

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT



**SUBSURFACE INVESTIGATION**

STATE JOB NO. BR1610

FEDERAL AID PROJECT NO. STPB-0016(62)

BURLINGTON NORTHERN SANTA FE RAILWAY (BONO) (S)

COUNTY ROAD NO. 27

IN CRAIGHEAD COUNTY

LETTING OF SEPTEMBER 21, 2016

The information contained herein was obtained by the Department for design and estimating purposes only. It is being furnished with the express understanding that said information does not constitute a part of the Proposal or Contract and represents only the best knowledge of the Department as to the location, character and depth of the materials encountered. The information is only included and made available so that bidders may have access to subsurface information obtained by the Department and is not intended to be a substitute for personal investigation, interpretation and judgment of the bidder. The bidder should be cognizant of the possibility that conditions affecting the cost and/or quantities of work to be performed may differ from those indicated herein.

**ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT**

November 17, 2014

**TO:** Mr. Rick Ellis, Bridge Engineer

**SUBJECT:** Job No. BR1610  
Burlington Northern Santa Fe Railway (Bono) (S)  
County Road 27 (CCR 352)  
Craighead County

Transmitted herewith is a brief summary of the geology and site conditions, summary of percent material passing #200 sieve and Atterberg Limits test results (for liquefaction susceptibility analysis), along with the logs of the rotary wash borings conducted in the vicinity of the bridges and approaches of the above referenced job. The samples obtained by the Standard Penetration tests were brought to the laboratory and visually classified by experienced lab personnel to verify the field identification.

It is anticipated that bridge ends will be founded on piling and interior bents will be founded on pile supported footings. It is recommended that the west bridge embankment be internally reinforced with geogrid. Geogrid placement and specification recommendations are detailed in the attached draft Special Provision, along with Figure 1 and Figure 2.

The embankment analysis was based on a 26 foot embankment height with 3H:1V bridge end slopes. Seismic analysis included a coefficient of horizontal acceleration of 0.498 as provided by Bridge Design. FHWA publication NHI-10-025 Volume II indicates that a value of one-half the horizontal coefficient may be utilized in the design of reinforced embankments. Therefore, a value of 0.249 was utilized in this design. This configuration provides for a satisfactory Factor of Safety for seismic and static conditions.

If you have any questions concerning these recommendations, please contact the Geotechnical Section.

  
Michael C. Benson  
Materials Engineer

MCB:rpt

Attachment

cc: State Construction Engineer – Master File Copy  
District 10 Engineer  
Roadway Design  
G. C. File

## ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

SPECIAL PROVISION  
BR1610  
**GEOSYNTHETIC INTERNAL REINFORCED EMBANKMENT  
CONSTRUCTION**

**Description:** This item shall consist of furnishing and installing a geosynthetic internal reinforcement for embankment construction in accordance with the plans and specifications. The geosynthetic internal reinforcement shall be placed as described herein, from Station 112+00 to the West Bridge End Slope.

**Materials:** Geogrid shall be manufactured as a single layer regular network of integrally-connected longitudinal and transverse polymer tensile elements with a geometry that permits significant mechanical interlock with the backfill material. The geogrid structure shall remain dimensionally stable under construction stresses and have a high resistance to damage during construction, to ultraviolet degradation and to all forms of chemical and biological degradation encountered in the soil being reinforced.

The geogrid shall also conform in all respects to the following physical requirements:

Provide a geogrid with a minimum tensile strength,  $T_{allow}$  specified in the plans and this Special Provision.

Where:  $T_{allow} = T_{ult} / RF$

And  $RF = FS_{ID} \times FS_{CR} \times FS_D$

Determine  $T_{ult}$  (Ultimate Tensile Strength) according to ASTM D 6637 Method B (note, that the same test shall be used for definition of the geogrid creep reduction factor) and ASTM D 4759.

Determine  $FS_{ID}$ ,  $FS_{CR}$ , and  $FS_D$  according to the following:

$FS_{ID}$  Determine the Partial Factor of Safety for Installation Damage from the results of full scale construction damage tests conducted according to ASTM D 5818. If possible, conduct the tests using project-specific backfill and construction placement techniques. Use a default value of 3.0 if no installation damage testing has been conducted. The minimum value for  $FS_{ID}$  is 1.1.

$FS_{CR}$  Determine the Partial Factor of Safety for Creep Deformation according to ASTM D 5262. Collect test data for a minimum duration of 10,000 hours for both standard and elevated temperatures. Extrapolate the test results to a 75-year design life as provided in Appendix B of FHWA Publication No. FHWA-NHI-10-025, "Design and Construction of Mechanically

## ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

## SPECIAL PROVISION

## BR1610

**GEOSYNTHETIC INTERNAL REINFORCED EMBANKMENT  
CONSTRUCTION**

Stabilized Earth Walls and Reinforced Soil Slopes –Volume II”. If testing has not been conducted, default values for  $FS_{CR}$  are:

| <u>Polymer Type</u> | <u><math>FS_{CR}</math></u> |
|---------------------|-----------------------------|
| Polyester           | 3.0                         |
| Polypropylene       | 5.0                         |
| Polyethylene        | 5.0                         |

$FS_D$  The Durability Reduction Factor is dependent on the susceptibility of the geogrid to attack from chemicals, thermal oxidation, hydrolysis, stress cracking, and microorganisms. The minimum reduction factor for the combined effects of chemical and biological degradation is:

| <u>Polymer Type</u> | <u><math>FS_D</math></u> |
|---------------------|--------------------------|
| Polyester           | 1.20                     |
| Polypropylene       | 1.25                     |
| Polyethylene        | 1.10                     |

Identify, store, and handle geogrids according to ASTM D 4873. Limit geogrid exposure to ultraviolet radiation to less than 10 days.

The Contractor shall furnish to the Engineer a production certification that the geogrid supplied meets the respective criteria set forth in these specifications. The certification shall state the name of the manufacturer, product name, style number, chemical composition of the filaments, ribs, or yarns, and other information to fully describe the geogrid. The Contractor shall supply test data from an independent laboratory to support certified values submitted.

