1.4 | |
| DmsShortPowerRecoveryMessage | NTCIP 1203 Clause 2.7.1.1.1.8 | |
| DmsLongPowerRecoveryMessage | NTCIP 1203 Clause 2.7.1.1.1.9 | |
| dmsShortPowerLossTime | NTCIP 1203 Clause 2.7.1.1.1.10 | |
| dmsResetMessage | NTCIP 1203 Clause 2.7.1.1.1.11 | |
| DmsCommunicationsLossMessage | NTCIP 1203 Clause 2.7.1.1.1.12 | |

| Object | Reference | Project Requirement |
|---|---|---|
| dmsTimeCommLoss | NTCIP 1203 Clause 2.7.1.1.1.13 | |
| dmsEndDurationMessage | NTCIP 1203 Clause 2.7.1.1.1.15 | |
| dmsMemoryMgmt | NTCIP 1203 Clause 2.7.1.1.1.16 | The DMS shall support the following Memory Management Modes: normal clearChangeableMessages clearVolatileMessages |
| dmsMultiOtherErrorDescription | NTCIP 1203 Clause 2.7.1.1.1.20 | If the vendor implements any vendor-specific MULTI tags, the DMS shall be provided with documentation that includes meaningful error messages within this object whenever one of these tags generates an error. |
| dmsIllumLightOutputStatus | NTCIP 1203 Clause 2.8.1.1.1.9 | |
| watchdogFailureCount | NTCIP 1203 Clause 2.11.1.1.1.5 | |
| dmsStatDoorOpen | NTCIP 1203 Clause 2.11.1.1.1.6 | |
| fanFailures | NTCIP 1203 Clause 2.11.2.1.1.8 | |
| fanTestActivation | NTCIP 1203 Clause 2.11.2.1.1.9 | |
| tempMinCtrlCabinet | NTCIP 1203 Clause 2.11.4.1.1.1 | |
| tempMaxCtrlCabinet | NTCIP 1203 Clause 2.11.4.1.1.2 | |

| ~~Object~~ | ~~Reference~~ | ~~Project Requirement~~ |
|---|---|---|
| ~~tempMinSignHousing~~ | ~~NTCIP 1203 Clause 2.11.4.1.1.5~~ | |
| ~~tempMaxSignHousing~~ | ~~NTCIP 1203 Clause 2.11.4.1.1.6~~ | |

### 10.2.16 *NTCIP Compliance Documentation*

Software shall be supplied with full documentation, including a CD-ROM containing ASCII versions of the following Management Information Base (MIB) files in Abstract Syntax Notation 1 (ASN.1) format:

1. The relevant version of each official standard MIB Module referenced by the device functionality.

2. If the device does not support the full range of any given object within a Standard MIB Module, a manufacturer specific version of the official Standard MIB Module with the supported range indicated in ASN.1 format in the SYNTAX and/or DESCRIPTION fields of the associated OBJECT TYPE macro. ~~The filename of this file shall be identical to the standard MIB Module, except that it will have the extension ".man".~~

3. A MIB Module in ASN.1 format containing any and all manufacturer-specific objects supported by the device with accurate and meaningful DESCRIPTION fields and supported ranges indicated in the SYNTAX field of the OBJECT-TYPE macros.

4. A MIB containing any other objects supported by the device.

Additionally, the manufacturer shall provide a test procedure that demonstrates how the NTCIP compliance of both, the data dictionaries (NTCIP 1201, 1203, and their amendments) and the communications protocols have been tested.

The manufacturer shall allow the use of any and all of this documentation by any party authorized by the Procuring Agency for systems integration purposes at any time initially or in the future, regardless of what parties are involved in the systems integration effort.

### 10.2.17 *Dynamic Message Sign Operation*

The Dynamic Message Sign shall support three distinct modes.

1. System Control: System control is the normal mode of operation. The SCU responds to commands from the system computer.

2. Local Control: This is the mode of operation that is used to test the sign operation. In this mode, the SCU responds to commands from a portable computer that is interfaced to the SCU ~~via the second RS-232 port~~.

3. Failed Condition: This is the mode of operation that is used when the hardware watchdog timer or the communications watchdog timer is not reset, or a communications error is detected, or an error is detected by the SCU. In this mode, the sign face is blank (all LED pixels are off).

### 10.2.18 *Sign Control Test Software*

The Design-Builder shall provide Test Software that meets the following requirements:

1. The software shall operate on a laptop computer with at least 64 MB RAM memory.

~~2. The software shall interface with the SCU using a RS-232 serial port and a null modem cable~~

2. The software shall interface with the SCU using the SCU Ethernet port and crossover cable.

3. The software shall be provided on CD. The Department shall have the right to make an unlimited number of copies for use with the SCUs acquired for this project.

4. The software shall include access security by name, password, and access rights.

5. The software shall provide interface using Active Directory Service Interfaces (ADSI).

6. The software shall initiate a test pattern that energizes and verifies each individual pixel in the sign.

7. The test pattern shall be supported by a test report that documents the results of the test.

8. The test report shall be written to disk with ASCII characters.

9. The software shall include a communication monitoring function that meet the following requirements:

    a. Display on the screen of the portable computer the commands received by the SCU from the system computer.

    b. Display the response transmitted by the SCU to the system computer.

14. Shall have built in security levels of access, including login/password access.

15. The software shall be provided with the ability to install the client on Operator Workstations.

16. The Central Software shall include full software maintenance support for duration of three years.

17. The software shall also include the following functionality:

    a. Full diagnostic test of peripherals
    b. Remote SCU reset and password override
    c. Set/view brightness levels
    d. View NTCIP conformance group values
    e. Separate windows for multi-monitor display
    f. Support the latest NTCIP 1203 font table changes and graphics objects
    g. Display real time date/time/speed/temperature fields
    h. Variable spacing between characters
    i. View and Run Schedule Day Plans by week, month, year

## 10.2.20 *Roadside DMS Cabinet (Type C Cabinet)*

The Design-Builder shall provide a ground-mounted cabinet for each DMS. The DMS cabinet is labeled as a Type C cabinet in the Plans. (See section 10.2.13 for additional Roadside DMS Cabinet requirements)The cabinet shall meet the following requirements:

1. Shall meet the same lighting, 19" rack, and ventilation requirements as Caltrans Type 170 model 332 cabinet.

2. Shall meet the applicable requirements of a Type C equipment cabinet in Section 6.

3. A slide-out notebook shelf, power, and connections to the Sign Controller Unit (SCU) shall be provided at the roadside DMS cabinet to allow for control of the sign from the roadside cabinet with a laptop computer.

4. Shall be ground mounted.

5. Shall be constructed of 5052 sheet aluminum alloy with a minimum thickness of 1/8 inch.

6. All inside and outside edges shall be free of burrs.

7. The outside surface of the cabinet shall have a smooth, uniform, and natural aluminum finish.

c. SPD surge current rating shall equal or exceed 50kA per mode. Per phase rating shall equal or exceed 100kA per phase.

d. Leads shall be as short and straight as possible.

e. All metal oxide varistors used for surge protection shall be rated in the appropriate voltages and its operational status shall be monitored via visual indicator.

f. SPD operating temperature shall be between -40°F and 185°F.

26. Shall include both serial and Ethernet communication cable surge protection devices with the following characteristics:

a. Hybrid Multi-stage Suppression components, including gas tube and silicon avalanche diode

b. Response time to greater than 1 nanosecond

c. UL listed (UL 1449, UL 497, 497A, 497B, etc. as appropriate) and bonded to the same single-point ground point. Any DIN rail mounted SPD's shall be grounded via conductor and shall not rely solely upon the DIN rail's mechanical connection as a grounding point.

d. Sides shall be clearly marked 'protected' and 'unprotected'

27. Provide sunshields and mounting fasteners on all roadside DMS cabinets. Sunshields and fasteners shall meet the following minimum requirements:

a. Sunshields shall be 0.125 inch aluminum with smoothed, deburred edges and rounded corners. Provide cutouts for door handles and/or locks as required.

b. Cabinets shall be equipped with press-in threaded inserts on the cabinet interior. Sunshields shall be mounted by fasteners and aluminum or stainless steel standoffs tightened into the threaded inserts. Provide a minimum of four inserts/fasteners for top face sunshields.

c. Provide a minimum of six inserts/fasteners for any door or side sunshield.

d. For doors or sides greater than 54 inches tall, provide inserts and fasteners sufficient for a maximum vertical or horizontal distance of 27 inches between any fasteners.

e. Furnish and install a top face sunshield on all cabinets.

f. Furnish and install door or side sunshields on any cabinet face that is within 60 degrees in either direction of due south. A minimum of two door or side faces shall have sunshields on any cabinet. A cabinet with a face exactly perpendicular to the south shall have three shields.

28. Provide agency name, device name and ID labels on all roadside DMS cabinets. Labels shall meet the following minimum requirements:

    a. Labels shall be flat black lettering on a reflective white background. Lettering shall be a minimum of 1 inch in height.

    b. Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.

    c. The agency name labels shall be "TDOT ITS" in one continuous adhesive sheet.

    d. The device ID labels shall include the acronym and hyphen "DMS-" and shall be one continuous adhesive sheet.

    e. The device ID shall be numerals corresponding to the location and shall be installed adjacent to the acronym sheet. Examples are "DMS-02401" and "DMS-07503".

    f. Labels shall be installed along the top of the cabinet door (front cabinet door on DMS cabinets), with TDOT ITS label at the top and the device ID labels immediately underneath.

