

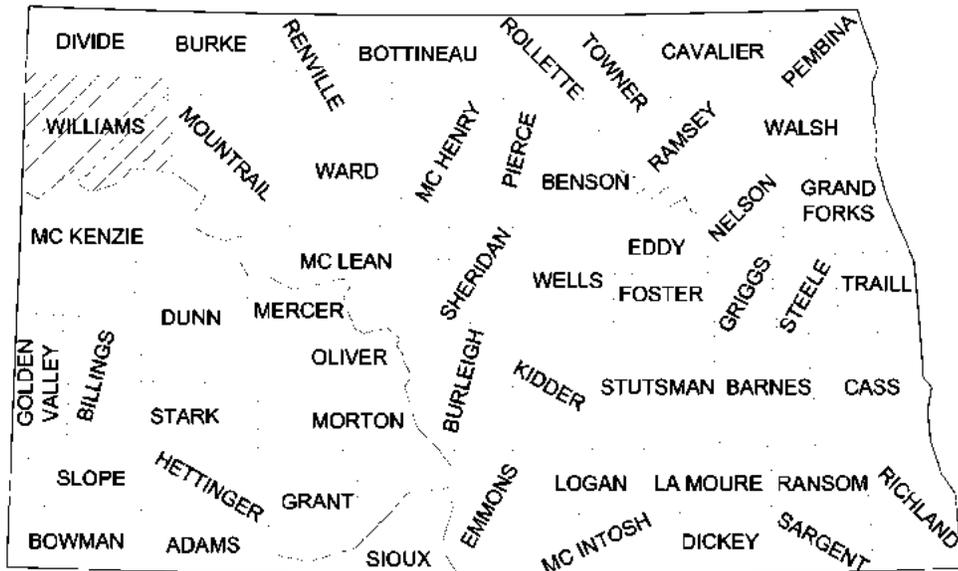
PHASE I LINEAR SOIL SURVEY AND RECOMMENDATIONS

PROJECT NO. 7-804(055)304

PCN 20891

COUNTY WILLIAMS

Highway 1804 RP 312.661 to RP 316.686



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NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

JANUARY 2016

SS-7-804(055)304

From CO RD 42 to Temp NE TRR

CERTIFICATION

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly registered professional engineer under the laws of the State of North Dakota. This document was originally issued and sealed by Steven Weisenberger, Registration number 6115 PE on 1-8-15 and the original document is stored at the North Dakota Department of Transportation.





Steve Weisenberger, P.E.

1-8-15

Date

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1.0 INTRODUCTION

This report is presented in accordance with DOWL's contract with North Dakota Department of Transportation (NDDOT) to provide geotechnical services for the 1804 Reconstruction project. This report covers work associated with the Phase I alignment area located between stations 16508+50 and 16721+00 (21,250 feet). The scope for work for this phase includes:

- Linear Soil Survey Report;
 - Includes definition of underground mine workings within the ROW
 - Includes definition of soils in widening areas based on boring information
- Slope Stability Report;
- Foundation Recommendations Report for Stoney Creek Bridge.

Pavement section design will be performed by NDDOT.

Currently borings have been advanced along the entire 12 mile alignment for the linear soil survey. This report presents laboratory test data and analysis associated with the Phase I construction area which begins at (RP) 312.661 and terminates at RP 316.686 with Stationing ranging from 16508+50 to 16721+00 (approximately 4 miles) only. Testing is ongoing for the linear soil survey borings conducted along the Phase II portion of the alignment and will be presented in a supplemental report upon completion of the testing. Additional investigations may be conducted at cut fill/widen areas and potential borrow areas (if needed) along the phase II portion of the alignment. Additional supplemental reports will be provided as the phase II portion of the project progresses.

The purpose of this report is to present the results of the linear soil survey along the Phase 1 portion of the alignment, stability analysis at cut slope areas, results of the geophysical investigation to identify subsurface mine workings and foundation recommendations pertinent to the reconstruction of Stony Creek bridge crossing. This report includes a description of area geology, summaries of field investigation and lab testing and presents findings and recommendations pertinent to the project development.

1.1 PROJECT BACKGROUND

Project Location

The reconstruction project will consist of two Phases; The Phase 1 Project reconstruction area is located on North Dakota State Highway 1804, in Williams County, in Township 154 North, Range 100 West, Sections 14, 15, 19, 20, 21, 22, and 23 (See Figure 1). The Phase 1 portion of the project begins at Reference Point (RP) 312.661 and terminates at RP 316.686 with Stationing

ranging from 16508+50 to 16721+00 (+/-4 miles). The future Phase II reconstruction portion of the alignment will extend from Station 16508+50 (RP 312.661) east to station 16102+00 RP 304.96)(+/-7.7 miles). The project traverses mainly rolling terrain used primarily for dryland farming and petroleum development. There are also industrial and residential developments throughout the corridor with bridge crossings over an existing railroad tracks and Stony Creek (NDDOT Bridge #1804-315-641).

Proposed Project Improvements

The project consists of an approximate 4 mile (21,250 feet) section of ND 1804 just east of Williston, ND. The proposed improvements include:

- Roadway Widening
- Roadbed restoration
- Resurfacing
- Traffic operations improvements
- Access modifications
- Possible building relocations
- Bridge replacement
- Improve highway geometrics and capacity.

2.0 SITE INVESTIGATION

The site investigation included review of existing geotechnical and geologic information, site reconnaissance and subsurface exploration program. The field exploration program consisted of a reconnaissance of the project alignment and subsurface exploration. The visual reconnaissance included observation of surface conditions such as apparent geologic hazards, drainage conditions, and performance of existing roadways and related structures.

2.1 DOCUMENT REVIEW

The geotechnical document review included a review of pertinent documents provided for the project. There was no previous information available for the general alignment area. The following documents were reviewed:

- Boring logs for Stony Creek crossing and B.N.R.R. overpass;
- Foundation Report for Stony Creek Crossing, PN HES-7-804(P1)315 November 13, 1985;
- Pile driving records for Stony Creek Bridge, dated April 29, 1987;
- Construction plans for Stony Creek Bridge, project No. 804-315.641
- Little Muddy River Bridge Foundation Report, Memo from Materials and Research - Project No. BRF-7-801() 316 February 1, 1980
- Geologic Map of Williams County, North Dakota, Plate 1, Bulletin 48

2.2 SITE RECONNAISSANCE

The site reconnaissance consisted of a meeting with North Dakota Road Maintenance personnel at the District office in Williston. A general site alignment walkover was conducted while staking boring locations. DOWL Geotechnical Engineers Greg Underhill and David Barrick met with Mr. Ed Nelson and others and discussed any ongoing subgrade or other problem areas along the alignment. According to Ed the only area that exhibited subgrade problems was the alignment between Stony Creek Bridge and the BNSF railroad overpass. This area has required over digs and patching over the years. The typical repair was to over dig 1.5 to 2 feet below existing pavement, replace with road mix and patch. Numerous patched areas along this alignment are evident. According to Ed, the existing surfacing section in this area is typically 4 inches HBP with a 2-inch overlay overlaying and varying thicknesses of road base.

The visual reconnaissance while staking boring location included observation of roadway surfacing conditions, observations in regard to apparent geologic hazards (landslides or subsidence), site drainage conditions and current stability of cut and fill slopes. The maintenance review consisted primarily of conversations with Ed Nelson in regard to any problem areas. SNF forms 60472 were not filled out during the staking of boring locations or drilling. General observations indicated that the overall pavement conditions were good to excellent along the alignment with the exception of that portion between Stony Creek Bridge and the BNSF railroad overpass which has required digouts and asphalt patches over the years.

2.3 SUBSURFACE EXPLORATION

DOWL advanced 29 borings along the project alignment during October 14 to October 22, 2015. The drilling program was conducted in one phase. Photographs were taken of the boring locations and are presented in Appendix F. The borings were advanced utilizing a Diedrich D-50 rubber tired drill rig equipped with hollow-stem augers and automatic hammer. Twenty-three borings were advanced for the ND 1804 Phase 1 linear soil survey and one (B-100) boring was advanced at the 132nd Road NW intersection with ND 1804. Six borings (B-19, B-20, B-21, B-76, B-79, and B-103) were advanced to evaluate two proposed cut sections. Two borings (B-63 and B-64) were advanced to evaluate subsurface conditions at the Stony Creek Bridge. The borings were advanced to depths ranging from 4.9 to 104.5 feet. The borings were located in the field by handheld GPS and Survey. Table 1 presents a summary of the boring locations. Boring locations are also shown on the Site Vicinity Map (see figure 1) and the Plan and Profile sheets presented in Appendix A. It is noted that the profiles shown on the sheets are preliminary and may change as the design progresses.

Table 1				
Geotechnical Boring Locations				
ND 1804 Reconstruction – Phase I				
Boring Number	Station	Offset	Elevation (feet)	Boring Depth (feet)
B-1	16720+35	20' Right	1,863.8	6.0
B-1A	16715+40	20' Left	1,865.6	6.0
B-2	16706+51	20' Right	1,867.2	6.0
B-3	16696+48	20' Left	1,886.7	6.0
B-4	16686+59	20' Right	1,910.5	6.0

B-5	16676+43	20' Left	1,899.4	6.0
B-5A	16668+64	20' Left	1,870.2	11.5
B-6	16666+56	20' Right	1,868.2	6.0
B-7	16656+49	20' Left	1,892.2	6.0
B-8	16646+90	8' Right	1,946.1	11.0
B-9	16635+95	8' Left	1,964.0	6.0
B-10	16626+56	8' Right	1,968.5	6.0
B-11	16616+53	8' Left	1,975.1	6.0
B-12	16606+56	8' Right	1,993.8	6.0
B-13	16596+49	8' Left	2,036.3	6.0
B-14	16586+41	8' Right	2,060.0	6.0
B-15	16576+68	8' Left	2,076.0	6.0
B-16	16566+79	8' Right	2,083.9	6.0
B-17	16556+63	8' Left	2,071.3	6.0
B-18	16546+55	8' Right	2,088.1	6.0
B-19	16536+45	8' Left	2,148.4	26.0
B-20	16534+01	8' Right	2,156.6	36.5
B-21	16516+58	8' Left	10.25	6.0
B-63	16664+74	54' Left	1,861.3	96.0
B-64	16663+50	36' Right	1,868.5	104.5
B-76	16537+06	118' Right	2,161.4	49.0
B-79	16533+54	139' Right	2,174.6	51.0
B-100	16601+30	143' Left	2,014.1	4.9
B-103	16526+55	8' Right	2,140.8	11.0

The drilling was performed under the direction of a DOWL Geotechnical Engineer. At each boring location, Standard Penetration Test (SPT) sampling was performed using an automatic hammer system driver and 2-inch outside diameter split-spoon sampler in accordance with ASTM D 1586. During the test, a sample was driven into the soil simulating a series of drops of a 140 lb. weight falling 30 inches for a total penetration of 18 inches into the soil. The number of blows required for each 6 inches of penetration was recorded. The Standard Penetration Resistance ("N-value") of the soil was then calculated as the number of blows required for the final 12 inches of penetration. If 50 blows were recorded within a single 6-inch interval, the test was terminated and the blow count was recorded as 50 blows for the number of inches of penetration. The resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils.

As drilling progressed soil samples were field classified according to ASTM D 2488 (Visual-Manual Procedure). Select samples were taken to DOWL's materials testing laboratory for further testing. Continuous logs of the borings were produced during the drilling to record soil and groundwater conditions. The boring logs are presented in Appendix B. The "N" values shown on the boring logs are uncorrected for overburden and/or split spoon sampler size. It is noted in order to allow adequate sample return that a large split spoon (California Sampler (3-inch OD)) was used for the first drive in most borings advanced for the linear soil survey. The spoon size is indicated by the appropriate symbol on the boring log as defined in the legend in Appendix B.

The soil descriptions shown on the boring logs are based on field and laboratory testing in accordance with ASTM Standards D 2487 or D 2488. The stratigraphic contacts shown on the individual borehole logs represent the approximate boundaries between soil types. The actual transitions may be more gradual or abrupt. The soil and groundwater conditions depicted are only for the specific dates and locations reported, and therefore, are not necessarily representative of other locations and times.

2.4 GEOLOGIC SETTING

The predominant geologic unit at the surface of the alignment's corridor is Sheet Moraine (glacial drift) overlying the Tertiary Fort Union Formation as described by North Dakota Geological Survey – Bulletin 48 (See Figure 2 and Figure 3). The Sheet Moraine is described as a thin sheet of glacial drift draped over the pre-existing topography formed by the underlying Tertiary Fort Union Group. The Tertiary Fort Union Group is composed of the Tongue River Formation and the Sentinel Butte Formation. The Tongue River Formation is composed of yellowish fine grained sandstone, with thin interbedded layers of siltstone, clay, mudstone and coal seams. The sandstone tends to be either massive or cross-bedded in some areas. The Sentinel Butte Formation is known to consist of gray-brown silt, sand, clay, and sandstone with numerous and extensive lignite beds. The Sentinel Butte formation was deposited by rivers, swamps, and lakes during the Paleocene Epoch, and can be up to 600 feet thick in areas.

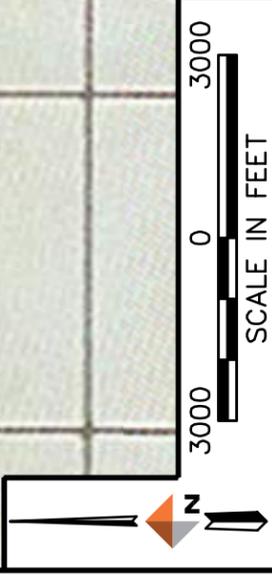
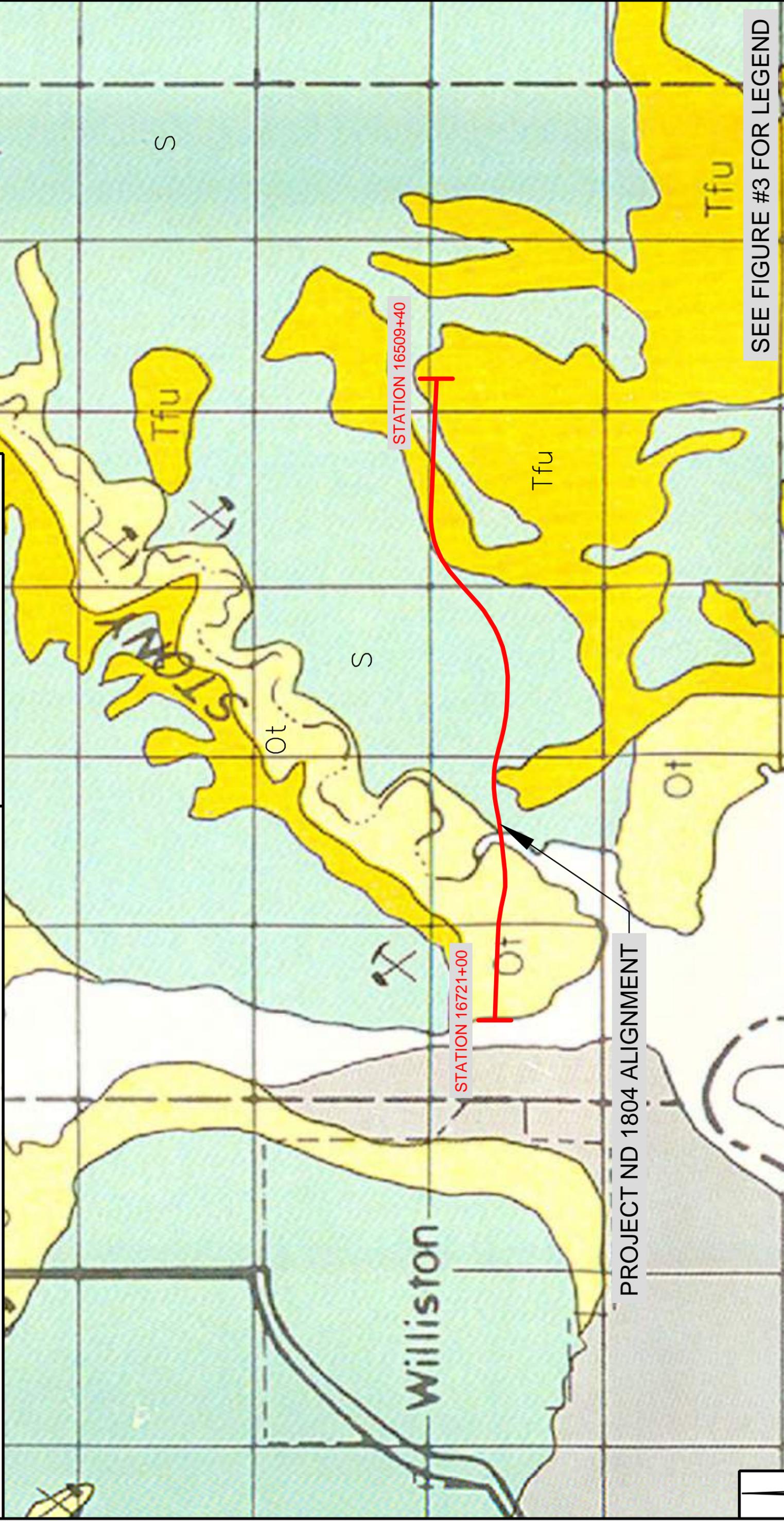
Both the Tertiary Fort Union Group and Outwash Terrace deposits can be observed along the Stony Creek channel alignment. Outwash Terrace is characterized as having nearly level, bench like water-deposited accumulation of gravel and sand, sandy gravel and gravelly sand with a few boulders and cobbles.

NORTH DAKOTA GEOLOGICAL SURVEY

NORTH DAKOTA STATE WATER COMMISSION

PLATE 1.—GEOLOGIC MAP OF WILLIAMS COUNTY, NORTH DAKOTA

BULLETIN 48
COUNTY GROUND WATER STUDIES 9



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NORTH DAKOTA 1804 RECONSTRUCTION - PHASE I
 GEOTECHNICAL INVESTIGATION
 GEOLOGIC MAP OF WILLIAMS COUNTY, NORTH DAKOTA

SEE FIGURE #3 FOR LEGEND

PROJECT	6024.20997.01
DATE	11/12/2015

FIGURE 2

EXPLANATION

GLACIAL LANDFORMS

	APPAM END MORaine A CURVED, LOOP-SHAPED RIDGE OF DRIFT WITH MANY SMALL SUPERIMPOSED LINEAR RIDGES. COMPOSED CHIEFLY OF TILL. THE MORaine IS ABOUT 3 MILES LONG AND 1.5 MILES WIDE WITH MEDIUM TO HIGH LOCAL RELIEF (25 TO 100 FEET BETWEEN ADJACENT HIGHS AND LOWS).
	GREnORA END MORaine AN AREA OF SMALL LINEAR RIDGES AND SOME DEAD-ICE MORaine FEATURES EXTENDING FROM GREnORA SOUTHWEST TO THE MONTANA LINE. COMPOSED MOSTLY OF TILL AND HAS LOW TO HIGH (10 TO 50 FEET) LOCAL RELIEF.
	HAMLET END MORaine A BAND OF LOW PARALLEL RIDGES WITH SOME DEAD-ICE FEATURES EXTENDING FROM HAMLET 5 MILES TO THE SOUTHWEST. LOCAL RELIEF IS LOW (LESS THAN 20 FEET). COMPOSED MOSTLY OF TILL.
	McGREGOR END MORaine A NORTHEAST-SOUTHWEST TRENDING BAND OF LOW RIDGES NORTHWEST OF McGREGOR. RELIEF IS LOW, BUT THE RIDGES CAN BE DISTINGUISHED ON THE AERIAL PHOTOS.
	DEAD-ICE MORaine (HIGH-RELIEF) HILLS, KNOBS, SLOUGHS, KETTLES, RIDGES, TRENCHES, AND MANY DEAD-ICE FEATURES. RIDGES MAY BE PRESENT AS IN AN END MORaine, BUT THERE IS NO OVERALL TREND OF ACTIVE-ICE LINEAR FEATURES. TILL IS THE PRIMARY CONSTITUENT, BUT SMALL AREAS OF SAND AND/OR GRAVEL CAN BE FOUND THROUGHOUT THE AREA. LOCAL RELIEF RANGES FROM 25 TO 150 FEET. GENERALLY THERE IS NON-INTEGRATED DRAINAGE.
	DEAD-ICE MORaine (LOW-RELIEF) SAME AS HIGH-RELIEF DEAD-ICE MORaine EXCEPT THAT THE LOCAL RELIEF IS GENERALLY LESS THAN 50 FEET. THERE IS SOME INTEGRATED DRAINAGE.
	GROUND MORaine A FLAT TO GENTLY ROLLING DRIFT PLAIN CONSISTING MAINLY OF TILL. LOCAL RELIEF IS LOW (LESS THAN 15 FEET).
	SHEET MORaine A THIN SHEET OF GLACIAL DRIFT DRAPED OVER THE PRE-EXISTING TOPOGRAPHY AND REFLECTING MUCH OF THE UNDERLYING TOPOGRAPHY. COMPOSED MOSTLY OF TILL. OCCURS IN THE SOUTHERN 1/4 TO 1/2 OF WILLIAMS COUNTY.
	OUTWASH PLAIN, COLLAPSED A HILLY AREA UNDERLAIN PRIMARILY BY SAND AND GRAVEL. LOW TO HIGH LOCAL RELIEF (10 TO 75 FEET) WITH SOME KETTLES.
	LAKE PLAIN, COLLAPSED A GENTLY ROLLING TO HILLY AREA OF LAKE DEPOSITS, MOSTLY OF CLAY AND SILT. LOCAL RELIEF IS LOW (LESS THAN 15 FEET).
	KAME A MOUND OR HILL OF STRATIFIED SAND AND GRAVEL.
	KAME TERRACE A LINEAR DEPOSIT OF STRATIFIED DRIFT, PREDOMINATELY SAND AND GRAVEL, PRESENT ALONG THE WALLS OF COTTONWOOD CREEK MELT-WATER CHANNEL.
	ICE CONTACT DEPOSIT UNDIFFERENTIATED AN IRREGULAR-SHAPED DEPOSIT OF DRIFT, MOSTLY SAND AND GRAVEL BUT WITH SOME TILL.
	DISINTEGRATION RIDGE, GRAVEL A NARROW, STEEP-SIDED RIDGE OF SAND AND GRAVEL. MAY BE SEGMENTED OR CONTINUOUS AND STRAIGHT OR SINUOUS.

	DISINTEGRATION RIDGE, TILL A NARROW STEEP-SIDED RIDGE OF TILL.
	DRIFT-MANTLED BEDROCK SCARP A STEEP ABUTMENT ON THE GROUND MORaine OR SHEET MORaine UNDERLAIN BY THIN GLACIAL DEPOSITS OVER A BEDROCK SCARP.
	DRIFT-MANTLED CHANNEL OR KETTLE CHAIN A LINEAR DEPRESSION UNDERLAIN BY TILL. STEEP SIDED IN THE AREAS OF GROUND MORaine AND DEAD-ICE MORaine.
	ICE CONTACT FACE A STEEP ABUTMENT OF GLACIAL DRIFT.

PROGLACIAL LANDFORMS

	OUTWASH PLAIN A GENTLY UNDULATING TO NEARLY FLAT SURFACE UNDERLAIN BY SAND AND GRAVEL WITH SOME SILT AND CLAY. COMMONLY STRATIFIED.
	OUTWASH TERRACE A NEARLY LEVEL, BENCHLIKE, WATER-DEPOSITED ACCUMULATION OF SAND AND GRAVEL, SANDY GRAVEL, GRAVELLY SAND WITH A FEW BOULDERS AND COBBLES.
	LAKE PLAIN GENTLY UNDULATING TO FLAT DEPOSIT OF CLAY, SILT AND SOMETIMES SAND AND GRAVEL, GENERALLY STRATIFIED.
	MELT-WATER CHANNEL A STEEP-SIDED TRENCH THAT CARRIED MELT-WATER FROM A GLACIER, MAY BE UNDERLAIN BY SAND, GRAVEL OR TILL. ARROW SHOWS THE DIRECTION OF THE MOST RECENT FLOW OF MELT-WATER.

NONGLACIAL LANDFORMS

	ALLUVIAL FLOODPLAIN A LEVEL TO GENTLY UNDULATING ACCUMULATION OF STREAM DEPOSITS THAT ARE GENERALLY STRATIFIED AND ADJACENT TO A STREAM. UNDERLAIN BY INTERBEDDED CLAY, SILT, SAND, GRAVEL AND SOME ORGANIC DEBRIS.
	ALLUVIAL TERRACE A FLAT OR GENTLY SLOPING BENCH ABOVE AND ADJACENT TO THE FLOODPLAIN OF THE MISSOURI RIVER. UNDERLAIN BY INTERBEDDED CLAY, SILT, SAND, GRAVEL AND ORGANIC DEBRIS.
	SAND DUNES AN AREA OF AEOLIAN SAND DEPOSITS CHARACTERIZED BY LOW MOUNDS OF SAND AND BLOWOUTS.
	QUATERNARY WIOTA GRAVEL FINE TO MEDIUM SAND AND SANDY GRAVEL CONSISTING OF 70 TO 80 PERCENT CHERT AND QUARTZITE. REDDISH BROWN TO BROWN. OVERLAIN BY TILL IN WILLIAMS COUNTY.
	TERTIARY FORT UNION GROUP TONGUE RIVER-SENTINEL BUTTE FORMATIONS UNDIFFERENTIATED. EXPOSED IN THE AREA OF STUDY, BUT THE CONTACT BETWEEN THE TWO FORMATIONS HAS NOT BEEN ESTABLISHED. CONSISTS OF CLAY, SILT, SAND AND LIGNITE BEDS. COLORS RANGE FROM LIGHT GRAY TO YELLOWISH GRAY TO YELLOW.

NAMED FORMATIONS

SYMBOLS	
	LIGNITE MINE
	GRAVEL PIT (GLACIAL GRAVELS)
	GRAVEL PIT (WIOTA GRAVEL, BROWN, QUARTZITIC)
	GRAVEL PIT ("SCORIA ROCK")
	NESSON ANTICLINE

NORTH DAKOTA GEOLOGICAL SURVEY NORTH DAKOTA STATE WATER COMMISSION BULLETIN 48 COUNTY GROUND WATER STUDIES 9 PLATE I

3.0 LABORATORY TESTING

Soil samples collected during the field investigation were returned to DOWL’s materials laboratory for observation by the project geotechnical engineer. Soil samples were classified in accordance with AASHTO and the Unified Soil Classification System (USCS).

Representative soil samples were selected for laboratory testing after careful visual examination and consideration of the design criteria. The following tests were performed as part of this project:

Table 2 Laboratory Testing 1804 Phase I Investigation	
Test	Purpose of Test
Natural Moisture Content (AASHTO T-265)	To determine the natural (in-situ) water content and to correlate with optimum moisture content for compaction.
Atterberg Limits (AASHTO T-89 &90)	To determine soil characteristics for classification and determine behavior conditions of silts and clays corresponding to varying moisture content.
Particle-Size Distribution (AASHTO T-88)	To determine the grain sizes of the soils for classification and identification of physical characteristics.
Moisture-Density Curve (AASHTO T-180)	To determine the relationship of water content to the density of soil during the compaction process.
CBR (AASHTO T-193)	To determine the strength and stability of subgrade soil and base course.
Unconfined Compressive Strength (AASHTO T-208/T-226)	To determine an estimated unconfined compressive strength of cohesive soils or rock.

Laboratory test results, which were completed following the field exploration, are presented on the boring logs in Appendix B. Laboratory tests performed by DOWL were performed in general accordance with the AASHTO and NDDOT Geotechnical Manual-Laboratory Work. Data for individual tests are summarized on the Laboratory Testing Summary and detailed lab results are presented on individual Laboratory Test Data Reports in Appendix C.

4.0 SUBSURFACE CONDITIONS

The subsurface profiles consist of existing pavement surfacing sections overlaying shallow to deep embankment fills. Existing roadway cut slopes were excavated predominately into the Fort Union Geologic Formation which, along the Phase-1 portion of the alignment, consists predominately of fat and lean clay with some interbedded siltstone, sandstone and coal layers. Glacial drift formations overlay the Fort Union in relatively thin layers at some locations. The glacial drift formations consist of lean and fat clay with scattered gravels and small erratic's (cobbles and occasional boulders). Relatively thick (2 to 3 feet) coal seams were encountered within the subgrade at deeper cut area Station +/-16530 to +/-16540. Soil moisture within the immediate subgrade was typically relatively low, ranging from slightly moist to moist with some wet zones. Groundwater was not encountered in any of the linear soil survey borings. Detailed soil profiles are indicated on the boring logs. The subsurface conditions are described in more detail in the following sections.

4.1 EXISTING PAVEMENT SECTIONS

Table 3 presents existing asphalt and base thicknesses observed in the borings advanced along the centerline of the existing present traveled way. Based on the NDDOT Pavement Design Recommendation Report, it appears that placement of bituminous base; overlays and milling were conducted at various times during the history of the project. It was not possible to discern bituminous base from hot bit pavement in the asphalt sections measured east of the BN overpass. It is noted that the base course thickness for at boring B-2 is 42 inches. It is not evident if this thickness is from utility trench backfill as no utilities were in the specific area. The thickness could be the result of a dig out and backfill area.

Table 3				
Existing Asphalt Pavement and Base Course Thickness				
ND 1804 Reconstruction – Phase I				
Boring #	Station	Offset	Asphalt Thickness (inches)	Base Course Thickness (inches)
B-1	16720+35	20' Right	9.25	4
B-1A	16715+40	20' Left	9.00	6
B-2	16706+51	20' Right	5.75	42
B-3	16696+48	20' Left	6.25	11
B-4	16686+59	20' Right	7.75	11
B-5	16676+43	20' Left	6.00	10

B-5A	16668+64	20' Left	8.00	4
B-6	16666+56	20' Right	7.00	18
B-7	16656+49	20' Left	6.75	2
B-8	16646+90	8' Right	7.50	5
B-9	16635+95	8' Left	10.50	7
B-10	16626+56	8' Right	9.50	6
B-11	16616+53	8' Left	11.00	9
B-12	16606+56	8' Right	11.50	9
B-13	16596+49	8' Left	9.50	6
B-14	16586+41	8' Right	9.00	8
B-15	16576+68	8' Left	8.75	7
B-16	16566+79	8' Right	9.50	8
B-17	16556+63	8' Left	8.75	7
B-18	16546+55	8' Right	10.50	8.5
B-19	16536+45	8' Left	9.00	13
B-20	16534+01	8' Right	9.50	12
B-21	16516+58	8' Left	10.25	8

4.2 SUBGRADE SOIL CONDITIONS

General Alignment

The reconstructed vertical and horizontal alignment will generally follow the existing alignment with the exception of deeper cut areas which are required to improve sight distance. New embankment fill depths are minor along the Phase I alignment. The subgrade soil conditions along the current alignment consist predominately of shallow embankment fills derived from the adjacent glacial drift and underlying Fort Union formations. The fill and native subgrade soils varied from lean and fat clay with some sand and silts and ranged from A-2-4, A-4, A-6 to A-7-6 according to ASSHTO Classification. The deeper cut area at stations 16524+00 to 16545+00 encounter undisturbed Fort Union Formations.