The embankment material placed within the limits of this Special Provision shall consist of a clay material with a minimum plasticity index (PI) of 10 and a maximum plasticity index (PI) of 40. Non-plasticity and/or low plasticity (less than 10) granular material (sand, silt or clayey gravel) will not be acceptable. The Contractor shall perform quality control and acceptance sampling and testing of the compacted embankment material for density and moisture content in accordance with Subsection 210.02 and 210.10, at the frequencies established in Section 210. The Contractor shall perform quality control and acceptance sampling and testing of the compacted embankment material for plasticity index in accordance with Section 306, except that the size of the standard lots will be 3000 cubic yards. There will be no direct payment made for fulfilling these material requirements but compensation shall be considered included in the price bid for Compacted Embankment (Special).

## ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

## SPECIAL PROVISION

## BR1610

**GEOSYNTHETIC INTERNAL REINFORCED EMBANKMENT  
CONSTRUCTION**

**Construction Methods:** The geogrid reinforcement shall be placed to the lines and dimensions shown in the plans or as directed by the Engineer. During clearing and grubbing in the embankment area, all organic and deleterious materials, and soft or loose compressible soils shall be excavated and removed from the fill area. Prior to fill placement, the exposed foundation soils shall be proof-rolled to detect any unstable locations, which shall subsequently be compacted or excavated and replaced with compacted fill.

Correct orientation (roll direction) of the geogrids shall be verified by the Engineer. All geogrids shall be placed/unrolled per manufacturer's recommendations. The contractor shall provide the Engineer detailed installation recommendations from the manufacturer. All geogrid shall be placed to lay flat, pulled tight and pinned or weighted down to hold its position until the subsequent soil layer can be placed.

In the roadway embankment reinforcement zone, geogrid shall be placed in continuous longitudinal strips perpendicular to the face of the embankment slope. The curved transition from side slope to bridge end slope shall be constructed of rectangular pieces of grid. Grid shall be overlapped so that the entire embankment is covered. The roadway reinforcement zone shall contain a minimum of four layers of geogrid placed on two foot intervals. The top layer shall be placed two feet from finished subgrade. Geogrid in the upper reinforcement zone shall have a  $T_{allow} = 4000$  Lb/ft.

The slope reinforcement zone shall consist of the embankment slope area below the full width roadway reinforcement zone. Geogrid in these slopes shall be placed in continuous longitudinal strips perpendicular to the face of the embankment. Each strip shall be a minimum of twenty five feet long. The highest layer shall be placed a maximum of two foot below the upper reinforcement zone. The slope reinforcement shall be placed on two foot intervals to where the toe of the slope intercepts the existing ground after clearing and grubbing is complete. The curved transition from side slope to bridge end slope shall be constructed of rectangular pieces of grid. Grid shall be overlapped so that the entire embankment is covered. Geogrid in the slope reinforcement zone shall have a  $T_{allow} = 1000$  Lb/ft.

Overlaps of geogrid between rolls shall be located no less than 30 feet from the finished slope surface. Geogrid shall be overlapped a minimum of 5 feet. The number of overlaps shall be limited to one per strip of geogrid. Mechanical bar connections shall be placed per manufacturer's recommendations if required.

## ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

## SPECIAL PROVISION

## BR1610

**GEOSYNTHETIC INTERNAL REINFORCED EMBANKMENT  
CONSTRUCTION**

Adjacent strips of geogrid do not need to be overlapped. The embankment fill between layers of geogrid reinforcement shall be prepared in accordance with Section 210, Excavation and Embankment of the Standard Specifications for Highway Construction, Edition of 2014. Reinforcement can be placed directly on the prepared embankment. No special surface treatment will be required. If a sheep's-foot roller is utilized, the imprints are acceptable surface for geogrid reinforcement placement.

Tracked construction equipment shall not be operated directly upon the geogrid. A minimum fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles shall be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid.

Rubber-tired equipment may pass over geogrid reinforcement at slow speeds of less than 10 mph. Sudden breaking and sharp turning shall be avoided.

**Method of Measurement:** All embankment material including the geogrid reinforcement will be measured in accordance with Section 210 Excavation and Embankment of the Standard Specifications for Highway Construction, Edition of 2014 for Compacted Embankment.

**Basis of Payment:** Placement and compaction of embankment material and furnishing and installing geogrid reinforcement shall be paid for under the item "Compacted Embankment (Special)", which price shall be full compensation for all costs involved in furnishing all material; for proof rolling ground surfaces or subgrade; for constructing the embankments in accordance with Section 210 and this Special Provision; for quality control and acceptance sampling and testing; and for all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

| <b>Pay Item</b>                | <b>Pay Unit</b> |
|--------------------------------|-----------------|
| Compacted Embankment (Special) | Cubic Yard      |