## 10.3 Installation Requirements

### 10.3.1 *General Requirements*

1. All equipment shall be installed according to the manufacturer's recommendations and the Plans. The Design-Builder shall have a DMS manufacturer representative commission the signs after installation.
2. DMS structures, sign cases, and cabinets shall be grounded in accordance with the DMS and the structure manufacturers' recommendations and the Standard Specifications.
3. Do not install the DMS sign case on the support structure until the structure grounding systems have been successfully completed and accepted, and the structure ground connection has been installed.
4. Do not install electrical service or electronic devices in the roadside DMS cabinet or connect to the cabinet until the cabinet grounding systems have been successfully completed and accepted, and the cabinet ground connection has been installed.
5. Bundle all like cabling to minimize crosstalk and electrical interference. Route wiring to

prevent conductors from being in contact with devices in the cabinet and metal edges. Arrange wiring so that any removable assembly may be removed without disturbing or unhooking conductors

6. All power and communications wiring shall be one continuous run from cabinet to sign structure. No splicing of wiring will be permitted unless approved by the Engineer.
7. Do not install electronic devices in the cabinet until electrical service has been installed and activated, and the cabinet ventilation fan is operational.
8. A minimum of two 2-inch spare conduits shall be installed in the base of all DMS cabinets and shall terminate in the adjacent communications cable pull box. Spare conduits in the cabinet base and the pull box shall be sealed with blank duct plugs.
9. Prior to installation, all sign cases and cabinets must be stored in a location and manner approved by TDOT. The signs shall not be sitting directly on the ground or in a manner where standing water, mud, or debris will come in contact with the sign. The storage location should be free from excessive debris or other matter that may harm or deteriorate the sign. During storage, sign cases shall be structurally supported in accordance with the DMS manufacturer's recommendations.
10. The Design-Builder is responsible for coordinating with the Department for IP addresses and integrating the DMS system into the manufacturer provided DMS central control software.

### 10.3.2 *Documentation*

The documentation for the Dynamic Message Signs shall consist of the following: Communications Protocol (refer to Section 11.2.15), Operator's Manual, Maintenance Procedure Manual, Equipment Drawings, and Electrical Schematic Diagrams.

1. Operator's Manual

   This document shall fully describe the operation of the Dynamic Message Signs using the Windows based software that runs on a notebook computer. This document shall clearly define all functions that are supported by the software. The manual shall define the normal operation of the signs and the software including resetting and restarting the software package. Ten hardcopies of this document shall be supplied. Additionally, an electronic copy shall be provided that includes the capability for word searches. The manual shall include the following:

   a. General Description

   b. General Characteristics

   c. Installation

   d. Adjustments

   e. Theory of Operation

   f. Maintenance

### 10.3.3 *Warranty*

The complete Dynamic Message Sign assembly shall carry a one-year manufacturer's warranty from the date of final acceptance against any imperfections in workmanship or materials. The warranty shall include but not be limited to sign face panels (LED), Sign Controller Unit, sign communications hardware, and sign ventilation system.

### 10.3.4 *Training*

Prior to the acceptance of the first DMS unit, training shall be provided for the Department's engineering, maintenance, and operations staff, at a facility provided by the Department. The training shall include all material and manuals required for each participant.

The training shall be provided for two identical non-consecutive one day sessions for at least ten (10) engineering and operations personnel. The training shall include a complete demonstration of the operation and capabilities of the DMS equipment. This session shall include a complete review of any field adjustments or calibration that may be required for the LED's or any sign component. The training shall include operation instructions, theory of operation, circuit description, field adjustments, preventive maintenance procedures, troubleshooting and repair of all components. Particular attention shall be given to the operation of the software packages to be provided including procedures for configuring the signs, displaying messages and diagnosing faults. Attention shall also be given to graphics creation.

### 10.3.5 *Testing Requirements*

1. General Requirements

    a. The Design-Builder shall conduct a project testing program for all DMS as required in Section 1.5 of this SP. The project testing program for DMS shall include but is not limited to the additional specific requirements in this subsection.

    b. All test results shall confirm physical and performance compliance with this SP.

2. DMS Bench Test Component (BTC)

    The Design-Builder shall perform BTC on the DMS as they arrive from the factory. The goal of the DMS BTC is to verify that the DMS were not damaged during shipping. The BTC shall test or inspect the following DMS components:

    a. External or internal visible damage

    b. DMS display damage

c. Verify all pixels are operational

d. Verify that the ventilation system works

e. Verify that all equipment is secured

f. Verify sign configurations

g. Run System Diagnostics Check

3. DMS Pre-Installation Test (PIT)

The Design-Builder shall perform PIT on the DMS prior to installation on-site. The goal of the DMS PIT is to verify that the DMS were not damaged during storage after shipping. The PIT shall test or inspect the following DMS components:

a. External or internal visible damage

b. DMS display damage

c. Verify all pixels are operational

d. Verify the ventilation system works

e. Verify all equipment is secured

f. Verify sign configurations

4. DMS Bench Test System (BTS)

The Design-Builder shall perform BTS on the DMS to verify that the DMSs are compatible and operational interoperability with the communication equipment, central software, and existing equipment. The Design-Builder shall refer to Section 1 of this SP for additional BTS requirements.

5. DMS Stand Alone Test (SAT)

The Design-Builder shall perform SAT on the DMS as they arrive from the factory. The goal of the SAT is to verify that the DMS has been properly installed and commissioned according to the manufacturer requirements. The SAT shall include at minimum the following tests and inspections:

a. Verify the signs have been attached properly to the structure.

b. Verify the sign case and roadside cabinet have been grounded.

c. Verify the sign has been properly connected to the power.

d. Verify the sign case has no structural damage or deformities.

e. Verify all pixels are operational.

f. Verify local sign control through the serial port.

g. Verify local sign control through the Type A Network Switch.

h. Verify text, colors and graphics can be displayed.

i. Verify diagnostics reporting by running maintenance software.

j. Verify environmental sensor operation by witnessing fan activation, correct temperature readings, ambient light sensors, etc.

## 10.4 Measurement

The Dynamic Message Sign will be measured in units of each and paid for at the contract unit price per each. The price shall include furnishing, installing, system integration, and testing of the complete dynamic message sign including the sign case, light sources, display apparatus, wiring, controller, roadside DMS (Type C) cabinet, communications interface, wiring between the sign case and DMS cabinet, structure mounted conduit, fittings, and junction boxes, sign case support connections to the sign support structure, satisfactory completion of testing and training requirements, ~~3G~~ wireless communication platform (identified remote locations only), and all work, equipment, and appurtenances as required to effect the full operation including remote and local control of the sign complete in place and ready for use. (Note this item does not include the sign support structure). The price bid shall also include all system documentation including: shop drawings, operations and maintenance manuals, wiring diagrams, block diagrams, and other material necessary to document the operation of the DMS. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

## 10.5 Payment

The contract unit price shall be full compensation for all work specified in this section.

Payment will be made under:

| Item No. | Description | Unit |
|---|---|---|
| 725-21.~~01~~02 | DYNAMIC MESSAGE SIGN (MULTI-COLOR) | EACH |

Dynamic Message Signs sites will be paid per each as follows:

## 15.2 Materials

### 15.2.1 *General*

1. Furnish equipment for the LAN that complies with IEEE standard 802. Furnish Ethernet LAN switches that are fully compatible and interoperable with the network monitoring software, ~~the Ethernet~~ the existing network architecture and configuration, and the existing firewall and switch at the TMCs.

2. Furnish Ethernet Switches that comply with the following electrical safety requirements: UL60950 or CSA C22.2 No. 60950 (safety requirements for IT equipment) and FCC Part15 Class A for EMI emissions.

### 15.2.2 *Network Switch (Type A) (L2 Field Ethernet Switch)*

1. L2 Field Switches will be placed in locations shown on the Plans. L2 Field Switches fabricated for use in traffic signal controller cabinets shall meet or exceed NEMA TS- 2 requirements for temperature, shock, humidity, and vibration.