Table 4 presents a summary of soil classifications and Atterberg limits encountered along the alignment:

Table 4
Summary of Atterberg Limits
ND 1804 Reconstruction – Phase I

AASHTO Class	Liquid Limit Range (%)	Liquid Limit Average (%)	Plastic Limit Range (%)	Plastic Limit Average (%)	Plasticity Index Range (%)	Plasticity Index Average (%)	*Swell Potential
A-2-4	26	26.0	16	16.0	10	10.0	Low
A-4	21 - 26	24.3	15 – 19	16.8	2 – 9	7.5	Low
A-6	27 – 37	32.6	12 – 14	13.1	13 – 24	19.4	Low
A-7-6	42 – 69	51.3	15 – 24	18.6	26 – 47	32.7	Marginal

*Swell potential is based on the average PI for the AASHTO class soils tested. Low: PI<25, Marginal: 25≤PI≤35, High>35

Fort Union Formation material was encountered at depth as indicated by hard cohesive soils and dense granular soils. The upper portion of the formations is typically consists of residual soils (completely weathered bedrock). The Formation material at depth consisted predominately of soft claystone (hard clay) with some sandstone/siltstone (dense sand and silt) and occasional coal layers. The Fort Union Formation encountered at this project location and within the depth intervals drilled is classified, according to bedrock description, as soft and highly to completely weathered.

Cut and fill sections and corresponding soils types encountered are discussed in the following sections.

Proposed Cut Sections Observations

There are two significant cut sections that involve the excavation at vertical curves and regrading associated side slopes. Also, there is a cut section that involves the regrading of associated side slopes only.

A total of three cut sections are evaluated with 6 borings within the corridor. Borings were advanced to depths ranging from 6.0 to 51.0 feet. The station range within the corridor of the three cut sections are as follows:

- 16509+40 to 16521+00 (Boring B-21) (maximum roadway centerline cut depths of approximately 6 feet).

- 16524+00 to 16545+00 (Borings B-19, B-20, B-76, B-79 and B-103) (maximum roadway centerline cut depths of approximately 15 feet and maximum cut slope heights 28 feet).
- 16636+00 to 16655+00 Borings B-7, B-8 and B-9 were advanced in the roadway along this area. There is minimal center line cut along this area but adjacent cut slopes will be flattened to 3:1. (cut slope heights ranging from 15 to 18 feet). Geotechnical borings were not advanced within the side hill cut areas at this area due to access and utility issues.

Soils Encountered:

- Fat clays, silty sands, sandy silts and interbedded coal seams. Soils at final new subgrade elevations will vary from A-4 to A-7-6

Densities/Consistencies:

- Cohesionless material densities range from very loose to very dense.
- Cohesive material consistencies range from medium stiff to hard with some soft layers.

Groundwater:

- Groundwater was not encountered at the time of the investigation within borings advanced at the cut locations.

Coal close to Subgrade: Coal was encountered near subgrade elevations between Stations 16524+00 to 16545+00:

B-19 location: The proposed asphalt elevation will be at approximately 2,137.5 feet. This will be below a 3.1 foot thick coal layer that ranges in elevation from 2,143.2 to 2,140.1 feet.

B-20 location: The proposed asphalt elevation will be at approximately 2,140.1 feet. This will be slightly below a 2.7 foot thick coal layer that ranges in elevation from 2,143.5 to 2,140.8 feet.

For planning considerations it should be assumed that coal seams will be encountered within cut within the majority of the cut area within the vicinity of B-19 and B-20. This coal layer will likely be considered common excavation because it will be removed to construct the pavement section. However; if coal is encountered at subgrade elevation it must be removed in accordance to NDDOT Standard specification 203.04 A.4 which requires a 6 foot removal between the graded shoulders and 1 foot below the final surface elevation from the graded shoulders and the top of the backslopes.

Fill Section Observations

One fill embankment section was evaluated with one (1) boring within the corridor, with a boring depth of 6.0 feet. The stationing within the corridor of the fill embankment section is as follows:

- 16620+00 to 16628+00 (Boring B-10) (maximum roadway fill heights of approximately 3 feet)

Soils Encountered:

- Predominately stiff sandy lean clay with gravel that is described as fill overlying medium stiff native sandy lean clay (A-4 to A-6 soils).

4.3 GROUNDWATER

Groundwater was not encountered in any of the borings advanced along the linear soil survey or within cut /fill areas at the time of the investigation. Groundwater was encountered in borings B-63 and B-64 which were advanced at the Stony Creek Bridge abutments. Groundwater depths of 13.5 and 15.4 feet were recorded at the time of the investigation (October 22, 2015). The borings were backfilled shortly after drilling and weren't allowed to fully stabilize.

Fluctuations of groundwater occur due to seasonal moisture conditions, irrigation practices, changes in land use, and many other factors. Groundwater conditions may vary from those encountered at the time of the field investigation depending upon the influence of these factors. Evaluation of these factors is beyond the scope of this report.

5.0 ANALYSIS & DESIGN RECOMMENDATIONS

The following sections present geotechnical recommendations in regard to subgrade soil considerations, embankment fills, cut slope stability, underground mine workings and Stony Creek Bridge reconstruction to assist in planning and design.

5.1 SUBGRADE SOIL CONSIDERATIONS

General Subgrade Along Centerline:

Based on the site reconnaissance and observations during drilling, subgrade conditions along the

current alignment are stable with no indications of significant subgrade issues with exception of that portion of the alignment between Stony Creek Bridge and the BN railroad overpass. This area has required maintenance over the years requiring over-digs and replacement with road base and asphalt patch. Past performance indicates that available borrow material from adjacent geologic formations will provide adequate subgrade fill provided proper moisture conditioning and compaction is accomplished. The existing pavement sections did not indicate any issues from swelling soils although it appears there are fat clays within the existing subgrade.

Soils have been described previously and will consist predominately of fine grained soils ranging from A-2-4, A-4,A-6 to A-7-6 classifications. It is noted that the soils are moisture sensitive. While insitu subgrade soil moisture conditions are generally close to or slightly elevated above optimum along most portions of the alignment which will allow proper re-compaction and efficient equipment operation, soil conditions will change drastically during wet weather conditions. Moisture sensitive subgrades should be anticipated throughout the project alignment. These soils are susceptible to failure due to heavy equipment traffic under wet conditions. As heavy equipment travels over exposed subgrades, the soils can easily fail creating soft areas which are characterized by rutting and pumping. These soft areas of failed subgrade are very difficult to compact, to achieve a suitable subgrade, unless permitted to dry out.

Another common problem with moisture sensitive subgrades is a lack of proper surface water drainage during construction. If rain and snowmelt are allowed to pond over exposed subgrade areas during construction, the subgrades become wet and soft. These areas are worsened by repetitive tracking of construction equipment.

CBR Tests

Table 5 presents a summary of CBR tests (ASTM 1883) conducted on subgrade soil samples taken at various boring locations. The soil samples were compacted 90 percent of Modified Proctor near optimum moisture content. The values are typically low.

Table 5			
Summary of California Bearing Ratio (CBR) Tests			
Subgrade Soil Samples Compacted to 90% of Modified Proctor (AASHTO T-180)			
ND 1804 Reconstruction – Phase I			
Boring	AASHTO Class	CBR (%)	
		0.1 in. Penetration	0.2 in. Penetration
B-5	A-7-6 (15)	1.0	0.9
B-7	A-7-6 (30)	1.6	1.4
B-13	A-2-4 (0)	3.7	3.6
B-18	A-7-6 (15)	1.9	1.7

Coal Excavation Areas:

Coal seams were encountered near subgrade elevation between Stations 16524+00 to 16545+00. Coal may be encountered at other areas where borings were not advanced. Subexcavation per NDDOT Specification 203.04 A.4 may be required if coal is encountered at subgrade elevations.

Alignment Subgrade Between Stony Creek Bridge and BNRR Overpass:

As discussed previously there have been ongoing subgrade problems along this portion of the alignment. Based on subgrade information from borings B-4 through B-6 the subgrade soils consist of fat and lean clays A-6 to A-7-6. Subgrade moisture is elevated considerably above optimum at some locations. The occurring subgrade problems may likely be contributed in part to inadequate compaction of the BNSF railroad overpass approach fill.

Because of the ongoing problems in this area it is recommended to perform a subcut in this area and utilize a stabilization fabric. A stabilization design has been conducted utilizing the Giroud-Han method. The results of the analysis, assuming a subgrade CBR of 1.5, indicate that suitable subgrade stabilization can be achieved by subcutting and using a heavy stabilization geosynthetic with 10 inches of aggregate base. The pavement section may then be constructed on this stabilized subgrade. The current NDDOT specification for subgrade stabilization provides for biaxial geogrid. There are new products on the market. At this time, for discussion, DOWL suggests utilizing a heavy stabilization fabric manufactured by Mirafi (RS580i) that is comparable to Triaxial geogrid. The advantage of this geosynthetic is that the fabric has permeability and does not require use of a filter fabric between fine grained subgrade and geogrid/aggregate base. Specification and installation guidelines in regard to Mirafi RS580i are provided in Appendix E.

5.1.1 Subgrade moisture content

Subgrade moisture typically ranges from 5.9 to 28.2 percent along the Phase 1 alignment. The following Table 6 presents a summary of insitu subgrade moisture conditions relative to stationing along alignment intervals:

Table 6 ND 1804 Reconstruction – Phase I Summary of insitu subgrade moisture conditions for all soil types relative to stationing			
Boring Interval	Station Interval	Range of Moisture Contents (%)	Average
B-1 to B-4	16720+35 to 16686+59	5.9-21.5	14.5
B-5 to B-7	16676+43 to 16656+49	13.3-23.5	19.8
B-8 to B-17	16646+90 to 16556+63	9.6-17.7	13.6
B-18 to B-21	16546+55 to 16516+10	22.5-28.2	25.6
B-21	16516+58	10.7-16.2	13.7

Table 7 presents a summary of modified proctor (AASHTO T 180) testing for the various AASHTO soil classifications encountered.

Table 7 Summary of Modified Proctor Tests (AASHTO T-180) ND 1804 Reconstruction – Phase I			
AASHTO Class	Maximum Dry Density Range (pcf)	Optimum Moisture Content Range (%)	Average In-Place Moisture Content (%)
A-2-4	126.8	10.7	11.5
A-4	123.0	11.0	14.0
A-6	122.0 to 132.0	9.0 to 13.0	12.5
A-7-6	111.0 to 127.9	10.0 to 15.0	19.1

It is noted that the optimum moisture range for all soil types is 9 to 15 percent. In summary, moisture contents are somewhat elevated above optimum along the station intervals of 16676+43 to 16656+49 and 16546+55 to 16516+10. Portions of these alignment areas may be problematic

in regard to subgrade preparation. These areas are discussed below.

The majority of the alignment between Stations 16676+43 to 16656+49 consists of the approach fill between Stony Creek and the BNSF railroad overpass. As discussed previously this area has been problematic over the years and has required digouts (see section 5.1).

The interval between 6546+55 to 16516+10 consists of the relatively deep cut and as discussed previously may require subexcavation and subgrade replacement to remove coal deposits or unsuitable wet soils dependent upon the final pavement section elevations.

5.1.2 Subgrade preparation

Placement of new fill will be required at widening areas and subgrade prep at pavement section removal areas. It is recommended that 12-inches of subgrade preparation be conducted for this project. Subgrade preparation should comply with NDDOT Specific 230.02 Type A in cut areas and in fill areas. Subgrade prep in adjacent widening areas will require removal of topsoil, If unstable soils are present below the topsoil, scarification and drying or over-excavation and replacement of the unsuitable soils could be considered. Compaction control should be in accordance with AASHTO T-180 and Specification 203.04E Type A.

5.1.3 Subexcavation removal of unsuitable material

Subexcavation along the alignment may be required at cut area between stations 16524+00 to 16545+00 to remove the coal seam at subgrade elevation dependent upon final pavement section elevations. Subexcavation may also be required at other areas if lignite, excessively wet subgrade soils or high plasticity fat clays are encountered. Coal should be removed as specified in section 203.04A4. If encountered during construction, it is recommended that high plasticity fat clays and/or any lignite layers be removed to a minimum of 6 feet below final subgrade elevation.

5.2 EMBANKMENT FILLS

Minimal embankment fills are required along the Phase 1 alignment. The proposed embankment slopes will be 3H:1V (Horizontal to Vertical). Based on review of existing fill slopes, fills constructed at the proposed fill slope angles are considered stable for the soil conditions encountered. If embankment design slope ratios require adjustment or greater embankment fill heights are required either in the design or construction phases of the project, the Geotechnical Section should be contacted to review changes and provide additional recommendations if

necessary.

5.3 CUT SLOPE STABILITY

The plans indicate that proposed cut slopes will be to 3:1. Roadway centerline cut depths will vary and are shown to be as deep as 15.5 feet at Station 16532+00. Side slope cut depths also vary and the maximum cut is shown to be as deep as 28 feet. Soils within the cut areas consist of sheet moraine (glacial drift) overlaying residual soils or soft bedrock of the Fort Union Formation. The soils encountered were typically stiff to very stiff lean and fat clay and very loose to dense silty sand or with some interbedded coal seams. Some soft clay and loose sand layers were encountered within soil profiles. However, medium stiff clay and medium dense sand predominates. Hard clay and/or dense silty sand is encountered at a depth of approximately 28 feet in borings B-76 and B-79. Groundwater was not encountered in any of the borings advanced within the cut areas and soil moisture was typically moderate to low; however, the soil was above moisture content at Station 16534+01 (B-20) at the depth of 27.5 (El. 2,129.1 feet) to 34.0 (El. 2,122.6 feet).

The existing cut slopes along the alignment are typically steeper than the proposed 3:1 slopes. The existing cut slopes exhibit good stability with some minor shallow creep zones. Intuitively the proposed 3:1 excavation slopes will maintain adequate stability over time. However, the proposed cut slopes are slightly deeper than the existing cuts. Slope stability analysis have been conducted to evaluate the deeper 3:1 cut slopes which will extend into the Fort Union Formations at depth.

Cut Slope Stability: In order to evaluate cut slope stability a sensitivity analysis was conducted of cross sections aligned with geotechnical borings and a proposed slope of 3:1 with cuts ranging from 18 to 25 feet. Stability runs were conducted assuming relatively conservative strength values for the existing soils profiles. The stability analysis has been completed utilizing the SLOPE/W computer program. Computer runs of these soil profiles are presented in the detail Appendix D.

Strength parameters for the analysis were determined based on unconfined compressive strength tests for the clay soils and correlation of SPT test results to angle of internal friction for the granular soils. Numerous stability runs where completed. Soil strength test results are presented in Appendix F. Table 8 presents the soil strength parameters used in the analysis:

Table 8 Strength Parameters Assumed for Stability Analysis ND 1804 Reconstruction – Phase I					
Engineering Properties and Soil Types					
Material	γ (pcf)	Effective Stress		Total Stress	
		ϕ'	C' (psf)	ϕ	C (psf)
Fat Clay (CH)	90 to 100	-	-	0	1,500 to 4500
Silty to Clayey Sand (SM to SC)	100	30	20	-	-
Interbedded Coal	60	-	-	20	100
Silty Sand (SM)	95 to 110	20 to 35	0	-	-
Sandy Silt (ML)	85 to 95	0 to 35	0 to 75	-	-

Table 9 presents the results of the analysis.

Table 9 Cut Slope Stability Summary ND 1804 Reconstruction – Phase I			
Station	Factor of Safety (FOS)		
	Spencer Circular Failure FOS	Spencer Non-Circular Failure FOS	Recommended Factor of Safety (FOS)
16533+53 3:1 Cut	3.80	3.71	1.3 to 1.5
16537+06 3:1 Cut	5.92	5.04	1.3 to 1.5

Based on the use of conservative soil strength parameter values and the fact that groundwater is not present in any of the cut areas, the proposed 3:1 cut slopes will exhibit adequate long term stability. It is noted that there are isolated zones of loose sand that, if exposed in the cut areas, may exhibit some minor surficial sloughing over time.

If slope ratios require adjustment either in the design or construction phases of the project, the Geotechnical Section should be contacted to review changes and provide additional

recommendations, if necessary

Cut Excavation: Excavation should not be problematic considering the relatively soft nature of the Fort Union bedrock formations. The dense layers of the formations were easily drilled with hollow stem augers. Some ripping may be required. We do not anticipate any special provisions for bedrock excavation.

It is noted that fat clay layers, coal and carbonaceous clay layers exist in a somewhat random nature within the cut areas. A 2.7 foot thick coal layer will be exposed in the roadway section at Station 1634+01 (B-20).

5.4 MINE WORKINGS

There is some concern that nearby underground shallow mine workings may cause subsidence to occur within proposed new roadway embankments. The areas of concern are along the alignment between Stations 16662+00 to 16571+00. In order to evaluate the potential for near surface mine stopes or adits and potential subsidence, a geophysical investigation was conducted using ground penetrating radar (GPR) methods. GPR traverses were conducted along north and south sides of the roadway within the current ditch lines. A detailed report is presented in Appendix E. The results of the geophysical investigation indicate that there are some “suspect” areas. Detailed mapping of the traverses is presented in Appendix E and indicates the locations of the suspect areas. The possible void areas are summarized in the following Tables 10 and 11. Hollow stem auger Borings will be advanced within the “Suspect” areas to either confirm or dispel the presence of mine working voids. The borings will be spaced on 5 to 6 foot centers along the suspect area alignments and advanced typically to 20 foot depths or deeper as indicated on tables 10 and 11.

Table 10 Ground Penetrating Radar Survey Geophysical Surveys Possible Mine Working Void Locations				
South Profile				
Suspect Area	Stationing Range	Length (feet)	Width (feet)	Approximate Depth Range (feet)
1	16606+36 to 16606+96	60	10	9 to 20
2	16592+39 to 16592+69	30	13	10 to 23

Table 11
Ground Penetrating Radar Survey
Geophysical Surveys
Possible Mine Working Void Locations

North Profile				
Suspect Area	Stationing Range	Length (feet)	Width (feet)	Approximate Depth Range (feet)
1	16649+30 to 16650+10	80	17	10 to 27
2	16609+86 to 16610+81	95	12	9 to 21
3	16604+41 to 16605+01	60	12	7 to 19
4	16603+01 to 16603+96	95	13	9 to 22

5.5 STONY CREEK CROSSING

At this time A 11X12 Quadbox culvert is proposed for the Stony Creek crossing. It is proposed to embed the culvert 1 foot into the existing stream bed and cover the culvert with approximately seven (7) feet of fill to attain proper grade. Geotechnical recommendations are presented in the following sections:

Foundation Conditions: Borings B-63 and B-64 were advanced at the existing bridge abutments to evaluate subsurface conditions at the Stony Creek Bridge. The borings were located at the west and east abutment areas respectively. The borings were advanced to depths of 96 to 104.5 feet respectively. Coring was conducted between the depths of 95 to 104.5 in boring 64. Borings were not advanced within the streambed area due to permitting and access constraints. It is DOWL's opinion that the soil profile encountered in the upper 48 feet of Boring B-63 is most representative of soil conditions that may be encountered directly under the streambed. Soils encountered in the upper 45 feet of B-63 consist of very loose to loose interbedded silty, clayey and poorly graded sand with minor amounts of gravel. These deposits extend to the approximate depth of 22 feet. Soft Fat clay is then encountered underlying the sand deposits and extends to a depth of approximately 48 feet where some gravel layers are encountered and the clay becomes very stiff to hard with depth. Fat clay extends to the greatest depth drilled 104.5 feet. Unconfined compressive strengths of the clay ranged from 1.8 kips per square foot (ksf) at a depth of 45 feet to 22 ksf at a depth of 95 feet. Groundwater depths of 13.5 and 15.4 feet were recorded in B-63 and B-64 respectively at the time of the investigation (October 22, 2015). Groundwater elevations in the streambed will be controlled by stream flows.

5.5.1 Box Culvert

The proposed Quad box culverts will be 48 feet in width and extend along Stony Creek approximately 128 feet. It is proposed to cover the culvert with approximately 7 feet of fill. This magnitude of fill will cause settlement of the culverts from consolidation of the saturated, loose/very soft foundation soils. As discussed previously the stream bed material is variable, however, we are assuming that the soil profile in Boring B-63 is representative of a worst case profile. The bottom of the box culvert is proposed to be installed at elevation 1846.6. Based on Boring B-63 there will be an approximate six (6) foot layer of loose sand and gravel directly underlying culvert then soft fat clay extending to 33 feet below the bottom of the culvert. Below this elevation the subgrade formations “stiffen up” and significant consolidation is not anticipated.

A settlement analysis has been conducted assuming the above referenced culvert/fill configuration and soft subgrade extending 33 feet below the culvert bottom. Hand calculations as well as use of the Sigma/W computer program have been conducted (see Appendix G). It is noted that consolidation tests were not conducted on the clay during the investigation at the bridge site as it was assumed that that bridge would be replaced using driven piling. Given the SPT values and insitu moisture contents in relation to Liquid and Plastic limits (insitu moisture between the LL and PL), it is obvious that the clay soils are normally consolidated and compressible. Based on experience a value of 0.3 was assumed for the compression index (C_c) of the soil. The results of the analysis indicate that estimated settlements between 8 to 14 inches could occur from placement of seven feet of fill over the culverts.

It is noted that the stream bed soil profile is variable and that portions of the new culverts will require excavation into the existing embankments. Thus foundation soils under portions of the existing embankment will have already been slightly consolidated while portions of the foundation soils in the middle of the streambed will not have experienced previous loading and will have the potential to consolidate more than the foundation soils under the embankments. This scenario has the potential to cause differential settlement to occur under the box culverts. The wide footing width of the culverts will “bridge” the foundation soils to some degree thus distributing the weight of the fill. However, it is our opinion that consideration should be given to minimize the potential of total and differential settlements which, if extensive enough, could cause cracking of the concrete box culverts.

The following options could be utilized to minimize settlements of the culverts:

1. Preload the site;
2. Over-excavation and replacement of a portion of the foundation soils with structural fill and geosynthetic reinforcement or;
3. Foundation over-excavation and replacement in conjunction with use of lightweight fill.

These options are discussed in the following sections:

Preload:

The culvert site could be preloaded by placing temporary culverts and filling the culvert location with soil and allow time for the foundation soils to consolidate. Typically this could take 3 to 6 months. Preloading may not be feasible given the construction timeline and sequencing.

Foundation over-excavation:

Construction sequencing would consist of a minimum of 30 inches over-excavation, placement of stabilization geotextile and crushed, washed gravel (no.57 stone). The structural fill gravel would then be placed and compacted prior to placement of the box culverts. The gravel should extend three (3) feet laterally beyond the outer edge of the culvert. Two layers of heavy geotextile stabilization fabric (Mirafi RS580i or equal) would be utilized within the gravel fill at 12 inch vertical spacing. Culvert backfill should be placed according to NDDOT Specifications. An R-1 Geotextile fabric should be placed between all backfill and native alluvial soils. This option would provide a stable platform for construction, distribute fill loads and help alleviate differential settlements. However, some settlement would still occur due to the fill weight- the actual magnitude of which is hard to predict.

Foundation over-excavation and use of lightweight fill:

Construction would consist of foundation over-excavation as discussed previously in conjunction with utilization of lightweight fill (expanded polystyrene (EPS) blocks) instead of earth fill. This option would ensure no excessive settlement occurs as the foundation soils would not be loaded significantly. The over-excavation depth possibly could be reduced to 24 inches with reinforcement in order to allow a stable foundation for construction of the box culverts.

6.0 LIMITATIONS

The conclusions and recommendations presented in this report assume that site conditions are not substantially different than those exposed by the explorations. If during construction, subsurface conditions are different from those encountered or appear to be present, the DOWL Geotechnical Section should be advised at once to review those conditions and reconsider recommendations where necessary.

If there is a substantial lapse of time between submission of this report and the start of work at the site, and if conditions have changed due to natural causes or construction operations at or near the site, this report should be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions.

This report was prepared for the use of the NDDOT and its Consultants for this project. It should be made available to prospective contractors for information on factual data only and not as a warranty of subsurface conditions.

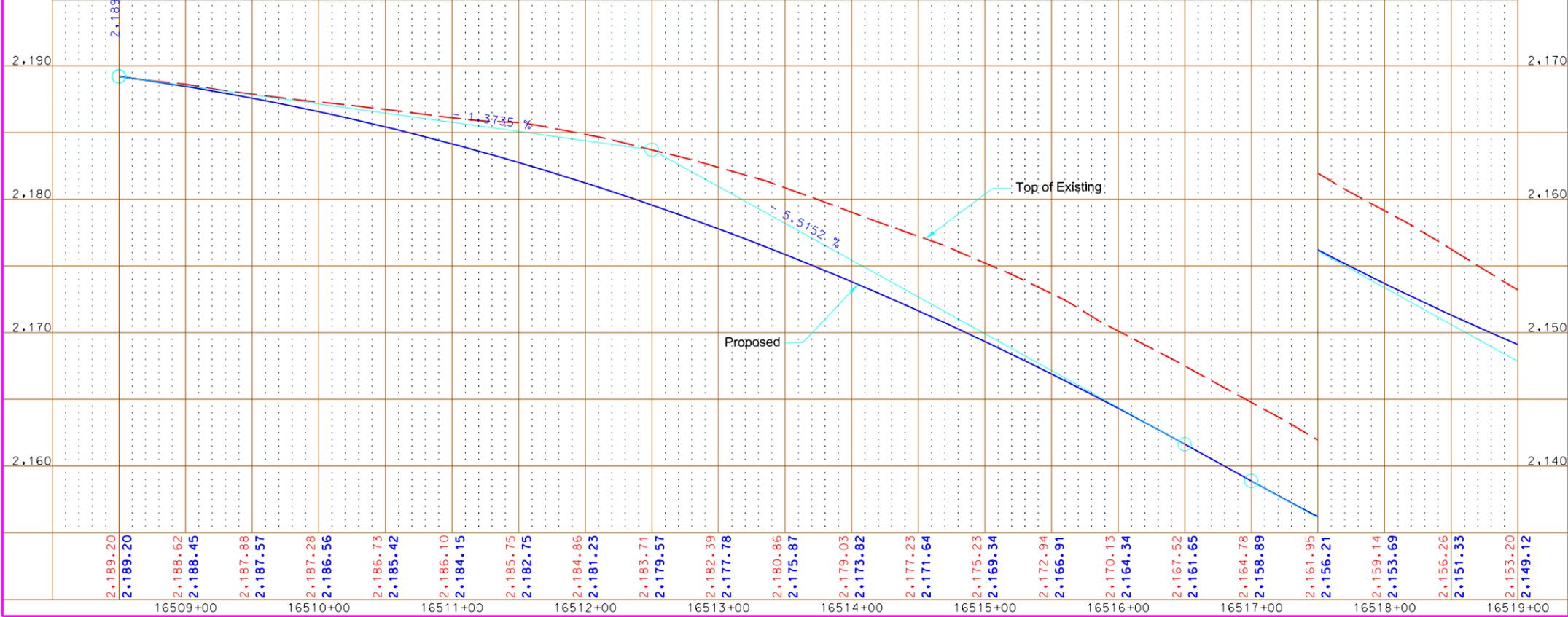
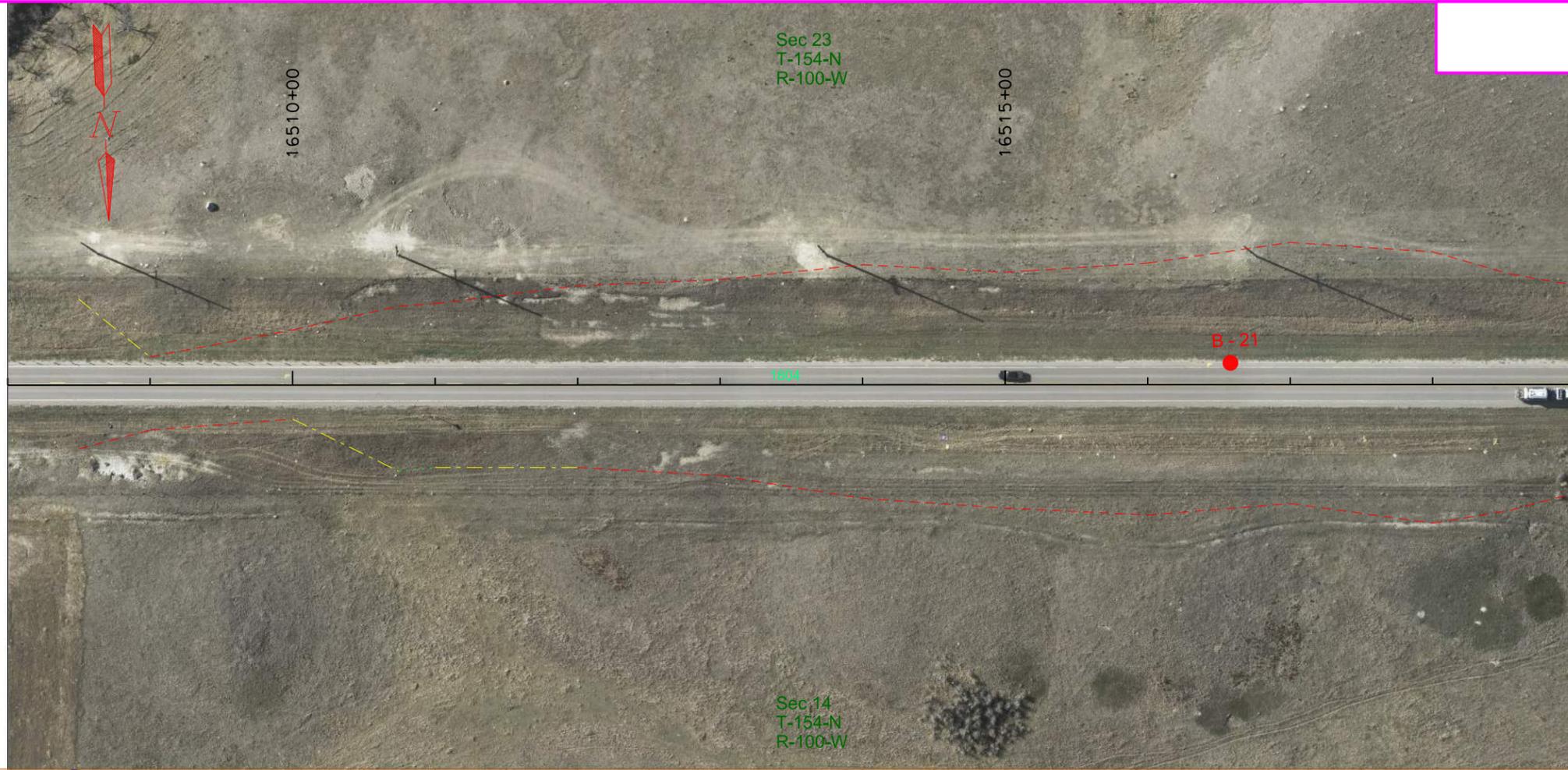
These services have been performed in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing in this area under similar conditions. No warranty is made or implied.

