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

(Rev. 08-22-11) September 03, 2005

SPECIAL PROVISION

REGARDING

COMPACTION GROUTING

DESCRIPTION OF WORK

The work to be performed under this Specification consists of grouting above the rock surface to reduce future sinkhole risk. The grouting is intended to fill voids and displace soft soils in an effort to improve the support to the upper soils and the overlying roadway structure. The work entails the injection of a low slump grout using compaction grouting equipment. The work shall consist of furnishing all labor, project control, tools, equipment, materials, and supervision necessary to carry out the work. Specifically, includes submitting, prior to mobilization, a detailed description of the planned procedures for review by the Engineer, injection of the grout as described in the Plans and Specifications, and providing experienced personnel to supervise the grouting operations.

QUALIFICATIONS

The Contractor shall submit in writing to the Engineer his qualifications to perform the work, or those of his grouting subcontractor. When a grouting subcontractor is used, this information is required for the subcontractor approval process.

Those qualifications shall include, but are not limited to, the following:

(a) Records of the Contractor's past successful experience in performing compaction grouting of soil overlying limestone or other carbonate rock. A minimum of five projects within the last five years is required. Experience with slurry grouting, penetration grouting, slab jacking or other types of grouting shall not be accepted as meeting this requirement. The documentation should include project locations, names of clients, costs, and volume of grout used.

(b) Documentation of the experience of the grouting crew members including length of employment with the Contractor, work experience, work resume, and specialized education and training history. The grouting superintendent/engineer shall have 3 years or more experience in compaction grouting in areas of carbonate rock (karst terrain). Each crew shall have no more than one trainee.

CONSTRUCTION

The work shall include the following:

(a) Submittal of a detailed description of the grouting procedure prior to equipment mobilization.

(b) Installation of steel casing to approximately 1 ft above the rock surface at each grout injection location.

(c) Injection of grout with supervision by experienced personnel.

(d) Provide a movement monitoring system of the roadway and nearby existing structures.

The Contractor shall, throughout the duration of the grouting, coordinate his work and cooperate with the Engineer. Specifically, the Contractor shall work closely with those concerned with any underground construction elements, existing or planned, which may require adjustment to the grout hole locations. The Contractor shall also provide at least one person who shall be present at the all times during casing installation and grouting who is familiar with the operations involved and will direct the work. The Contractor shall submit a schedule of all construction events and planning for review by the Engineer prior to mobilization.

MATERIALS

Cement shall be Portland cement conforming to all requirements of **Section 901.01** of the Standard Specifications.

The fine aggregate shall conform to all requirements of **Section 903.01** of the Standard Specifications. Additives to enhance flow or other performance criteria shall be permitted on approval of the Engineer.

Water shall be fresh, clean, and reasonably free of sewage, acid, alkali, salts, and organic matter.

Materials shall be properly delivered and handled to prevent the damage, contamination, and/or segregation of aggregates by proper arrangement and use of stockpiles. Cement stored on-site shall be covered to prevent dampness and contamination.

The cost of quality assurance testing of cement and aggregates shall be borne by the Contractor. Certified test reports and certificates, when required, shall be submitted to the Engineer and all other agencies and persons as he may designate.

All grout material, proportioning, mixing, transporting, and testing shall be in accordance with TDOT Standard Specifications for Road and Bridge Construction and TDOT Procedures for the Sampling, Testing, and Acceptance of Materials and Products (SOP 1-1) portland cement concrete non-structural concrete for small quantities.

EQUIPMENT

The on-site grout plant, if used, shall be designed to handle the specified materials for this type of work. The mixer shall be of the plaster and mortar type to ensure complete and uniform mixing of the materials used and shall be of sufficient capacity to continuously provide the pumping unit with mixed grout at its required pumping rate.

The grout pump shall be capable of continuously delivering the specified grout materials at a pressure of at least 600 psi. Pressure gauges shall be supplied at the pump and at the grout lead pipe. An adequate communications system shall be maintained between the grout plant, pump, and injection location so as to allow strict control of the pumping operations. A total grout pumping capacity of at least 30 cubic yards per 8 hour shift shall be provided.

Grout casing shall be steel casing of adequate strength to withstand the required pumping, drilling and/or jacking pressures. The casing shall have an inside diameter of at least 2 inches in order to handle the specified low slump material without plugging. The casing shall be installed by augering, drilling, and/or jacking in a manner that ensures that the grout pipes are free of soil and debris, and that a tight seal is made around the casing sufficient to withstand the grouting pressures. The installation of the grout casing shall be performed in such a manner as to

extend the casing to the interpreted top of the bedrock at anticipated depths as shown in the Plan of Primary Grout Hole Locations in the Plans.

Grout casing pulling jacks shall be provided capable of withdrawing the steel. The Contractor shall adequately protect grout pipes from foreseeable hazards. After grouting at each grout hole location, the Contractor shall plug each hole and return the area to its original conditions.