2. Furnish L2 Field Ethernet Switches that have the option for din rail mounting as well as rack mounting.

3. Furnish Field Ethernet switches with internal Power Supply meeting the following power supply requirements:

    a. 85 to 264 VAC (50/60Hz)/ 88 to 300~~Vdc~~VDC.

    b. Power supply shall have two stage isolation accomplished via two transformers: first steps down from primary AC/DC to 48VDC; the second steps down from 48VDC to the final DC voltage required by the switch.

    c. A power cord of not less than 5 feet in length shall be supplied

4. Furnish Field Ethernet Switches that weigh no more than 15 lbs. and are no more than 250 cubic inches in volume.

5. Furnish field Ethernet switches with the following minimum characteristics and features:

    a. Minimum of Eight (8) 10BASE-T/100BASE-TX ports

    b. Minimum of two (2) 1000 BaseX Optical uplink ports that utilize SFP plugs

- IEEE 802.1s multiple spanning tree
- IEEE802.~~1~~3AD link aggregation
- IEEE 802.3x flow control
- IGMPv2 with 256 IGMP groups
- Port Rate Limiting
- Configuration via test file which can be modified through standard text editor
- Forwarding/filtering rate shall be 14,880 packets per second (PPS) for 10Mps,148,800 for 100Mps, 1,488,000 for 1000Mps
- DHCP Option 82

iii. Network Management Functionality Requirements

- Shall be interoperable with the existing network infrastructure (Cisco core multi-layer switches, distribution multilayer switches, firewalls, and routers)
- Shall have the ability to run container applications
- SNMPv2 and SNMPv3
- RMON
- GVRP, or VTP
- Port Mirroring
- 802.1x port security
- Radius Server and TACACS+ Server
- SSL – Secure Socket Layer
- SSH – Secure Shell
- TFTP
- Network Time Protocol (NTPv3)

- Simple Network Time Protocol (SNTPv3)
- Management via web ~~or Telnet~~ only if HTTPS SSL and SSH

### 15.2.5 *Physical and Environmental Requirements*

1. Each Ethernet bridge shall be rack or shelf mountable in a 19" EIA-310 style equipment rack, and shall not exceed 2 rack units in height (3.5") and shall fit sufficiently within the depth of the field cabinet. These dimensions shall be inclusive of any required external devices including, but not limited to power supplies. Each Ethernet bridge shall be industrially hardened for application in a non-environmentally controlled cabinet.

2. The field Ethernet bridge shall operate within temperatures ranging from -4°F TO 149°F (- 20°C to 65°C) with a relative humidity between 0% and 90%.

### 15.2.6 *Network Management and Remote Monitoring Software (NMS)*

1. TDOT currently uses an existing NMS platform to monitor the field network. The existing platform is ~~InterMapper by Dartware.~~SNMPc by CastleRock. Network Configuration Management and Network Performance Monitoring modules are monitored using Orion by SolarWinds.

2. Design-Builder shall coordinate with TDOT IT to update the NMS with the Design-Builder's proposed changes.

## 15.3 Installation Requirements

### 15.2.1 *General*

1. Coordinate all work at, near, or inside buildings with the Engineer. Do not work on buildings or enter buildings without prior, written authorization from the Engineer. Coordinate and obtain approval from Engineer regarding allowable working time in buildings. Obtain necessary permits and inspections. Work shall not commence until the necessary permits are issued, posted on site, and approved plans are available on site. The Design-Builder shall coordinate installation with TDOT staff at least two (2) weeks in advance of needing access to the installed cable(s)/network equipment.

2. Furnish MAC addresses in a spreadsheet for all equipment utilized as part of this project, in addition to the equipment models, serial numbers, and firmware revisions. Equipment shall be registered in the name of TDOT. Affix a MAC Address label to each device utilized. Furnish IP addresses for all equipment utilized as part of this project. Affix final IP address to each device utilized. Use labels that do not smear or fade.

3. In field equipment cabinets, fully integrate new Ethernet switches with the fiber optic termination panels. Integrate all field equipment as called for in Plans.

4. Fully integrate proposed switches with existing TMC Core switches and computer and central system hardware to form a complete local area network that allows users from TDOT TMC as shown on the Plans to access applications on application servers and the CCTV central hardware and the proposed field communication network.

5. Fully integrate upgraded LAN to accomplish/maintain L2 Field Switch, L3 Aggregation Switch, and L3 Core Switch failover and fault tolerance.

6. Fully integrate LAN equipment to provide user authentication and security functions to prevent unauthorized users and data from entering the freeway system LAN.

7. No Ethernet switch purchase, configuration, or deployment can occur until the Design-Builder's RDD has been approved in final form by the Engineer.

### 15.2.2 *Ethernet Bridge*

All equipment shall be installed according to the manufacturer's recommendations these specifications and the Plans.

1. Each T-1 service port shall be protected from line surges from telephone-company outside plant cables. Each bridge shall be provisioned to support streaming video over the aggregate bandwidth back to the TMC. At the TMC a central switch/router will be the primary destination for receiving all field camera video feeds over one telephone service provider multiple T-1 circuits. The Design-Builder shall be responsible for establishing the MLPPP parameters to interface with the telephone service provider T-1 circuits for communication with the TMC central system. Each communication hub shall be configured initially to accept up to four (4) T-1, with an aggregate total of 1.544 Mbps per T-1.

2. The video encoder's data port associated with the CCTV control shall each be configured to transmit at a minimum of 9600bps (or higher data rates as compatible with the CCTVs).

3. Under this contract, the Design-Builder shall be required to submit an IP addressing convention to the Engineer for approval, prior to configuring the Ethernet Bridge and video encoder addresses. The non-volatile configuration files for each Ethernet bridge, when appropriate, shall be provided electronically (CD-ROM, USB drive, or approved equal) to the Engineer as part of the as-built documentation for the system configuration.

### 15.2.3 *Coordination with Central System Provider / Integrator*

1. The Design-Builder shall coordinate his/her efforts with those of the TDOT's Central System Provider (~~Telvent's MIST platform~~ SwRI's SCS platform). The Design-Builder shall accommodate the System Provider's work in every way including planning and testing support for system integration. In general, the Design-Builder shall install and

### 17.2.4 *Project Submittal Program*

1. The project submittal program requirements are outlined in Section 1.8 of this SP. Additional specific submittal requirements are detailed in the individual SP sections.

### 17.2.5 *System Documentation*

1. The system documentation requirements are outlined in Section 1.9 of this SP. Additional specific system documentation is detailed in the individual SP sections.

### 17.2.6 *As-Built Documentation*

1. Prior to the Conditional System Acceptance Tests, all Department approved changes shall be incorporated by the Design-Builder into all submitted documents and drawings, including the project Plans. Copies of the updated drawings shall be submitted to the Department to serve as the final as-built configuration drawings. In the Project Plans, each drawing shall be identified under the sheet number block, with the words "AS-BUILT", the date and the approval. The as-built drawings shall consist of a neatly marked-up set of plans using a red permanent marker. The drawing shall indicate the as-built location of all equipment including, but not limited to: poles, cabinets, conduit, pull boxes, gates, etc. As part of the as-built drawings, the Design-Builder shall use a hand-held GPS unit to determine the GPS coordinates (in a format approved by the engineer) for all standalone devices, structures, and outside plant infrastructure including field devices, poles and sign structures, pull boxes, equipment cabinets, signs, etc. These coordinates shall be summarized in a GPS Coordinates Database in a Microsoft Excel or Access table that indicates the following minimum information:

    a. Device/equipment name and number (where applicable)

    b. Roadway name and station number

    c. Sheet number in Plans

    d. GPS coordinates

    This information shall also be included in the equipment inventory and maintenance database described in Section 18.

2. In addition to submitting an original hardcopy of the AS-BUILT drawings, the Design-Builder shall submit a ~~high resolution scanned image~~ PDF file (with markups created using digital entries) of each AS-BUILT sheet. High Quality ~~scanned images~~ marked sheets shall be submitted electronically in a PDF format ~~approved by the Engineer~~. The Design-Builder shall also submit AS-BUILT plans in a MicroStation. The as-built drawings shall consist of a neatly marked-up set of plans using a red font in a

# DESIGN-BUILD
# RFP CONTRACT BOOK 3
# PROJECT SPECIFIC INFORMATION

**TENNESSEE DEPARTMENT OF TRANSPORTATION**

**Interstate 75 at Interstate 24 Interchange Modification**

**Hamilton County- TENNESSEE**

**CONTRACT NUMBER: DB1801**

**July 27, 2018**

**Addendum #1 August 24, 2018**

**Addendum #2 September 26, 2018**

**Addendum #3 November 13, 2018**

# 1. GENERAL

This **Contract Book 3 (Project-Specific Information)** contains the requirements and conditions by which the Design-Builder shall design and construct the Project, except for any portions of the work that may be stipulated within this **Contract Book 3 (Project-Specific Information)** to be performed by the Tennessee Department of Transportation (TDOT, or "the Department").

The order of precedence of **Contract Book 3 (Project-Specific Information)** with the other contract documents is described in **Contract Book 2 (Design- Build Contract)**.

The Definition of Terms corresponding with this **Contract Book 3 (Project-Specific Information)** can be found in the Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction and/or **Design-Build Standard Guidance** (**DB Standard Guidance**):

https://www.tn.gov/content/dam/tn/tdot/construction/design-build_projects/Design-Build_Guidance_01-31-17.pdf.

All work shall be completed in accordance with the most current version of the Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction at the time of the Proposal Due Date, unless specifically stated herein.

The Functional Plans, roll plots, and pertinent reference information are listed in **Appendix B** and provided on the Project website.

## 0 *GENERAL PROJECT DESCRIPTION; SCOPE OF WORK*

The Design-Builder shall perform all ~~necessary~~ surveying ~~updates~~, design and construction services necessary to construct (roadway and structures) the I-75 Interchange at I-24 Project (the "Project").