Any conclusions by a construction contractor or bidder relating to construction means, methods, techniques, sequences or costs based upon the information provided in this report are not the responsibility of the NDDOT or DOWL.

APPENDIX A

PLAN AND PROFILE SHEETS – BORING LOCATIONS

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	1



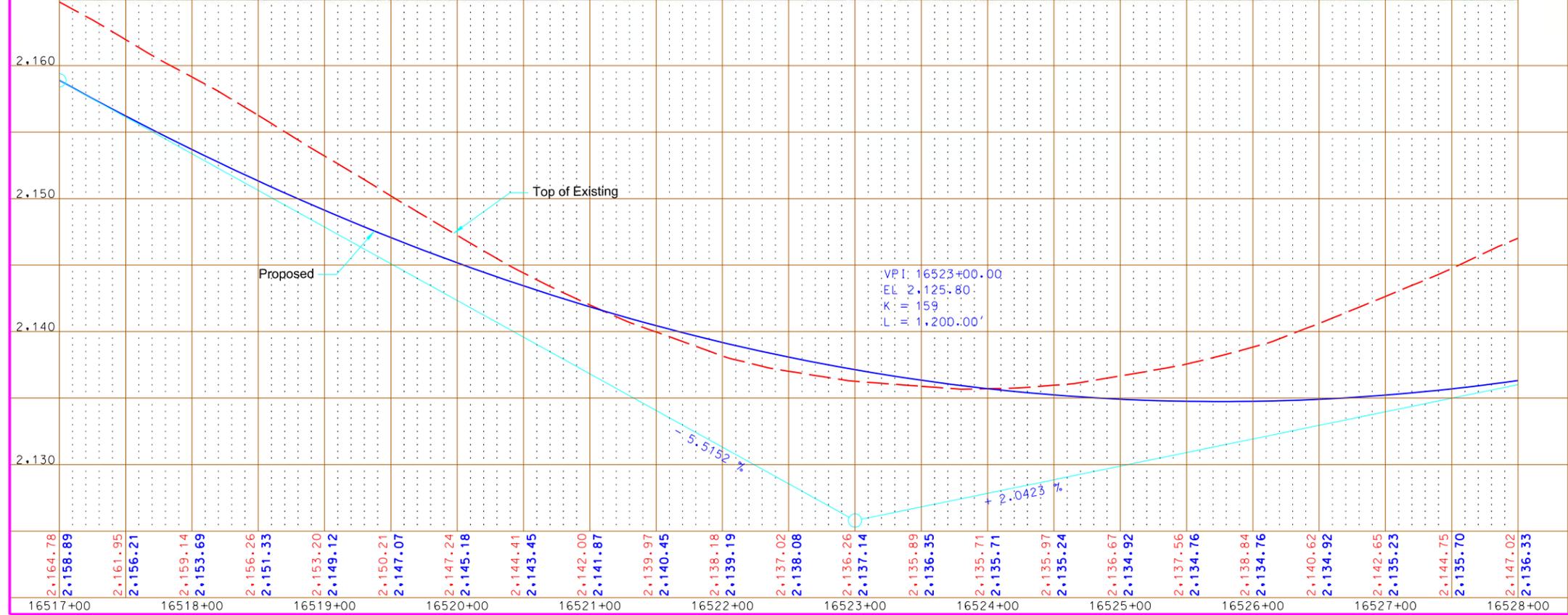
- LEGEND**
- - - - - Proposed Fill
 - - - - - Proposed Cut
 - - - - - Proposed cut/fill Transition
 - Bore Hole

PRELIMINARY

This document
is preliminary
and not for
construction or
implementation
purposes.

Plan and Profile
ND 1804 Reconstruction
Williams County, ND
Sta 16508+50 to Sta 16519+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	2



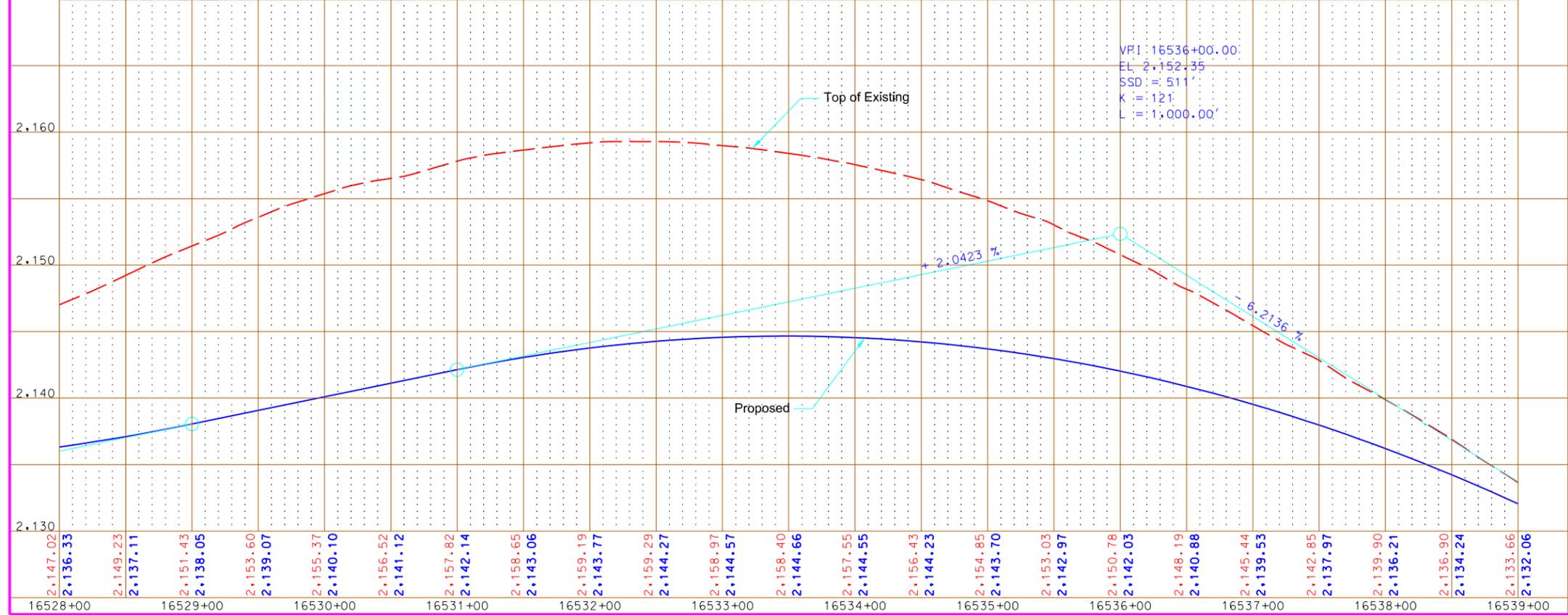
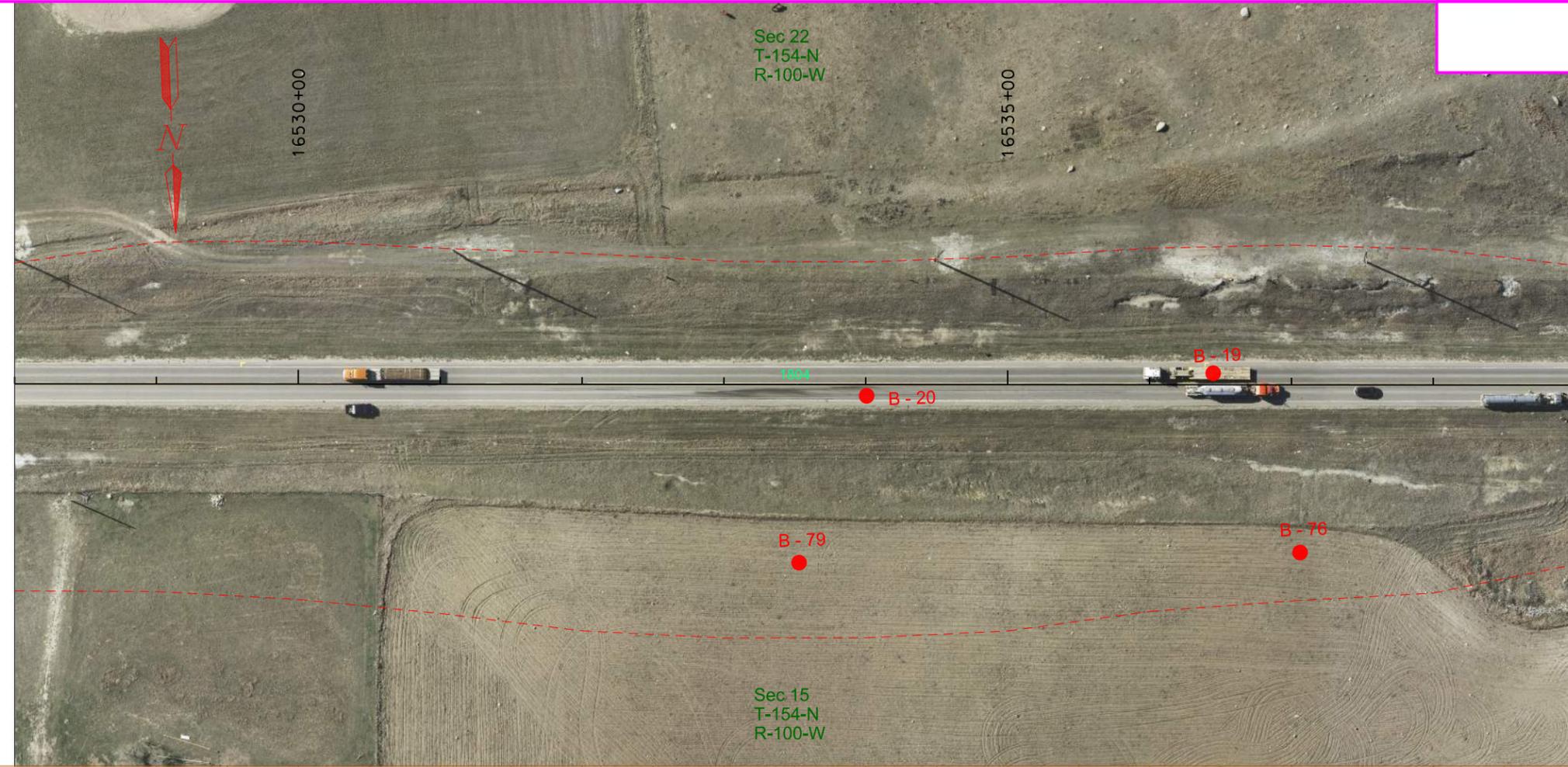
- LEGEND**
- Proposed Fill
 - Proposed Cut
 - Proposed cut/fill Transition
 - Bore Hole

PRELIMINARY

This document is preliminary and not for construction or implementation purposes.

Plan and Profile
 ND 1804 Reconstruction
 Williams County, ND
 Sta 16517+00 to Sta 16528+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	3



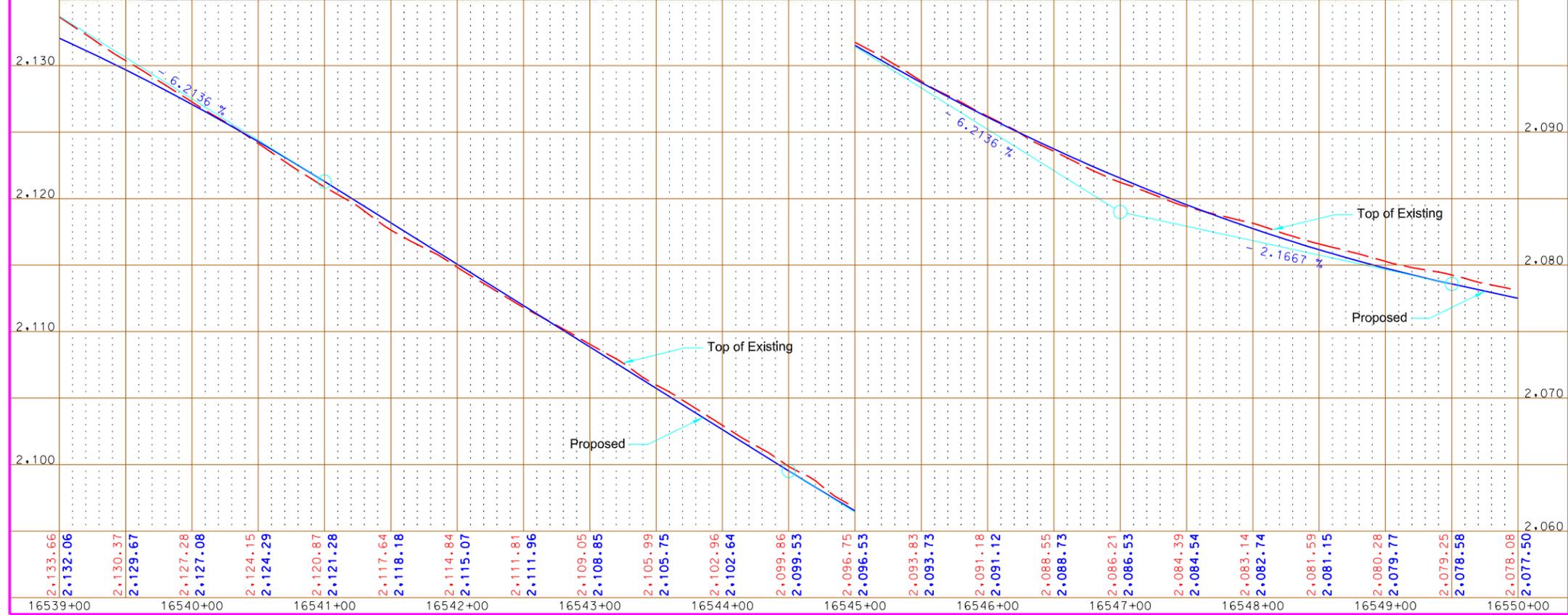
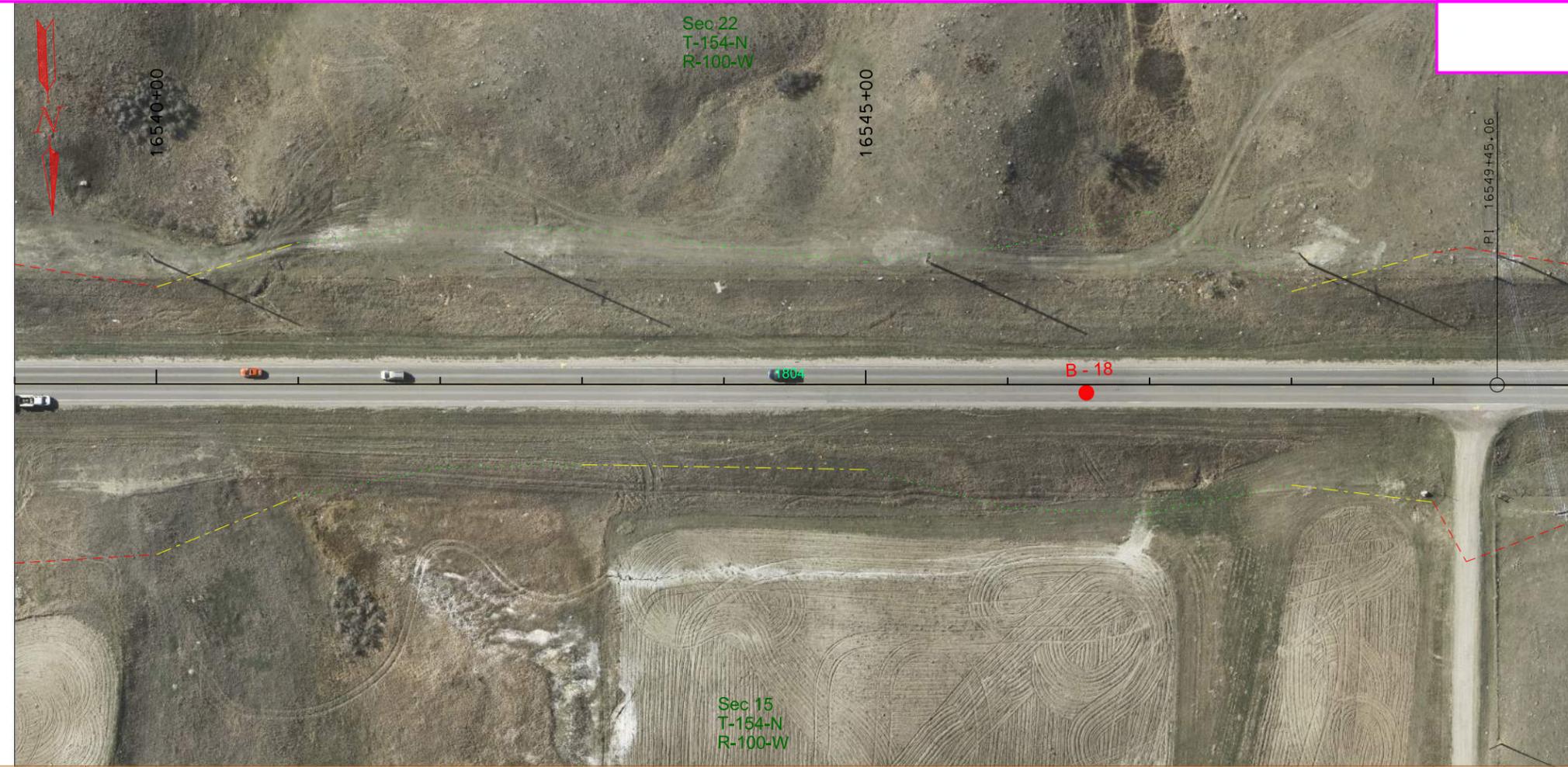
LEGEND

- Proposed Fill
- Proposed Cut
- Proposed cut/fill Transition
- Bore Hole

This document is preliminary and not for construction or implementation purposes.

Plan and Profile
 ND 1804 Reconstruction
 Williams County, ND
 Sta 16528+00 to Sta 16539+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	4

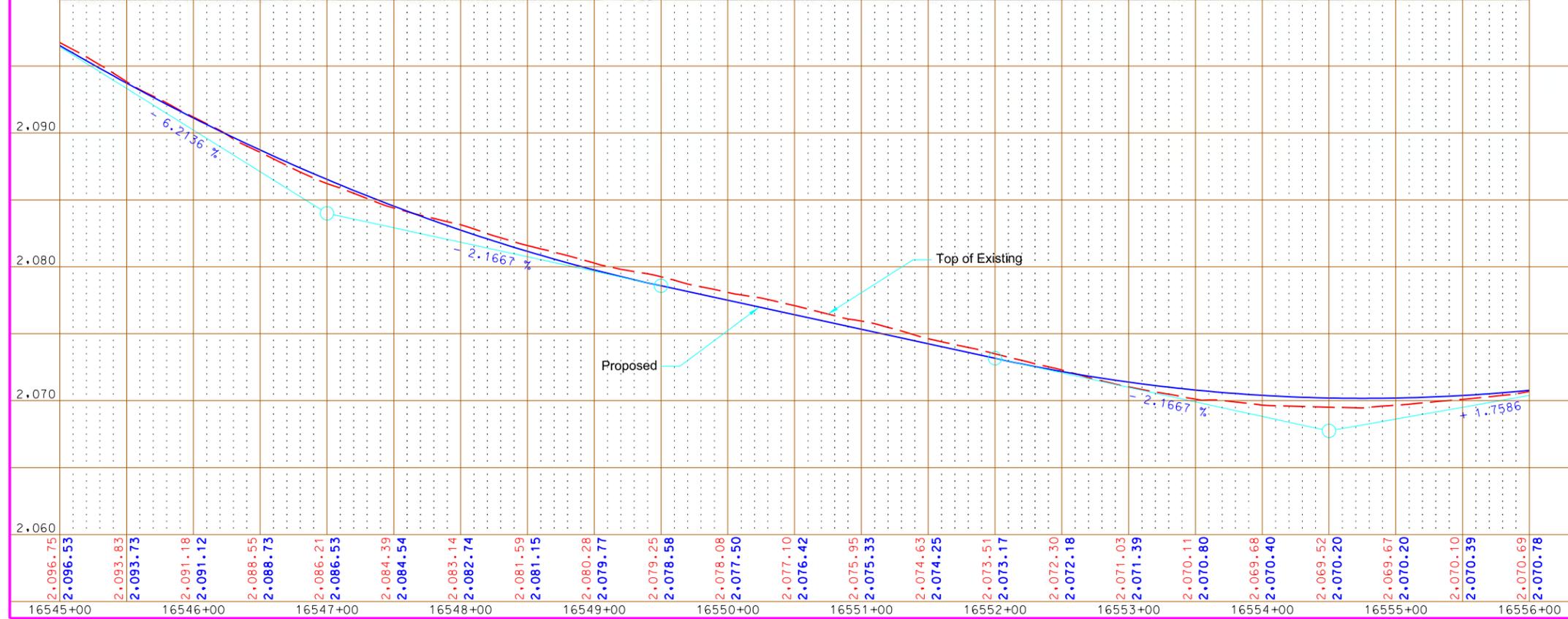


- LEGEND**
- Proposed Fill
 - Proposed Cut
 - Proposed cut/fill Transition
 - Bore Hole

This document is preliminary and not for construction or implementation purposes.

Plan and Profile
 ND 1804 Reconstruction
 Williams County, ND
 Sta 16539+00 to Sta 16550+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	5



- LEGEND**
- - - Proposed Fill
 - - - Proposed Cut
 - - - Proposed cut/fill Transition
 - Bore Hole

PRELIMINARY

This document is preliminary and not for construction or implementation purposes.

Plan and Profile
 ND 1804 Reconstruction
 Williams County, ND
 Sta 16545+00 to Sta 16556+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	7

Sec 22
T-154-N
R-100-W

16575+00

16570+00

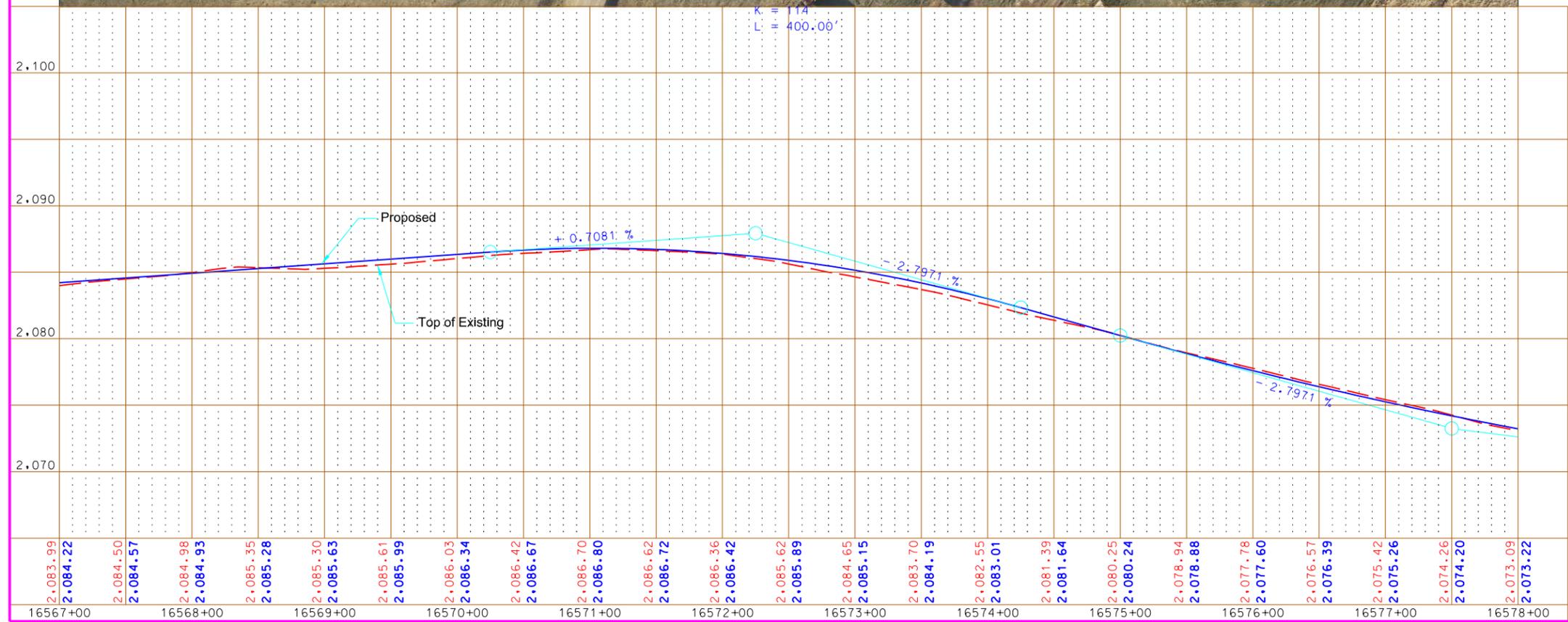
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1804

B-15

Sec 22
T-154-N
R-100-W

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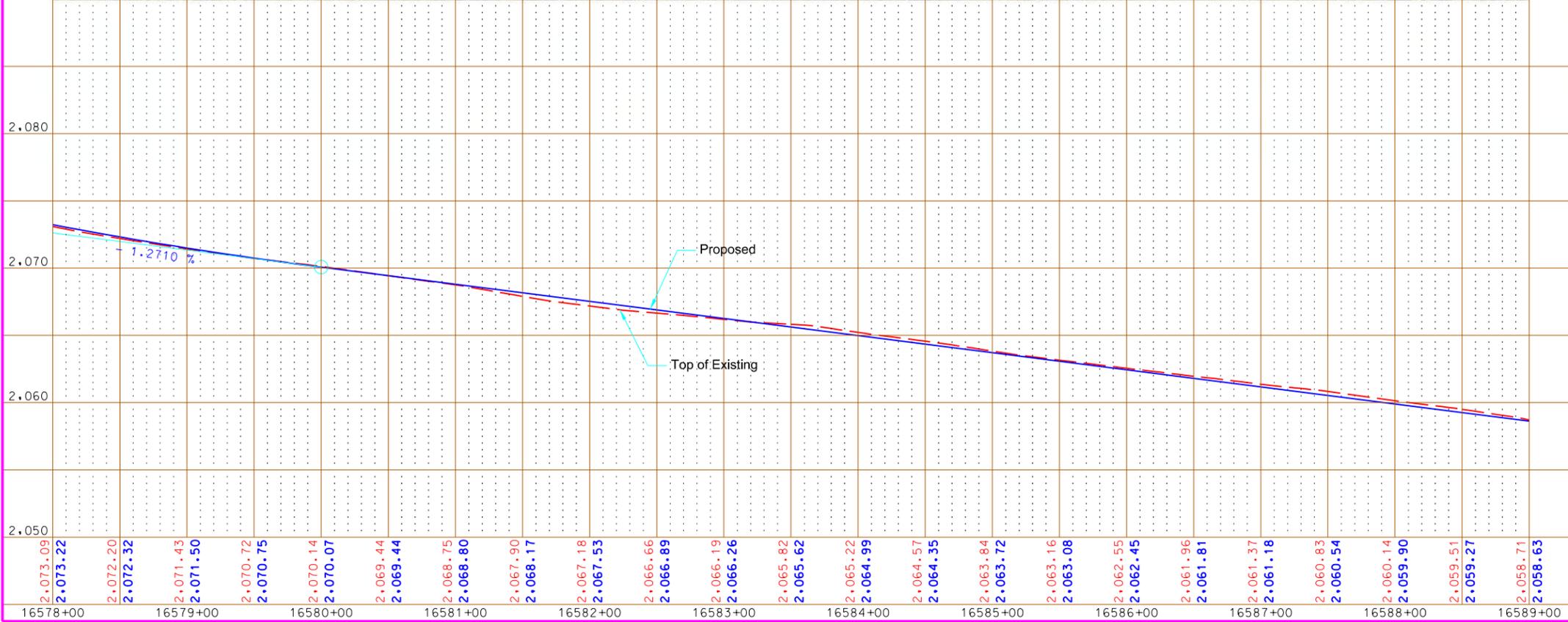


- LEGEND**
- - - - - Proposed Fill
 - - - - - Proposed Cut
 - - - - - Proposed cut/fill Transition
 - Bore Hole

This document is preliminary and not for construction or implementation purposes.

