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May 15, 2017

MEMORANDUM TO: John L. Pilipchuk, LG, PE  
State Geotechnical Engineer

FROM: Ben D. Lackey Jr, PE  
CATLIN Senior Geotechnical Engineer

STATE PROJECT: 40238.1.4 (U-4902D)  
F.A. NUMBER: NHS-0017(76)  
COUNTY: NEW HANOVER

DESCRIPTION: US 17 Business (Market Street) from Lendire Road to Marsh Oaks Drive

SUBJECT: Geotechnical Report Addendum – Ground Improvement

CATLIN Engineers and Scientists (CATLIN) have completed a subsurface investigation and recommendations addendum to address the long term settlement and slope stability in the area listed below.

<u>Line</u>	<u>Station +/-</u>
-L-	277+47 to 279+77

CATLIN recommends the use of lightweight aggregate embankment with high strength fabric for embankment stabilization for the proposed roadway embankment and as a replacement for the existing roadway embankment in this area.

#### 1. Fabric for Embankment Stabilization

The fabric for the embankment stabilization shall be installed in the following area, as shown on the detail plan, prior to placement of the lightweight aggregate embankment fill. Fabric for embankment construction shall meet the requirements of the attached “Fabric for Embankment Stabilization” special provision. Recommend a quantity of 3,650 square yards of Fabric for Embankment Stabilization in the contract.

<u>Line</u>	<u>Station +/-</u>
-L-	277+47 to 279+77

2. Removal of the existing Roadway Embankment

The existing roadway embankment shall be removed from the following area.

<u>Line</u>	<u>Station +/-</u>
-L-	277+47 to 279+77

Recommend 3,100 cubic yards of suitable unclassified excavation be included in the contract. Use of suitable unclassified excavation material shall meet the requirements of the attached “Special Handling of Unclassified Excavation” special provision.

3. Lightweight Aggregate

Lightweight aggregate shall be used to construct the proposed embankment to subgrade from -L- Station 277+47 ± to 279+77 ±. Lightweight aggregate for construction shall meet the requirements of the attached “Lightweight Aggregate” special provision. Include a quantity of 3,000 tons of Lightweight Aggregate in the contract.

4. Shoulder and Slope Material

The fill slope material should be placed to a height of 1 foot on the roadway side slopes which are formed with lightweight aggregate. Material for fill slope shall meet the requirements of the attached “Shoulder and Fill Slope Material” project special provision. Recommend 275 cubic yards of borrow excavation should be included in the contract.

5. Fabric for Soil Stabilization

The fabric for soil stabilization shall be installed between the lightweight aggregate embankment. Include 7,300 square yards of Fabric for Soil Stabilization in the contract to be used in the following sections, as shown on the detail plan.

<u>Line</u>	<u>Station +/-</u>
-L-	277+47 to 279+77

5. Attachments

- Quantity Summary
- Special Provisions
  
- 1. Fabric for Embankment Stabilization
- 2. Lightweight Aggregate
- 3. Shoulder and Fill Slope Material
- 4. Special Handling of Unclassified Excavation
  
- Plan Sheet
  
- 1. Lightweight Aggregate Embankment Detail Plan (1 sheet)

Prepared By:



Lee Stone, P.G.  
CATLIN Senior Geologist



Ben D. Lackey Jr. P.E.  
CATLIN Geotechnical Engineer

**Quantity Summary**

<b><u>Item Number</u></b>	<b><u>Description</u></b>	<b><u>Quantity</u></b>	<b><u>Comment</u></b>
	Fabric for Embankment Stabilization (SP)	3,650 SY	See Section 1
	Special Handling of Unclassified Excavation (SP)	3,100 CY	See Section 2
	Lightweight Aggregate (SP)	3,000 TON	See Section 3
0106000000-E	Borrow Excavation for Shoulder and Fill Slope Material	275 CY	See Section 4
0196000000-E	Fabric for Soil Stabilization	7,300 SY	See Section 5

**FABRIC FOR EMBANKMENT STABILIZATION****DESCRIPTION:**

This work consists of furnishing and installing synthetic fabric for stabilizing embankment in accordance with this provision or as directed by the Engineer. The work shall include maintaining the fabric in the required configuration until completion and acceptance of overlying work items. The fabric shall be placed at the locations shown in the plans or as directed by the Engineer.

**MATERIAL:**

The fabric material for embankment stabilization shall be made of high-tenacity polyester in the machine direction with a plain straight weave pattern and polyester or polypropylene in the cross direction or approved equal. The fabric shall be composed of strong rot-proof synthetic fibers formed into a fabric of the woven type. The fabric shall be free of any treatment or coating which might significantly alter its physical properties after insulation.