The Project shall consist of the modification and reconstruction of the I-75 Interchange at I-24 in Hamilton County. The roadway improvements shall begin at the Georgia state line and extend on I-75 to a point approximately 455 feet south of the existing I-75 bridge over the CSX railroad, and to a point just west of the I-24/Spring Creek Road bridges as depicted on the Functional Plans.

The Project shall include the widening of the I-75 roadway to include an additional lane in each direction, widening of all interstate-to-interstate ramps to three lanes, modifications to I-24 ramps to enter and exit I-75 from the right side, and modifications to the Ringgold Road and Welcome Center traffic pattern.

The Design-Builder's general responsibilities with respect to the scope of work for the Project shall include without limitation the following, as more particularly described within this **Contract Book 3 (Project-Specific Information)**:

- Replacing the existing median barrier with a 51-inch high median barrier from the Georgia State Line to south of Spring Creek;
- Replacing the storm sewer system on I-75 from the Georgia State Line to south of Spring Creek;
- Adding an additional lane on I-75 as shown on the Functional Plans;
- ~~Providing~~ Meet or exceed a minimum ~~60~~50-mph design speed for all system interchange ~~ramps~~;
- Widening I-75 to add an additional lane from S. Chickamauga Creek to a point south of the CSX Railroad as shown on the Functional Plans using concrete pavement with ~~asphalt~~ concrete shoulders.
- Rehabilitating the existing concrete pavement from S. Chickamauga Creek to a point south of the CSX Railroad as shown on the Functional Plans;
- Constructing new bridges and widening the existing bridge over S. Chickamauga Creek;
- Widening the I-75 southbound to I-24 westbound interstate-to-interstate ramp and I-24 eastbound to I-75 northbound interstate-to-interstate ramp from two to three lanes;
- Realigning and widening the I-75 northbound to I-24 westbound interstate-to-interstate ramp and the I-24 eastbound to I-75 southbound interstate-to-interstate ramp from two to three lanes;
- Adding sidewalk and curb and gutter along both sides of Spring Creek Road;
- Adding new noise walls;
- Removing and replacing all guardrail. Installing new guardrail in locations shown on the Functional Plans;
- Resurfacing all existing asphalt pavement within the project limits;
- Modifying existing drainage structures and installing proposed drainage improvements; including replacing the storm sewer system on I-75 from the Georgia State Line to south of Spring Creek;
- Replacing all lighting within the project limits;
- Relocating utilities;
- Relocating and improving ITS facilities;
- Installing new overhead signs and sign structures as shown in the roll plots; and
- Replacing control access fence at locations detailed in this RFP.

## 0 *PROJECT GOALS*

The Project's primary purposes are to provide present and future congestion relief, reduce high crash rates and address deficiencies of the existing interchange to meet the intent of the approved Interstate Access Request (IAR). The following goals have been established for the Project (not listed in any specific order):

- Minimize inconvenience to the public during construction.
- Provide a management system or approach that ensures the requirements of the Project will be met or exceeded.
- Provide a high-quality project that minimizes future maintenance.
- Provide a solution consistent with the Department's Roadway Design Standards.
- Adhere to local, state, and federal environmental regulations and/or permits required in executing and/or completing the Project.
- Incorporate Best Management Practices (BMPs) to control sediment, storm water runoff/discharge, or other environmental parameters established for the Project.
- Implement innovative solutions to maximize the return on taxpayer investment by reducing costs or improving quality of the transportation system.
- Complete construction as quickly as possible and not later than ~~October 30, 2022~~August 31, 2023.
- Incorporate safety into all aspects of design and construction with the goal of zero incidents and accidents.
- Provide a visually pleasing finished product.

## 0 *DEPARTMENT-PROVIDED MATERIALS*

The Functional Plans and Department-supplied materials are listed in **Appendix B**.

All documents have been published on the Department's project website:

https://www.tn.gov/tdot/tdot-construction-division/transportation-construction-alternative-contracting/transportation-construction-division-alternative-contracting-design-build-i.html

The Design-Builder shall acknowledge that materials furnished by the Department are preliminary and provided solely to assist the Design-Builder in the development of the project design. The Design-Builder shall be fully responsible for the accuracy and completeness of all work performed under this contract. The Design-Builder shall be fully liable and hold the Department harmless for any additional costs and all claims against the Department which may arise due to errors, omissions and negligence of the Design-Builder in performing the work required by this contract.

The Design-Builder is responsible for verifying all information provided by the Department.

# 2. PROJECT MANAGEMENT

The Design-Builder shall prepare and administer a Project Management Plan (PMP) containing the Design-Builder's approach to managing the design and construction activities of the Project in accordance with the **DB Standard Guidance** and the specific requirements defined herein.

The PMP shall contain, at a minimum, the following component parts:

- Organizational Structure and Staffing Plan
- Critical Path Method (CPM) Schedule
- Quality Management Plan
- Environmental Compliance Plan
- Safety and Health Plan
- Public Relations and Public Information Plan
- Records Management Plan

Within 30 Days of Contract Award, the Design-Builder shall meet with the Department at the Post-Award Meeting to discuss development of the components of the PMP for Review and Acceptance by the Department prior to the start of any Work.

The Design-Builder shall use the Project Understanding and Approach, and the Project Management and Approach submitted with the Proposal as a foundation to prepare the PMP component plans. The Design-Builder shall implement all elements of the PMP.

The successful Design-Builder is required to utilize PlanGrid software for the project. The Design-Builder shall contact PlanGrid directly to obtain usage license and service information. Information about PlanGrid and contact information for purchasing licenses at TDOT's special rate can be found at the following link: https://www.tn.gov/tdot/tdot-construction-division/transportation-construction-division-resources/plangrid.html

## 0 *ORGANIZATIONAL STRUCTURE AND STAFFING PLAN*

The Design-Builder shall prepare an Organization Structure and Staffing Plan for the purpose of ensuring that appropriate qualified staff are employed by the Design-Builder to perform the Work and are able to carry out the Work in a manageable and safe manner.

The plan shall identify the Key Personnel and key management staff including the Key Personnel level 1 and level 2 identified in the Statement of Qualifications (SOQ) and on the Response Category 2 form.

The Design-Builder shall provide an organizational chart that graphically represents the hierarchy and functional interaction of the Key Personnel, and indicates the functional responsibilities of each. The organizational chart shall be part of the PMP.

and to track and document any possible schedule impacts. Ten (10) business days shall be allocated in the CPM Schedule for activities requiring the Department's Review and Acceptance, or Review and Comment.

## Schedule and Cost Controls

The Design-Builder shall develop procedures for schedule and cost control on the Project, including the cost control and schedule management system to be used to control and coordinate the cost and schedule of the work.

The cost-control approach shall include a description of the proposed approach for calculating progress performance for preparing the monthly payment requests using the Pay Item activities, Schedule of Items and CPM Schedule.

The Design-Builder shall include a procedure for re-scheduling of its work to achieve schedule recovery objectives and how these objectives will be enforced with its work force and subcontractors.

## Liquidated Damages for Failure to Meet Completion Deadline

The Design-Builder shall complete the Project within the time limitations set forth in **Contract Book 2 (Design-Build Contract)** and Special Provision 108B.

If the Design-Builder fails to complete the Project within the time limitations set forth in the Contract, then the Department will suffer substantial losses and damages. The Contract therefore provides that a sum shall be deducted from monies due the Design-Builder, not as a penalty, but as Liquidated Damages, if such completion is delayed.

If Design-Builder fails to complete all work specified in the contract on or before the Design-Builder's completion date, set forth in RFP Book 2 Section D.3, a sum of money equal to **$30,000** per Calendar Day for the first 30 calendar days after the Design-Builder's completion date shall be deducted from monies due to the Design-Builder, not as penalty, but as liquidated damages. For each calendar day thereafter, a sum of money equal to **$100,000** shall be deducted from monies due to the Design-Builder, not as a penalty, but as liquidated damages.

The Time Value (B) used for calculation of selection of the Design-Builder is **$30,000**.

# 0 *QUALITY MANAGEMENT PLAN*

The Design-Builder shall prepare a Quality Management Plan (QMP) in accordance with Section 2.5 of the **DB Standard Guidance** and the requirements herein.

The QMP shall consist of a:

- Design Quality Management Plan
- Construction Quality Management Plan

## Design Quality Management Plan

The Design Quality Management Plan (DQMP) shall describe the quality roles and responsibilities of the Design-Builder's design quality management team and procedures for implementing the

The Design-Builder shall guarantee and provide full cooperation in relation to CEI, audits, reviews, request for information etc.

## o *ENVIRONMENTAL COMPLIANCE PLAN*

The Design-Builder shall prepare an Environmental Compliance Plan (ECP) in accordance with Section 2.5.4 of the DB Standard Guidance.

## o *SAFETY AND HEALTH PLAN*

The Design-Builder shall prepare a Safety Plan in accordance with Section 2.5.5 of the **DB Standard Guidance**.

## o *PUBLIC RELATIONS AND PUBLIC INFORMATION PLAN*

The Design-Builder shall comply with Section 7.2.8 of the **DB Standard Guidance** and address the following the project-specific requirements:

### Internal and External Communications

The Design-Builder shall describe the internal and external communication process between the Design-Builder and the Department, the Department's staff, external stakeholders, third parties and public affected by the work.