Plan and Profile
1804 Reconstruction
Williams County, ND
Sta. 16567+00 to Sta. 16578+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	8



- LEGEND**
- - - - - Proposed Fill
 - - - - - Proposed Cut
 - - - - - Proposed cut/fill Transition
 - Bore Hole

PRELIMINARY

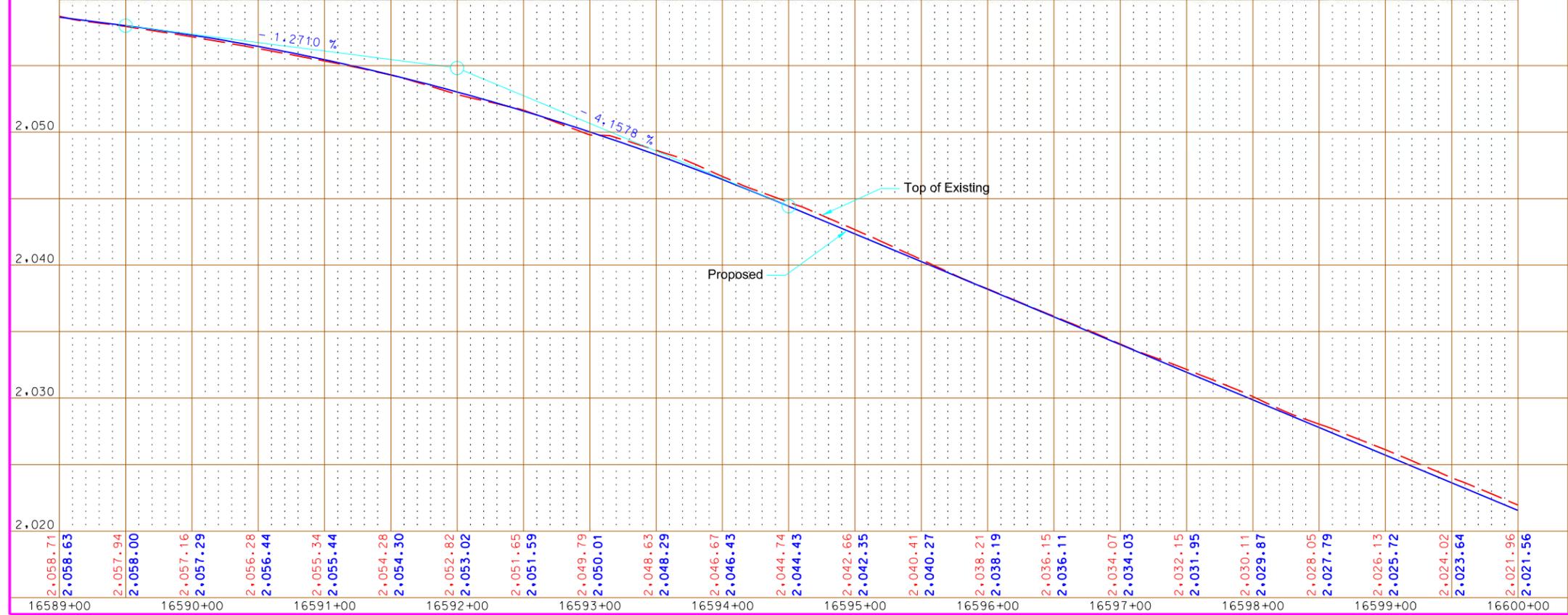
This document
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implementation
purposes.

Plan and Profile
1804 Reconstruction
Williams County, ND
Sta. 16578+00 to Sta. 16589+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	9



Curve C2
 PI = 16600+10.59
 Delta = 43° 12' 11" (RT)
 De = 1° 30' 00"
 R = 3,819.83
 T = 1,512.60
 L = 2,880.29



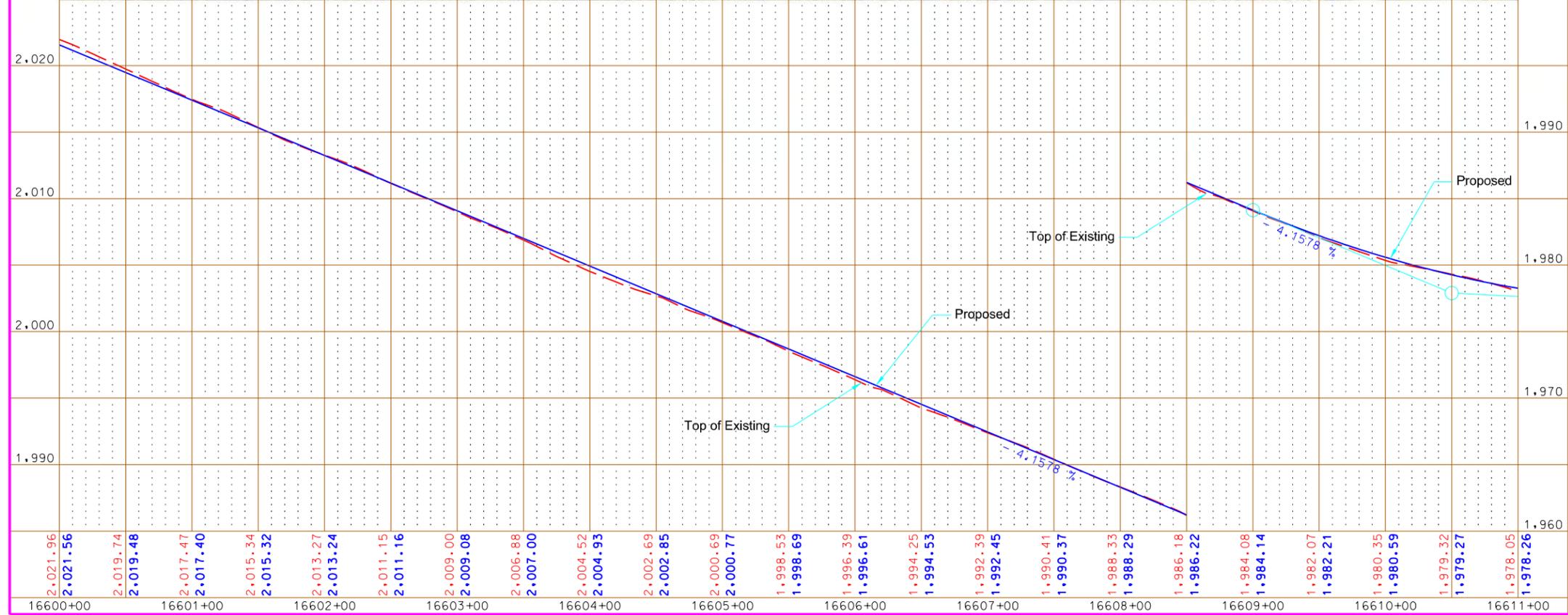
- LEGEND**
- Proposed Fill
 - Proposed Cut
 - Proposed cut/fill Transition
 - Bore Hole

PRELIMINARY

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Plan and Profile
1804 Reconstruction
Williams County, ND
Sta. 16589+00 to Sta. 16600+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	10



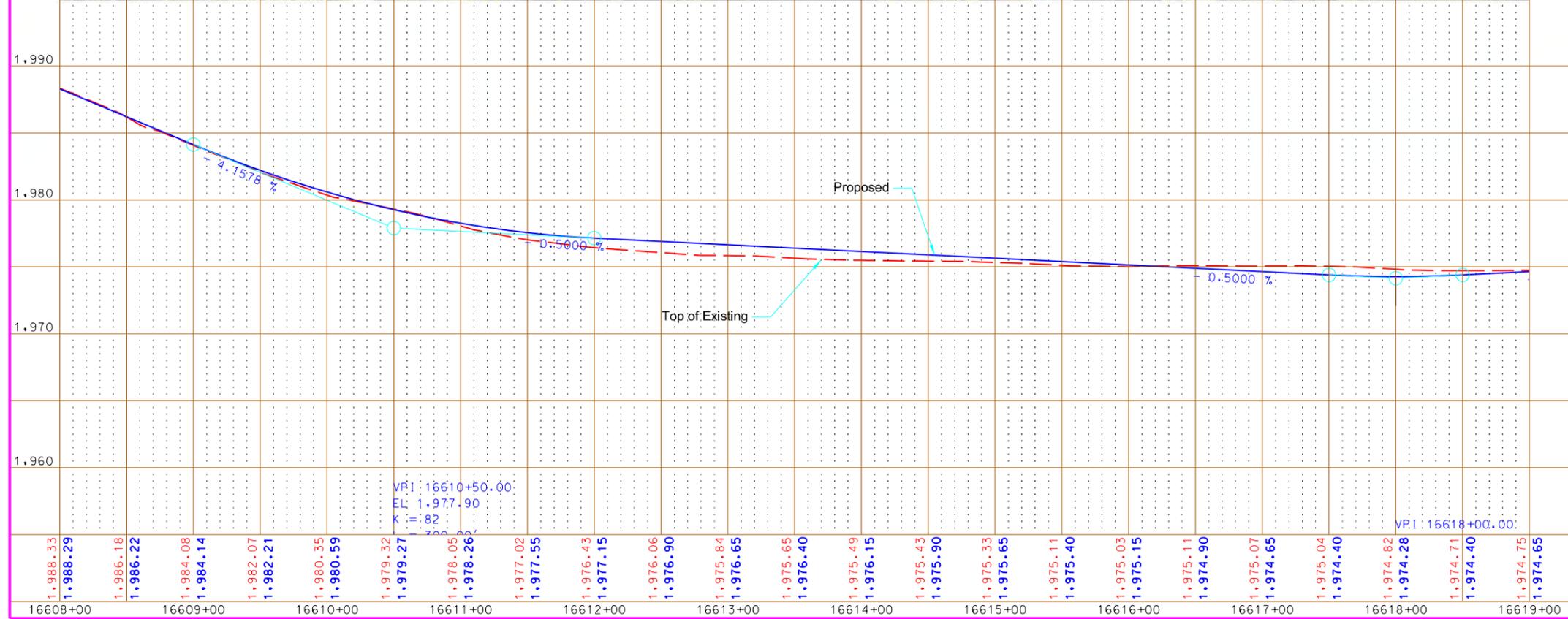
- LEGEND**
- - - - - Proposed Fill
 - - - - - Proposed Cut
 - - - - - Proposed cut/fill Transition
 - Bore Hole

PRELIMINARY

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Plan and Profile
1804 Reconstruction
Williams County, ND
Sta. 16600+00 to Sta. 16608+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	11



- LEGEND**
- - - - - Proposed Fill
 - - - - - Proposed Cut
 - - - - - Proposed cut/fill Transition
 - Bore Hole

PRELIMINARY

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Plan and Profile
1804 Reconstruction
Williams County, ND
Sta. 16608+00 to Sta. 16619+00

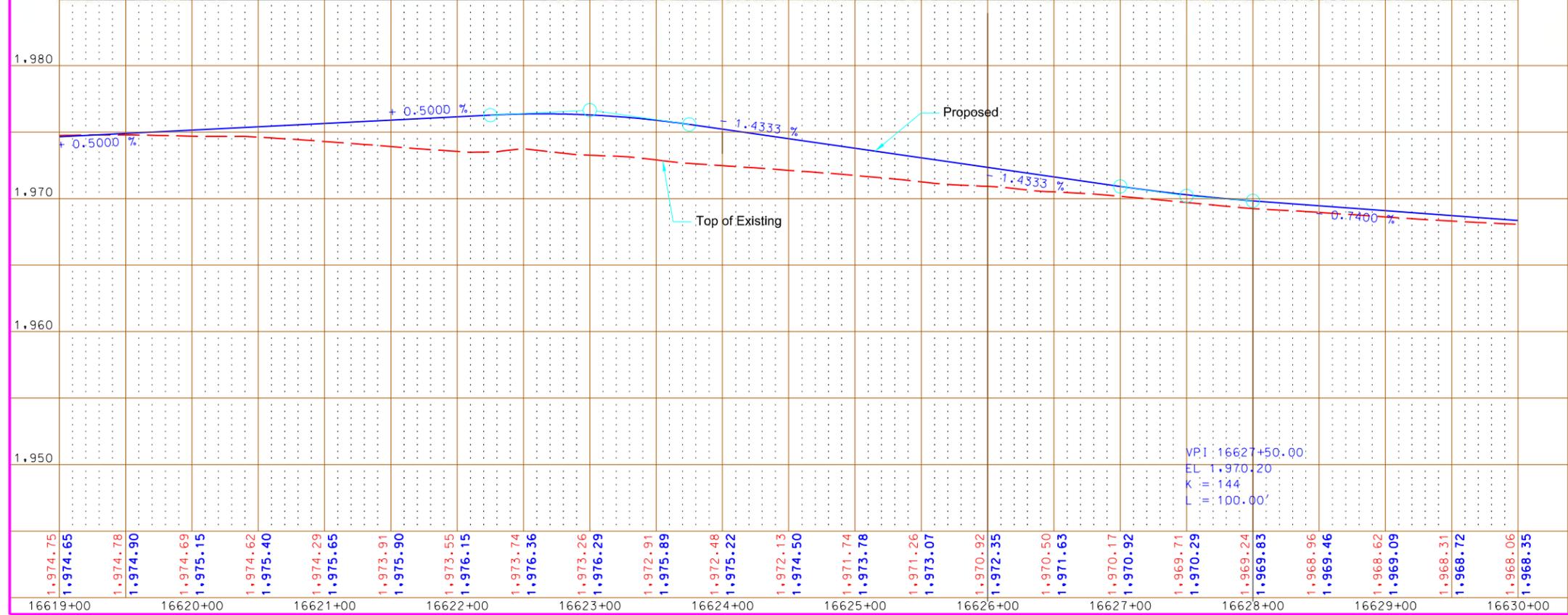
STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	12



Curve C3
 PI = 16624+37.48
 Delta = 13° 15' 27" (RT)
 Da = 1° 00' 00"
 R = 5,729.65
 T = 665.86
 L = 1,325.77

LEGEND

- - - - - Proposed Fill
- - - - - Proposed Cut
- - - - - Proposed cut/fill Transition
- Bore Hole

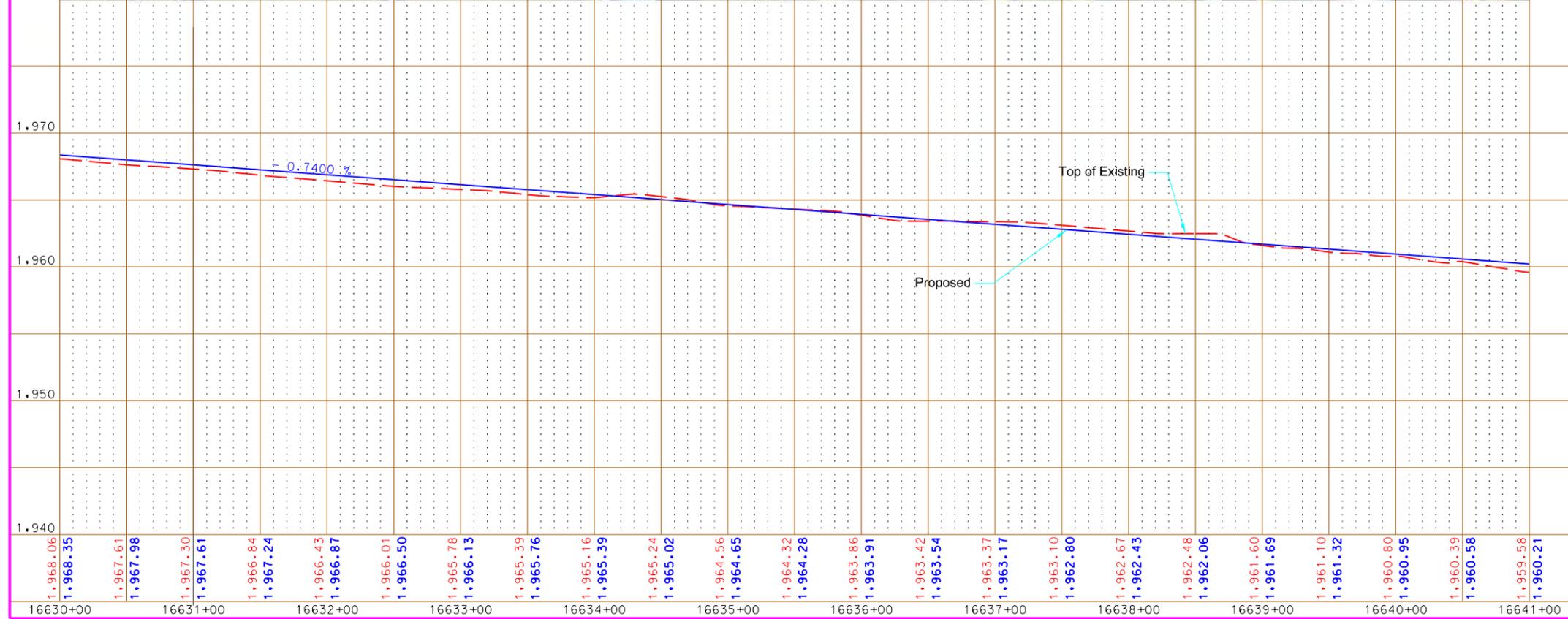
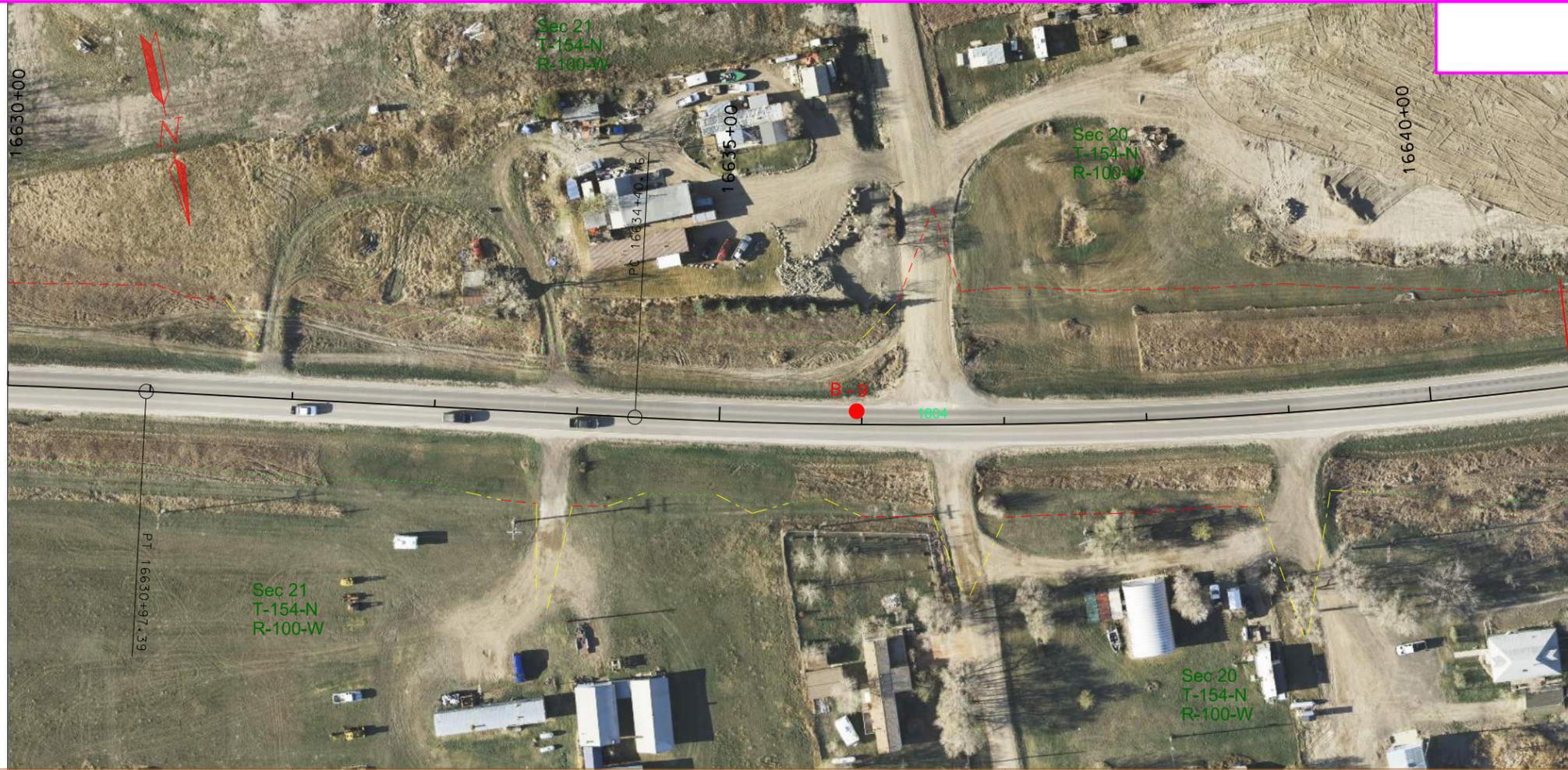


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Plan and Profile
1804 Reconstruction
Williams County, ND
Sta. 16619+00 to Sta. 16630+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	13



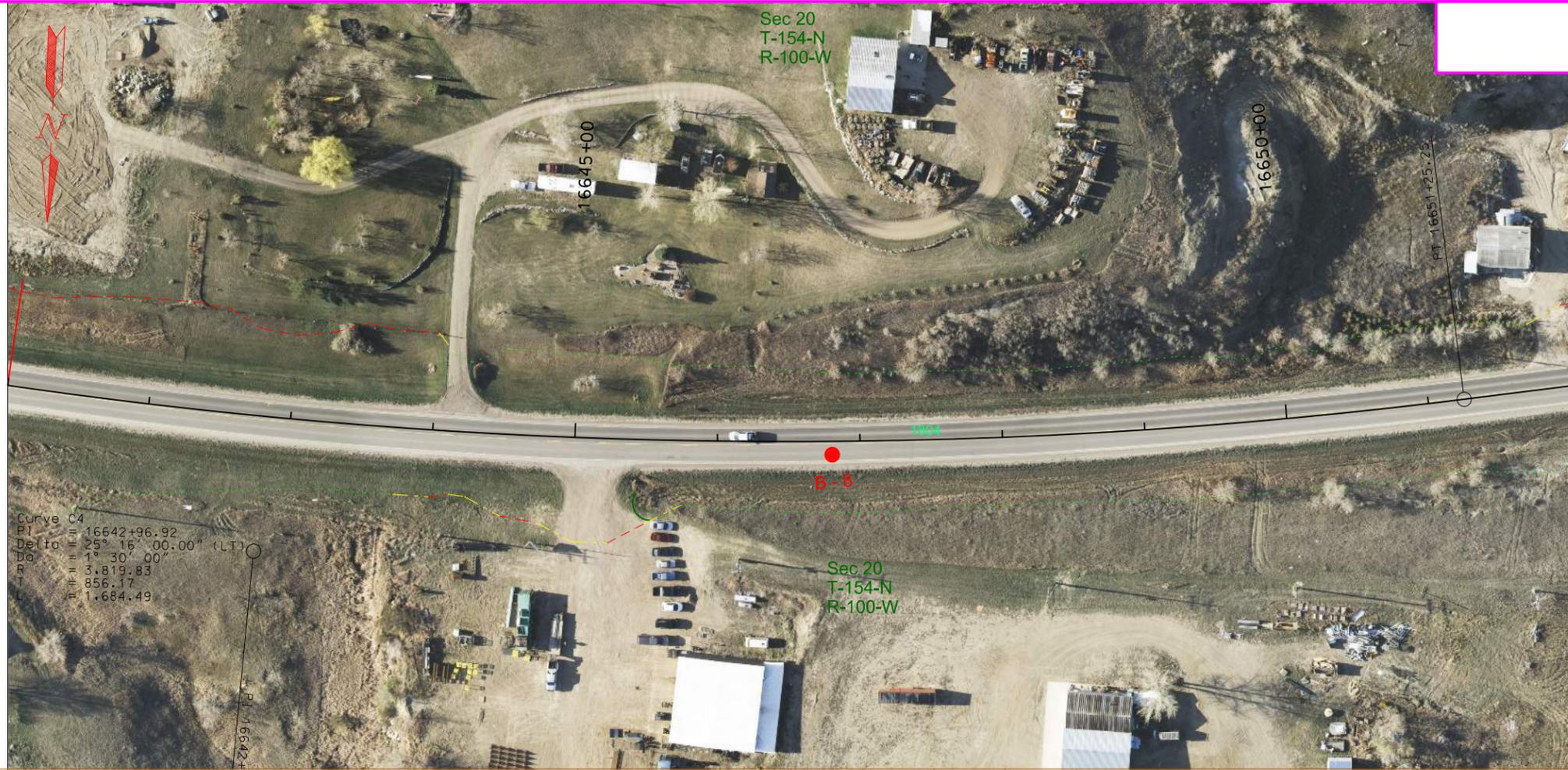
- LEGEND**
- - - - - Proposed Fill
 - - - - - Proposed Cut
 - - - - - Proposed cut/fill Transition
 - Bore Hole

PRELIMINARY

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purposes.

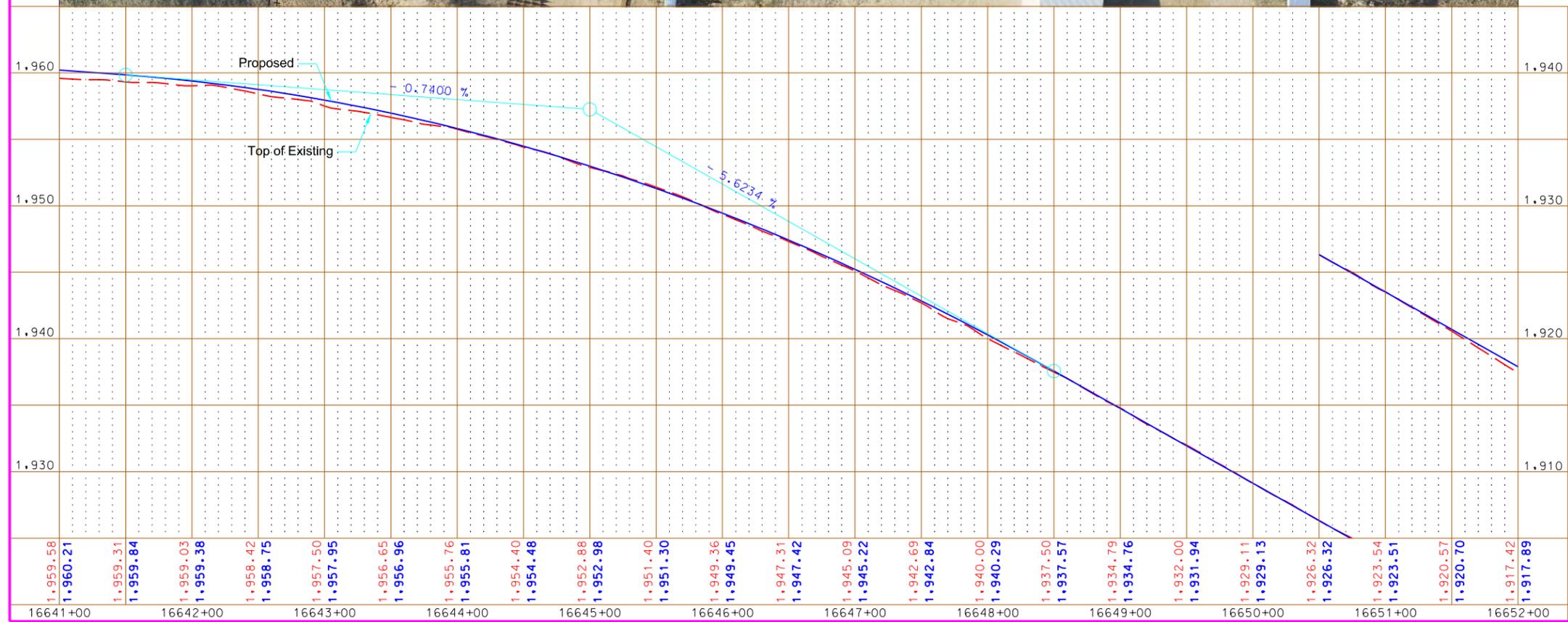
Plan and Profile
1804 Reconstruct
Williams County, ND
Sta. 16630+00 to Sta. 16641+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	14



Curve C4

PI	= 16642+96.92
Delta	= 25° 16' 00.00" (LT)
Da	= 1° 30' 00"
R	= 3,819.83
T	= 856.17
L	= 1,684.49



LEGEND

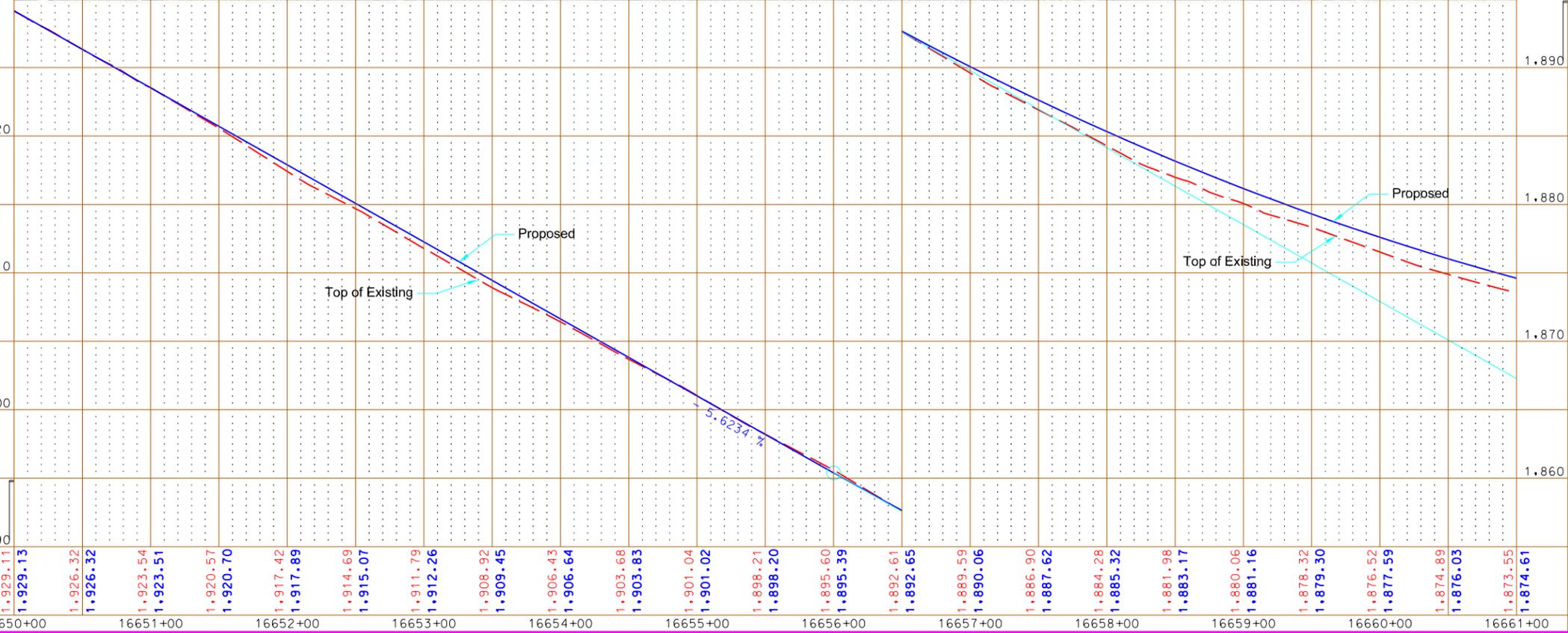
- - - Proposed Fill
- - - Proposed Cut
- - - Proposed cut/fill Transition
- Bore Hole