GROUTING

The work consists of injecting 0-inch to 3-inch slump grout under pressure into the grout holes. The slump will be measured with a standard slump cone. Grouting mixes, pressures, and pumping rate shall be determined in the field by the Contractor based on existing soil conditions and reaction and approved by the Engineer.

Grout holes shall be drilled and continuously cased to the top of the rock as indicated by refusal of the drilling tools or other method acceptable to the Engineer. Adjustments to the grout hole locations may be required, upon approval by the Engineer, to avoid existing and future underground elements. Primary grout holes shall be located in a pattern as shown on the Plan of Primary Grout Hole Locations included in the Plans. Depending on field observation of the drilling and grouting operations, the Engineer may add additional intermediate secondary grout holes to the Contractor's scope of work at the contract unit rates. A field layout of the primary grout holes and any required secondary grout holes shall be made by the Contractor during the grouting operations and provided to the Engineer on a daily basis.

The grout mix shall be approximately 3-6 sacks of Portland cement per cubic yard of grout. The grout mix design including all proposed additives and consideration of water to be added at the site (if grout is delivered from off-site) shall be submitted to the Engineer for approval prior to mobilization. Water will be added as required to achieve a pumpable mix of not more than a 3-inch slump. Injected grout shall have an average unconfined compressive strength of not less than 1,500 psi at 28 days. If agitated continuously, the grout may be held in the grout plant for not more than 2 hours. All concrete material, proportioning, mixing, transporting, and testing shall be in accordance with *TDOT Standard Specifications for Road and Bridge Construction* and *TDOT "Procedures for the Sampling, Testing, and Acceptance of Materials and Products (SOP 1-1)"*.

GROUT INJECTION PROCEDURES

At each grout hole location, the grout casing shall be installed to refusal of the drilling equipment (as interpreted top of bedrock), then the grout casing shall be lifted approximately 1 foot. Grout shall then be pumped into the subsurface using the following limiting criteria:

- When the injection pressure at the grout casing header exceeds 400 psi, while injecting at a rate of approximately 0.25 cubic feet/minute.
- When the roadway surface elevation exceeds the design grade elevation as determined by the monitoring system.
- When the maximum quantity of grout has been injected. The maximum quantity of grout to be injected at any location shall be 8 cubic yards (not including the grout required to fill the grout hole itself) unless otherwise directed by the Engineer.
- When upward movement of nearby adjacent structures occurs as determined by the monitoring system.

The arrangement of the grouting equipment shall be so as to provide a continuous flow of grout to the injection point and to permit accurate pressure and flow rate control regardless of the magnitude of the grout take. During grouting operations, the Contractor shall take such precautions as may be necessary to prevent drill cuttings, equipment exhaust, oil, wash water, and grout from defacing or damaging adjacent structures. The Contractor shall furnish such pumps as may be necessary to handle wastewater and grout from his operations, and will clean up all waste resulting from his operations.

The Contractor shall keep records of all grouting operations, such as logs of each grout hole, time and nature and each change in grouting conditions, pressures, rates of pumping, composition of grout mix and any other data which the Engineer deems as necessary. Such records will be made available to the Engineer. Upon completion of the grouting procedures, the Contractor will be responsible for confirming that the roadway has been restored to the degree acceptable to the Engineer.

MONITORING

A ground heave monitoring system will be provided and maintained by the Contractor. It shall be adequate to monitor key movement in the area influenced by the grouting. After the completion of the grouting program, the monitoring system shall be removed; all grout holes patched, and the surface restored as indicated in this Special Provision.

Any roadway heave in excess of 0.75 inch will require corrective action. The Tennessee Department of Transportation will determine the required repair and procure the corrective action. The cost of the corrective action will be born by the Contractor and will be deducted from any money due to the Contractor, not as a penalty, but as liquidated damages.

BASIS OF PAYMENT

The grouting work including all additions and subtractions to the scope of the pre-treatment grouting program shall be conducted on the basis of lump sum and unit rates as follows:

ITEM	UNIT
(204-05.20) Grout casing installation	(L.F.)
(604-15.20) Compaction Grout	(C.F.)

PAYMENT

The contract prices for the various specified items of work and material shall constitute full compensation for mobilizing, demobilizing, and furnishing all equipment, materials, and labor necessary to perform the advancing and casing of holes and for grouting in accordance with this Specification.

Mobilization

One mobilization charge is allowed per purchase order.

Invoice information:

All work orders and invoices are to be submitted for payment to the Regional office in which the work was completed. Send payment information to:

TDOT Region 1
P O Box 58
Knoxville, TN 37901
attn: Ben Price, Regional Operations Engineer

TDOT Region 2
P O Box 22368
Chattanooga, TN 37422
attn: Gwen Whittaker, Regional Operations Engineer

TDOT Region 3
6601 Centennial Blvd.
Nashville, TN 37243
attn: Shay Deason, Regional Operations Engineer

TDOT Region 4
300 Benchmark Place
Jackson, TN 38301
attn: Jason Baker, Regional Director of Operations