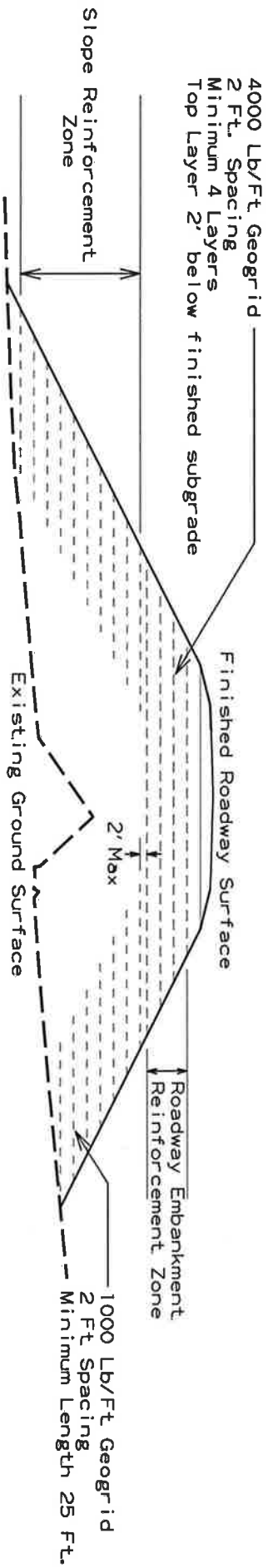
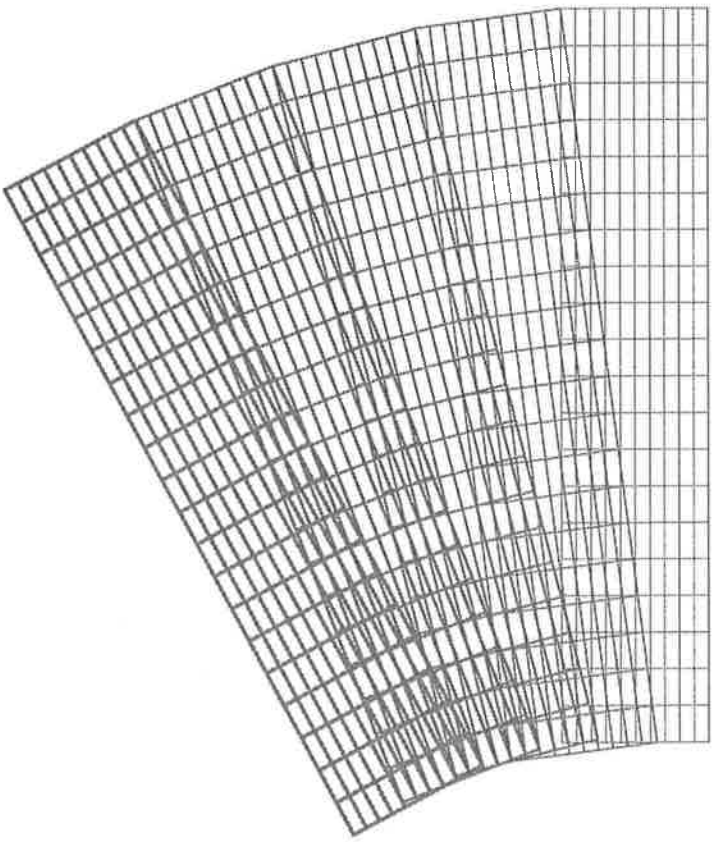


Figure 1 - Reinforced Slope Design

Side Slope to End Slope  
Geogrid Transition



Geogrid Overlap

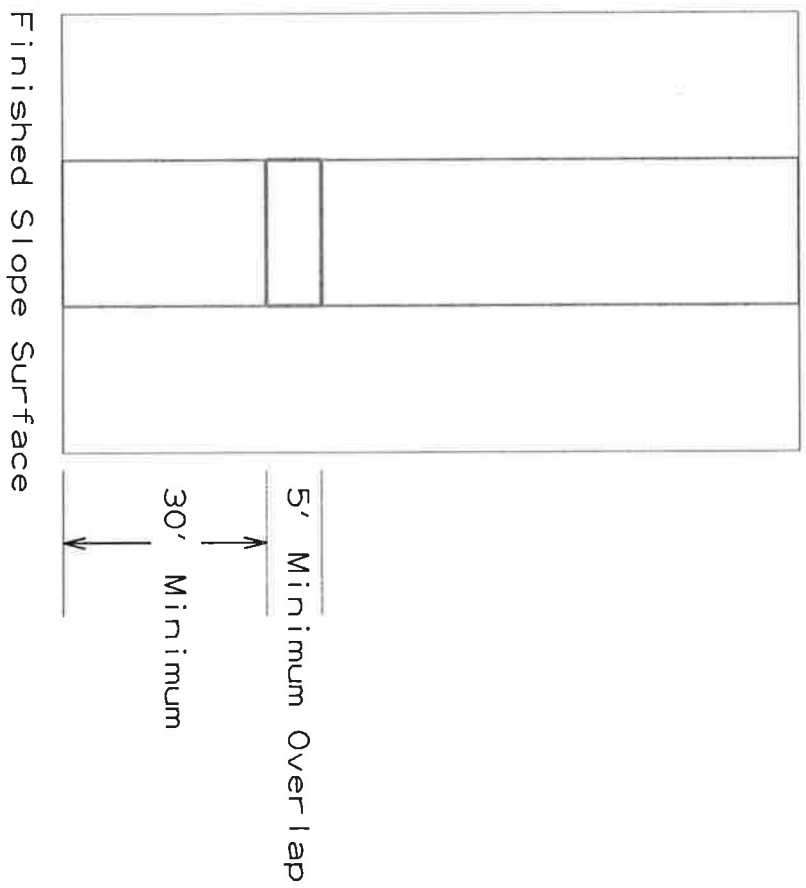


Figure 2 - Geogrid Special Details



## GEOLOGY AND SITE CONDITIONS

Job No. BR1610

Burlington Northern Santa Fe Railway (Bono) (S)

Craighead County

County Road 27 (CCR 352)

### **Site Conditions**

The proposed structure is an overpass for the Burlington Northern Santa Fe Railway on a new alignment. The new alignment crosses a moderately to heavily wooded area connecting Gainesville Road (CCR 352) to Jacksonport Road (CCR 353). A residence is located to the north of the east end of the proposed overpass. Overhead power lines parallel the west side of CCR 353 at the proposed intersection of CCR 352 and CCR 353.

### **Site Geology**

The overpass alignment is located on the mapped deposits of Quaternary silt and sand deposits (map symbol Qss). The silt and sand deposits include lenses of gravel. The silt and sand deposits are underlain by sands and clays of the Paleogene Wilcox Group. The borings encountered Wilcox deposits at depths varying from 25 to 45 feet below ground level.

#### Subsurface Conditions:

Based on the results of the borings, the subsurface stratigraphy may be generalized as follows:

- 0 to 45 Feet: Varies from dry to wet, stiff to very hard, brown and gray **clay to clay with sand** to medium dense to very dense, brown **sandy silt to sand with gravel and cobbles**. Some samples from this zone contain organic matter.
- 45 to 101.5 Feet: Varies from moist to wet, very stiff to very hard, brown and gray **silty clay to clay with sand** to medium dense to very dense, brown to gray silt to clayey **sand**.