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Plan and Profile
1804 Reconstruction
Williams County, ND
Sta. 16641+00 to Sta. 16650+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	15



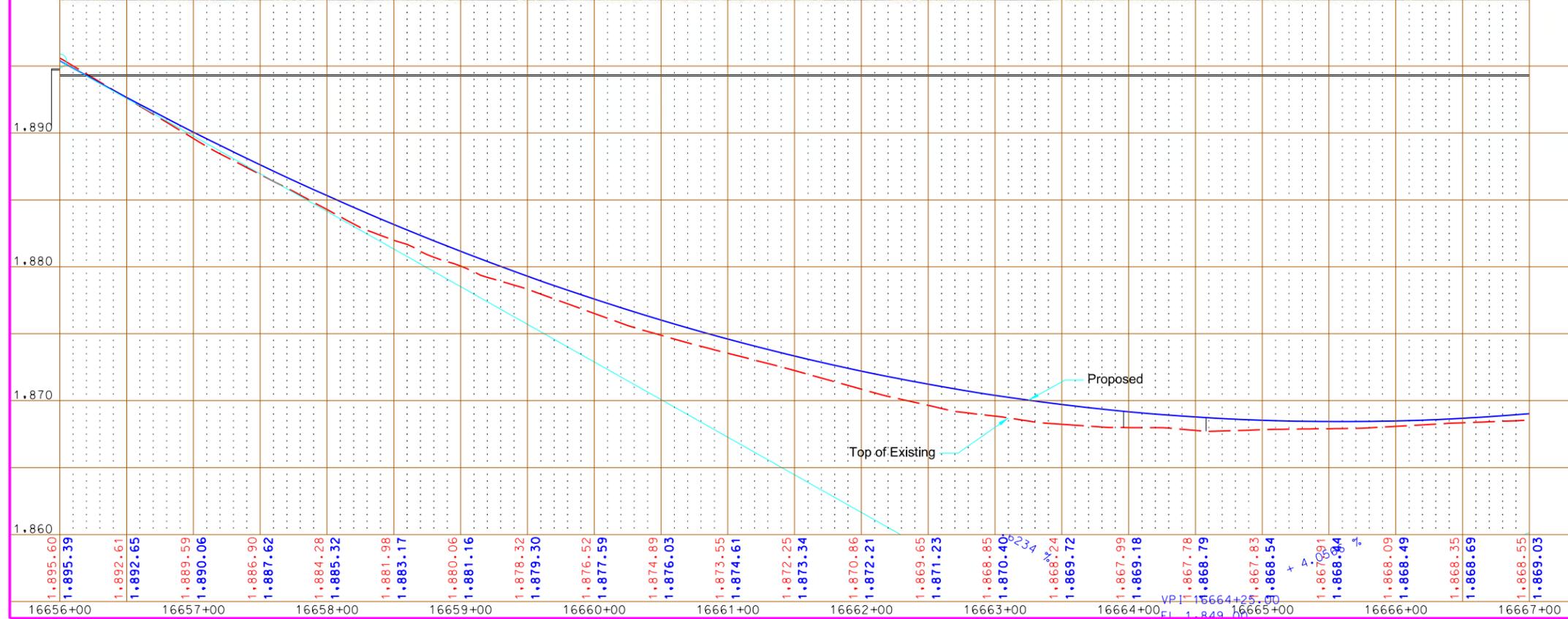
- LEGEND**
- Proposed Fill
 - Proposed Cut
 - Proposed cut/fill Transition
 - Bore Hole

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Plan and Profile
1804 Reconstruction
Williams County, ND
Sta. 16650+00 to Sta. 16656+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	16



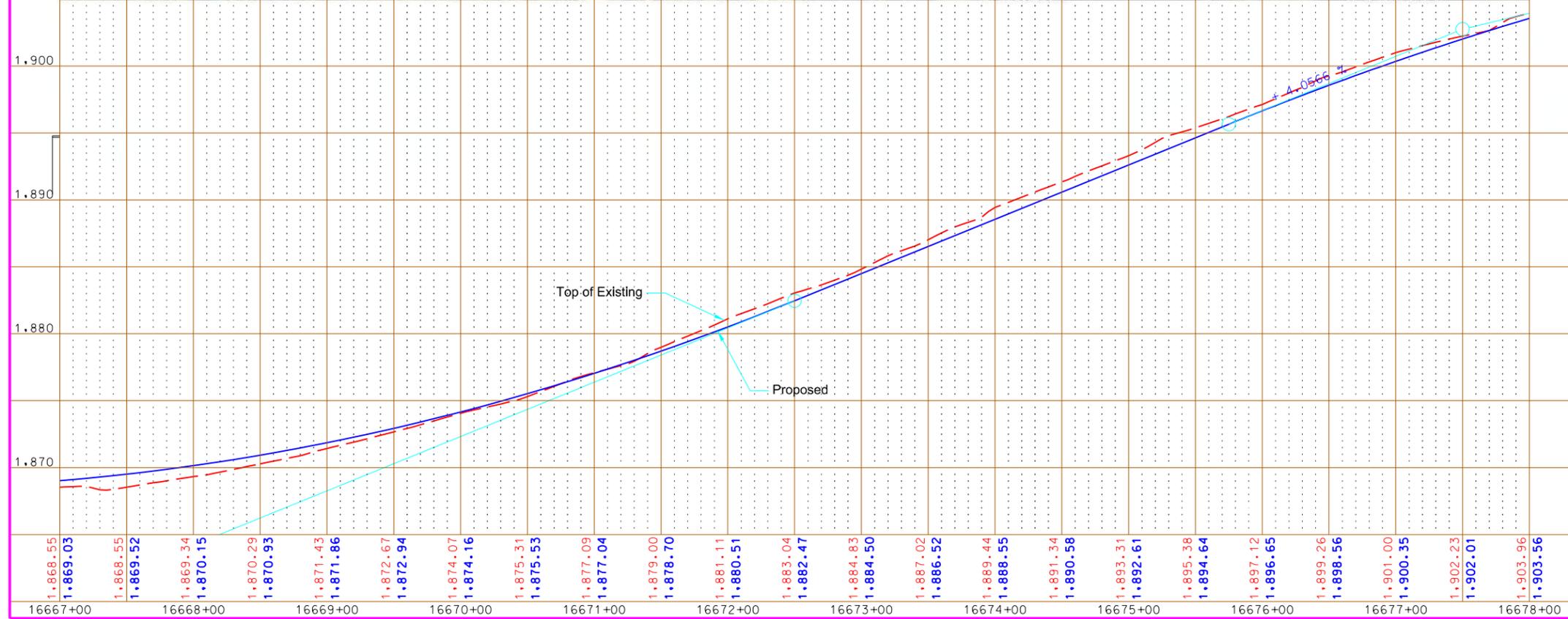
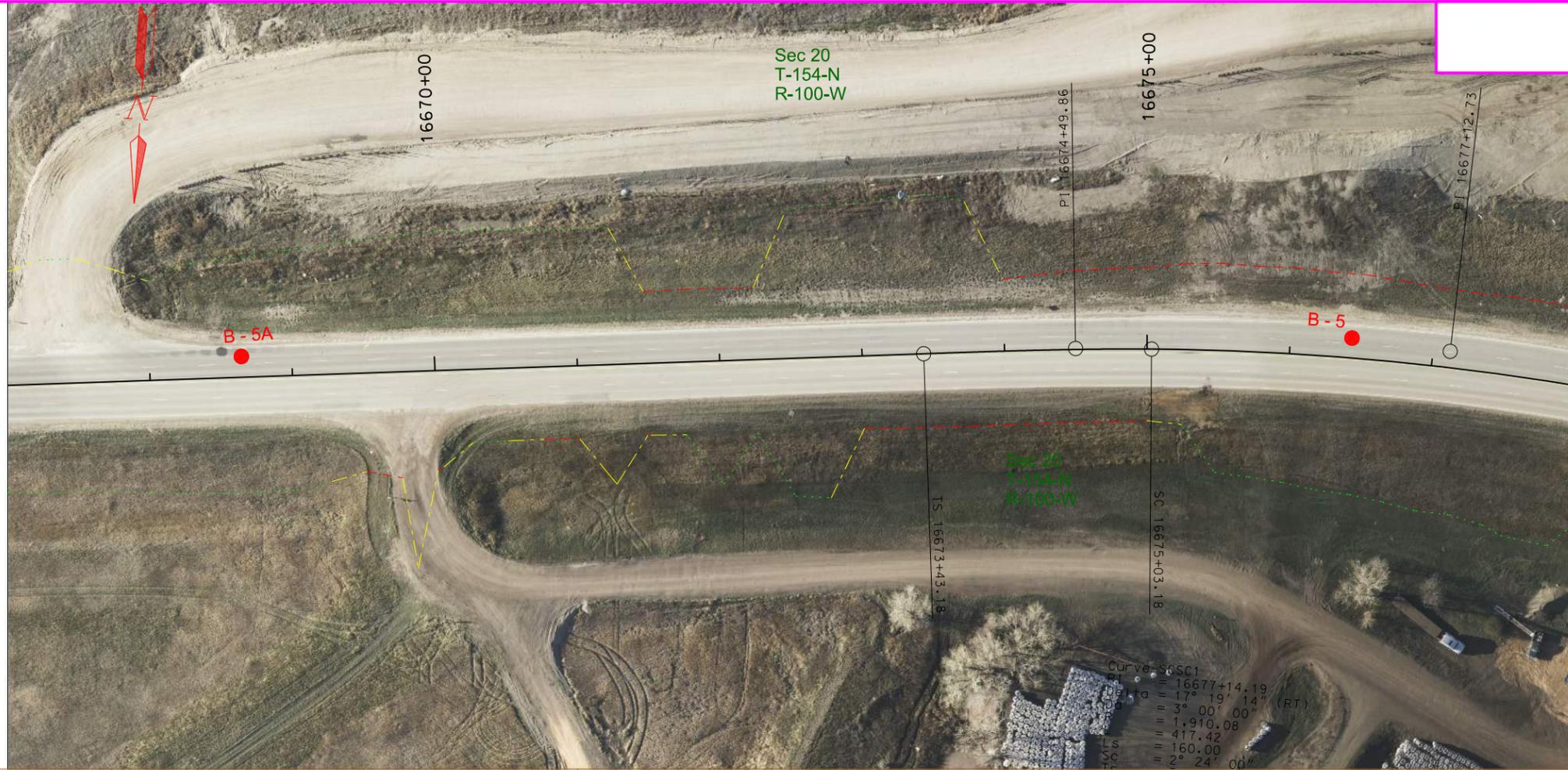
- LEGEND**
- - - - - Proposed Fill
 - - - - - Proposed Cut
 - - - - - Proposed cut/fill Transition
 - Bore Hole

PRELIMINARY

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Plan and Profile
1804 Reconstruction
Williams County, ND
Sta. 16656+00 to Sta. 16667+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	17



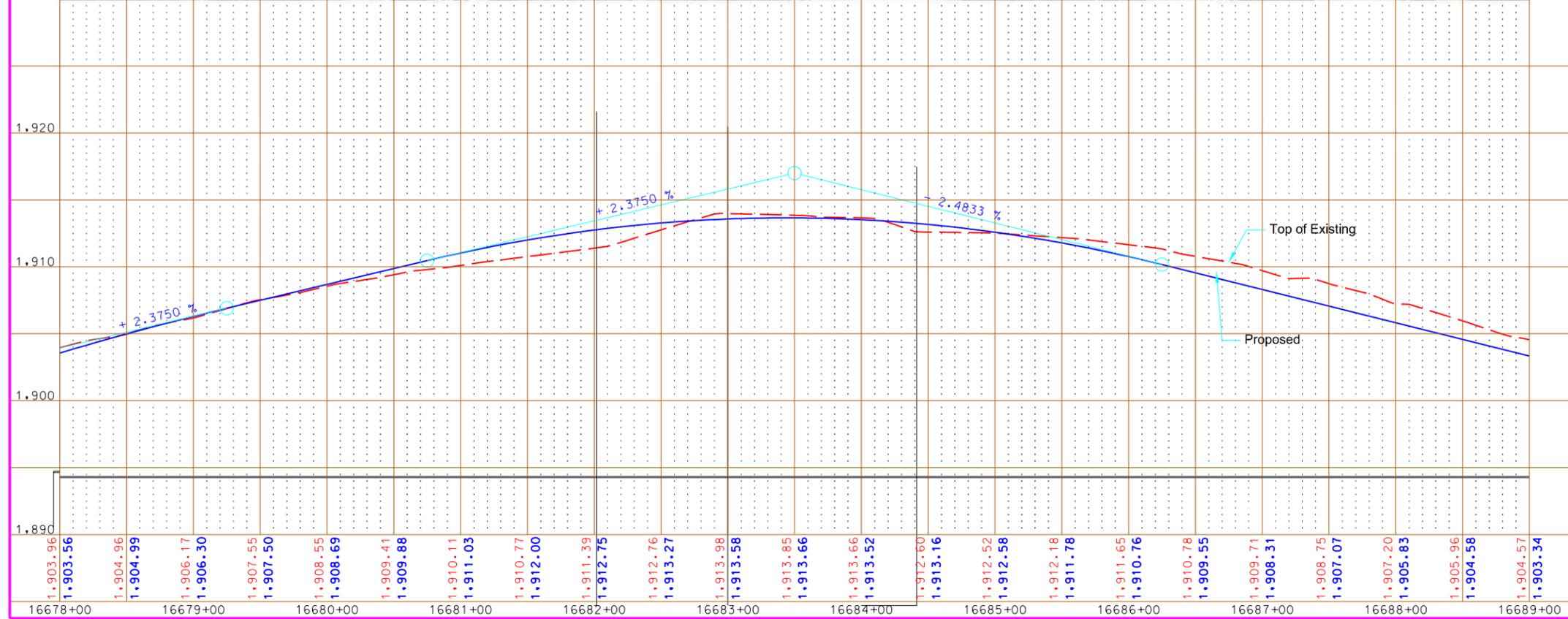
- LEGEND**
- - - - - Proposed Fill
 - - - - - Proposed Cut
 - - - - - Proposed cut/fill Transition
 - Bore Hole

PRELIMINARY

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Plan and Profile
1804 Reconstruction
Williams County, ND
Sta. 16667+00 to Sta. 16678+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	18



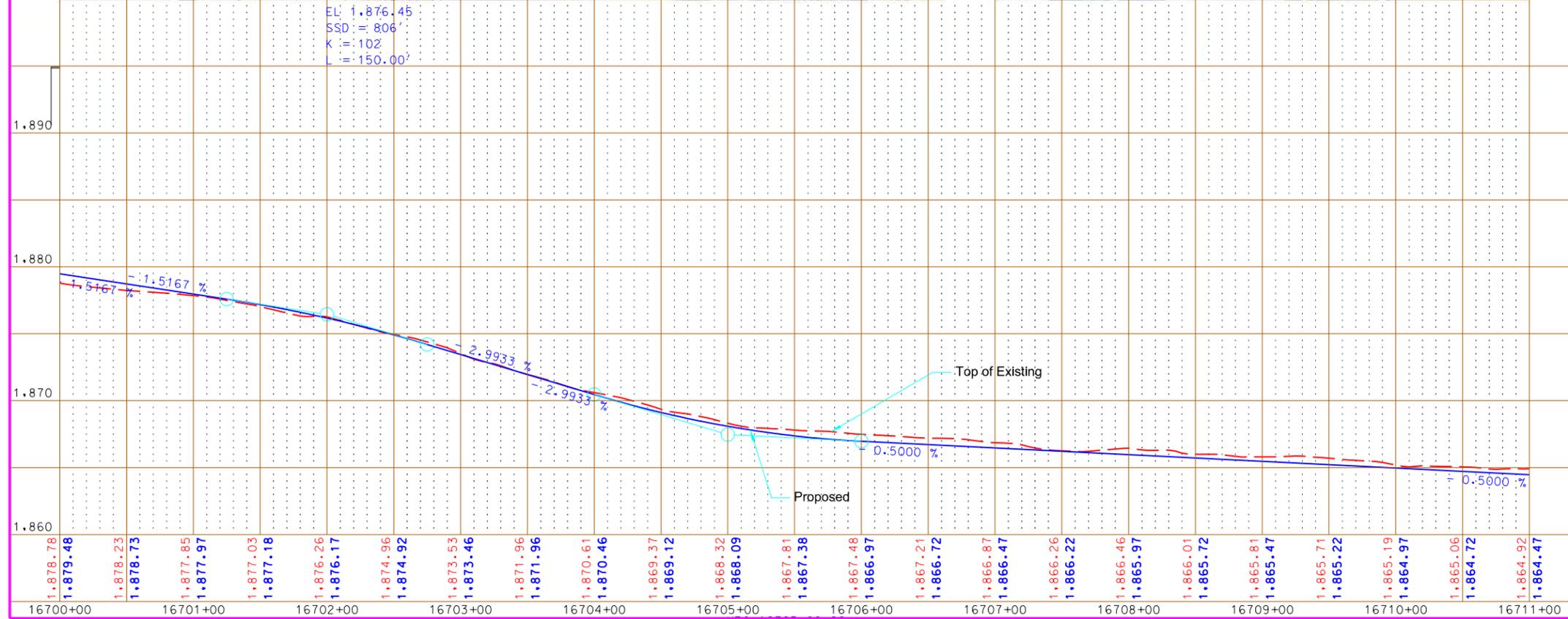
- LEGEND**
- Proposed Fill
 - Proposed Cut
 - Proposed cut/fill Transition
 - Bore Hole

PRELIMINARY

This document is preliminary and not for construction or implementation purposes.

Plan and Profile
1804 Reconstruction
Williams County, ND
Sta. 16678+00 to Sta. 16689+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	20



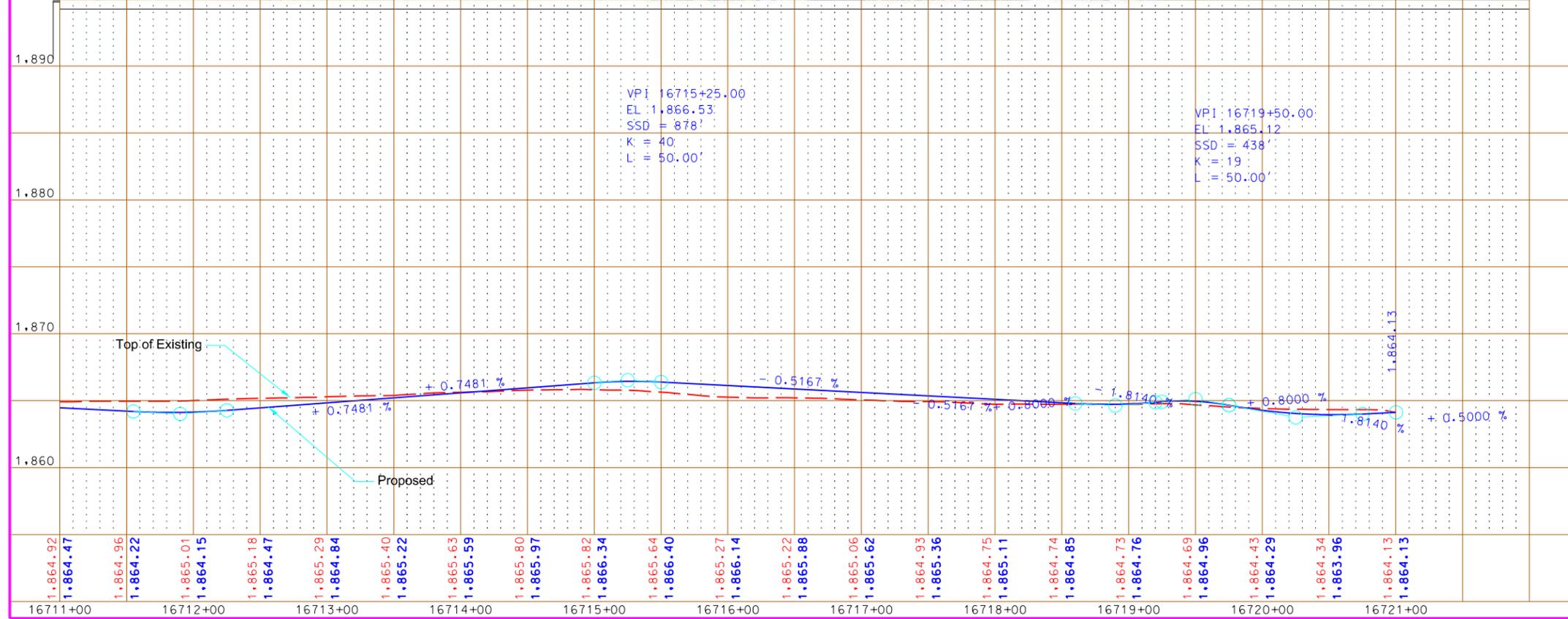
- LEGEND**
- - - - - Proposed Fill
 - - - - - Proposed Cut
 - - - - - Proposed cut/fill Transition
 - Bore Hole

PRELIMINARY

This document is preliminary and not for construction or implementation purposes.

Pland and Profile
 ND 1804 Reconstruction
 Williams County, ND
 Sta. 16700+00 to Sta. 16711+00

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	7-804(055)304	60	21



- LEGEND**
- - - - - Proposed Fill
 - - - - - Proposed Cut
 - - - - - Proposed cut/fill Transition
 - Bore Hole

PRELIMINARY

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Pland and Profile
ND 1804 Reconstruction
Williams County, ND
Sta. 16711+00 to Sta. 16721+00

APPENDIX B
LOG OF BORINGS

Boring Log Descriptive Terminology



Key to Soil Symbols and Terms

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS		SYMBOLS		TYPICAL DESCRIPTIONS
		GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	Well-graded gravels, gravel sand mixtures, little or no fines.
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	SW	Well-graded sands, gravelly sands, little or no fines.
			SP	Poorly graded sands, gravelly sands, little or no fines.
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	Silty sands, sand-silt mixtures.
			SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils.

NOTE: DOWL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

Notes

SPT (Standard Penetration Test-ASTM D1586):
The number of blows of a 140 lb (63.6 kg) hammer falling 2.5 ft (750 mm) used to drive a 2 in (50 mm) O.D. Split Spoon sampler for a total of 1.5 ft (0.45 m) of penetration.
Written as follows:
first 0.5 ft (0.15 m) - second 0.5 ft (0.15 m) - third 0.5 ft (0.15 m)
(ex: 1-3-9)
Note: if the number of blows exceeds 50 before 0.5 ft (0.15 m) of penetration is achieved, the actual penetration follows the number of blows in parentheses
(ex: 12-24-50 (0.09 m), 34-50 (0.4 ft), or 100 (0.3 ft)).
WR denotes a zero blow count with the weight of the rods only.
WH denotes a zero blow count with the weight of the rods plus the weight of the hammer.

Soil Classifications are Based on the Unified Soil Classification System, ASTM D2487 and D2488. Also included are the AASHTO group classifications (M145). Descriptions are based on visual observation, except where they have been modified to reflect results of laboratory tests as deemed appropriate.

Order of Descriptors

- Group Name
- Consistency or Relative Density
- Moisture Condition
- Color
- Particle size descriptor(s) (coarse grained soils only)
- Angularity of coarse grained soils
- Other relevant notes

Criteria For Descriptors Consistency of Fine Grained Soils

Consistency	N-Value (uncorrected)
Very Soft	< 2
Soft	2 - 4
Medium Stiff	5 - 8
Stiff	9 - 15
Very Stiff	16 - 30
Hard	> 30

Apparent Density of Coarse Grained Soils Relative Density

Relative Density	N-Value (uncorrected)
Very Loose	< 4
Loose	4 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

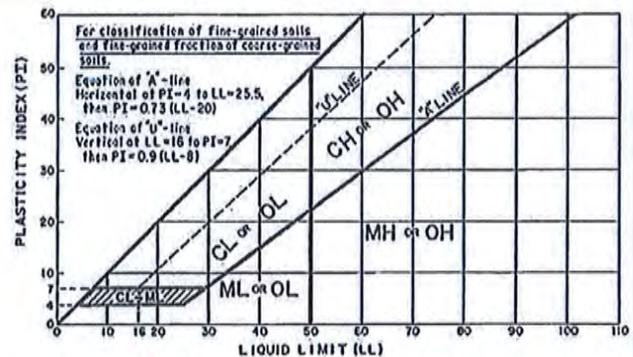
Moisture Condition

- | | |
|-------|--|
| Dry | -Absence of moisture, dusty, dry to the touch. |
| Moist | -Damp, but no visible water. |
| Wet | -Visible free water. |

Definition of Particle Size Ranges

Soil Component	Size Range
Boulder	> 12 in (300 mm)
Cobble	3 in (75 mm) - 12 in (300 mm)
Gravel	No. 4 Sieve (4.75 mm) to 3 in (75 mm)
Sand	No. 200 (0.075 mm) to No. 4 Sieves (4.75 mm)
Silt	< No. 200 Sieve (0.075 mm)*
Clay	< No. 200 Sieve (0.075 mm)*

*Use Atterberg limits and chart below to differentiate between silt and clay.



Angularity of Coarse-Grained Particles

- Angular** - Particles have sharp edges and relative plane sides with unpolished surfaces.
- Subangular** - Particles are similar to angular description, but have rounded edges.
- Subrounded** - Particles have nearly plane sides, but have no edges.
- Rounded** - Particles have smoothly curved sides and well-rounded corners and edges.

Example soil description: Sandy FAT CLAY, soft, wet, brown.

Boring Log Descriptive Terminology



Key to Rock Symbols and Terms

Rock Type	Symbol	Rock Type	Symbol	Rock Type	Symbol
Argillite		Dolomite		Quartzite	
Basalt		Gneiss		Rhyolite	
Bedrock (other)		Granitic		Sandstone	
Breccia		Limestone		Schist	
Claystone		Siltstone		Shale	
		Conglomerate			

Order of Descriptors

- Rock Type
- Color
- Grain size (if applicable)
- Stratification/Foliation (as applicable)
- Weathering
- Field Hardness
- Other relevant notes

Criteria For Descriptors

Grain Size

Description	Characteristic
Coarse Grained	Individual grains can be easily distinguished by eye
Fine Grained	Individual grains can be distinguished with difficulty

Stratum Thickness

Thickly Bedded	3-10 ft (1-3 m)
Medium Bedded	1-3 ft (300 mm - 1 m)
Thinly Bedded	2-12 in (50-300 mm)
Very Thinly Bedded	< 2 in (50 mm)

Weathering

Highly Weathered	More than half of the rock is decomposed; rock is weakened so that a minimum 2 inch (50mm) diameter sample can be broken readily by hand across rock fabric
Moderately Weathered	Rock is discolored and noticeably weakened, but less than half is decomposed; a minimum 2 inch (50mm) diameter sample cannot be broken readily by hand across rock fabric
Slightly Weathered	Rock is slightly discolored, but not noticeably lower in strength than fresh rock

Rock Field Hardness

Very Soft	Can be carved with knife. Can be excavated readily with point of rock hammer. Can be scratched readily by fingernail.
Soft	Can be grooved or gouged readily by knife or point of rock hammer. Can be excavated in fragments from chips to several inches in size by moderate blows of the point of a rock hammer.
Medium	Can be grooved or gouged 0.05 in (2 mm) deep by firm pressure of knife or rock hammer point. Can be excavated in small chips to pieces about 1 in (25 mm) maximum size by hard blows of the point of a rock hammer.
Moderately hard	Can be scratched with knife or pick. Gouges or grooves to 0.25 in (6 mm) can be excavated by hard blow of rock hammer. Hand specimen can be detached by moderate blows.
Hard	Can be scratched with knife or pick only with difficulty. Hard hammer blows required to detach hand specimen.
Very Hard	Cannot be scratched with knife or sharp rock hammer point. Breaking of hand specimens requires several hard blows of a rock hammer.

Example Rock Log
SANDSTONE, gray, fine grained, thickly bedded, slightly weathered, hard field hardness.

Notes:

Qu = Unconfined Compressive Strength obtained from laboratory testing at the given depth.

Miscellaneous Soil/Rock Symbols and Terms

	Concrete
	Asphalt
	Water
	Boulders and Cobbles
	Coal
	Fill
	Millings
	Topsoil

Explanation of Text Fields in Boring Logs:

Material Description: Lithologic Description of soil or rock encountered.

Remarks: Comments on drilling, including method, bit type, and problems encountered.

Notes: Legal Description, explanation of survey method used, and horizontal coordinates.

General Notes

- Descriptions on these boring logs apply only at the specific boring, and at the time the borings were made. These logs are not warranted to be representative of subsurface conditions at other locations or times.
- Water level observations apply only at the specific boring, and at the time the borings were made. Due to the variability of groundwater measurements given the type of drilling used, and the stratification of the soil in the boring, these logs are not warranted to be representative of groundwater conditions at other locations or times.
- Other terms may be used as descriptors, as defined by the profession.

Operation Types:	Sample Types:

-Soil and Rock descriptions are based on visual observation, except where they have been modified to reflect results of laboratory tests as deemed appropriate.