The Design-Builder shall provide all information required for communication purposes. The communication activities are mainly intended for the Department and Department staff (internal stakeholders) but shall also focus on neighboring public and communities (e.g., City of East Ridge), companies and organizations, emergency services, Hamilton County, City of Chattanooga, environmental agencies and other external services.

The focus on the construction communication shall support the following goals:

- Ensure that the entire project is executed in the least disruptive and positive manner possible for the Department.
- Maintain the best possible long-term relations with all relevant external stakeholders.
- Ensure that the work is performed in the most effective and efficient way.

### Handling Complaints

The Design-Builder shall process complaints that result from performing the work, whether ~~addressed~~ received directly or through the Department to the Design-Builder, as soon as possible and react in a proactive way ~~with the aim to minimize the nuisance~~.

The Design-Builder shall notify the Department within two hours after receiving a complaint and inform what actions will be taken in order to resolve the cause of the complaint.

The Design-Builder shall keep a complete and updated complaint register of all complaints received, addressed directly to the Design-Builder or through the Department.

The complaint register shall include all relevant information in relation to the complaint (who, when received, contents), the actions planned concerning the complaint, the person(s) responsible for the communication and the status of the complaints (open, closed).

The Design-Builder shall coordinate all public communication with the Department.

## Provide Information for Project Website

The Design-Builder shall coordinate with the Department and provide Project-related information to the Department for Review and Acceptance including:

- Contact information;
- Project maps;
- Current Project activities and progress;
- Timing of street and interstate ramp closures and openings;
- Recommended route alternatives during closures, with maps;
- Newsletters and meeting materials; and
- Calendar of, and announcements for, meetings and special events.

## Liaison with the Media

Unless otherwise specifically authorized in writing by the Department, the Design-Builder shall provide no news release, press release, or any other statement to a member of the news media regarding this Project without the Department's prior written authorization. The Design-Builder shall require this clause within all Subcontractors agreements.

# 0 *RECORDS MANAGEMENT PLAN*

The Design-Builder shall describe procedures for managing and maintaining Project record documents in accordance with Sections 5.2.11 and Chapter 7 of the **DB Standard Guidance** and the project-specific requirements herein.

The Department will perform a combination of Audits, Reviews, Inspections etc. to assess whether the Design-Builder's integrated project management is functioning properly and determine whether its records and information are reliable and up to date.

Upon completion of the Project, the Design-Builder shall provide the Alternative Contracting Office a transmittal letter, an electronic copy (CAD and signed PDF's) of the As-Built drawings, and final foundation type, including footing elevations and lengths of individual piles, prior to final payment of funds to the Design-Builder.

The Professional Engineer in charge of the development of the Project plans shall place his seal, including signature and date, on the right side of the title sheet. All plans sheets shall contain the seal, including signature and date, of the Professional Engineer in charge of its development.

The As-Built Plans and the Design-Builder Specifications following construction completion shall incorporate any changes to the Readiness-for-Construction Design Review Plans and

# 3. ROADWAY

The roadway shall be designed to adhere to the latest editions of all appropriate TDOT Roadway Standard Drawings, TDOT Roadway Design Guidelines and Instructional Bulletins, TDOT Drainage Manual, TDOT Traffic Design Manual, TDOT Design CADD Standards, TDOT Survey Manual and the Department accepted AASHTO *Policy on Geometric Design of Highways and Streets,* and *Manual on Uniform Traffic Control Devices (MUTCD).*

Microstation and Geopak shall be used in the preparation of CADD and design files.

## 0 *GENERAL*

The Project shall consist of the following I-75 Segments:

**Segment 1** (from the Georgia state line to just north of Ringgold Road – approx. 1,710 LF total) will consist of removing the existing median barrier wall and the inside shoulder pavement, modifying or reconstructing existing cross drains, installing new storm drainage system along the shoulders, installing new 51-inch-tall single slope median barrier wall, milling and overlaying existing asphalt pavement, signing and pavement marking.

**Segment 2** (from just north of Ringgold Road to approx. 1,130' north of the existing Welcome Center off ramp – approx. 3,340 LF total) will consist of removing the existing median barrier wall and the inside shoulder pavement, modifying or reconstructing existing cross drains, installing new storm drainage system along the shoulders, installing new 51-inch-tall single slope median barrier wall, milling and overlaying existing asphalt pavement, widening with full depth asphalt pavement, signs and pavement markings.

**Segment 3** (from approx. 1130' north of the existing Welcome Center off ramp to approx. 112' west of S. Chickamauga Creek bridge – approx. 5,260 LF total) (Includes I-75 Interchange @ I-24 to a point just west of the I-24/Spring Creek Road bridges) will consist of constructing proposed roadway on a new alignment with new full depth pavement, drainage systems, 51-inch-tall single slope median barrier wall, bridges, retaining walls, guardrail, signing and pavement marking.

**Segment 4** (from approx. 112' west of S. Chickamauga Creek bridge to 455' west of the CSX Railroad bridge – approx. 3,725 LF total) will consist of widening the existing roadway and outside shoulders with concrete ~~pavement and outside asphalt shoulders~~, rehabilitating the existing concrete pavement, extending existing cross-drain culverts, widening the Chickamauga Creek bridge, and constructing retaining walls, guardrail, signs and pavement markings. The roadway and shoulders will be widened to full-width and match the Ultimate Phase with the exception of approximately 650 LF of asphalt outside shoulder to allow for guardrail transition on the north end of the project (I-75 northbound); the travel lanes will be transitioned to match the existing lanes (to the north) using pavement markings. The following concrete repair quantities are anticipated:

Concrete Repair (Partial Depth): 20 S.Y.
Concrete Repair (Full Depth): 900 C.Y.

Concrete repairs shall be performed in accordance with Special Provision SP502A and Standard Drawing RP-J-23.

All existing concrete pavement on I-75 shall be ground and the joints sawed, cleaned, and sealed in accordance with Special Provisions SP502J and SP503.

## Payment for Select Quantity Overruns

The following table is provided to cover select quantities that are above those anticipated in the scope. Additional repair areas/quantities shall be pre-approved (in writing) by the Department prior to commencing work or no payment will be received, see Design Build Standard Guidance section 2.11.2 for additional details. No payment will be provided for repairs required due to work being performed by the Design-Builder. When the Design-Builder utilizes any item in the table below, he must provide the Department with an invoice detailing the location, purpose, and quantity used, for tracking purposes. Failure to provide invoices throughout the progress of the project may result in non-payment for overrun quantities.

| ITEM | TYPE | UNIT | UNIT PRICE | QUANTITY |
|---|---|---|---|---|
| Uniformed Police Officer | As specified by Special provision | HOUR | $50 | Hours exceeding 2,500 |
| Temporary Traffic Control | Changeable Message Sign Unit | EACH | $6,500 | Signs exceeding 15 |
| Concrete Repairs | FULL DEPTH PCC PAVEMENT REPAIR | C.Y. | $475 | Quantity that exceeds 900 C.Y. |
| | PARTIAL DEPTH PCC PAVEMENT REPAIR | S.Y. | $200 | Quantity that exceeds 20 S.Y. |
| Bridge Repairs | Concrete Repairs | S.F. | $130 | Quantity that exceeds 25 S.F. |
| | Epoxy Injection Repair (Complete and In Place) | L.F. | $120 | Quantity that exceeds 1,150 L.F. |

*Reference DB Standard Guidance: § 9.2.6, 9.2.7 & 2.11.2*

## Design Requirements

The proposed horizontal and vertical alignments of I-75 and the interstate-to-interstate ramps shall be designed and constructed to meet or exceed a minimum ~~60~~50-mph design speed for a rolling urban freeway.

All other proposed ramps shall be designed and constructed to match the design speeds shown on the Functional Plans.

Traffic lanes on I-75, interstate-to-interstate ramps, and ramps with 2 or more lanes shall be 12 ft. wide. One-lane ramps shall be 16 ft. wide.

the TDOT Roadway Design Guidelines. The Design-Builder shall submit plans as outlined in the TDOT Roadway Design Guidelines to the TDOT Structures Division for Grade Approval.

The ramp construction and closures shall be phased in accordance with Special Provision 108B. Access to all side roads shall be maintained throughout the duration of construction.

The Design-Builder shall identify the need for any special roadway design details (i.e. any special drainage structures, rock embankment, special guardrail, retaining walls, concrete barrier designs, etc.) and shall provide special design drawings to the Department for Review and Acceptance.

The Design-Builder shall ensure that all applicable "General and Special Notes" found in Section VI of the current edition of the TDOT Roadway Design Guidelines are adhered to during construction.

The geometric configurations of all roadway components shall be designed to provide adequate drainage and prevent hydroplaning (during construction and when complete). Cross slopes shall be in accordance with the requirements of the roadway typical section as shown in the Functional Plans. Design-Builder to provide hydraulic calculations (including spread calculations) to the Department.

All proposed slopes associated with the roadway shall be sodded.

All existing access-control fence located within the following limits will be replaced with the exception of that which is within a wetland area as designated on the survey provided by the Department.