# Lab Test Summary

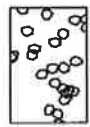
Project: BR1610

| Station | Location | Depth<br>(ft) | Plastic<br>Limit | Liquid<br>Limit | Plasticity<br>Index | % Passing<br>No. 200 |
|---------|----------|---------------|------------------|-----------------|---------------------|----------------------|
| 114+76  | 24' RT   | 4.4           | 18               | 34              | 16                  | 100                  |
| 114+76  | 24' RT   | 9.4           | 21               | 30              | 9                   | 99                   |
| 114+76  | 24' RT   | 15.0          | 22               | 28              | 6                   | 99                   |
| 114+76  | 24' RT   | 20.0          | 22               | 28              | 6                   | 99                   |
| 114+76  | 24' RT   | 25.0          | 16               | 36              | 20                  | 92                   |
| 114+76  | 24' RT   | 30.0          | NP               |                 |                     | 14                   |
| 114+76  | 24' RT   | 35.0          | NP               |                 |                     | 19                   |
| 114+76  | 24' RT   | 40.0          | NP               |                 |                     | 81                   |
| 114+76  | 24' RT   | 45.0          | 15               | 22              | 7                   | 88                   |
| 114+76  | 24' RT   | 50.0          | NP               |                 |                     | 73                   |
| 114+76  | 24' RT   | 55.0          | NP               |                 |                     | 62                   |
| 114+76  | 24' RT   | 60.0          | NP               |                 |                     | 70                   |
| 114+76  | 24' RT   | 65.0          | NP               |                 |                     | 25                   |
| 114+76  | 24' RT   | 70.0          | 14               | 19              | 5                   | 95                   |
| 114+76  | 24' RT   | 75.0          | NP               |                 |                     | 19                   |
| 114+76  | 24' RT   | 80.0          | NP               |                 |                     | 12                   |
| 114+76  | 24' RT   | 85.0          | NP               |                 |                     | 30                   |
| 114+76  | 24' RT   | 90.0          | NP               |                 |                     | 83                   |
| 114+76  | 24' RT   | 95.0          | NP               |                 |                     | 12                   |
| 114+76  | 24' RT   | 100.0         | NP               |                 |                     | 19                   |

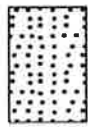
# LEGEND

## SOIL TYPES

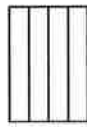
( SHOWN IN SYMBOL COLUMN )  
( PREDOMINANT TYPE SHOWN HEAVY )



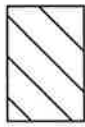
GRAVEL



SAND



SILT



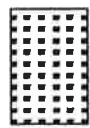
CLAY



ORGANIC  
MATTER

## ROCK TYPES

( SHOWN IN SYMBOL COLUMN )



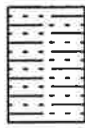
SANDSTONE



SHALE  
or  
SILTSTONE



LIMESTONE  
or  
DOLOMITE



ALTERNATING  
LAYERS of  
SHALE and  
SANDSTONE



OTHER

## SAMPLER TYPES

( SHOWN IN SAMPLE COLUMN )

### SHELBY TUBE



UNDISTURBED  
SAMPLE  
RECOVERY

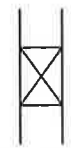


DISTURBED  
SAMPLE  
RECOVERY

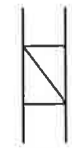


NO  
RECOVERY

### SPLIT SPOON

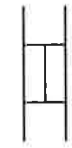


SAMPLE  
RECOVERY



NO  
RECOVERY

### ROCK CORING



% RECOVERY  
INDICATED ON LOGS

## TERMS DESCRIBING CONSISTENCY OR CONDITION

| GRANULAR SOIL |              | CLAY      |              | CLAY-SHALE |              | SHALE  |             |
|---------------|--------------|-----------|--------------|------------|--------------|--|-------------|
| *N' Value     | Density      | *N' Value | Consistency  | *N' Value  | Consistency  | *N' Value  | Consistency |
| 0-4           | Very Loose   | 0-1       | Very Soft    | 0-1        | Very Soft    | 31-60 Soft<br>Over 60<br>More than 2'<br>Penetration<br>in 60 Blows Medium Hard<br>Less than 2'<br>Penetration<br>in 60 Blows Hard |             |
| 5-10          | Loose        | 2-4       | Soft         | 2-4        | Soft         |  |             |
| 11-30         | Medium Dense | 5-8       | Medium Stiff | 5-8        | Medium Stiff |  |             |
| 31-50         | Dense        | 9-15      | Stiff        | 9-15       | Stiff        |  |             |
| Over 50       | Very Dense   | 16-30     | Very Stiff   | 16-30      | Very Stiff   |  |             |
|               |              | 31-60     | Hard         | 31-60      | Hard         |  |             |
|               |              | Over 60   | Very Hard    | Over 60    | Very Hard    |  |             |

1. Ground water elevations indicated on boring logs represent ground water elevations at date or time shown on boring log. Absence of water surface implies that no ground water data is available but does not necessarily mean that ground water will not be encountered at locations or within the vertical reaches of these borings.
2. Borings represent subsurface conditions at their respective locations for their respective depths. Variations in conditions between or adjacent to boring locations may be encountered.
3. Terms used for describing soils according to their texture or grain size distribution are in accordance with the Unified Soil Classification System.

Standard Penetration Test – Driving a 2.0” O.D., 1-3/8” I.D. sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30 inches. It is customary to drive the spoon 6.0 inches to seat into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and performing the test are recorded for each 6 inches of penetration on the drill log. The field “N” Value ( $N_f$ ) can be obtained by

adding the bottom two numbers for example:  $\frac{6}{8-9} \Rightarrow 8 + 9 = 17 \text{ blows / ft}$ . The “N” Value corrected to 60%

efficiency ( $N_{60}$ ) can be obtained by multiplying  $N_f$  by the hammer correction factor published on the boring log.