The fabric shall contain stabilizers and/or inhibitors to make the filaments resistant to deterioration resulting from ultraviolet or heat exposure. The fabric shall be a pervious sheet of synthetic fibers oriented into a stable network so that the fibers retain their relative positions with respect to each other. The edges of the fabric shall be furnished to prevent the outer yarn from pulling away from the fabric. The fabric shall be free of defects or flaws which significantly affect its physical and/or filtering properties. Sheets of fabric shall be sewn together with a seam that furnishes the required minimum strengths. The seam thread shall be made of synthetic fibers which are resistant to deterioration, as are the fabric fibers. Lamination of fabric sheets to produce the physical requirements of a fabric layer will not be accepted.

During all periods of shipment and storage, the fabric shall be wrapped in a heavy duty protective covering to protect the fabric from direct sunlight ultraviolet rays, mud, dust, dirt, and debris. The fabric shall not be exposed to temperatures greater than 140°F. After the protective wrapping has been removed, the fabric shall not be left uncovered under any circumstances for longer than one (1) week.

The fabric shall meet the following requirements:

All values represent minimum average roll values (any roll in a lot should meet or exceed the minimum values in this table).

<u>Fabric Property</u>	<u>Test Method</u>	<u>Requirements</u>
Min. Puncture Strength	ASTM D-4833	135 lbs
Min. Bursting Strength	ASTM D-3786	600 psi
Trapezoid Tear	ASTM D-4533	135 lbs
AOS, US STD Sieve	ASTM D-4751	20-70
Seams, Strength Cross Machine Direction Only	ASTM D-4884	500 lbs/ft
Ultraviolet (UV) % Strength Retained	ASTM D-4355	30%
Permeability	ASTM D-4491	.002 in/sec
Tensile Strength at 5% Strain	ASTM D-4595 (Wide Strip Test)	Machine Direction 8000 lbs/ft
Ultimate Tensile Strength	ASTM D-4595 (Wide Strip Test)	Machine Direction 20000 lbs/ft

The Contractor shall furnish certified reports by an approved independent testing laboratory with each shipment of material attesting that the fabric meets the requirements of this provision; however, the material shall be subject to inspection, test, or rejection by the Engineer at any time. The Contractor shall furnish the Engineer certified test reports by an approved independent testing laboratory attesting that the sewn seam provides the required strength.

The Contractor shall furnish and place over the embankment stabilization fabric as shown in the plan or as directed by the Engineer.

CONSTRUCTION METHODS:

The fabric for embankment stabilization shall be placed at locations shown in the plans or as directed by the Engineer. The locations should be cleared and free of obstructions, debris, and pockets. Stumps shall be cut smooth at the ground elevation with the root system left intact. At the time of installation, the fabric shall be rejected if it had defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, or storage.

The fabric for embankment stabilization shall be placed with the machine direction as shown on the plans or as directed by the Engineer. Fabric shall be laid smooth and free from tension, stress folds, wrinkles, or creases. All joints parallel to the machine direction shall be sewn by an approved method to develop the required seam strength. All sewn seams shall be placed facing upwards to allow for inspection. No seams will be allowed perpendicular to the machine direction. The lightweight aggregate should be placed and compacted using low ground pressure equipment as directed by the Engineer. All fabric which is damaged as a result of installation will be required to be replaced or repaired at the direction of the Engineer with no additional cost to the Department. Compaction equipment shall be such that it will not harm the fabric.

A lightweight aggregate layer at a depth shown in the plan or as directed by the Engineer shall be placed over the geosynthetic layer. End dumping fill directly on the fabric is not permitted. Spreading and compaction of lightweight aggregate with low ground pressure (<4 psi) equipment is required until 2 feet of lightweight fill has been placed.

Any fabric which is damaged as a result of installation or which is left uncovered for longer than one week after placement shall be replaced at no additional cost to the Department.

METHOD OF MEASUREMENT

The quantity of fabric to be paid for will be the number of square yards of "Fabric for Embankment Stabilization" measured along the surface of the ground which has been acceptably placed. No separate measurement will be made of overlapping fabric.

BASIS OF PAYMENT:

The quantity of fabric, measured as provided above, will be paid for at the contract unit price per square yard for "Fabric for Embankment Stabilization". Such price and payment will be full compensation for furnishing, hauling, placing, compaction, and all incidentals necessary to complete the work.

Pay Item:      Fabric for Embankment Stabilization.....Square Yard

**LIGHTWEIGHT AGGREGATE****(SPECIAL)****GENERAL:**

Furnish and place lightweight aggregate as shown on the plans, according to this provision, and as directed by the Engineer. Use ESCS (Expanded Shale Clay Slate) produced by the rotary kiln method conforming to ASTM C-330 (latest edition).