- I-75 Northbound from Spring Creek to South Chickamauga Creek
- I-75 Southbound from South Chickamauga Creek to I-24 Westbound at Spring Creek Rd.

All permanent and temporary safety appurtenances (sign supports, guardrail, barrier rail, impact attenuators, etc.) shall meet current TDOT standards and shall have all required Department certification documents.

Portions of the City of Chattanooga are protected from flooding by a system that includes levees, walls, pumps and other earthworks. The area along the northern boundary of this project that stretches from South Chickamauga Creek to west of Spring Creek Road is in close proximity or contains several of these flood control measures. The pump station at Cornelison Road and the pump station at Spring Creek Road along with all required piping must remain fully functional at all times during and after this project. No modification or excavation of the levee will be allowed. Portions of the ramp from I-75 South to I-24 West also serve as part of the flood control system. Therefore, any work on this ramp must result in a finished grade elevation equal to, or higher than, the existing. Earthworks along right of way between Spring Creek Road and Eastgate Loop that are part of the flood control system are not to be disturbed. The Design-Builder shall not impact the existing Brainerd Levee Pump Station System located within the existing right-of-way. Any impacts to the facility shall be the responsibility of the Design-Builder. ~~For clarification or questions concerning the flood control features or their function in this area, please contact Mr. Bill Payne, City Engineer at (423) 643-6160.~~

## Deviations and Exceptions

The functional design of the project is based upon an approved Interstate Access Request (IAR). Any deviations from the approved IAR including ingress and egress points will require coordination

- An existing 24-in. reinforced concrete pipe at STA. 328+45.91 +/-, 104.94-ft. RT +/-, which collects runoff from the I-75 southbound off-ramp at Ringgold Road and ultimately drains into the drainage system surrounding Bass Pro Shops. The drainage area at the outfall of the 24-inch pipe is 3.99 Acres.
- An existing 60-in. storm sewer system at STA. 2306+29.11 +/-, 353.02-ft. RT +/-, which collects runoff from west of the I-75 southbound on-ramp at Ringgold Road and the eastern cloverleaf for Ringgold Road and drains into the drainage system surrounding Bass Pro Shops, ultimately draining to West Chickamauga Creek. The drainage area at the outfall of the 60-inch pipe is 27.85 Acres.
- An existing 18-in. reinforced concrete pipe at STA. 2357+46.25 +/-, 24.01-ft. RT +/-, which collects runoff from the I-24/I-75 interchange and drains southeast into a low wetland area, ultimately draining into West Chickamauga Creek. The drainage area at the outfall of the 18-inch pipe is 5.22 Acres.
- An existing 54-in. reinforced concrete pipe at STA. 929+97.62 +/-, 90.48-ft. RT +/-, which collects runoff from the I-24/I-75 interchange, as well as, receives outflow from another 54-in. reinforced concrete pipe draining the Eastgate Towncenter area and is metered by an existing storm water pump station operated by City of Chattanooga (identified as Pump Station #1 in original TVA construction plans). Combined flows drain southeast into a low wetland area, ultimately draining into West Chickamauga Creek. The drainage area at the outfall of the 54-in. pipe is 159.10 Acres.
- An existing 8-foot x 8-foot reinforced concrete box at STA.442+27.59 +/-, 122.93-ft. RT +/- which collects runoff from a portion of Brainerd Subdivision as well as the CSX Railroad ROW and drains southeast, ultimately flowing into South Chickamauga Creek. The drainage area at the outfall of the 8-ft. x 8-ft. box is 72.87 Acres.
- A potential outfall that may be used by the Contractor is located at an existing 48-in. reinforced concrete pipe at Sta. 693+66.27 +/-, 78.54-ft. LT +/-, which collects runoff from west of the Spring Creek Road area and runoff from I-24 at Spring Creek Road crossing and ultimately drains south to Spring Creek. The drainage area at the outfall of the 48-inch pipe is 49.25 Acres.

The re-use of existing drainage structures, pipes, etc. (except underdrains) within the Project limits is encouraged by the Department provided the facilities meet the requirements of the Contract and are not impacted by construction activities.

The use of blind junctions and/or non-accessible structures shall not be allowed unless otherwise approved in writing by the Department. The Design-Builder shall not install and/or utilize longitudinal storm sewer pipes under travel lanes unless otherwise approved in writing by the Department. If no modification or upgrading of the existing stormwater management system is required, the Design-Builder shall, at a minimum, maintain the existing system. This maintenance includes, but is not limited to, silt removal from any pipe, ditch, or structure, and removal of any debris prior to the use of any existing stormwater system. This maintenance shall be at the Design-Builder's expense.

Damage to existing infrastructure due to the Design-Builder's operation shall be immediately repaired to maintain existing system capacity at all times. This permanent repair shall be at the Design-Builder's expense.

AMS STD-595 color No. 36440. except the top and traffic face of the parapets which shall be white, AMS STD 595 Color No. 37886.

Drilled shafts shall be constructed according to Special Provision 625 Drilled Shaft Specifications.

The bridges shall be constructed while maintaining the minimum number of lanes open to traffic during construction as specified in this RFP. The minimum vertical and horizontal clearances shall be maintained during construction as specified in this RFP and TDOT's Standard Specifications for Road and Bridge Construction.

Temporary rolling road blocks, lane closures, and detours will be permitted during the setting of beams for the bridges. This RFP includes details and submittal requirements for temporary traffic disruptions.

Bridges shall be designed and detailed according to current TDOT Structures Policies.

On mainline I-75 bridges and ramps, a special split barrier could be used to account for the difference in elevation between the northbound and southbound bridges. In order to utilize split barriers, they shall be approved by the Department prior to construction and detailed on the bridge drawings where used.

## Bridge 4, Widening I-75 Over South Chickamauga Creek

The golf cart path and greenway shall have adequate protection for pedestrians, proper lighting, and remaining open at all times during project duration. The Design Builder shall field verify the location of all elements of existing bridge before geometry is developed on the widened portion. Permanent under bridge lighting is required on the proposed bridge widening to properly light the greenway and the golf paths. The entire bridge deck and approach slabs for Bridge 4 shall receive a thin epoxy overlay friction course topping.

### 0*NOISE WALLS*

The Design-Builder shall be responsible for the design and construction of Noise Barrier Walls as per the NEPA document, the Noise Barrier Evaluation dated May 30, 2018, and plans. The noise barrier walls shall be designed using the AASHTO LRFD Bridge Design Specifications, Eighth Edition (2017), Section 15. The Noise Barrier Evaluation includes the preliminary noise barrier design information based on the functional plans. The FHWA TNM files are included in the Reference Documents and should be used by the Design-Builder to assess proposed design changes. TDOT will use the TNM files to evaluate any modifications to the noise barrier proposed by the Design-Builder.

The Design-Builder shall ensure that all proposed work is completed within existing right-of-way limits utilizing any measures necessary. If the Design Builder deems that ROW and/or easement acquisitions are unavoidable, the Design Builder will be responsible for all ROW and easement activities including but not limited to appraisals, appraisal reviews, and acquisitions.

The top of wall elevation shall not be less than the top of wall elevation as shown in the noise analysis. The bottom of the wall shall not provide any gaps between the wall and the final grade except as required to accommodate drainage.

Ground-mounted barriers and barriers on bridges shall be connected to ensure no gaps

The traffic face of the walls shall be ~~absorptive where designated in the plans.~~ reflective and meet the following requirements: ~~See Special Provision 718NB for specifications and testing requirements.~~

- Concrete formliners shall be used to achieve the specified pattern and texture on both the highway and community sides of the barrier. Methods that involve rolling of any kind to achieve the specified pattern and texture will not be permitted.
- A minimum 1-inch depth of reveal at joints shall be achieved on both the highway and community sides of the noise barrier.
- Top noise barrier panels shall include a 12-inch wide smooth band across the top of each panel on both sides.
- All posts shall be cut flush with the highest adjacent panel.
- The formliners for both the highway and community sides of the noise barrier shall be approved by the TDOT Environmental Division (Tammy Sellers, 615.741.5367), TDOT Structures Division (Houston Walker, 615.741.3351), and TDOT Region 2 prior to the manufacture of the noise wall panels.
- The highway side of the noise barrier shall be Custom Rock Pattern #1102 Rectangular Cut Stone or an approved equal. Four custom form liners, each with a unique pattern, (5' X 10') shall be developed with 20" tall coursing and 2" average joint relief.
- The Design-Builder shall apply an Anti-Graffiti product to the highway side of the Noise Wall. The product must be on TDOT's QPL 26 list and be intended for wall applications. It must be applied in accordance with the manufacturer's specifications.
- The highway side of the noise barrier (including posts) shall be texture coated to match other structures.