**ARKANSAS HWY. & TRANS. DEPARTMENT  
MATERIALS DIVISION - GEOTECHNICAL SEC.**

BORING NO. 1  
PAGE 1 OF 3

JOB NO. BR1610 Craighead County  
JOB NAME: Burlington Northern Santa Fe Railway (Bono)  
County Road No. 27  
STATION: 114+76  
LOCATION: 24' Right of Center Line of Construction  
LOGGED BY: Donnie Thornton

DATE: October 22-23, 2013  
TYPE OF DRILLING: Rotary Wash  
EQUIPMENT: CME 850 w/ CME Automatic Hammer  
HAMMER CORRECTION FACTOR: 1.23

COMPLETION DEPTH: 100.3

| DEPTH<br>FT. | SYMBOL | SAMPLES | DESCRIPTION OF MATERIAL  | SOIL GROUP | PLASTIC LIMIT | % MOIST. | LIQUID LIMIT | DRY WEIGHT | LBS PER CU.FT. | NO. OF BLOWS PER 6-IN. | % S C R | % R Q D |
|--------------|--------|---------|--|------------|---------------|----------|--------------|------------|----------------|------------------------|---------|---------|
|              |        |         | SURFACE ELEVATION: 336.1   |            |               |          |              |            |                |                        |         |         |
| 5            |        | X       | Moist, Stiff, Reddish Brown Clay                                       | CL         | 18            |          | 34           |            |                | $\frac{3}{5-6}$        |         |         |
|              |        |         |  | -          |               |          |              |            |                |                        |         |         |
| 10           |        | X       | Moist, Medium Stiff, Reddish Brown Silty Clay with some Organic Matter | CL         | 21            |          | 30           |            |                | $\frac{2}{4-5}$        |         |         |
|              |        |         |  | -          |               |          |              |            |                |                        |         |         |
| 15           |        | X       | Moist, Medium Stiff, Reddish Brown Silty Clay with some Organic Matter | CL-ML      | 22            |          | 28           |            |                | $\frac{3}{4-4}$        |         |         |
|              |        |         |  | -          |               |          |              |            |                |                        |         |         |
| 20           |        | X       | Moist, Medium Stiff, Brown Silty Clay                                  | CL-ML      | 22            |          | 28           |            |                | $\frac{2}{2-3}$        |         |         |
|              |        |         |  | -          |               |          |              |            |                |                        |         |         |
| 25           |        | X       | Moist, Stiff, Brown Clay   | CL         | 16            |          | 36           |            |                | $\frac{3}{4-6}$        |         |         |
|              |        |         |  | -          |               |          |              |            |                |                        |         |         |
| 30           |        | X       | Wet, Very Dense, Brown Silty Sand with Gravel                          | SM         | NP            |          |              |            |                | $\frac{25}{64-33}$     |         |         |
|              |        |         |  | -          |               |          |              |            |                |                        |         |         |
| 35           |        |         |  |            |               |          |              |            |                |                        |         |         |

REMARKS: Hollow stem augers were utilized to a depth of 9.4'.

**ARKANSAS HWY. & TRANS. DEPARTMENT  
MATERIALS DIVISION - GEOTECHNICAL SEC.**

BORING NO. 1  
PAGE 2 OF 3

JOB NO. BR1610 Craighead County  
JOB NAME: Burlington Northern Santa Fe Railway (Bono)  
County Road No. 27  
STATION: 114+76  
LOCATION: 24' Right of Center Line of Construction  
LOGGED BY: Donnie Thornton

DATE: October 22-23, 2013  
TYPE OF DRILLING: Rotary Wash  
EQUIPMENT: CME 850 w/ CME Automatic Hammer  
HAMMER CORRECTION FACTOR: 1.23

COMPLETION DEPTH: 100.3

| DEPTH<br>FT. | SYMBOL | SAMPLES | DESCRIPTION OF MATERIAL   | SOIL GROUP | PLASTIC LIMIT | % MOIST. | LIQUID LIMIT | DRY WEIGHT | LBS PER CU.FT. | NO. OF BLOWS PER 6-IN. | % S C R | % R Q D |
|--------------|--------|---------|---|------------|---------------|----------|--------------|------------|----------------|------------------------|---------|---------|
|              |        |         | SURFACE ELEVATION: 336.1  |            |               |          |              |            |                |                        |         |         |
| 40           |        | X       | Wet, Medium Dense, Brown Silty Sand                                       | SM         | NP            |          |              |            |                | 8<br>12-16             |         |         |
| 45           |        | X       | Wet, Dense, Brown Silt with Sand  | ML         | NP            |          |              |            |                | 10<br>15-21            |         |         |
| 50           |        | X       | Moist, Very Stiff, Brown and Gray Clay with Silt Seams and Organic Matter | CL-ML      | 15            |          | 22           |            |                | 10<br>12-18            |         |         |
| 55           |        | X       | Moist, Dense, Gray Silt with Sand   | ML         | NP            |          |              |            |                | 13<br>16-25            |         |         |
| 60           |        | X       | Wet, Very Dense, Gray Sandy Silt  | ML         | NP            |          |              |            |                | 18<br>20-60<br>(5")    |         |         |
| 65           |        | X       | Wet, Very Dense, Brown and Gray Sandy Silt with Trace of Organic Matter   | ML         | NP            |          |              |            |                | 9<br>18-40             |         |         |
| 70           |        | X       | Wet, Very Dense, Gray Silty Sand  | SM         | NP            |          |              |            |                | 44<br>60<br>(2")       |         |         |

REMARKS: Hollow stem augers were utilized to a depth of 9.4'.