LOG OF BORING

Boring B-1

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433612.6 ft	Station: 16720 + 35
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1213115.22 ft	Offset: 20 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1863.8 ft
Date Started: 10/14/15	Date Finished: 10/14/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 19 - B	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
1							Asphalt, black.	0.8						Asphalt Pavement: 9.25 inches
1862.8								1863.0	11					Base Course: 4 inches Auger Cuttings Bulk Sample: 1.1 to 4.5 feet Max. Dry Density: 120 pcf Opt. Moisture: 14%
2			60		3 - 6 - 7	BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, rounded to subangular, [A-1].	1.1							
1861.8						FILL, Lean CLAY with sand (CL), stiff, moist, brown to multi-colored, [A-7].	1862.7	15	45	16	74			
3														
1860.8								18						
4														
1859.8							Lean CLAY with sand (CL), medium stiff, moist, gray, [A-7].	4.0						
1859.8								1859.8						
5			60		2 - 3 - 4									
1858.8														
6														
1857.8								6.0						
Boring Depth: 6.0 ft, Elevation: 1857.8 ft								1857.8						

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-1A

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433562.34 ft	Station: 16715 + 40
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1213608.62 ft	Offset: 20 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1865.6 ft
Date Started: 10/14/15	Date Finished: 10/14/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 19 - A	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
1							Asphalt, black.	0.8						Asphalt Pavement: 9 inches
1864.6								1864.8						Base Course: 6 inches
2			45		5 - 5 - 5		BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, rounded to subangular, [A-1].	1.3	6					
1863.6							FILL, Sandy Lean CLAY with gravel (CL), stiff, moist, gray, rounded, [A-7].	1864.3						
3							FILL, Lean CLAY with sand (CL), stiff to medium stiff, moist, gray, [A-7].	3.0						
1862.6								1862.6	19	46	16	78		Auger Cuttings Bulk Sample: 1.25 to 4.5 feet Max. Dry Density: 122 pcf Opt. Moisture: 12%
4							FILL, Poorly-Graded SAND with gravel (SP), medium dense, dry to moist, light brown to multi-colored, fine to coarse grained, rounded to subangular, [A-2].	4.6						
1861.6			67		13 - 12 - 10			1861.0						
5								6.0						
1860.6								1859.6						
6														
1859.6							Boring Depth: 6.0 ft, Elevation: 1859.6 ft							

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-2

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433567.18 ft	Station: 16706 + 51
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1214497.86 ft	Offset: 20 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1867.2 ft
Date Started: 10/14/15	Date Finished: 10/14/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 19 - A	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
1							Asphalt, black.	0.5	5		NP	12		Asphalt Pavement: 5.75 inches Base Course: 48 inches Auger Cuttings Bulk Sample: 0.5 to 4.0 feet
1866.2							BASE COURSE, Poorly-Graded SAND with silt and gravel (SP-SM), medium dense, moist, brown, fine to coarse grained, rounded to subrounded, [A-1].	1866.7						
2														
3														
1865.2														
4														
1864.2														
5														
1863.2														
6														
1862.2				73	3 - 4 - 5		Lean CLAY with sand (CL), stiff, moist, brown, [A-7]. minor rounded pebbles.	4.0	21					
1861.2								6.0						
Boring Depth: 6.0 ft, Elevation: 1861.2 ft								1861.2						

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations		<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()		<input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-3

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433486.45 ft	Station: 16696 + 48
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1215499.04 ft	Offset: 20 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1886.7 ft
Date Started: 10/14/15	Date Finished: 10/14/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 19 - A	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
0.5							Asphalt, black.	0.5	1886.2						Asphalt Pavement: 6.25 inches
1.4					8 - 10 - 8		BASE COURSE, Well-Graded GRAVEL with clay and sand (GW), medium dense, moist, dark brown to black, fine to coarse grained, rounded, [A-1].	1.4	1885.3	9					Base Course: 11 inches
1.4 - 4.5			55				Sandy Lean CLAY (CL), very stiff to stiff, moist, brown, [A-6].			12					Auger Cuttings Bulk Sample: 1.4 to 4.5 feet Max. Dry Density: 122 pcf Opt. Moisture: 12%
3 - 5 - 7			80							12	31	13	57		
6.0								6.0	1880.7						Boring Depth: 6.0 ft, Elevation: 1880.7 ft

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-4

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433446.82 ft	Station: 16686 + 59
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1216488.29 ft	Offset: 20 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1910.5 ft
Date Started: 10/14/15	Date Finished: 10/14/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 20 - C	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
0.6							Asphalt, black.	0.6						Asphalt Pavement: 7.75 inches
1.6							BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, rounded to subangular, [A-1].	1.6	13					Base Course: 11 inches
1.6 to 4.5			35		6-4-5		FILL, Sandy Lean CLAY (CL), stiff to medium stiff, moist to dry, brown to black, [A-6]. minor coal fragments.	1.6 to 4.5	15					Auger Cuttings Bulk Sample: 1.6 to 4.5 feet
4.0								4.0	14	34	13			
4.0 to 6.0			40		3-3-3			6.0						

Boring Depth: 6.0 ft, Elevation: 1904.5 ft

6.0
1904.5

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-5

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich	Boring Location N: 433244.7 ft	Station: 16676 + 43
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1217484.62 ft	Offset: 20 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1899.4 ft
Date Started: 10/14/15	Date Finished: 10/14/15	Drilling Fluid: None	Datum: NAD83	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 20 - C	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
0.5							Asphalt, black.	0.5	1898.9						Asphalt Pavement: 6 inches
1.3					2-3-4		BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, rounded to subangular, [A-1].	1.3	1898.1	22	42	15	66		Auger Cuttings Bulk Sample: 1.3 to 4.5 feet Max. Dry Density: 119 pcf Opt. Moisture: 10% CBR: 1.0
4.0							FILL, Sandy Lean CLAY (CL), medium stiff, moist to wet, black, [A-7].	4.0	1895.4						
6.0					3-4-5		FILL, Fat CLAY (CH), stiff, moist, gray to black, [A-7].	6.0	1893.4	23	69	22	90		
Boring Depth: 6.0 ft, Elevation: 1893.4 ft															

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-5A

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433315.07 ft	Station: 16668 + 64
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1218261.11 ft	Offset: 20 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1870.2 ft
Date Started: 10/14/15	Date Finished: 10/14/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 20 - C	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
1							Asphalt, black.	0.7						Asphalt Pavement: 8 inches
1869.2								1869.5						
2			0		3 - 2 - 4		BASE COURSE, Well-Graded SAND with gravel (SW), medium dense, moist, brown, fine to coarse grained, subangular to rounded, [A-2].	1.0						Base Course: 4 inches
1868.2							FILL, Sandy Lean CLAY (CL), medium stiff, moist, dark gray, [A-7].	1869.2						Auger Cuttings Bulk Sample: 1.0 to 4.5 feet
3														
1867.2														
4														
1866.2														
5			90											
1865.2														
6														
1864.2														
7			60		9 - 10 - 10		FILL, Clayey GRAVEL (GC), medium dense, moist, gray, rounded, [A-2].	6.3	19	46	20	73		
1863.2							Lean CLAY with sand (CL), very stiff, moist, gray to black, [A-7]. minor coal fragments.	6.6						
1863.2								1863.6						
8														
1862.2														
9														
1861.2														
10														
1860.2									15					
11			67		4 - 6 - 8		Sandy Lean CLAY (CL), stiff, dry to moist, brown to gray, [A-7]. very minor rounded gravel.	9.0						
1859.2								1861.2						
								11.5						
								1858.7						
Boring Depth: 11.5 ft, Elevation: 1858.7 ft														

Water Level Observations		<input type="checkbox"/> During Drilling: Not Encountered	Remarks:
<input type="checkbox"/> After Drilling: ()		<input type="checkbox"/> After Drilling: ()	

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ



LOG OF BORING

Boring B-6

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433357.58 ft	Station: 16666 + 56
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1218466.4 ft	Offset: 20 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1868.2 ft
Date Started: 10/14/15	Date Finished: 10/14/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 20 - C	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests	
								Elev. (ft)							
0.6							Asphalt, black.	0.6						Asphalt Pavement: 7 inches	
1							BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, subangular to rounded, [A-1].	1867.6						Base Course: 18 inches	
2							FILL, Lean CLAY with sand (CL), stiff to very stiff, dry to moist, gray to light brown, [A-7]. minor coal fragments throughout strata with approximately 40% coal at 5.7 feet.	2.1	20					Auger Cuttings Bulk Sample: 2.0 to 4.5 feet	
3			60		3 - 5 - 4	1865.2		24							
4								2.1							
5			80		3 - 7 - 12	1863.2									
6								6.0							
Boring Depth: 6.0 ft, Elevation: 1862.2 ft								1862.2							

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations		<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()		<input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-7

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433459.58 ft	Station: 16656 + 49
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1219468.09 ft	Offset: 20 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1892.2 ft
Date Started: 10/14/15	Date Finished: 10/14/15	Drilling Fluid: None	Datum: NAD83	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 20 - A	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
1							Asphalt, black.	0.6						Asphalt Pavement: 6.75 inches Base Course: 2 inches Auger Cuttings Bulk Sample: 0.7 to 4.5 feet Max. Dry Density: 121.5 pcf Opt. Moisture: 13.2% CBR: 1.6
1891.2							BASE COURSE, Well-Graded SAND with gravel (SW), medium dense, moist, brown, fine to coarse grained, subangular to rounded, [A-1].	1891.6	18					
2			60		4 - 3 - 6		FILL, Fat CLAY with sand (CH), stiff, moist, light green to light brown, [A-7].	0.7						
1890.2							FILL, COAL, black, fine grained, thinly bedded, very soft field hardness.	2.1						
3							FILL, Fat CLAY with sand (CH), medium stiff, moist, light brown to light green, [A-7]. 3/4" thick coal seam at 5.4 feet.	1890.1						
1889.2								2.5	13	55	15	76		
4								1889.7						
1888.2									21					
5			53		2 - 3 - 3									
1887.2														
6								6.0						
1886.2								1886.2						

Boring Depth: 6.0 ft, Elevation: 1886.2 ft

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-8

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433696.85 ft	Station: 16646 + 90
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1220611.36 ft	Offset: 8 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1946.1 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Datum: NAD83	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 20 - A	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
0.6							Asphalt, black.	0.6	1945.5						Asphalt Pavement: 7.5 inches
1.0							BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, rounded to subangular, [A-1].	1.0	1945.1	14			67		Base Course: 5 inches
2.0			70		5 - 5 - 10		FILL, Sandy Lean CLAY with gravel (CL), stiff, dry to moist, brown, subrounded, [A-6].	2.0	1944.1	12	31	12	44		
3.0							FILL, Clayey SAND (SC), medium dense, moist, brown, fine to coarse grained, [A-6]. minor gravel.	3.0	1943.1	15	35	13	60		
4.0							FILL, Sandy Lean CLAY (CL), stiff, moist, brown, [A-6].	4.0	1942.1						Auger Cuttings Bulk Sample: 1.0 to 4.5 feet Max. Dry Density: 12 pcf Opt. Moisture: 11%
5.0			67		3 - 4 - 6		Sandy Lean CLAY (CL), stiff, moist, brown to black, [A-6]. minor coal fragments.	5.0	1941.1	16	37	14	67		
6.0								6.0	1940.1						
7.0								7.0	1939.1						
8.0								8.0	1938.1						
9.0								9.0	1937.1	15	37	13	63		
10.0			80		4 - 5 - 7			10.0	1936.1						
11.0								11.0	1935.1						

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Boring Depth: 11.0 ft, Elevation: 1935.1 ft

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()		



LOG OF BORING

Boring B-9

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433530.76 ft	Station: 16635 + 95
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1221500.08 ft	Offset: 8 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1964.0 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 21 - B	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
1							Asphalt, black.	0.9						Asphalt Pavement: 10.5 inches
1963.0								1963.1						Base Course: 7 inches
2					6-5-6		BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, subangular to rounded, [A-1].	1.5						Auger Cuttings Bulk Sample: 1.5 to 4.5 feet
1962.0			0			FILL, Silty, Clayey SAND (SC-SM), medium dense, dry to moist, brown, fine to coarse grained, [A-6].	1962.5							
3									12	24	18	49		
1961.0														
4														
1960.0														
5					3-3-5		FILL, Gravelly Lean CLAY (CL), medium stiff, moist, brown, subrounded, [A-6].	4.5	11			65		
1959.0			53					1959.5						
6								6.0						
1958.0								1958.0						

Boring Depth: 6.0 ft, Elevation: 1958.0 ft

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-10

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433322.01 ft	Station: 16626 + 56
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1222414.73 ft	Offset: 8 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1968.5 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 21 - B	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
1							Asphalt, black.	0.8						Asphalt Pavement: 9.5 inches
1967.5								1967.7						Base Course: 6 inches
2							BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, rounded to subangular, [A-1].	1.3	15			69		Auger Cuttings Bulk Sample: 1.3 to 4.5 feet
1966.5			60		9 - 8 - 7		FILL, Sandy Lean CLAY (CL), stiff, dry to moist, brown, [A-4].		11	24	15	55		
3									11	26	17	64		
1965.5														
4							Sandy Lean CLAY (CL), medium stiff, dry to moist, brown to dark brown, [A-6].	4.0						
1964.5								1964.5						
5			60		3 - 4 - 3									
1963.5														
6								6.0						
1962.5								1962.5						

Boring Depth: 6.0 ft, Elevation: 1962.5 ft

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-11

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433201.47 ft	Station: 16616 + 53
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1223407.56 ft	Offset: 8 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1975.1 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 21 - C	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
1							Asphalt, black.	0.9	1974.2						Asphalt Pavement: 11 inches
2							BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, rounded to subangular, [A-1].	1.7	1973.4	15					Base Course: 9 inches
3			55		4 - 4 - 4		FILL, Sandy Lean CLAY (CL), medium stiff, dry to moist, brown to light brown, [A-4].								Auger Cuttings Bulk Sample: 1.7 to 4.5 feet
4										13	26	16	56		
5			73		6 - 9 - 11		Lean CLAY with sand (CL), very stiff, dry to moist, dark brown to black, [A-7]. minor coal fragments.	4.5	1970.6	18					
6								6.0	1969.1						

Boring Depth: 6.0 ft, Elevation: 1969.1 ft

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input type="checkbox"/> After Drilling: ()	Remarks:
<input type="checkbox"/> After Drilling: ()	<input type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-12

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433243.25 ft	Station: 16606 + 56
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1224400.04 ft	Offset: 8 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1993.8 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 21 - A	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
1							Asphalt, black.	1.0	1992.8						Asphalt Pavement: 11.5 inches
2							BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, rounded to subangular, [A-1].	1.7	1992.1						Base Course: 9 inches
3			5		5 - 7 - 10		FILL, Sandy Lean CLAY (CL), very stiff, dry to moist, brown, subrounded, [A-6].			13	30	14	54		Auger Cuttings Bulk Sample: 1.7 to 4.5 feet
4							FILL, Sandy Lean CLAY (CL), medium stiff, dry to moist, dark brown to brown, [A-4].	4.0	1989.8	13	25	16			
5			60		3 - 4 - 4										
6								6.0	1987.8						

Boring Depth: 6.0 ft, Elevation: 1987.8 ft

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-13

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433509.17 ft	Station: 16596 + 49
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1225367.44 ft	Offset: 8 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2036.3 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 21 - A	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
1							Asphalt, black.	0.8						Asphalt Pavement: 9.5 inches
2035.3								2035.5						Base Course: 6 inches
2					4 - 4 - 3		BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, rounded to subangular, [A-1].	1.3	11			59		
2034.3			65				FILL, Sandy Lean CLAY (CL), medium stiff, dry to moist, brown to dark brown, [A-2]. organic roots.	2035.0						
3								2033.3	13			68		Auger Cuttings Bulk Sample: 1.3 to 4.5 feet
2033.3								2033.0						Max. Dry Density: 126.8 pcf
4							FILL, Clayey SAND (SC), very loose, dry to moist, brown, fine to coarse grained, [A-2]. organic roots.	3.3	11	26	16	34		Opt. Moisture: 10.7%
2032.3								2033.0						CBR: 3.7
5					2 - 2 - 2				14					
2031.3			60											
6								6.0						
2030.3								2030.3						

Boring Depth: 6.0 ft, Elevation: 2030.3 ft

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-14

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 434053.87 ft	Station: 16586 + 41
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1226210.11 ft	Offset: 8 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2060.0 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 21 - A	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
0.8							Asphalt, black.	0.8						Asphalt Pavement: 9 inches
1.4							BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, subangular to rounded, [A-1].	1.4	18					Base Course: 8 inches
1.4			70		5 - 3 - 5		FILL, Sandy SILT (ML), medium stiff, dry to moist, dark brown, [A-4]. organic roots.	1.4						Auger Cuttings Bulk Sample: 1.4 to 4.5 feet
4.0							FILL, Sandy Lean CLAY with gravel (CL), medium stiff, moist, brown to tan, subangular, [A-6].	4.0	14					
6.0			60		2 - 3 - 4			6.0						

Boring Depth: 6.0 ft, Elevation: 2054.0 ft

2054.0

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-15

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 434673.23 ft	Station: 16576 + 68
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1226960.67 ft	Offset: 8 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2076.0 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Datum: NAD83	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 22 - B	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
0.7							Asphalt, black.	0.7						Asphalt Pavement: 8.75 inches
1.3							BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, subangular to rounded, [A-1].	1.3	15					Base Course: 7 inches
1.3 to 4.5			75		7 - 4 - 5		FILL, Sandy SILT (ML), medium stiff to stiff, dry to moist, dark brown, [A-4]. organic roots.	1.3 to 4.5						Auger Cuttings Bulk Sample: 1.3 to 4.5 feet
2.0 to 3.0									17					
3.0 to 4.5														
4.5 to 5.5			60		2 - 3 - 3				14					
6.0								6.0						

Boring Depth: 6.0 ft, Elevation: 2070.0 ft

2070.0

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()		



LOG OF BORING

Boring B-16

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 435281.43 ft	Station: 16566 + 79
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1227737.89 ft	Offset: 8 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2083.9 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 22 - B	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
1							Asphalt, black.	0.8						Asphalt Pavement: 9.5 inches
2082.9								2083.1						Base Course: 8 inches
2			75		7 - 4 - 5		BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, subangular to rounded, [A-1].	1.5	10					
2081.9							FILL, Clayey SAND (SC), loose, moist to dry, brown, fine to coarse grained, [A-6].	2082.4						
3									12					
2080.9									10	27	14	49		Auger Cuttings Bulk Sample: 1.5 to 4.5 feet
4							Lean CLAY with sand (CL), medium stiff, dry to moist, brown to dark brown, [A-7].	4.0						Max. Dry Density: 132 pcf
2079.9								2079.9	13					Opt. Moisture: 9%
5			67		2 - 3 - 3									
2078.9														
6								6.0						
2077.9								2077.9						

Boring Depth: 6.0 ft, Elevation: 2077.9 ft

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-17

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 435588.29 ft	Station: 16556 + 63
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1228699.97 ft	Offset: 8 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2071.3 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Datum: NAD83	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 22 - B	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
1							Asphalt, black.	0.7						Asphalt Pavement: 8.75 inches
2070.3								2070.6						Base Course: 7 inches
2			55		5 - 4 - 4		BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, rounded to subangular, [A-1].	1.3	10					Auger Cuttings Bulk Sample: 1.3 to 4.5 feet
2069.3							FILL, Sandy Lean CLAY (CL), medium stiff, dry to moist, brown, [A-7].	2070.0						
3								3.0						
2068.3							FILL, Sandy Lean CLAY with gravel (CL), medium stiff, moist, brown, subrounded, [A-6].	2068.3						
4									14					
2067.3														
5			73		2 - 3 - 5									
2066.3														
6								6.0						
2065.3								2065.3						

Boring Depth: 6.0 ft, Elevation: 2065.3 ft

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-18

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 435609.56 ft	Station: 16546 + 55
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1229705.05 ft	Offset: 8 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2088.1 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 15 - D	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
1							Asphalt, black.	0.9						Asphalt Pavement: 10.5 inches
2087.1								2087.2						Base Course: 8.5 inches
2					5-4-5		BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, rounded to subangular, [A-1].	1.6	23					Auger Cuttings Bulk Sample: 1.6 to 4.5 feet Max. Dry Density: 127.9 pcf Opt. Moisture: 10.7% CBR: 1.9
2086.1			55			FILL, Sandy Lean CLAY (CL), medium stiff, dry to moist, brown to black, [A-7].	2086.5							
3						FILL. COAL, black, fine grained, thinly bedded, very soft field hardness.	3.2							
2085.1						FILL, Sandy Lean CLAY (CL), medium stiff, dry to moist, brown to black, [A-7].	2084.9	11	46	18	63			
4								2084.5						
2084.1									27					
5					2-3-4		FILL. COAL, black, fine grained, thinly bedded, very soft field hardness.	5.5						
2083.1							FILL, Sandy Lean CLAY (CL), medium stiff, dry to moist, brown to black, [A-7].	2082.6						
6								5.9						
2082.1								2082.2						
								6.0						
								2082.1						

Boring Depth: 6.0 ft, Elevation: 2082.1 ft

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Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
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LOG OF BORING

Boring B-19

Sheet 1 of 2

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 435559.75 ft	Station: 16536 + 45
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1230714.12 ft	Offset: 8 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2148.4 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 15 - D	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
0.8							Asphalt, black.	0.8	2147.6						Asphalt Pavement: 9 inches
1.8							BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, subangular to rounded, [A-1].	1.8	2146.6						Base Course: 13 inches
33			60		4 - 4 - 5		FILL, Fat CLAY (CL), stiff, moist, gray to dark red, [A-7].	33							
67			60		2 - 5 - 7		COAL, black, fine grained, thinly bedded, very soft field hardness.	5.2	2143.2	67			36		
26								26							
8.3			100		4 - 5 - 10		Fat CLAY (CH), very stiff to stiff, dry to moist, gray to white, [A-7]. alkali layering.	8.3	2140.1						
23								23							
26			87		6 - 11 - 15			26		54	19	95			Auger Cuttings Bulk Sample: 11.0 to 14.5 feet Max. Dry Density: 111 pcf Opt. Moisture: 14%

Water Level Observations		<input type="checkbox"/> During Drilling: Not Encountered <input type="checkbox"/> After Drilling: ()	Remarks:
<input type="checkbox"/> After Drilling: ()			

(2) MDT LOG OF BORING - MDT_REVISED_2009+(CPT_IMPORT).GDT - 12/8/15 11:22 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ



LOG OF BORING

Boring B-19

Sheet 2 of 2

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 435559.75 ft	Station: 16536 + 45
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1230714.12 ft	Offset: 8 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2148.4 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 15 - D	
Logger: David Barrick				

Depth (ft) Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests	
14 2134.4		B	100		10 - 19 - 22		Sandy SILT (ML), hard, dry to moist, tan to gray, [A-4].	14.2 2134.2	13		NP				
16 2132.4									17		NP	67			
18 2130.4			100		15 - 15 - 18				22						
20 2128.4			100		8 - 11 - 11		Sandy SILT (ML), very stiff, moist, gray to light orange, [A-4].	19.8 2128.6	11	21	19	67		Auger Cuttings Bulk Sample: 20.0 to 24.0 feet Max. Dry Density: 123 pcf Opt. Moisture: 11%	
22 2126.4		B							60						
24 2124.4			60		2 - 4 - 4		Interbedded COAL, black, fine grained, thinly bedded, very soft field hardness.	23.2 2125.2							
26 2122.4			80		4 - 5 - 11		Silty SAND (SM), medium dense, moist, tan to orange, fine grained, [A-4].	24.9 2123.5	32						
Boring Depth: 26.0 ft, Elevation: 2122.4 ft								26.0 2122.4							

(2) MDT LOG OF BORING - MDT_REVISED_2009+(CPT_IMPORT).GDT - 12/8/15 11:22 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations		<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: 0	Remarks:
<input checked="" type="checkbox"/> After Drilling: 0			



LOG OF BORING

Boring B-20

Sheet 1 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 435570.42 ft	Station: 16534 + 01
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1230958.81 ft	Offset: 8 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2156.6 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 15 - D	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
							Asphalt, black.	0.8							Asphalt Pavement: 9.5 inches
							BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, subangular to rounded, [A-1].	1.8	2155.8						Base Course: 12 inches
2							FILL, Sandy Fat CLAY (CH), stiff, moist, orange to light green, [A-7].	1.8	2154.8	24					
4			87		3 - 4 - 6		Fat CLAY (CH), very stiff, dry to moist, brown to tan, [A-7].	3.5	2153.1	22	53	20	91		
6			100		3 - 6 - 10		Fat CLAY with sand (CH), stiff to very stiff, moist, gray to orange, [A-7]. minor coal fragments.	6.5	2150.1	25					
8			93		3 - 5 - 6			6.5	2150.1	27					
10			107		4 - 8 - 9										
12			73		3 - 5 - 5		Interbedded COAL, black, fine grained, thinly	13.1	2143.5	65					

Water Level Observations		<input type="checkbox"/> During Drilling: Not Encountered	Remarks:
<input type="checkbox"/> After Drilling: ()		<input type="checkbox"/> After Drilling: ()	

(2) MDT LOG OF BORING - MDT_REVISED_2009+(CPT_IMPORT).GDT - 12/8/15 11:22 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ



LOG OF BORING

Boring B-20

Sheet 2 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 435570.42 ft	Station: 16534 + 01
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1230958.81 ft	Offset: 8 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2156.6 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Datum: NAD83	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 15 - D	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
14							bedded, very soft field hardness. USCS classification - Sandy Elastic Silt.		2142.6	52	52	35	57		
16			80		3 - 3 - 8			15.8	2140.6						
							Fat CLAY with sand (CH), very stiff, moist, light green to orange, [A-7].	16.5	2140.1						
							Fat CLAY (CH), very stiff to stiff, moist, green to orange, [A-7].	24							
18			107		6 - 8 - 10			28	2138.6	58	24	98			
20			73		6 - 6 - 7			25	2136.6	52	21	94			Auger Cuttings Bulk Sample: 20.0 to 22.5 feet Max. Dry Density: 115 pcf Opt. Moisture: 15%
22		B						20	2134.6						
24			100		9 - 11 - 12			23.4	2132.6						
							Sandy SILT (ML), very soft to very stiff, moist to wet, gray to tan, fine grained, [A-4]. natural moisture above optimum at 27.5 to 34.0 feet.	18	2133.2						
26			33		2 - 2 - 2				2130.6						

Water Level Observations		<input type="checkbox"/> During Drilling: Not Encountered	Remarks:
<input type="checkbox"/> After Drilling: ()		<input type="checkbox"/> After Drilling: ()	

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:22 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ



LOG OF BORING

Boring B-20

Sheet 3 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 435570.42 ft	Station: 16534 + 01
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1230958.81 ft	Offset: 8 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2156.6 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 15 - D	
Logger: David Barrick				

(2) MDT LOG OF BORING - MDT_REVISED_2009+(CPT_IMPORT).GDT - 12/8/15 11:22 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
28 2128.6			13		1 - 1 - WH			12		NP	62			
30 2126.6			27		1 - 1 - 1			23						
32 2124.6			27		3 - 3 - 3			60						
34 2122.6			87		5 - 12 - 14									
36 2120.6														
Boring Depth: 36.5 ft, Elevation: 2120.1 ft								36.5 2120.1						

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
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LOG OF BORING

Boring B-21

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 435471.75 ft	Station: 16516 + 58
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1232698.79 ft	Offset: 8 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2166.8 ft
Date Started: 10/16/15	Date Finished: 10/16/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 14 - C	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
1							Asphalt, black.	0.9						Asphalt Pavement: 10.25 inches
2165.8								2165.9						Base Course: 8 inches
2							BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, rounded to subangular, [A-1].	1.5	11					Auger Cuttings Bulk Sample: 1.5 to 4.5 feet
2164.8							FILL, Sandy SILT (ML), stiff, moist, brown, [A-4].	2165.3						
3			80		5 - 4 - 5		Sandy SILT (ML), stiff, moist, brown, [A-4].	2.5	16					
2163.8								2164.3						
4							Sandy Lean CLAY (CL), stiff, moist, brown, [A-7].	4.5	14					
2162.8								2162.3						
5			47		2 - 4 - 5									
2161.8														
6								6.0						
2160.8								2160.8						

Boring Depth: 6.0 ft, Elevation: 2160.8 ft

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Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-63

Sheet 1 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433309.5 ft	Station: 16664 + 74
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1218654.51 ft	Offset: 58 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1861.3 ft
Date Started: 10/22/15	Date Finished: 10/22/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Jared Zak		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 20 - C	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
			53		3 - 4 - 4		TOPSOIL, Sandy Lean CLAY (CL), Boulders, moist to wet, black.	0.3	1861.0						
			20		3 - 3 - 2		Sandy Lean CLAY (CL), medium stiff to soft, moist to wet, brown, [A-7]. organic roots and occasional gravel, cobbles and boulders.								
5			40		2 - 2 - 2			5.6	1855.7						
			53		1 - 1 - 1			8.4	1852.9						
10			60		WH - 1 - 1		Silty SAND (SM), very loose to loose, moist to wet, brown, medium grained, [A-3].								
			60		3 - 2 - 4										
15			73		2 - 3 - 4		Poorly-Graded SAND (SP), loose, wet, brown, fine to coarse grained, [A-2].	14.0	1847.3						
			60		3 - 3 - 6			18.2	1843.1						
20			47		3 - 3 - 2		Clayey GRAVEL with sand (GC), loose, wet, gray, fine to coarse grained, subrounded to subangular, [A-2].	19.5	1841.8						
							Poorly-Graded SAND with gravel (SP), loose, wet, gray, fine to coarse grained, subrounded to rounded, [A-2].	22.0	1839.3						
							Fat CLAY (CH), soft, moist, gray, [A-7].								
25			93		2 - 1 - 3										
30			100					30.0	1831.3	33	65	18	99	92	UCS: 1.474 ksf Direct Shear: 14.0 deg Cohesion: 0.267 ksf
							Fat CLAY (CH), soft to medium stiff, moist, dark gray to brown, [A-7]. dark green with gray mottling at 44.5 feet.								
35			100		1 - 2 - 1										

Water Level Observations		<input type="checkbox"/> During Drilling: 13.5 ft (1847.8 ft) <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()		<input type="checkbox"/> During Drilling: () <input checked="" type="checkbox"/> After Drilling: ()	

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LOG OF BORING

Boring B-63

Sheet 2 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433309.5 ft	Station: 16664 + 74
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1218654.51 ft	Offset: 58 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1861.3 ft
Date Started: 10/22/15	Date Finished: 10/22/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Jared Zak		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 20 - C	
Logger: David Barrick				

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Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
40 1821.3			120		1 - 2 - 1									
45 1816.3			120		2 - 3 - 2									
50 1811.3			87		14 - 19 - 21		Poorly-Graded GRAVEL with sand (GP), dense, wet, brown to gray, fine to coarse grained, rounded to subrounded, [A-1]. intermittent 2 to 3 inch thick silty sand layers.	48.0 1813.3						
55 1806.3			80		6 - 9 - 11		Silty SAND (SM), medium dense, moist, gray to black, medium grained, [A-3]. coal fragments.	54.0 1807.3						
60 1801.3			100		6 - 11 - 15		Fat CLAY (CH), very stiff to hard, moist, bluish gray to black, [A-7]. black lignite layering.	58.0 1803.3						
65 1796.3			93		13 - 20 - 29									
70 1791.3			93		12 - 22 - 31				17	64	20	100	113	UCS: 13.9 ksf