- At a later date, TDOT Region 2 will identify the formliner that will be used on the community side from the list below:
    - Random Cut Stone #1106 manufactured by Custom Rock (or an approved equal)
    - Rustic Ashlar #1103 manufactured by Custom Rock (or and approved equal)
- At a later date, Region 2 will specify the Federal Standard Color to be used for the community side of the noise barrier (including posts).
- Texture coating shall be applied to ensure all panels and posts appear uniform in color. Several applications shall be applied to ensure all color uniformity. The Design-Builder shall obtain approval from TDOT Region 2 that the noise barrier surfaces are uniform in color before ceasing texture coating operations.
- The Design-Builder shall cast a sample barrier panel with the approved formliners and colors. If the sample meets the requirements of this provision, TDOT will approve the panel and this panel shall serve as a standard for acceptance of subsequent noise barrier panels. If accepted, the demonstration panel can be incorporated into the completed project.
- The demonstration panel shall be delivered to the project site. The delivery location shall be approved in advance by the TDOT Region 2 Construction Division (423.510.1217).
- The Design-Builder shall insure all panels are protected during all aspects of truck loading/unloading and transport to the project installation location.
- The panels shall be flush with one another; gaps between barrier panels shall not be permitted.
- The horizontal joints between panels shall line up from one bay of panels to the next. Horizontal joints shall have tongue-and-groove configurations.
- No gaps shall exist between the base of the barrier panels and the ground.
- Prior to installation, the Design-Builder shall inspect delivered products for any defects.
- Panels that exhibit deficiencies or damage after installation shall be replaced or repaired by the Design-Builder at the discretion of TDOT and to the satisfaction of TDOT at the expense of the Design-Builder. Deficiencies include, but are not limited to, crumbling, cracking, crazing, scaling, spalling, efflorescence and segregation.
- After installation, the Design-Builder shall remove dirt from panels with water.

The location of the posts shall consider the location of any drainage structures, utilities, or other obstructions that would interfere with post placement.

The new noise walls shall be constructed using concrete posts and concrete panels. ~~The concrete used in the posts and panels must have a compressive strength of at least 3,000 psi.~~ The post spacing shall not exceed 20 feet. Ground mounted noise wall posts shall be embedded into drilled shaft foundations. Bolted connections will not be allowed.

The panels shall be a minimum of 2 feet into ground. The bottom panels in a bay may be tapered in height with a minimum height of 1 foot. ~~The horizontal joints between the panels shall align with adjacent panel sections. The horizontal joints shall have a tongue and groove configuration.~~

The posts and panels shall be flush at the top. The top of wall elevation shall vary by no more than 2 feet in adjacent bays.

~~The posts and panels shall be texture-coated or stained as specified in Special Provision 718NB. Both sides of panels and posts shall be coated.~~

~~The noise wall panels shall have a pattern using a form-liner on both sides as specified in Special Provision 718NB. The pattern shall be concurred with by the Department before fabrication may begin.~~

Only the minimum amount of vegetation necessary for the placement of the walls may be removed as directed by the Department. Where possible, stumps and roots are to remain to prevent ground disturbance. Any damage to vegetated areas outside the limits of construction shall be repaired at the Design-Builder's expense. These areas are to be returned to their pre-construction state as directed and concurred with by the Department.

The Design-Builder shall notify the Department and all adjoining properties and stakeholders thirty (30) days prior to proposed noise barrier wall clearing, or construction.

~~Bridge bent footings being constructed in sensitive environmental areas or areas close to existing streams shall adhere to the environmental requirements set forth in the RFP.~~

### 0*RETAINING WALLS*

Retaining walls shall be built in accordance with Special Provision 624, Retaining Walls.

All retaining wall finish requirements for retaining walls visible to the public and traffic shall receive an ashlar stone finish. Retaining walls not visible to the public or traffic shall receive a Class II, Rubbed Finish as specified in the TDOT specifications.

The retaining wall locations, wall lengths, and the beginning and end stations of walls, as shown on the Functional Plans are approximate. The final locations and wall lengths shall be determined by the Design Builder.

Retaining walls being constructed in sensitive environmental areas or areas close to existing streams shall adhere to the environmental requirements set forth in the RFP.

## 5. INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

The Design-Builder shall prepare ITS design/plans and install ITS related equipment/structures as described herein in accordance with the TDOT Standard Drawings, TDOT Standard Traffic Operations

The Design-Builder's data collection for streams, wetlands, springs, sinkholes or other jurisdictional features shall be with mapping grade accuracy (defined as sub meter).

## Mitigation of Streams and Wetlands

The Design-Builder shall be responsible for all stream and wetland mitigation required for the Project including all costs associated with obtaining mitigation, maintenance, and monitoring of the mitigation site. This may include (but is not limited to):

- Planning;
- Design;
- Permitting;
- Construction of on-site/off-site mitigation for stream and/or wetlands impacts;
- Post-construction monitoring and maintenance of the mitigation sites;
- Purchasing of wetland mitigation credits from an approved bank or site; and/or
- Purchasing of stream mitigation from an approved site/organization.

All stream & wetland mitigation shall follow the requirements outlined in the Stream Mitigation Guidelines for the State of Tennessee, prepared by the TDEC, Division of Water Resources Permits Section and federal mitigation requirements of the Department of the Army, Corps of Engineers 33 CFR Parts 325 and 332. All proposed stream and wetland mitigation shall be submitted to and coordinated with the Department's Region 2 Environmental Tech Office for coordination with regulatory agencies prior to the submittal of the permit application. It shall be the responsibility of the Design-Builder to make any and all adjustments deemed necessary by the regulatory agencies to the proposed mitigation plan.

The Design-Builder shall be responsible for all on-site/off-site mitigation requirements listed in the permits and all costs associated with mitigation requirements.

## 0*PERMITTING*

The Department has not, nor will the Department procure permits for the Design-Builder. The Design-Builder shall determine all of the permits required in order to perform the work.

The Design-Builder shall be solely responsible for and obtain any necessary building, demolition, grading, and environmental permits or approvals, including but not limited to archaeology, ecology, historical, hazardous materials, air and noise, TVA 26a, TDEC ARAP/401, USACE Section 404, and TDEC National Pollution Discharge Elimination System (NPDES) permits, from federal, state and/or local agencies regarding any material and staging areas and the operation of any project-dedicated asphalt and/or concrete plants, and any waste or borrow areas that will be used. Any such permits shall be supplied to the Department's Region 2 Environmental Tech Office prior to the commencement of activities in the permitted area(s).

The Design-Builder is responsible, under the laws and regulations listed above, to avoid and minimize, to the maximum extent practicable, impacts to Waters of the State and/or Waters of the U.S. when designing and constructing the project. Avoidance and minimization of impacts are

- Quadrangle name and number;
- Project information (including PIN, State Project Number, project description, County name, nearest city);
- Scale bar (quad map scale shall be set to 1:24,000);and
- North arrow.

- Copy of signed CN1091 form (the originally-signed CN1091 form shall be submitted to TDEC).
- Signed DA/TVA form or DA form (if applicable). DA/TVA form must be filled out if an Individual Section 404 Permit is required.
- ~~Section 26a Permit is not applicable because the Project is located outside of the TVA's jurisdiction.~~
- Individual Section 404 Permit applications require the names and addresses of property owners adjacent to all permit impacts listed on a separate permit sketch.
- Individual permit sketches.
- Hydrologic Determination Field Data Sheet (ifapplicable).
- Ecology Field Data Sheet (if applicable).
- Habitat Assessment Field Data Sheet (ifapplicable).
- Wetland Determination Data Form (ifapplicable).
- TRAM Decision Form (if applicable).
- Quad map showing impact area and listing all environmental features.
- Photographs of all environmentalfeatures.
- Marked-up plan sheets from the Environmental BoundariesReport.
- A copy of all coordination correspondence between the Department and the USFWS.
- TDEC Division of Natural Areas, endangered species database search.
- A copy of all coordination correspondence between the Department and the TWRA.
- Federal Emergency Management Agency (FEMA) flood map for the subject project with construction limits labeled.
- FEMA No-Rise Certification letter or Conditional Letter of Map Revision (CLOMR) (if applicable).
- A copy of approved NEPA document (Environment Assessment, Finding of No Significant Impact, Categorical Exclusion, etc.).

temporary traffic control, transportation and information strategies. The Transportation Management Plan shall be in accordance with TDOT Standard Specifications for Road and Bridge Construction, TDOT Standard Drawings, TDOT Standard Traffic Operations Drawings, TDOT Traffic Design Manual, TDOT Design Guidelines, TDOT Work Zone Safety and Mobility Manual, ATSSA Quality Guidelines for Temporary Traffic Control Devices and Features (Current Edition), and the latest edition of the Manual of Uniform Traffic Control Devices.

- Use Traffic Control materials from the Department's Qualified Products List (QPL) (https://www.tn.gov/tdot/materials-and-tests/research---product-evaluation-and-qualified-products-list.html )
- The Design-Builder shall insure drainage spread across all traffic lanes does not exceed allowable spread. Design-Builder shall provide drainage/spread calculations for all phases of traffic control phasing.