**MATERIAL PROPERTIES:**

Lightweight aggregate must have a proven record of durability, and be non-corrosive, with the following properties:

- Contains a maximum organic content of 0.1%
- Soundness Loss (AASHTO T104): Have a maximum soundness loss of less than 30% when subjected to four cycles of Magnesium Sulfate.
- Abrasion Resistance (ASTM C131): Have a maximum percentage of abrasion loss of less than 40%.
- Chloride Content (AASHTO T291): Have a chloride content of less than 100 ppm.
- Gradation (ASTM 136): use an aggregate gradation from ¾" to #4. Other gradations may be acceptable with approval of the Engineer.
- Aggregate loose unit weight (ASTM C29): Have a loose unit weight less than 55 lbs/ft<sup>3</sup>.
- In-place unit weight (ASTM D4253, D4254): Have an in-place compacted dry unit weight between 55 and 60 lbs/ft<sup>3</sup>. Material must be compacted to a minimum 65% relative density as determined by ASTM D4253 and D4254. Use a vibratory table when determining the maximum index density and unit weight in accordance with ASTM D4253. Determine the minimum index density and unit weight in accordance with ASTM D4254.
- Angle of Internal Friction (ASTM D3080): Minimum angle of internal friction of 40 degrees. Test a saturated representative sample (with particles larger than 0.75 inch removed) in a round or square shear box that is a minimum of 12 inches across.
- Resistivity (ASTM D1125): Have a resistivity greater than 3000 ohm-cm.
- pH (ASTM D1293): Have a pH greater than five but less than 10.





**SHOULDER AND FILL SLOPE MATERIAL:****(SPECIAL)**

DESCRIPTION: Perform the required shoulder and slope construction for this project in accordance with the applicable requirements of Section 560 and Section 235 of the 2006 *Standard Specifications* except as follows:

Construct the top 12 inches of shoulder and fill slopes with soils capable of supporting vegetation.

Provide soil with a P. I. greater than 6 and less than 25 and with a pH ranging from 5.5 to 6.8. Remove stones and other foreign material 2 inches or larger in diameter. All soil in subject to test and acceptance or rejection by the Engineer.

Obtain material from within the project limits or approved borrow source.

COMPENSATION: When the Contractor elects to obtain material from an area located beneath a proposed fill sections which does not require excavation for any reason other than to generate acceptable shoulder and fill material, the work of performing the excavation will be considered incidental to the item of *Borrow Excavation* or *Shoulder Borrow*. If there is no pay item for Borrow or Shoulder Excavation in the contract, this work will be considered incidental to *Unclassified Excavation*. Stockpile the excavated material in a manner to facilitate measurement by the Engineer. Fill the void created by the excavation of the shoulder and fill slope material with suitable material. Payment for material used from the stockpile will be made at the contract unit price for *Borrow Excavation* or *Shoulder Borrow*. If there is no pay item for *Borrow Excavation* or *Shoulder Borrow*, then the material will be paid for at the contract unit price for *Unclassified Excavation*. The material used to fill the void created by the excavation of the shoulder and fill slope material will be made at the contract unit price for *Unclassified Excavation*, *Borrow Excavation*, or *Shoulder Borrow*, depending on the source of the material.

Material generated from undercut excavation, unclassified excavation, or clearing and grubbing operations that is placed directly on the shoulders or slope areas, will not be measured separately for payment, as payment for work requiring the excavation will be considered adequate compensation for depositing and grading the material on the shoulder slopes.

When undercut excavation is performed at the direction of the Engineer and the material excavated is found to be suitable for use as shoulder and fill slope material, and there is no area on the project currently prepared to receive the material generated by the undercut operation, the Contractor may construct a stockpile for use as borrow at a later date. Payment for the material used from the stockpile will be made at the contract unit price for *Borrow Excavation* or *Shoulder Borrow*.

When shoulder material is obtained from the borrow sources or from stockpiled material, payment for the work of shoulder construction will be made at the contract unit price per cubic yard for *Borrow Excavation* or *Shoulder Borrow* in accordance with the applicable provisions of Section 230 or Section 560 of the 2006 *Standard Specifications*.

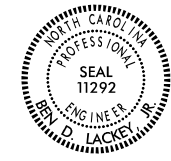
**SPECIAL HANDLING OF UNCLASSIFIED EXCAVATION****(SPECIAL)****GENERAL**

Use any suitable unclassified excavation material removed from the excavation from the stations listed below in accordance with NCDOT Standard Specification 225, except the material shall not be used in the top 3 feet of the proposed embankment or backfill. These soils may be utilized in areas outside the pavement section or in lower portions of high fills at the discretion of the Engineer.