Water Level Observations		<input type="checkbox"/> During Drilling: 13.5 ft (1847.8 ft) <input checked="" type="checkbox"/> After Drilling: 0	Remarks:
<input checked="" type="checkbox"/> After Drilling: 0	<input checked="" type="checkbox"/> After Drilling: 0		



LOG OF BORING

Boring B-63

Sheet 3 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433309.5 ft	Station: 16664 + 74
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1218654.51 ft	Offset: 58 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1861.3 ft
Date Started: 10/22/15	Date Finished: 10/22/15	Drilling Fluid: None	Datum: NAD83	Elevation Source: Plans
Driller: Jared Zak		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 20 - C	
Logger: David Barrick				

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Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
75 1786.3		X	87		8 - 21 - 19	[Hatched Lithology]	Fat CLAY (CH), hard, dry to moist, turquoise, [A-7].	74.5 1786.8						
80 1781.3		X	113		13 - 15 - 19		Fat CLAY with sand (CH), hard, dry to moist, gray, [A-7]. minor black lignite layering.	79.5 1781.8						
85 1776.3		X	107		15 - 20 - 27									
90 1771.3		X	100		13 - 18 - 28		Sandy Fat CLAY (CH), hard, dry to moist, bluish gray, [A-7].	90.0 1771.3						
95 1766.3		X	80		18 - 21 - 25			96.0 1765.3						

Boring Depth: 96.0 ft, Elevation: 1765.3 ft

Water Level Observations	<input type="checkbox"/> During Drilling: 13.5 ft (1847.8 ft) <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()		



LOG OF BORING

Boring B-64

Sheet 1 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433483.95 ft	Station: 16663 + 50
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1218956.91 ft	Offset: 36 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1868.5 ft
Date Started: 10/21/15	Date Finished: 10/22/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Jared Zak		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 20 - B	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
								Elev. (ft)						
0.3			60		4 - 4 - 5	TOPSOIL, Sandy Lean CLAY (CL), Boulders, dry, black.	1868.2							
5.6			53		3 - 5 - 6	FILL, Sandy Lean CLAY (CL), stiff to medium stiff, dry to moist, brown, [A-7]. coal layering at 5.6 feet and organic roots to 8.5 feet.								
9.5			60		9 - 7 - 5									
12.8			40		7 - 6 - 2									
15.7			67		5 - 3 - 3	Clayey SAND (SC), loose, moist, brown, medium grained, [A-3].	1859.0							
17.5			60		10 - 4 - 2	Poorly-Graded SAND (SP), loose, moist to wet, brown to orange, fine grained, [A-2].	1855.7							
18.5			87		3 - 4 - 7	Poorly-Graded SAND with clay and gravel (SP-SC), medium dense, wet, brown, fine to coarse grained, rounded, [A-2].	1852.8							
20.0			93		5 - 7 - 9	Poorly-Graded SAND with gravel (SP), medium dense to loose, wet, brown to multi-colored, fine to coarse grained, rounded, [A-2].	1851.0							
25.0			73		8 - 9 - 9									
30.8			33		3 - 5 - 5									
31.0			27		2 - 4 - 1	Gravelly Lean CLAY (CL), medium stiff, wet, gray, rounded, [A-6].	1837.7							
35.0			53		1 - 2 - 1	Silty CLAY (CL-ML), soft, moist to wet, brown, [A-7].	1837.5							

Auger Cuttings Bulks Sample: 13.0 to 15.0 feet

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Water Level Observations		Remarks:
<input type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> During Drilling: 15.4 ft (1853.1 ft)	



LOG OF BORING

Boring B-64

Sheet 2 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433483.95 ft	Station: 16663 + 50
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1218956.91 ft	Offset: 36 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1868.5 ft
Date Started: 10/21/15	Date Finished: 10/22/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Jared Zak		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 20 - B	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
38.0							Sandy Fat CLAY (CH), very soft, moist, gray, [A-7].	38.0	1830.5						
40.0			100		1 - 1 - 1		Fat CLAY (CH), very soft to stiff, moist, gray, [A-7].	40.0	1828.5						
45.0			100							29	60	18	96	92	UCS: 1.852 ksf Direct Shear: 24.7 deg Cohesion: 0.202 ksf
50.0			107		4 - 4 - 5										
52.0			53		2 - 1 - 2		Silty SAND (SM), very loose, wet, brown, medium grained, [A-3].	52.0	1816.5						
55.0			53												
59.5			47		3 - 5 - 7		Sandy Fat CLAY (CH), stiff to very stiff, moist, gray to tan, [A-7].	59.5	1809.0						
60.0			47												
65.0			93		9 - 15 - 19					21	101	21	59	111	UCS: 5.11 ksf
65.0			93												
70.0			87		7 - 11 - 22										
70.0			87												

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Water Level Observations		<input type="checkbox"/> During Drilling: 15.4 ft (1853.1 ft) <input checked="" type="checkbox"/> After Drilling: 0	Remarks:
<input checked="" type="checkbox"/> After Drilling: 0			



LOG OF BORING

Boring B-64

Sheet 3 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433483.95 ft	Station: 16663 + 50
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1218956.91 ft	Offset: 36 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1868.5 ft
Date Started: 10/21/15	Date Finished: 10/22/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Jared Zak		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 20 - B	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
75 1793.5			100		9 - 13 - 16		Fat CLAY (CH), very stiff, moist, gray to tan, [A-7]. black lignite layering.	74.5 1794.0						
80 1788.5			100		9 - 12 - 16		Fat CLAY (CH), very stiff to hard, moist, bluish gray, [A-7]. coal and alkali fragments.	79.5 1789.0						
85 1783.5			93		9 - 15 - 19									
90 1778.5			107		8 - 14 - 34		Fat CLAY (CH), hard, moist to dry, bluish gray to cream white, [A-7]. slow drilling at 93.0 feet, minor coal seams.	89.0 1779.5						
95 1773.5			75	74					18	84	24	100	114	UCS: 21.98 ksf
100 1768.5			82	55										
								104.5 1764.0						

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Boring Depth: 104.5 ft, Elevation: 1764.0 ft

Water Level Observations		<input type="checkbox"/> During Drilling: 15.4 ft (1853.1 ft) <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()		



LOG OF BORING

Boring B-76

Sheet 1 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 435683.65 ft	Station: 16537 + 06
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1230657.92 ft	Offset: 118 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2161.4 ft
Date Started: 10/21/15	Date Finished: 10/21/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Jared Zak		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 15 - D	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
0.3			67		2 - 2 - 2		TOPSOIL, Silty CLAY (CL-ML), moist, black, [A-7]. Sandy SILT (ML), soft to stiff, moist, brown, [A-4].	0.3	2161.1						
3.6			60		3 - 6 - 8		Fat CLAY with sand (CH), stiff, dry to moist, brown, [A-7].	3.6	2157.8						
4.8			87		5 - 3 - 4		Sandy Fat CLAY (CH), medium stiff to stiff, dry to moist, brown, [A-7].	4.8	2156.6						
9.5			73		3 - 4 - 7		Fat CLAY with sand (CH), stiff, moist, brown to orange, [A-7].	9.5	2151.9						Auger Cuttings Bulk Sample: 9.0 to 12.5 feet
14.0			93		2 - 5 - 7		Fat CLAY (CH), very stiff, moist, gray, [A-7]. white mottling with gypsum.	14.0	2147.4	25	69	24	98	UCS: 8.17 ksf	
14.0			100												
14.0			80		4 - 8 - 11										

Water Level Observations		<input type="checkbox"/> During Drilling: Not Encountered	Remarks:
<input type="checkbox"/> After Drilling: ()		<input type="checkbox"/> After Drilling: ()	

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:23 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ



LOG OF BORING

Boring B-76

Sheet 2 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 435683.65 ft	Station: 16537 + 06
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1230657.92 ft	Offset: 118 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2161.4 ft
Date Started: 10/21/15	Date Finished: 10/21/15	Drilling Fluid: None	Datum: NAD83	Elevation Source: Plans
Driller: Jared Zak		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 15 - D	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
18 2143.4			53		4 - 4 - 5		Interbedded COAL, black, fine grained, thinly bedded, very soft field hardness.	17.5 2143.9						
20 2141.4			73		6 - 10 - 13		Fat CLAY (CH), very stiff, moist, gray to black, [A-7]. 0.25 to 0.75 inch thick coal seams throughout strata.	19.2 2142.2						
22 2139.4														
24 2137.4			100											
26 2135.4			100		6 - 11 - 16									
28 2133.4			93		6 - 16 - 17		Fat CLAY with sand (CH), hard, moist, light brown to gray, [A-7].	27.5 2133.9						
30 2131.4			73		5 - 6 - 9		Fat CLAY (CH), stiff, moist, gray to black, [A-7]. 0.25 to 0.75 inch thick coal seams throughout strata.	29.5 2131.9						
32 2129.4			100											
34 2127.4							Silty SAND (SM), dense, moist, gray, fine grained,	34.4 2127.0						

Water Level Observations		<input type="checkbox"/> During Drilling: Not Encountered	Remarks:
<input type="checkbox"/> After Drilling: ()		<input type="checkbox"/> After Drilling: ()	

(2) MDT LOG OF BORING - MDT_REVISED_2009+(CPT_IMPORT).GDT - 12/8/15 11:23 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ



LOG OF BORING

Boring B-76

Sheet 3 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 435683.65 ft	Station: 16537 + 06
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1230657.92 ft	Offset: 118 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2161.4 ft
Date Started: 10/21/15	Date Finished: 10/21/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Jared Zak		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 15 - D	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
36 2125.4			100		13 - 18 - 22	[A-4].									
38 2123.4			113		14 - 28 - 31		Sandy SILT (ML), hard, moist to dry, gray to yellow, fine grained, [A-4].	37.5 2123.9							
40 2121.4			93		14 - 23 - 21										
42 2119.4			100		10 - 18 - 22		Fat CLAY (CH), hard, moist, tan to light orange, [A-7]. silty in part.	42.5 2118.9							
44 2117.4			107		11 - 14 - 20										
46 2115.4			107		9 - 15 - 26										
48 2113.4															
Boring Depth: 49.0 ft, Elevation: 2112.4 ft								49.0 2112.4							

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Water Level Observations		<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()			



LOG OF BORING

Boring B-79

Sheet 1 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 435690.06 ft	Station: 16533 + 54
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1231011.01 ft	Offset: 139 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2174.6 ft
Date Started: 10/21/15	Date Finished: 10/21/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Jared Zak		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 15 - D	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
0.4			67		3 - 6 - 3		TOPSOIL, Sandy Lean CLAY (CL), moist, black, [A-7].	2174.2						
2.0			60		3 - 6 - 7		Sandy Fat CLAY (CH), stiff, dry to moist, brown, [A-7]. organic roots.	2172.6						
2.0			80		3 - 4 - 4		Fat CLAY with sand (CH), stiff to medium stiff, dry to moist, brown, [A-7].	2172.6						
7.6			67		5 - 7 - 8		Silty SAND (SM), medium dense, dry to moist, tan, fine grained, [A-4].	2167.0						Auger Cuttings Bulk Sample: 5.0 to 7.5 feet
12.7			80		4 - 8 - 11		Clayey SAND (SC), medium dense, dry to moist, tan, fine grained, [A-6].	2161.9						
15.2			87		5 - 8 - 13		Fat CLAY (CH), medium stiff to very stiff, moist, brown to gray, [A-7].	2159.4						Auger Cuttings Bulk Sample: 15.0 to 17.5 feet

Water Level Observations		<input type="checkbox"/> During Drilling: Not Encountered	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()		

(2) MDT LOG OF BORING - MDT_REVISED_2009+(CPT_IMPORT).GDT - 12/8/15 11:23 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ



LOG OF BORING

Boring B-79

Sheet 2 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 435690.06 ft	Station: 16533 + 54
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1231011.01 ft	Offset: 139 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2174.6 ft
Date Started: 10/21/15	Date Finished: 10/21/15	Drilling Fluid: None	Datum: NAD83	Elevation Source: Plans
Driller: Jared Zak		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 15 - D	
Logger: David Barrick				

Depth (ft) Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
18 2156.6			67		4 - 3 - 2			18.9 2155.7						UCS: 6.186 ksf Direct Shear: 20.4 deg Cohesion: 2.028 ksf
20 2154.6			100			Fat CLAY (CH), medium stiff, wet to moist, orange to black, [A-7]. coal seams with wet clay.		28	87	22	99	96		
22 2152.6							Fat CLAY (CH), stiff to very stiff, dry to moist, gray, [A-7]. 0.25 to 0.5 inches coal seams at 23.5 feet.	21.0 2153.6						
24 2150.6			100		5 - 9 - 13									
26 2148.6			93		4 - 7 - 8									
28 2146.6			73		6 - 11 - 21		Interbedded COAL, black, fine grained, thinly bedded, very soft field hardness.	27.9 2146.7						
30 2144.6			80		6 - 10 - 15		Fat CLAY (CH), very stiff to hard, dry to moist, gray, [A-7].	28.8 2145.8						
32 2142.6			100		8 - 15 - 19									
34 2140.6														

Water Level Observations		<input type="checkbox"/> During Drilling: Not Encountered	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()		<input checked="" type="checkbox"/> After Drilling: ()	

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:23 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ



LOG OF BORING

Boring B-79

Sheet 3 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 435690.06 ft	Station: 16533 + 54
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1231011.01 ft	Offset: 139 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2174.6 ft
Date Started: 10/21/15	Date Finished: 10/21/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Jared Zak		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 15 - D	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
36 2138.6			100				Silty SAND (SM), very dense, dry to moist, light gray, fine grained, [A-4].	35.4 2139.2						
38 2136.6			100		19 - 26 - 32									
40 2134.6			107		17 - 32 - 27									
42 2132.6			93		3 - 4 - 5		Fat CLAY (CH), stiff to very stiff, moist, gray to black, [A-7]. thin coal seams with coarse silica fragments.	42.9 2131.7						
44 2130.6			80		4 - 8 - 11		Interbedded COAL, black, fine grained, thinly bedded, very soft field hardness.	45.6 2129.0						
48 2126.6			93		13 - 22 - 31		Fat CLAY with sand (CH), hard, dry to moist, tan to gray, [A-7].	47.6 2127.0						
50 2124.6			120		16 - 33 - 44		Silty SAND (SM), very dense, dry to moist, light gray to tan, fine grained, [A-4].	49.2 2125.4						
Boring Depth: 51.0 ft, Elevation: 2123.6 ft								51.0 2123.6						

(2) MDT LOG OF BORING - MDT_REVISED_2009+(CPT_IMPORT).GDT - 12/8/15 11:23 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations		<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()		



LOG OF BORING

Boring B-100

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433211.12 ft	Station: 16601 + 30
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1224955.25 ft	Offset: 143 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2014.1 ft
Date Started: 10/15/15	Date Finished: 10/15/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 21 - A	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
0.8							Asphalt, black.	2013.3						Asphalt Pavement: 9.25 inches
1.4							BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, rounded to subangular, [A-1].	2012.7	10					Base Course: 7 inches
1.4			25		7 - 5 - 7		FILL, Clayey SAND with gravel (SC), Boulders, stiff, moist to dry, brown to multi-colored, [A-6].	2012.7	12	31	12			Aguer Cuttings Bulk Sample: 1.4 to 4.5 feet
4.9			0		50/0.4ft			2009.2						

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	



LOG OF BORING

Boring B-103

Sheet 1 of 1

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 435531.04 ft	Station: 16526 + 55
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1231703.66 ft	Offset: 8 ft R
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 2140.8 ft
Date Started: 10/16/15	Date Finished: 10/16/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Dave Tokar		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 15 - D	
Logger: David Barrick				

Depth (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
Elev. (ft)								Elev. (ft)						
1							Asphalt, black.	0.9						Asphalt Pavement - 10.5 inches
2139.8								2139.9						Base Course - 10 inches
2							BASE COURSE, Well-Graded GRAVEL with sand (GW), medium dense, moist, brown, fine to coarse grained, rounded to subangular, [A-1].	1.7						Auger Cuttings Bulk Sample - 2.0 to 4.5 feet
2138.8							FILL, Silty SAND (SM), medium dense, moist, tan to orange, fine grained, [A-4].	2139.1						
3			40		4 - 6 - 6			3.4						
2137.8							Sandy Lean CLAY (CL), stiff, moist, light brown to black, [A-7]. minor coal seams.	2137.4						
4														
2136.8														
5			60		3 - 4 - 5									
2135.8														
6														
2134.8														
7														
2133.8														
8			87		4 - 18 - 37			8.6						
2132.8							Interbedded SANDSTONE, orange, fine grained, very thinly bedded, soft field hardness.	2132.2						
9								9.2						
2131.8							Silty SAND (SM), medium dense, moist, brown, medium grained, [A-4].	2131.6						
10			53		5 - 7 - 4									
2130.8														
11								11.0						
2129.8								2129.8						

Boring Depth: 11.0 ft, Elevation: 2129.8 ft

(2) MDT LOG OF BORING - MDT_REVISIED_2009+(CPT_IMPORT).GDT - 12/8/15 11:20 - Q:\24\20997\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Water Level Observations	<input type="checkbox"/> During Drilling: Not Encountered <input checked="" type="checkbox"/> After Drilling: ()	Remarks:
<input checked="" type="checkbox"/> After Drilling: ()	<input checked="" type="checkbox"/> After Drilling: ()	

APPENDIX C
LABORATORY TEST RESULTS



Lab Testing Sampling Summary

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
ND 1804 PHASE 1 RECONSTRUCTION
LABORATORY TESTING SUMMARY

Project No.: 6024.20997.01

Designation: 7-804(055)304

Length: 21,250 feet

County: Williams

Date: December 7, 2015

Submitted by: DOWL

Title: Geotechnical Consultant

Greg Underhill, PE

Adam McGill, PE

Geotechnical Engineer

Project Manager

BOREHOLE NUMBER	LAB NUMBER	LOCATION DESCRIPTION	DEPTH RANGE	REPRESENTING STATIONING		SOIL CLASS (AASHTO)	USCS CLASSIFICATION SYMBOL	LIQUID LIMIT - %	PLASTICITY INDEX - %	GRAVEL NO. 4 TO 3 IN.	SAND NO. 200 TO NO. 4	SMALLER THAN NO. 200	IN-PLACE UNIT WEIGHT - pcf (UNCONF. - DRY)	UNCONFINED, qu - KSF	DIRECT SHEAR - DEGREES	CALIFORNIA BEARING RATIO (CBR)	MAXIMUM DRY UNIT WEIGHT(T-180)-pcf	NATURAL MOISTURE - %	OPTIMUM MOISTURE CONTENT - %	
				STA.	OFFSET (ft)															
B-1	15085	Soil Survey	1.1-2.1'	16720+35	20 ft Right														11.3	
B-1	15086	Soil Survey	2.1-3.1'	16720+35	20 ft Right														14.8	
B-1	15087	Soil Survey	1.1-4.5'	16720+35	20' ft Right	A-7-6(20)	CL	45	29		25.9	74.1						120.0	17.8	14.0
B-1	15088	Soil Survey	4.5-6.0'	16720+35	20 ft Right															
B-1A	15089	Soil Survey	1.3-2.3'	16715+40	20 ft Left														5.9	
B-1A	15090	Soil Survey	2.3-3.3'	16715+40	20 ft Left														21.5	
B-1A	15091	Soil Survey	1.25-4.5'	16715+40	20 ft Left	A-7-6(22)	CL	46	30	3.0	19.1	77.9						122.0	19.2	12.0
B-1A	15092	Soil Survey	4.5-6.0'	16715+40	20 ft Left															
B-2	15093	Soil Survey	0.5-4.0'	16706+51	20 ft Right	A-1-b	SP-SM	NV	NP	41.0	47.1	11.9							5	
B-2	15094	Soil Survey	4.5-6.0'	16706+51	20 ft Right														20.9	
B-3	15095	Soil Survey	1.4-2.4'	16696+48	20 ft Left														8.8	
B-3	15096	Soil Survey	2.4-3.4'	16696+48	20 ft Left														11.8	
B-3	15097	Soil Survey	1.4-4.5'	16696+48	20 ft Left	A-6(7)	CL	31	18	0.1	42.9	57.0						122.0	12.0	13.0
B-3	15098	Soil Survey	4.5-6.0'	16696+48	20 ft Left															
B-4	15099	Soil Survey	1.6-2.6'	16686+59	20 ft Right														12.6	
B-4	15100	Soil Survey	2.6-3.6'	16686+59	20 ft Right														14.6	
B-4	15101	Soil Survey	1.6-4.5'	16686+59	20 ft Right															
B-4	15102	Soil Survey	4.5-6.0'	16686+59	20 ft Right	A-6(9)	CL	34	21	7.3	33.3	59.4							13.5	
B-5	15107	Soil Survey	1.3-3.3'	16676+43	20 ft Left															
B-5	15108	Soil Survey	1.3-4.5'	16676+43	20 ft Left	A-7-6(15)	CL	42	27	6.2	27.5	66.3				1.0	119.0	22.1	10.0	



Lab Testing Sampling Summary

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
ND 1804 PHASE 1 RECONSTRUCTION
LABORATORY TESTING SUMMARY

Project No.: 6024.20997.01

Designation: 7-804(055)304

Length: 21,250 feet

County: Williams

Date: December 7, 2015

Submitted by: DOWL

Title: Geotechnical Consultant

Greg Underhill, PE

Adam McGill, PE

Geotechnical Engineer

Project Manager

BOREHOLE NUMBER	LAB NUMBER	LOCATION DESCRIPTION	DEPTH RANGE	REPRESENTING STATIONING		SOIL CLASS (AASHTO)	USCS CLASSIFICATION SYMBOL	LIQUID LIMIT - %	PLASTICITY INDEX - %	GRAVEL NO. 4 TO 3 IN.	SAND NO. 200 TO NO. 4	SMALLER THAN NO. 200	IN-PLACE UNIT WEIGHT - pcf (UNCONF. - DRY)	UNCONFINED, qu - KSF	DIRECT SHEAR - DEGREES	CALIFORNIA BEARING RATIO (CBR)	MAXIMUM DRY UNIT WEIGHT(T-180)-pcf	NATURAL MOISTURE - %	OPTIMUM MOISTURE CONTENT - %	
				STA.	OFFSET (ft)															
B-5	15109	Soil Survey	4.5-6.0'	16676+43	20 ft Left	A-7-6(47)	CH	69	47	0.4	9.6	90.0						23.2		
B-5A	15103	Soil Survey	1.0-3.0'	16668+64	20 ft Left															
B-5A	15104	Soil Survey	1.0-4.5'	16668+64	20 ft Left															
B-5A		Soil Survey	4.5-6.5'	16668+64	20 ft Left															
B-5A	15105	Soil Survey	6.5-8.0'	16668+64	20 ft Left	A-7-6(18)	CL	46	26	4.0	23.3	72.7						19.1		
B-5A	15106	Soil Survey	10.0-11.5'	16668+64	20 ft Left													15.0		
B-6	15110	Soil Survey	2.1-3.1'	16666+56	20 ft Right													19.9		
B-6	15111	Soil Survey	3.1-4.1'	16666+56	20 ft Right													23.5		
B-6	15112	Soil Survey	2.1-4.5'	16666+56	20 ft Right															
B-6		Soil Survey	4.5-6.0'	16666+56	20 ft Right															
B-7	15113	Soil Survey	0.7-1.7'	16656+49	20 ft Left													18.2		
B-7	15114	Soil Survey	1.7-2.7'	16656+49	20 ft Left													23.3		
B-7	15115	Soil Survey	0.7-4.5'	16656+49	20 ft Left	A-7-6(30)	CH	55	40	7.4	16.4	76.2				1.6	123.0	13.3	10.0	
B-7	15116	Soil Survey	4.5-6.0'	16656+49	20 ft Left													20.5		
B-8	15117	Soil Survey	1.0-2.0'	16646+90	8 ft Right					9.2	23.7	67.1						13.5		
B-8	15118	Soil Survey	2.0-3.0'	16646+90	8 ft Right	A-6(4)	SC	31	19	13.4	42.9	43.7						11.9		
B-8	15119	Soil Survey	1.0-4.5'	16646+90	8 ft Right	A-6(10)	CL	35	22	9.8	30.5	59.7					127.0	15.3	11.0	
B-8	15120	Soil Survey	4.5-6.0'	16646+90	8 ft Right	A-6(13)	CL	37	23	5.0	27.8	67.2						15.8		
B-8	15121	Soil Survey	9.5-11.0'	16646+90	8 ft Right	A-6(12)	CL	37	24	11.1	26.3	62.6						15.3		
B-9	15122	Soil Survey	1.5-3.5'	16635+95	8 ft Left															



Lab Testing Sampling Summary

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
ND 1804 PHASE 1 RECONSTRUCTION
LABORATORY TESTING SUMMARY

Project No.: 6024.20997.01

Designation: 7-804(055)304

Length: 21,250 feet

County: Williams

Date: December 7, 2015

Submitted by: DOWL

Title: Geotechnical Consultant

Greg Underhill, PE

Adam McGill, PE

Geotechnical Engineer

Project Manager

BOREHOLE NUMBER	LAB NUMBER	LOCATION DESCRIPTION	DEPTH RANGE	REPRESENTING STATIONING		SOIL CLASS (AASHTO)	USCS CLASSIFICATION SYMBOL	LIQUID LIMIT - %	PLASTICITY INDEX - %	GRAVEL NO. 4 TO 3 IN.	SAND NO. 200 TO NO. 4	SMALLER THAN NO. 200	IN-PLACE UNIT WEIGHT - pcf (UNCONF. - DRY)	UNCONFINED, qu - KSF	DIRECT SHEAR - DEGREES	CALIFORNIA BEARING RATIO (CBR)	MAXIMUM DRY UNIT WEIGHT(T-180)-pcf	NATURAL MOISTURE - %	OPTIMUM MOISTURE CONTENT - %
				STA.	OFFSET (ft)														
B-9	15124	Soil Survey	1.5-4.5'	16635+95	8 ft Left	A-4(0)	SC-SM	24	6	5.4	45.9	48.7						12.1	
B-9	15123	Soil Survey	4.5-6.0'	16635+95	8 ft Left					21.6	13.9	64.5						11.2	
B-10	15125	Soil Survey	1.3-2.3'	16626+56	8 ft Right					1.4	30.0	68.6						14.6	
B-10	15126	Soil Survey	2.3-3.3'	16626+56	8 ft Right	A-4(2)	CL	24	9	10.2	35.2	54.6						11.0	
B-10	15127	Soil Survey	1.3-4.5'	16626+56	8 ft Right	A-4(3)	CL	26	9	2.8	33.1	64.1						11.4	
B-10	15128	Soil Survey	4.5-6.0'	16626+56	8 ft Right														
B-11	15129	Soil Survey	1.7-2.7'	16616+53	8 ft Left													15.1	
B-11	15130	Soil Survey	2.7-3.7'	16616+53	8 ft Left													15.0	
B-11	15131	Soil Survey	1.7-4.5'	16616+53	8 ft Left	A-4(3)	CL	26	10	0.1	44.3	55.6						12.7	
B-11	15132	Soil Survey	4.5-6.0'	16616+53	8 ft Left													17.7	
B-12	15133	Soil Survey	1.7-3.7'	16606+56	8 ft Right														
B-12	15134	Soil Survey	1.7-4.5'	16606+56	8 ft Right	A-6(5)	CL	30	16	3.5	42.1	54.4						12.5	
B-12	15135	Soil Survey	4.5-6.0'	16606+56	8 ft Right	A-4(2)	CL	25	9	3.5	38.1	58.4						13.3	
B-13	15136	Soil Survey	1.3-2.3'	16596+49	8 ft Left					4.6	36.5	58.9						11.1	
B-13	15137	Soil Survey	2.3-3.3'	16596+49	8 ft Left					0.2	32.3	67.5						12.7	
B-13	15138	Soil Survey	1.3-4.5'	16596+49	8 ft Left	A-2-4(0)	SC	26	10	6.0	60.0	34.0				3.7	126.8	10.8	10.7
B-13	15139	Soil Survey	4.5-6.0'	16596+49	8 ft Left													13.7	
B-14	15140	Soil Survey	1.4-2.4'	16586+41	8 ft Right													17.5	
B-14	15141	Soil Survey	2.4-3.4'	16586+41	8 ft Right													15.4	
B-14	15142	Soil Survey	1.4-4.5'	16586+41	8 ft Right														



Lab Testing Sampling Summary

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
ND 1804 PHASE 1 RECONSTRUCTION
LABORATORY TESTING SUMMARY

Project No.: 6024.20997.01

Designation: 7-804(055)304

Length: 21,250 feet

County: Williams

Date: December 7, 2015

Submitted by: DOWL

Title: Geotechnical Consultant

Greg Underhill, PE

Adam McGill, PE

Geotechnical Engineer

Project Manager

BOREHOLE NUMBER	LAB NUMBER	LOCATION DESCRIPTION	DEPTH RANGE	REPRESENTING STATIONING		SOIL CLASS (AASHTO)	USCS CLASSIFICATION SYMBOL	LIQUID LIMIT - %	PLASTICITY INDEX - %	GRAVEL NO. 4 TO 3 IN.	SAND NO. 200 TO NO. 4	SMALLER THAN NO. 200	IN-PLACE UNIT WEIGHT - pcf (UNCONF. - DRY)	UNCONFINED, qu - KSF	DIRECT SHEAR - DEGREES	CALIFORNIA BEARING RATIO (CBR)	MAXIMUM DRY UNIT WEIGHT(T-180)-pcf	NATURAL MOISTURE - %	OPTIMUM MOISTURE CONTENT - %	
				STA.	OFFSET (ft)															
B-14	15143	Soil Survey	4.5-6.0'	16586+41	8 ft Right														13.7	
B-15	15144	Soil Survey	1.3-2.3'	16576+68	8 ft Left														15.2	
B-15	15145	Soil Survey	2.3-3.3'	16576+68	8 ft Left														16.9	
B-15	15146	Soil Survey	1.3-4.5'	16576+68	8 ft Left															
B-15	15147	Soil Survey	4.5-6.0'	16576+68	8 ft Left														14.2	
B-16	15148	Soil Survey	1.5-2.5'	16566+79	8 ft Right														10.0	
B-16	15149	Soil Survey	2.5-3.5'	16566+79	8 ft Right														12.1	
B-16	15150	Soil Survey	1.5-4.5'	16566+79	8 ft Right	A-6(3)	SC	27	13	0.8	50.0	49.2					132.0	9.9	9.0	
B-16	15151	Soil Survey	4.5-6.0'	16566+79	8 ft Right														12.6	
B-17	15152	Soil Survey	1.3-2.3'	16566+63	8 ft Left														9.6	
B-17	15153	Soil Survey	1.3-4.5'	16566+63	8 ft Left															
B-17	15154	Soil Survey	2.3-3.3'	16566+63	8 ft Left														10.3	
B-17	15155	Soil Survey	4.5-6.0'	16566+63	8 ft Left														13.7	
B-18	15156	Soil Survey	1.6-3.6'	16546+55	8 ft Right														22.5	
B-18	15157	Soil Survey	2.6-3.6'	16546+55	8 ft Right														27.3	
B-18	15158	Soil Survey	1.6-4.5'	16546+55	8 ft Right	A-7-6(15)	CL	46	28	5.0	31.8	63.2				1.9	127.9	10.9	10.7	
B-18	15159	Soil Survey	4.5-6.0'	16546+55	8 ft Right														26.9	
B-19	15160	Soil Survey	2.5-4.0'	16536+45	8 ft Left														33.0	
B-19	15161	Soil Survey	4.5-6.0'	16536+45	8 ft Left					1.8	62.5	35.7							67.3	
B-19	15162	Soil Survey	7.5-9.0'	16536+45	8 ft Left														25.9	