**ARKANSAS HWY. & TRANS. DEPARTMENT  
MATERIALS DIVISION - GEOTECHNICAL SEC.**

BORING NO. 1  
PAGE 3 OF 3

JOB NO. BR1610 Craighead County  
JOB NAME: Burlington Northern Santa Fe Railway (Bono)  
County Road No. 27  
STATION: 114+76  
LOCATION: 24' Right of Center Line of Construction  
LOGGED BY: Donnie Thornton

DATE: October 22-23, 2013  
TYPE OF DRILLING: Rotary Wash  
EQUIPMENT: CME 850 w/ CME  
Automatic Hammer  
HAMMER CORRECTION FACTOR: 1.23

COMPLETION DEPTH: 100.3

| DEPTH<br>FT. | SYMBOL | SAMPLES | DESCRIPTION OF MATERIAL                                | SOIL<br>GROUP | PLASTIC<br>LIMIT | % MOIST. | LIQUID<br>LIMIT | DRY WEIGHT | LBS PER CU.FT. | NO. OF BLOWS<br>PER 6-IN. | %<br>S<br>C<br>R | %<br>R<br>Q<br>D |
|--------------|--------|---------|--|---------------|------------------|----------|-----------------|------------|----------------|---------------------------|------------------|------------------|
|              |        |         | SURFACE ELEVATION: 336.1                               |               |                  |          |                 |            |                |                           |                  |                  |
| 75           |        |         | Moist, Very Stiff, Gray and Brown Silty Clay           | CL-ML         | 14               |          | 19              |            |                | 7<br>6-19                 |                  |                  |
|              |        |         | Wet, Very Dense, Gray Silty Sand                       | SM            | NP               |          |                 |            |                | 60<br>(3")                |                  |                  |
|              |        |         | Wet, Very Dense, Gray Sand with Gravel                 |               |                  |          |                 |            |                |                           |                  |                  |
| 80           |        |         | Wet, Very Dense, Gray Sand with Silt                   | SW-SM         | NP               |          |                 |            |                | 60<br>(2")                |                  |                  |
| 85           |        |         | Wet, Very Dense, Reddish Brown to Gray Silty Sand      | SM            | NP               |          |                 |            |                | 60<br>(6")                |                  |                  |
| 90           |        |         | Moist, Very Dense, Gray Silt with Sand                 | ML            | NP               |          |                 |            |                | 37<br>60<br>(4")          |                  |                  |
| 95           |        |         | Wet, Very Dense, Brown and Gray to Gray Sand with Silt | SW-SM         | NP               |          |                 |            |                | 60<br>(2")                |                  |                  |
| 100          |        |         | Wet, Very Dense, Gray Silty Sand                       | SM            | NP               |          |                 |            |                | 60<br>(4")                |                  |                  |
|              |        |         | Boring Terminated                                      |               |                  |          |                 |            |                |                           |                  |                  |
| 105          |        |         |  |               |                  |          |                 |            |                |                           |                  |                  |

REMARKS: Hollow stem augers were utilized to a depth of 9.4'.

**ARKANSAS HWY. & TRANS. DEPARTMENT  
MATERIALS DIVISION - GEOTECHNICAL SEC.**

BORING NO. 2  
PAGE 1 OF 3

JOB NO. BR1610 Craighead County  
JOB NAME: Burlington Northern Santa Fe Railway (Bono)  
County Road No. 27  
STATION: 115+98  
LOCATION: Center Line of Construction  
LOGGED BY: Paul Christenberry

DATE: October 28-29, 2013  
TYPE OF DRILLING: Rotary Wash  
EQUIPMENT: CME 850 w/ CME  
Automatic Hammer  
HAMMER CORRECTION FACTOR: 1.23

COMPLETION DEPTH: 101.5

| DEPTH<br>FT. | SYMBOL | SAMPLES | DESCRIPTION OF MATERIAL   | SOIL GROUP | PLASTIC LIMIT | % MOIST. | LIQUID LIMIT | DRY WEIGHT | LBS PER CU.FT. | NO. OF BLOWS PER 6-IN. | % S C R | % R Q D |
|--------------|--------|---------|---|------------|---------------|----------|--------------|------------|----------------|------------------------|---------|---------|
|              |        |         |   |            |               |          |              |            |                |                        |         |         |
|              |        |         | SURFACE ELEVATION: 317.6  |            |               |          |              |            |                |                        |         |         |
| 5            |        |         | Moist, Stiff, Brown Silty Clay                                  |            |               |          |              |            |                | 4<br>5-5               |         |         |
| 10           |        |         | Moist, Very Stiff, Reddish Brown to Brown Clay with some Gravel |            |               |          |              |            |                | 7<br>8-11              |         |         |
| 15           |        |         | Wet, Medium Dense, Light Brown Sand, Gravel and Cobbles         |            |               |          |              |            |                | 7<br>10-11             |         |         |
| 20           |        |         | Wet, Medium Dense, Light Gray Sandy Silt                        |            |               |          |              |            |                | 7<br>12-16             |         |         |
| 25           |        |         | Moist, Very Hard, Gray Clay with Sand                           |            |               |          |              |            |                | 17<br>38-62<br>(5")    |         |         |
| 30           |        |         | Wet, Very Dense, Brown and Gray Silty, Clayey Sand              |            |               |          |              |            |                | 20<br>28-53            |         |         |
| 35           |        |         |   |            |               |          |              |            |                |                        |         |         |

REMARKS: Hollow stem augers were utilized to a depth of 9.6'.