The Transportation Management Plan will describe in detail all accommodations for traffic access and flow during all stages of construction for the life of the Project. The plan shall include the following:

- Detailed proposed sequencing plan that includes each step of the project including all major traffic shifts or changes, minor shifts or changes, closures, alternate traffic patterns.
- Overall goals of the sequencing plan and how the plan aligns with the Project Critical Path.
- Plans for providing Queue Protection~~/Smart Work Zone~~ during operations requiring temporary lane closures, temporary road closures, rolling roadblocks, traffic pacing, and setting up or removing long-term lane shifts.
- Conceptual construction staging diagrams (scale: 1 inch = 200 feet) including lane configuration and traffic management of the Interstate, State Routes, and local streets during the different stages of construction. Staging areas within the project limits shall be approved by the Department.
- Narrative description of how Design-Builder will schedule and sequence the construction to minimize impacts on the environment, communities and traveling public while still providing acceptable construction performance.
- Brief description of the laydown, recycling, staging, disposal areas, waste and borrow pits, and maintenance locations to be used during construction.
- Description of how the ROW and adjacent roads and properties will be maintained and protected, including the intended measures to be used to mitigate and minimize noise, vibration, light, dust, erosion/run-off and local road damage.

## Temporary Lane/Road closure

The Design-Builder will maintain the existing numbers of lanes on I-24, I-75, and all interstate-to-interstate ramps throughout construction except for Department-approved night or weekend lane or roadway closures except as noted below. Minimum lane widths will be eleven (11) feet. Minimum inside and outside shoulder widths will be two (2) feet.

# 11. MISCELLANEOUS

## 0*WELCOME CENTER*

The Design-Builder shall be expected to minimize disruptions to the normal operations of the Welcome Center located on I-75 north of the Ringgold Road interchange.

- Access and utility service shall be maintained to the Welcome Center at all times except for approved closures by the Department and the Department of Tourism. No closures will be allowed during designated federal or state holidays, special events, or periods designated by the Department suspending road closures.
- The Design-Builder shall submit a plan to the Department a minimum of ~~120~~ 90 days prior to closing the Welcome Center to complete ramp connections. The plan shall include the dates the Welcome Center will be closed and reopened, the work that will be performed during the closure, confirmation that all items and personnel are available to complete the work, and a plan for reopening the Welcome Center in the event the work is not completed by the scheduled reopening date. Maximum time of closure ~~should~~ shall not exceed ~~21~~ 30 consecutive calendar days. The Design-Builder shall not close the Welcome Center between Memorial Day and Labor Day. The plan shall be approved by both the Department and the Department of Tourism.
- Design-Builder shall obtain approval from the Department and the Department of Tourism a minimum or 30 days in advance for any temporary closures or disruption of services at the Welcome Center due to construction activities or utility relocations. Closures shall not exceed ~~1~~ 3 days and ~~should~~ must be scheduled ~~on a~~ for Tuesday, Wednesday, and/or Thursday.
- The Design-Builder shall not use the Welcome Center site as a storage or staging area.
- The work area for construction of all ramps and structures at the Welcome Center shall be limited to 30 feet beyond the toe of slope or edge of proposed structure.
- The Design-Builder shall erect a fence or other approved barrier at the edge of the construction area in front of the Welcome Center so that the construction site is not accessible to Welcome Center patrons.
- The Design-Builder shall not use the Welcome Center to park equipment or for parking by employees or subcontractors.
- Tree removal on the Welcome Center site shall be limited to the area required for construction of the proposed ramps and structures and shall not to exceed 10 feet beyond the toe of slope or 36 feet from the edge of the proposed shoulder and excludes areas required to achieve site distance.

## 0*CHATTANOOGA AIRPORT – HEIGHT RESTRICTIONS*

The Project is in the immediate proximity of the Chattanooga Airport and in-line with the runway glide slope. Height restrictions may apply to proposed structures including but not limited to bridges, lighting (including poles), ITS devices, utilities, and overhead signing. Height restrictions may also apply to construction equipment including but not limited to cranes.

DATE: 09/27/18 FULL-DEPTH DESIGN FOR SPRING CREEK RD. ROUTE: I-75/I-24

COUNTY: HAMILTON PROJ NO: 33005-0176-44 FED PROJ: IM/NH-75-1(131)

DESCRIPTION: I-75 INTERCHANGE MODIFICATION @ I-24

**ROADWAY DESIGN**

| | DESCRIPTION | THICKNESS |
|---|---|---|
| 411-02.10 | ACS {PG70-22) GR "D" | 1.25 |
| 307-02.08 | AC MIX (PG70-22) GR "B-M2" | 2.00 |
| 307-02.01 | AC MIX (PG70-22) GR "A" | 3.25 |
| 303-01 | MINERAL AGG BASE GRADING "D" | 10.00 |
| | TOTALS | 16.50 |

**OUTSIDE SHOULDER DESIGN**

| | DESCRIPTION | THICKNESS |
|---|---|---|
| 411-01.07 | ACS (PG64-22) GR "E" | 1.50 |
| 303-01 | MINERAL AGG BASE GRADING "D" | 15.00 |
| | TOTALS | 16.50 |

REMARKS: 1) MILL 1.25" FROM THE EXISTING PAVEMENT AND OVERLAY USING 1.25" OF "D-MIX" IF NEEDED

2) ELIMINATE SHOULDER DESIGN FOR CURB AND GUTTER SECTION

3) IF SHOULDER WIDTH IS 4 FT OR LESS, PLEASE REFER TO ROADWAY DESIGN GUIDELINE SECTION 3.125.05

## PAVEMENT DESIGN MAINLINE AND INTERSTATE TO INTERSTATE RAMPS

Roadway

| Alignment | Location | Overlay | | Widening | | Inside Shoulder | Outside Shoulder | Comments |
|---|---|---|---|---|---|---|---|---|
| | | New Alignment | | | Concrete Repair | | | |
| I-75 (Segment 1) | Mainline | N/A | A (2) | A | N/A | A (1) | A | (3) |
| I-75 (Segment 2) | Mainline | N/A | A (2) | A | N/A | A (1) | A | (3) |
| I-75 (Segment 3) | Mainline | A | A (2) | A | N/A | A (1) | A | (3) |
| I-75 (Segment 4) | Mainline | N/A | ~~A~~ N/A ~~(2)~~ | B | ~~B~~ N/A | ~~B~~ N/A | B | (3) |
| I-24 (Segment 3) | Mainline | N/A | A (2) | A | N/A | A (1) | A | (3) |
| NB I-75 to WB I-24 | Interstate to Interstate Ramp | A | A (2) | A | N/A | A (1) | A | (3) |
| SB I-75 to WB I-24 | Interstate to Interstate Ramp | N/A | A (2) | A | N/A | A (1) | A | (3) |
| EB I-24 to SB- I-75 | Interstate to Interstate Ramp | A | A (2) | A | N/A | A (1) | A | (3) |
| EB I-24 to NB- I-75 | Interstate to Interstate Ramp | A | A (2) | A | N/A | A (1) | A | (3) |

(1) Inside shoulder pavement same as full depth roadway
(2) See remarks on pavement design for overlay minimum thickness
(3) Aggregate underdrain w/pipe

## PAVEMENT DESIGN RAMPS

| Alignment | Location | Roadway | Inside Shoulder | Outside Shoulder | Comments |
|---|---|---|---|---|---|
| Ramp 'A' | Ringgold Rd. Interchange | A | A (1) | A | (2) |
| Ramp 'B' | Ringgold Rd. Interchange | A | A (1) | A | (2) |
| Ramp 'C' | Ringgold Rd. Interchange | A | A (1) | A | (2) |
| Ramp 'D' | Ringgold Rd./Rest Area to NB I-75 | C | C | C | |
| Ramp 'E' | Ringgold Rd. Interchange | A | A (1) | A | (2) |
| Ramp 'F' | Rest Area | C | C | C | |
| Ramp 'G' | Rest Area | C | C | C | |
| Ramp 'H' | Slip Ramp | C | C | C | |

(1) Inside shoulder pavement same as full depth roadway
(2) Aggregate underdrain w/pipe

# APPENDIX B – REFERENCE DOCUMENTS

All documents have been published on the Department's project website:

https://www.tn.gov/tdot/tdot-construction-division/transportation-construction-alternative-contracting/transportation-construction-division-alternative-contracting-design-build-i.html

**DOCUMENT**

- Functional Design
  - Functional Plans
    - Functional Plans
    - Functional X-Sections
    - Signing and Marking Layout (Phase 1)
    - Signing and Marking Layout (Ultimate Build-out)
    - Lighting Layout
    - ITS Layout
    - Utilities Roll Plot
  - Walls and Bridges
    - I-75 NB over Spring Creek
    - I-75 SB over Spring Creek
    - I-75 NB over I-75 NB to I-24 WB
    - I-75 SB over I-75 NB to I-24 WB
    - I-75 NB over I-24 EB to I-75 NB
    - I-75 SB over I-24 EB to I-75 NB
    - Widening I-75 over South Chickamauga Creek
    - Spring Creek Road over I-24 EB
    - Spring Creek Road over I-24 WB
- Environmental Documents
  - NEPA Document
  - Environmental Commitments
  - TDOT Waste and Borrow Manual (2017)
- Technical Support
  - ~~Preliminary Drainage Analysis~~
  - Geotechnical Reports
  - TDOT Bridge Inspection Reports
  - TDOT Bridge Deck Surveys
  - Traffic Count Data
  - Survey Files
  - Existing ITS Inventory
  - Noise Barrier Evaluation (including TNM file(s))