<u>Line</u>	<u>Station +/-</u>
-L-	277+47 to 279+77

GEOTECHNICAL ENGINEER

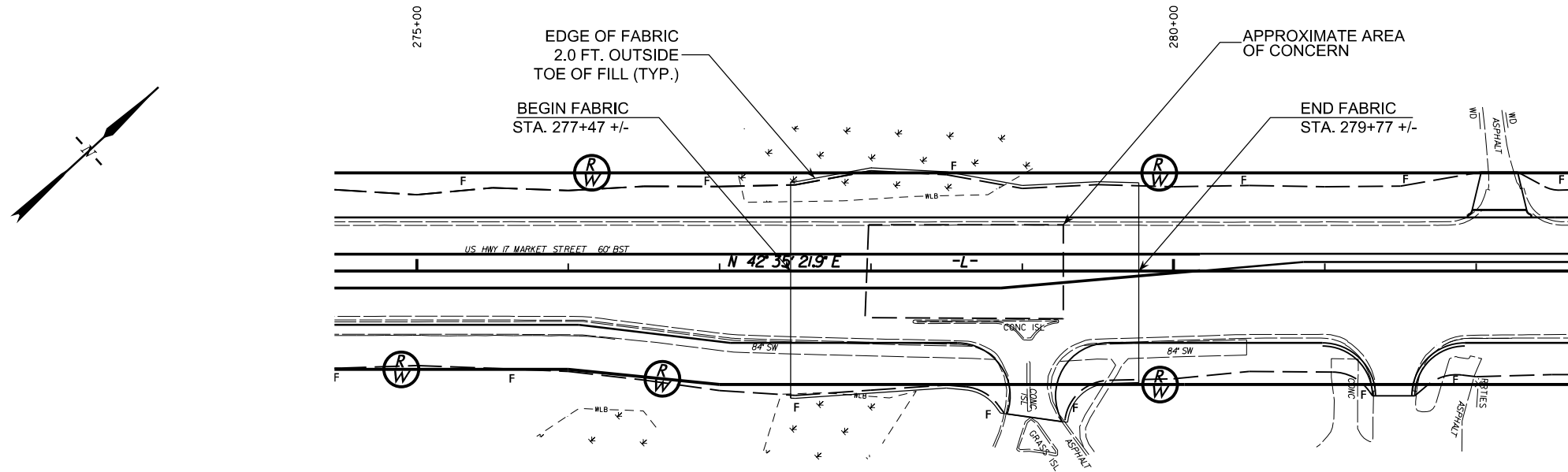
ENGINEER



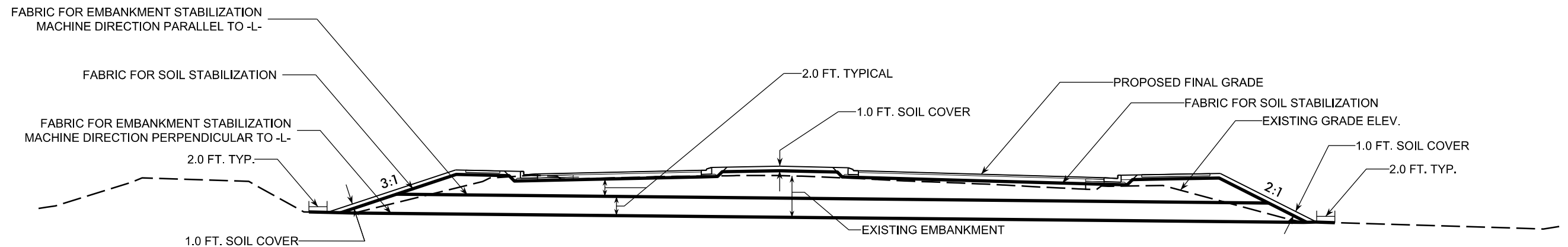
SIGNATURE DATE

SIGNATURE DATE

DOCUMENT NOT CONSIDERED FINAL UNLESS ALL SIGNATURES COMPLETED



FABRIC FOR EMBANKMENT STABILIZATION LAYOUT  
NOT TO SCALE



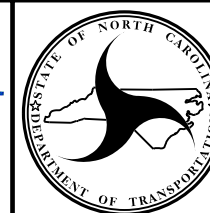
REMOVE EXISTING EMBANKMENT AND REPLACE WITH LIGHTWEIGHT AGGREGATE

TYPICAL SECTION  
NOT TO SCALE

PREPARED BY: Steve Hudson, P.G.	DATE 3/30/17
REVIEWED BY: Ben Lackey, P.E.	DATE 5/16/17

Prepared in the Office of:

**CATLIN**  
Engineers and Scientists  
Wilmington, North Carolina



NORTH CAROLINA  
DEPARTMENT OF TRANSPORTATION  
DIVISION OF HIGHWAYS  
**GEOTECHNICAL  
ENGINEERING UNIT**

LIGHTWEIGHT  
AGGREGATE  
FILL EMBANKMENT

REVISIONS					
NO.	BY	DATE	NO.	BY	DATE
1			3		
2			4		