**ARKANSAS HWY. & TRANS. DEPARTMENT  
MATERIALS DIVISION - GEOTECHNICAL SEC.**

BORING NO. 2  
PAGE 2 OF 3

JOB NO. BR1610 Craighead County  
JOB NAME: Burlington Northern Santa Fe Railway (Bono)  
County Road No. 27  
STATION: 115+98  
LOCATION: Center Line of Construction  
LOGGED BY: Paul Christenberry

DATE: October 28-29, 2013  
TYPE OF DRILLING: Rotary Wash  
EQUIPMENT: CME 850 w/ CME  
Automatic Hammer  
HAMMER CORRECTION FACTOR: 1.23

COMPLETION DEPTH: 101.5

| DEPTH<br>FT. | SYMBOL | SAMPLES | DESCRIPTION OF MATERIAL                               | SOIL<br>GROUP | PLASTIC<br>LIMIT | % MOIST. | LIQUID<br>LIMIT | DRY WEIGHT | LBS PER CU.FT. | NO. OF BLOWS<br>PER 6-IN. | %<br>S<br>C<br>R | %<br>R<br>Q<br>D |
|--------------|--------|---------|---|---------------|------------------|----------|-----------------|------------|----------------|---------------------------|------------------|------------------|
|              |        |         | SURFACE ELEVATION: 317.6                              |               |                  |          |                 |            |                |                           |                  |                  |
|              |        | X       | Moist, Hard, Brown and Gray Sandy Clay                |               |                  |          |                 |            |                | 7<br>22-30                |                  |                  |
| 40           |        | X       | Moist, Very Dense, Gray Sand with Silt                |               |                  |          |                 |            |                | 45<br>28-44               |                  |                  |
| 45           |        | X       | Moist, Very Hard, Gray and Brown Clay with Sand Seams |               |                  |          |                 |            |                | 16<br>23-39               |                  |                  |
| 50           |        | X       | Moist, Hard, Gray Clay with Sand                      |               |                  |          |                 |            |                | 8<br>16-23                |                  |                  |
| 55           |        | X       | Moist, Very Hard, Gray Clay with Light Gray Sand      |               |                  |          |                 |            |                | 4<br>10-78                |                  |                  |
| 60           |        | X       | Moist, Very Dense, Light Gray Sand with Clay          |               |                  |          |                 |            |                | 10<br>(.01")              |                  |                  |
| 65           |        | X       |   |               |                  |          |                 |            |                | 60<br>(5.5")              |                  |                  |
| 70           |        |         |   |               |                  |          |                 |            |                |                           |                  |                  |

REMARKS: Hollow stem augers were utilized to a depth of 9.6'.



**ARKANSAS HWY. & TRANS. DEPARTMENT  
MATERIALS DIVISION - GEOTECHNICAL SEC.**

BORING NO. 2  
PAGE 3 OF 3

JOB NO. BR1610 Craighead County  
JOB NAME: Burlington Northern Santa Fe Railway (Bono)  
County Road No. 27  
STATION: 115+98  
LOCATION: Center Line of Construction  
LOGGED BY: Paul Christenberry

DATE: October 28-29, 2013  
TYPE OF DRILLING: Rotary Wash  
EQUIPMENT: CME 850 w/ CME  
Automatic Hammer  
HAMMER CORRECTION FACTOR: 1.23

COMPLETION DEPTH: 101.5

| DEPTH<br>FT. | SYMBOL | SAMPLES | DESCRIPTION OF MATERIAL   | SOIL<br>GROUP | PLASTIC<br>LIMIT | % MOIST. | LIQUID<br>LIMIT | DRY WEIGHT | LBS PER CU.FT. | NO. OF BLOWS<br>PER 6-IN. | %<br>S<br>C<br>R | %<br>R<br>Q<br>D |
|--------------|--------|---------|---|---------------|------------------|----------|-----------------|------------|----------------|---------------------------|------------------|------------------|
|              |        |         |   |               |                  |          |                 |            |                |                           |                  |                  |
| 75           |        |         | Moist, Hard, Light Gray Sandy, Silty Clay with Trace of Lignite |               |                  |          |                 |            |                | 10<br>17-43               |                  |                  |
| 80           |        |         | Moist, Very Dense, Light Gray Sandy Silt                        |               |                  |          |                 |            |                | 12<br>22-60<br>(3")       |                  |                  |
| 85           |        |         | Moist, Very Dense, Light Gray Silty Sand                        |               |                  |          |                 |            |                | 52<br>48<br>(3")          |                  |                  |
| 90           |        |         | Moist, Very Hard, Light Gray Clay with Sand                     |               |                  |          |                 |            |                | 30<br>42<br>(2")          |                  |                  |
| 95           |        |         | Wet, Very Dense, Light Gray Silty Sand                          |               |                  |          |                 |            |                | 15<br>26-51               |                  |                  |
| 100          |        |         | Moist, Hard, Reddish Brown and Light Gray Sandy Clay            |               |                  |          |                 |            |                | 4<br>14-21                |                  |                  |
|              |        |         | Moist, Very Stiff, Dark Gray Clay with Trace of Lignite         |               |                  |          |                 |            |                | 7<br>11-15                |                  |                  |
|              |        |         | Boring Terminated   |               |                  |          |                 |            |                |                           |                  |                  |
| 105          |        |         |   |               |                  |          |                 |            |                |                           |                  |                  |

REMARKS: Hollow stem augers were utilized to a depth of 9.6'.

**ARKANSAS HWY. & TRANS. DEPARTMENT  
MATERIALS DIVISION - GEOTECHNICAL SEC.**

BORING NO. 3  
PAGE 1 OF 3

JOB NO. BR1610 Craighead County  
JOB NAME: Burlington Northern Santa Fe Railway (Bono)  
County Road No. 27  
STATION: 118+20  
LOCATION: Center Line of Construction  
LOGGED BY: Stanley Bates

DATE: October 20, 2014  
TYPE OF DRILLING: Rotary Wash  
EQUIPMENT: CME 750 w/ CME  
Automatic Hammer  
HAMMER CORRECTION FACTOR: 1.23

COMPLETION DEPTH: 100.2

| DEPTH<br>FT. | SYMBOL | SAMPLES | DESCRIPTION OF MATERIAL                                 | SOIL GROUP | PLASTIC LIMIT | % MOIST. | LIQUID LIMIT | DRY WEIGHT | LBS PER CU. FT. | NO. OF BLOWS PER 6-IN. | % S C R | % R Q D |
|--------------|--------|---------|---|------------|---------------|----------|--------------|------------|-----------------|------------------------|---------|---------|
|              |        |         |   |            |               |          |              |            |                 |                        |         |         |
|              |        |         | SURFACE ELEVATION: 341.7                                |            |               |          |              |            |                 |                        |         |         |
| 5            |        | X       | Dry, Hard, Brown Clay with Sand and some Organic Matter |            |               |          |              |            |                 | 16<br>24-35            |         |         |
| 10           |        | X       | Dry, Hard, Brown Clay with Sand                         |            |               |          |              |            |                 | 13<br>19-21            |         |         |
| 15           |        | X       | Moist, Very Dense, Brown Sandy Silt                     |            |               |          |              |            |                 | 24<br>35-34            |         |         |
| 20           |        | X       | Moist, Dense, Brown Sandy Silt                          |            |               |          |              |            |                 | 19<br>15-16            |         |         |
| 25           |        | X       | Moist, Medium Dense, Brown Sandy Silt                   |            |               |          |              |            |                 | 4<br>5-6               |         |         |
| 30           |        | X       | Moist, Medium Dense, Brown Silt                         |            |               |          |              |            |                 | 4<br>5-7               |         |         |
| 35           |        |         |   |            |               |          |              |            |                 |                        |         |         |

REMARKS: Hollow stem augers were utilized to a depth of 9.5'.

**ARKANSAS HWY. & TRANS. DEPARTMENT  
MATERIALS DIVISION - GEOTECHNICAL SEC.**

BORING NO. 3  
PAGE 2 OF 3

JOB NO. BR1610 Craighead County  
JOB NAME: Burlington Northern Santa Fe Railway (Bono)  
County Road No. 27  
STATION: 118+20  
LOCATION: Center Line of Construction  
LOGGED BY: Stanley Bates

DATE: October 20, 2014  
TYPE OF DRILLING: Rotary Wash  
EQUIPMENT: CME 750 w/ CME Automatic Hammer  
HAMMER CORRECTION FACTOR: 1.23

COMPLETION DEPTH: 100.2

| DEPTH<br>FT. | SYMBOL | SAMPLES | DESCRIPTION OF MATERIAL                                 | SOIL GROUP | PLASTIC LIMIT | % MOIST. | LIQUID LIMIT | DRY WEIGHT | LBS PER CU.FT. | NO. OF BLOWS PER 6-IN. | % S C R | % R Q D |
|--------------|--------|---------|---|------------|---------------|----------|--------------|------------|----------------|------------------------|---------|---------|
|              |        |         |   |            |               |          |              |            |                |                        |         |         |
|              |        |         | SURFACE ELEVATION: 341.7                                |            |               |          |              |            |                |                        |         |         |
| 40           |        |         | Moist, Very Hard, Brown Silty Clay with Trace of Gravel |            |               |          |              |            |                | 11<br>27-37            |         |         |
| 45           |        |         | Moist, Medium Dense, Gray Silt with Trace of Gravel     |            |               |          |              |            |                | 9<br>9-11              |         |         |
| 50           |        |         | Moist, Very Dense, Gray Silt with Sand                  |            |               |          |              |            |                | 10<br>60<br>(2")       |         |         |
| 55           |        |         | Moist, Very Dense, Gray Silty Sand                      |            |               |          |              |            |                | 36<br>36<br>(2")       |         |         |
| 60           |        |         | Moist, Very Dense, Gray Silt                            |            |               |          |              |            |                | 19<br>50-50<br>(2")    |         |         |
| 65           |        |         | Moist, Very Dense, Gray Silt                            |            |               |          |              |            |                | 12<br>24-60            |         |         |
| 70           |        |         | Moist, Hard, Brown and Gray Silty Clay                  |            |               |          |              |            |                | 9<br>19-40             |         |         |

REMARKS: Hollow stem augers were utilized to a depth of 9.5'.



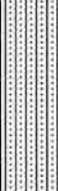



**ARKANSAS HWY. & TRANS. DEPARTMENT  
MATERIALS DIVISION - GEOTECHNICAL SEC.**

BORING NO. 3  
PAGE 3 OF 3

JOB NO. BR1610 Craighead County  
JOB NAME: Burlington Northern Santa Fe Railway (Bono)  
County Road No. 27  
STATION: 118+20  
LOCATION: Center Line of Construction  
LOGGED BY: Stanley Bates

DATE: October 20, 2014  
TYPE OF DRILLING: Rotary Wash  
EQUIPMENT: CME 750 w/ CME  
Automatic Hammer  
HAMMER CORRECTION FACTOR: 1.23

COMPLETION DEPTH: 100.2

| DEPTH<br>FT. | SYMBOL  | SAMPLES | DESCRIPTION OF MATERIAL  | SOIL<br>GROUP | PLASTIC<br>LIMIT | % MOIST. | LIQUID<br>LIMIT | DRY WEIGHT | LBS PER CU.FT. | NO. OF BLOWS<br>PER 6-IN. | %<br>S<br>C<br>R | %<br>R<br>Q<br>D |
|--------------|---|---------|--|---------------|------------------|----------|-----------------|------------|----------------|---------------------------|------------------|------------------|
|              |   |         | SURFACE ELEVATION: 341.7   |               |                  |          |                 |            |                |                           |                  |                  |
| 75           |    | X       | Moist, Very Hard, Light Brown and Gray Silty Clay with some Organic Matter |               |                  |          |                 |            |                | 17<br>29-47               |                  |                  |
| 80           |    | X       |  |               |                  |          |                 |            |                | 24<br>60<br>(3")          |                  |                  |
| 85           |   | X       | Moist, Very Dense, Gray Silty Sand   |               |                  |          |                 |            |                | 60<br>(3")                |                  |                  |
| 90           |  | X       |  |               |                  |          |                 |            |                | 60<br>(4")                |                  |                  |
| 95           |  | X       | Wet, Very Dense, Gray Clayey Sand  |               |                  |          |                 |            |                | 31<br>60-40<br>(1")       |                  |                  |
| 100          |  | X       | Wet, Very Dense, Gray Silty Sand<br>Boring Terminated                      |               |                  |          |                 |            |                | 60<br>(2")                |                  |                  |
| 105          |   |         |  |               |                  |          |                 |            |                |                           |                  |                  |

REMARKS: Hollow stem augers were utilized to a depth of 9.5'.