Lab Testing Sampling Summary

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
ND 1804 PHASE 1 RECONSTRUCTION
LABORATORY TESTING SUMMARY

Project No.: 6024.20997.01

Designation: 7-804(055)304

Length: 21,250 feet

County: Williams

Date: December 7, 2015

Submitted by: DOWL

Title: Geotechnical Consultant

Greg Underhill, PE

Adam McGill, PE

Geotechnical Engineer

Project Manager

BOREHOLE NUMBER	LAB NUMBER	LOCATION DESCRIPTION	DEPTH RANGE	REPRESENTING STATIONING		SOIL CLASS (AASHTO)	USCS CLASSIFICATION SYMBOL	LIQUID LIMIT - %	PLASTICITY INDEX - %	GRAVEL NO. 4 TO 3 IN.	SAND NO. 200 TO NO. 4	SMALLER THAN NO. 200	IN-PLACE UNIT WEIGHT - pcf (UNCONF. - DRY)	UNCONFINED, qu - KSF	DIRECT SHEAR - DEGREES	CALIFORNIA BEARING RATIO (CBR)	MAXIMUM DRY UNIT WEIGHT(T-180)-pcf	NATURAL MOISTURE - %	OPTIMUM MOISTURE CONTENT - %
				STA.	OFFSET (ft)														
B-19	15163	Soil Survey	9.5-11.0'	16536+45	8 ft Left													23.3	
B-19	15164	Soil Survey	11.0-14.5'	16536+45	8 ft Left	A-7-6(36)	CH	54	35		5.3	94.7					111.0	26.2	14.0
B-19	15165	Soil Survey	14.0-15.5'	16536+45	8 ft Left			NV	NP									13.4	
B-19	15166	Soil Survey	17.0-18.5'	16536+45	8 ft Left	A-4(0)	ML	NV	NP		32.6	67.4						17.3	
B-19	15167	Soil Survey	19.5-21.0'	16536+45	8 ft Left													22.2	
B-19	15168	Soil Survey	20.0-24.0'	16536+45	8 ft Left	A-4(0)	ML	21	2		32.9	67.1					123.0	11.3	11.0
B-19	15169	Soil Survey	22.5-24.0'	16536+45	8 ft Left													60.2	
B-19	15170	Soil Survey	24.5-26.0'	16536+45	8 ft Left													32.2	
B-20	15171	Soil Survey	2.5-4.0'	16534+01	8 ft Right													24.3	
B-20	15172	Soil Survey	4.5-6.0'	16534+01	8 ft Right	A-7-6(32)	CH	53	33		9.3	90.7						21.5	
B-20	15173	Soil Survey	7.5-9.0'	16534+01	8 ft Right													25.4	
B-20	15174	Soil Survey	9.5-11.0'	16534+01	8 ft Right													26.6	
B-20	15175	Soil Survey	12.5-14.0'	16534+01	8 ft Right													65.4	
B-20	15176	Soil Survey	14.5-16.0'	16534+01	8 ft Right	A-7-5(9)	MH	52	17		42.8	57.1						51.9	
B-20	15177	Soil Survey	17.5-19.0'	16534+01	8 ft Right													24.2	
B-20	15178	Soil Survey	19.5-21.0'	16534+01	8 ft Right	A-7-6(38)	CH	58	34		2.4	97.6						28.2	
B-20	15179	Soil Survey	20.0-22.5'	16534+01	8 ft Right	A-7-6(32)	CH	52	31		5.8	94.2					115.0	25.3	15.0
B-20	15180	Soil Survey	22.5-24.0'	16534+01	8 ft Right													19.8	
B-20	15181	Soil Survey	24.5-26.0'	16534+01	8 ft Right													18.0	
B-20	15182	Soil Survey	27.5-29.0'	16534+01	8 ft Right	A-4(0)	ML	NV	NP		37.8	62.2						11.9	



Lab Testing Sampling Summary

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
ND 1804 PHASE 1 RECONSTRUCTION
LABORATORY TESTING SUMMARY

Project No.: 6024.20997.01

Designation: 7-804(055)304

Length: 21,250 feet

County: Williams

Date: December 7, 2015

Submitted by: DOWL

Title: Geotechnical Consultant

Greg Underhill, PE

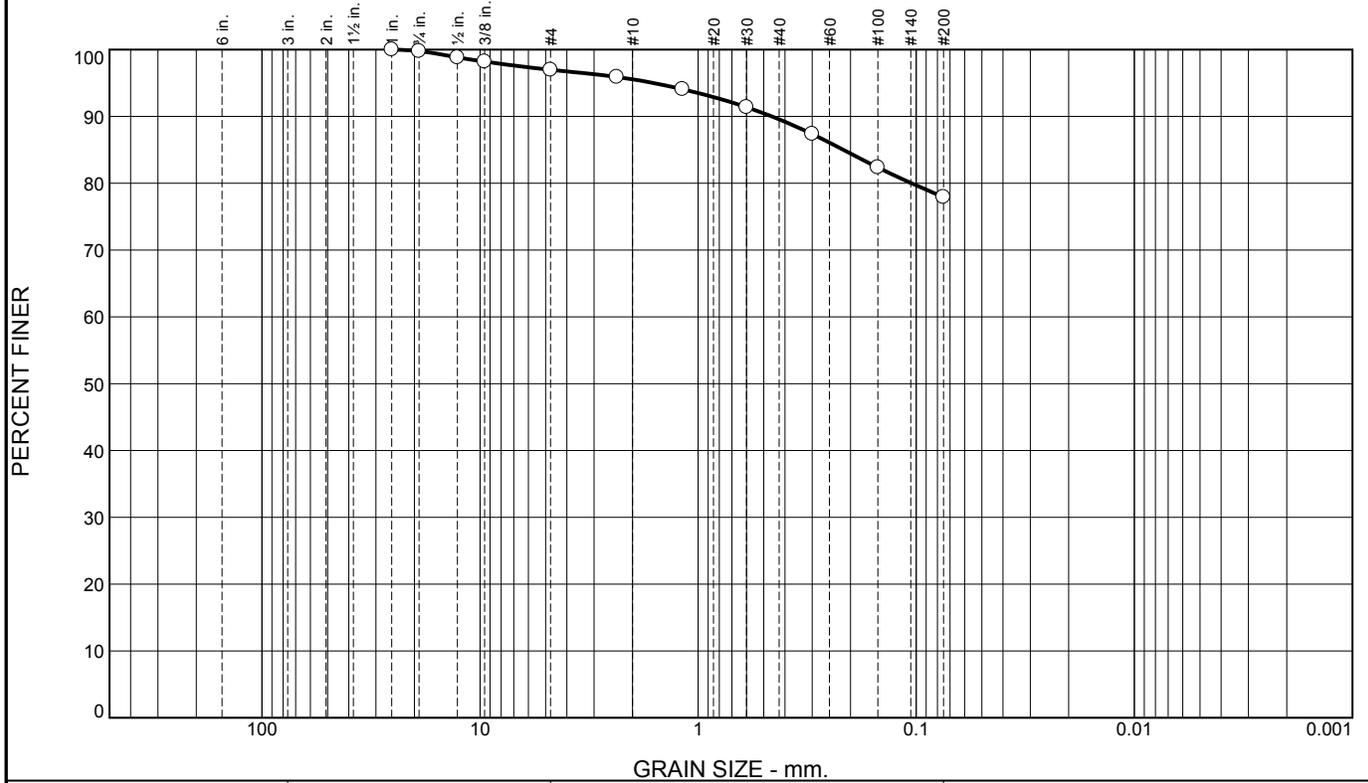
Adam McGill, PE

Geotechnical Engineer

Project Manager

BOREHOLE NUMBER	LAB NUMBER	LOCATION DESCRIPTION	DEPTH RANGE	REPRESENTING STATIONING		SOIL CLASS (AASHTO)	USCS CLASSIFICATION SYMBOL	LIQUID LIMIT - %	PLASTICITY INDEX - %	GRAVEL NO. 4 TO 3 IN.	SAND NO. 200 TO NO. 4	SMALLER THAN NO. 200	IN-PLACE UNIT WEIGHT - pcf (UNCONF. - DRY)	UNCONFINED, qu - KSF	DIRECT SHEAR - DEGREES	CALIFORNIA BEARING RATIO (CBR)	MAXIMUM DRY UNIT WEIGHT(T-180)-pcf	NATURAL MOISTURE - %	OPTIMUM MOISTURE CONTENT - %	
				STA.	OFFSET (ft)															
B-20	15183	Soil Survey	29.5-31.0'	16534+01	8 ft Right														23.2	
B-20	15182	Soil Survey	32.5-34.0'	16534+01	8 ft Right														59.9	
B-20	15185	Soil Survey	34.5-36.0'	16534+01	8 ft Right															
B-21	15186	Soil Survey	1.5-2.5'	16516+58	8 ft Left														10.7	
B-21	15187	Soil Survey	2.5-3.5'	16516+58	8 ft Left														16.2	
B-21	15188	Soil Survey	1.5-4.5'	16516+58	8 ft Left	A-4(0)	ML	20	2	0.9	47.0	52.1								
B-21	15189	Soil Survey	4.5-6.0'	16516+58	8 ft Left														14.4	
B-63		Stony Cr. Bridge	0.0-1.5'	16664+74	58 ft Left															
B-63		Stony Cr. Bridge	2.5-4.0'	16664+74	58 ft Left															
B-63		Stony Cr. Bridge	4.5-6.0'	16664+74	58 ft Left															
B-63		Stony Cr. Bridge	7.5-9.0'	16664+74	58 ft Left															
B-63		Stony Cr. Bridge	9.5-11.0'	16664+74	58 ft Left															
B-63		Stony Cr. Bridge	12.5-14.0'	16664+74	58 ft Left															
B-63		Stony Cr. Bridge	14.5-16.0'	16664+74	58 ft Left															
B-63		Stony Cr. Bridge	17.5-19.0'	16664+74	58 ft Left															
B-63		Stony Cr. Bridge	19.5-21.0'	16664+74	58 ft Left															
B-63		Stony Cr. Bridge	24.5-26.0'	16664+74	58 ft Left															
B-63	30930	Stony Cr. Bridge	29.5-31.5'	16664+74	58 ft Left	A-7-6(52)	CH	65	47	0.0	1.2	98.8	91.9	1.474	14.0				33.2	
B-63		Stony Cr. Bridge	34.5-36.0'	16664+74	58 ft Left															
B-63		Stony Cr. Bridge	39.5-41.0'	16664+74	58 ft Left															

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.2	2.8	1.5	6.0	11.6	77.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.0	100.0		
3/4"	99.8		
1/2"	98.8		
3/8"	98.2		
#4	97.0		
#8	95.9		
#16	94.1		
#30	91.4		
#50	87.4		
#100	82.4		
#200	77.9		

Material Description

lean clay with sand

Atterberg Limits
 PL= 16 LL= 46 PI= 30

Coefficients
 D₈₅= 0.2160 D₆₀=
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= CL AASHTO= A-7-6(22)

Remarks
 Sampled by DOWL

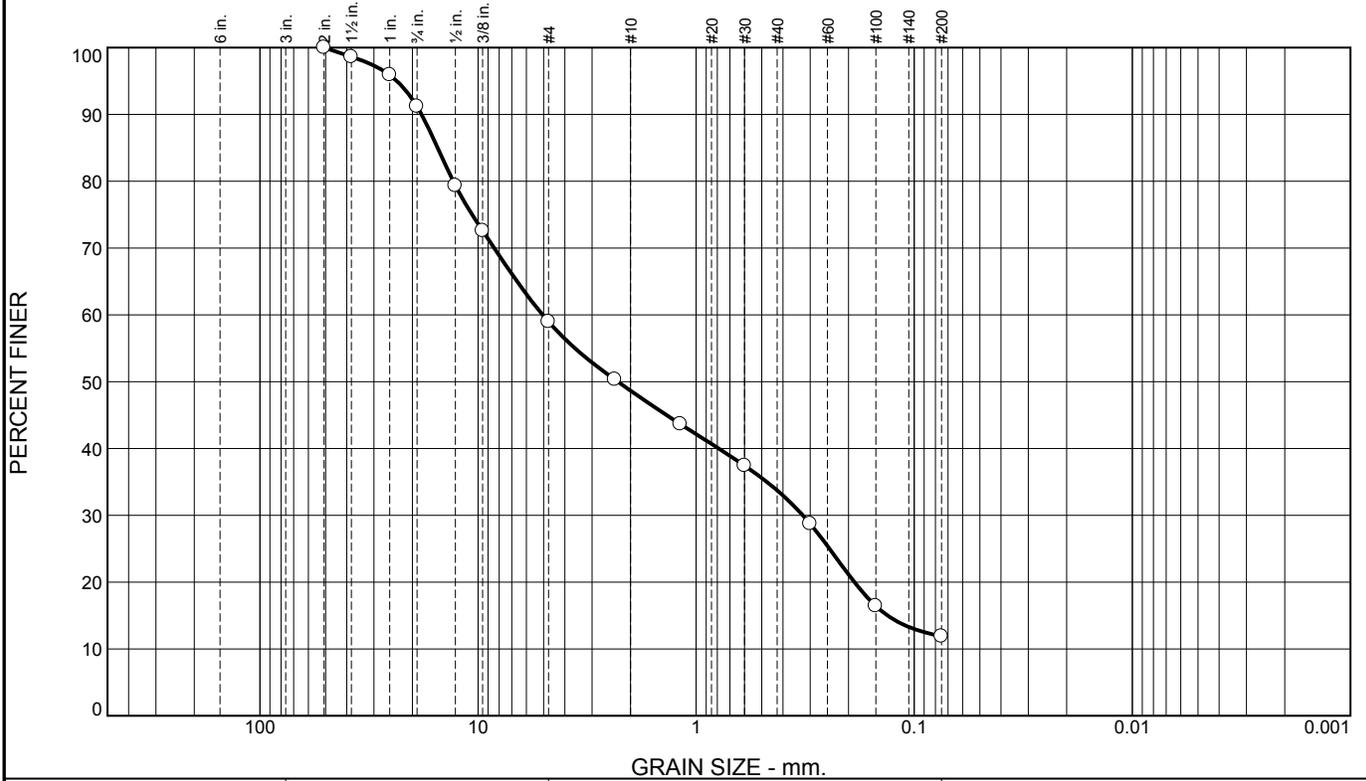
* (no specification provided)

Source of Sample: B-1A Depth: 1.25 - 4.5 ft Date: 11/25/2015
 Sample Number: 15091

	<p>Client: NDDOT</p> <p>Project: NDDOT HWY 1804 Geo Exploration</p> <p>Project No: 6024.20997.01</p>
---	---

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	8.8	32.2	10.3	15.0	21.8	11.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2	100.0		
1.5	98.6		
1	95.9		
3/4	91.2		
1/2	79.3		
3/8	72.6		
#4	59.0		
#8	50.3		
#16	43.6		
#30	37.4		
#50	28.7		
#100	16.4		
#200	11.9		

Material Description

poorly graded sand with silt and gravel

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D₉₀= 18.1648 D₈₅= 15.3254 D₆₀= 5.0555
D₅₀= 2.2871 D₃₀= 0.3241 D₁₅= 0.1325
D₁₀= C_u= C_c=

Classification

USCS= SP-SM AASHTO= A-1-b

Remarks

* (no specification provided)

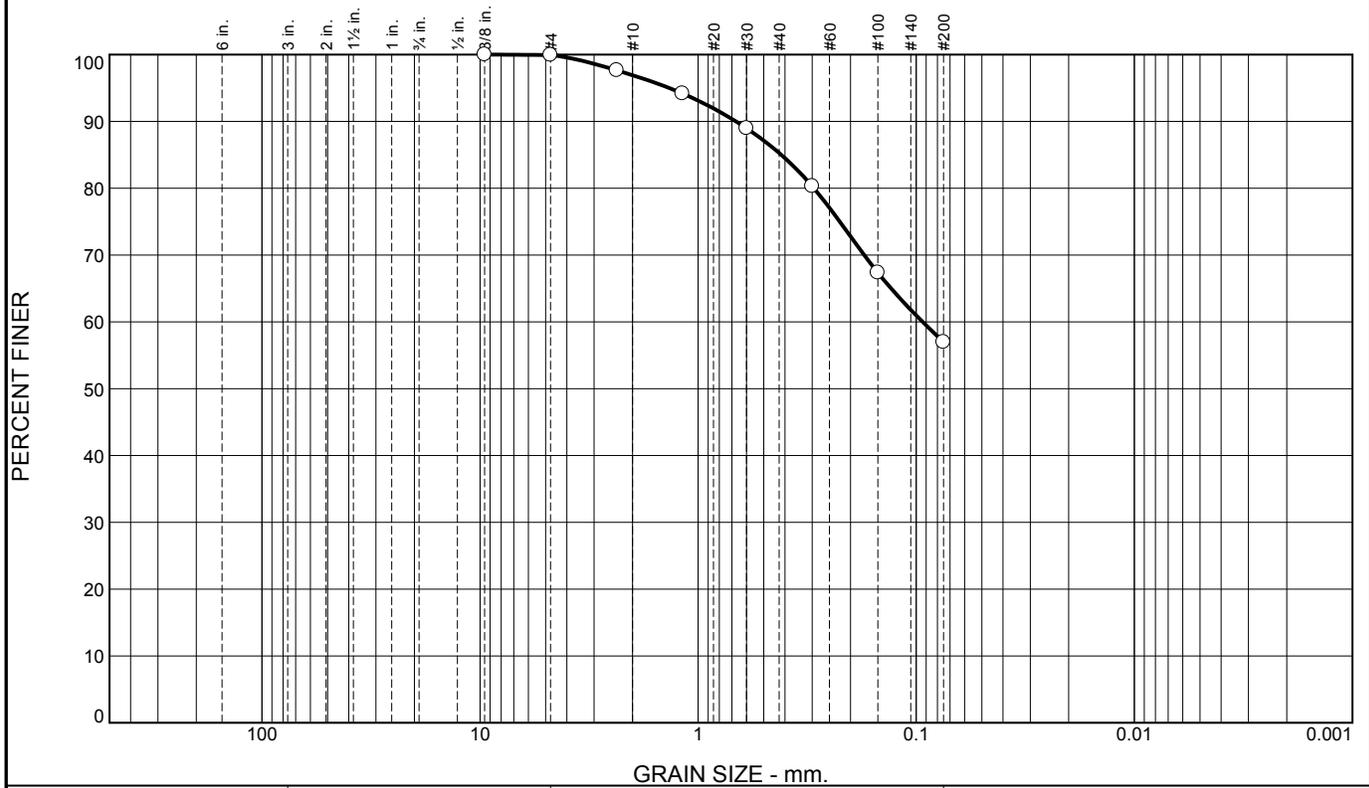
Source of Sample: B-2 Depth: 0.5 - 4.0 ft
Sample Number: 15093

Date:

	<p>Client: NDDOT</p> <p>Project: NDDOT HWY 1804 Geo Exploration</p> <p>Project No: 6024.20997.01</p>
---	---

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	3.0	11.6	28.3	57.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
#4	99.9		
#8	97.6		
#16	94.2		
#30	89.0		
#50	80.3		
#100	67.4		
#200	57.0		

Material Description

sandy lean clay

Atterberg Limits
 PL= 13 LL= 31 PI= 18

Coefficients
 D₉₀= 0.6716 D₈₅= 0.4159 D₆₀= 0.0934
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= CL AASHTO= A-6(7)

Remarks
 Sampled by DOWL

* (no specification provided)

Source of Sample: B-3 Depth: 1.4 - 4.5 ft
 Sample Number: 15097

Date: 11/30/2015

	<p>Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01</p>
	Figure

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	7.3	3.8	8.5	21.0	59.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	96.9		
3/8"	95.0		
#4	92.7		
#8	89.8		
#16	86.3		
#30	82.8		
#50	77.1		
#100	67.8		
#200	59.4		

Material Description

sandy lean clay

Atterberg Limits
 PL= 13 LL= 34 PI= 21

Coefficients
 D₉₀= 2.4756 D₈₅= 0.9083 D₆₀= 0.0793
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= CL AASHTO= A-6(9)

Remarks
 Sampled by DOWL

* (no specification provided)

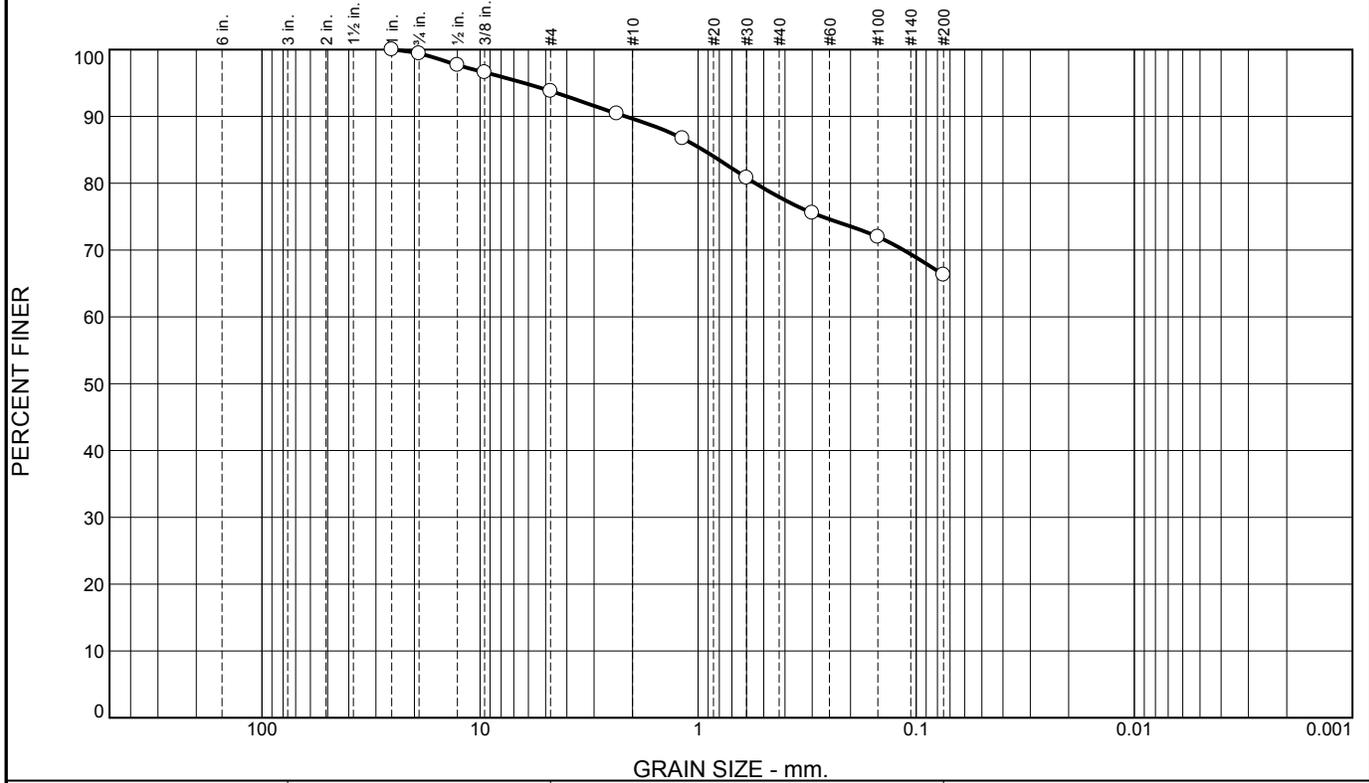
Source of Sample: B-4 Depth: 4.5 - 6.0 ft
 Sample Number: 15102

Date:

	Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01	Figure
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Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.6	5.6	4.2	11.7	11.6	66.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.0	100.0		
3/4"	99.4		
1/2"	97.7		
3/8"	96.6		
#4	93.8		
#8	90.4		
#16	86.7		
#30	80.8		
#50	75.6		
#100	72.0		
#200	66.3		

Material Description

sandy lean clay

Atterberg Limits
 PL= 15 LL= 42 PI= 27

Coefficients
 D₉₀= 2.1575 D₈₅= 0.9512 D₆₀=
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= CL AASHTO= A-7-6(15)

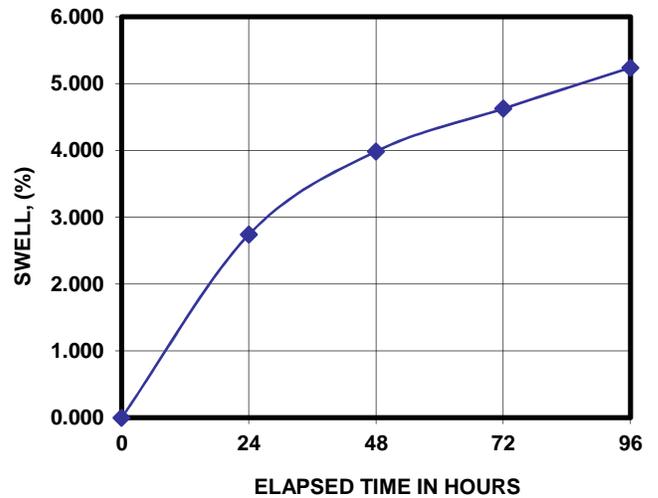
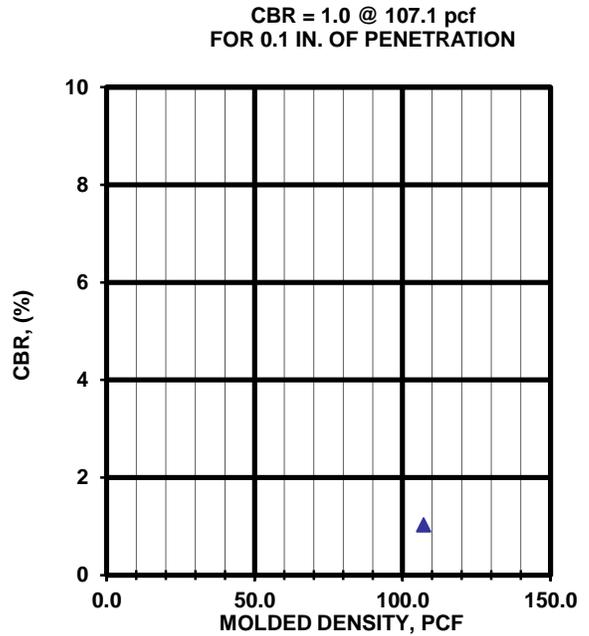
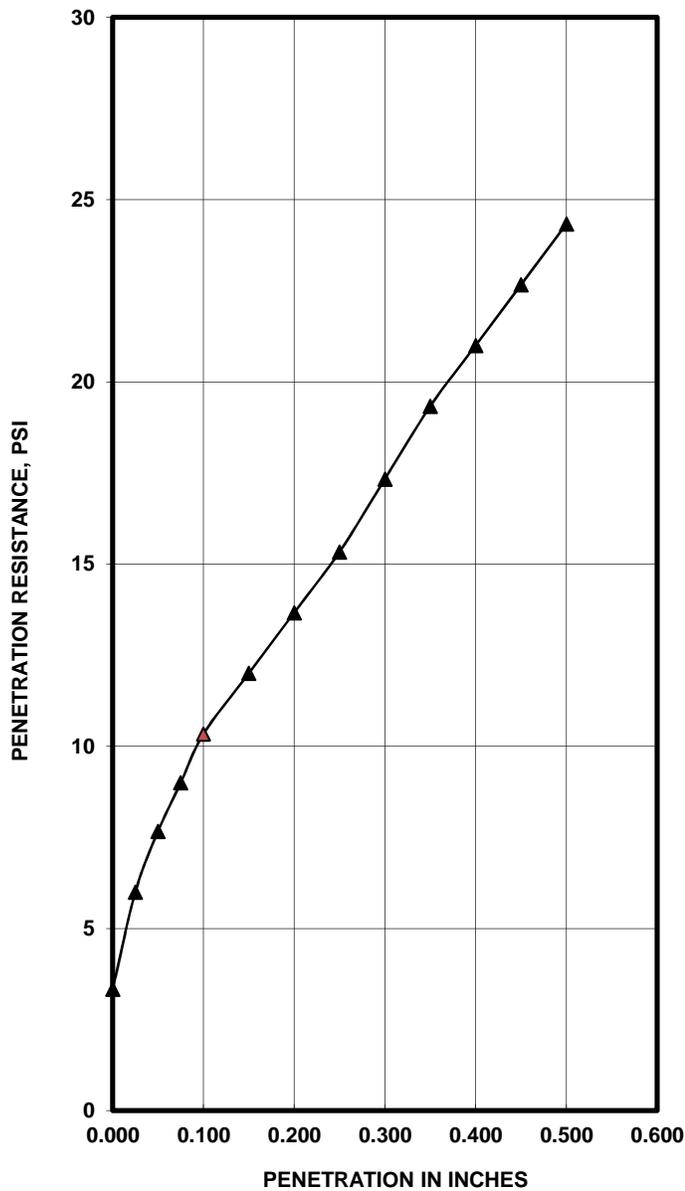
Remarks
 Sampled by DOWL

* (no specification provided)

Source of Sample: B-5 Depth: 1.3 - 4.5 ft Date: 11/19/2015
 Sample Number: 15108

	<p>Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01</p>
	Figure

Tested By: LM Checked By: LM



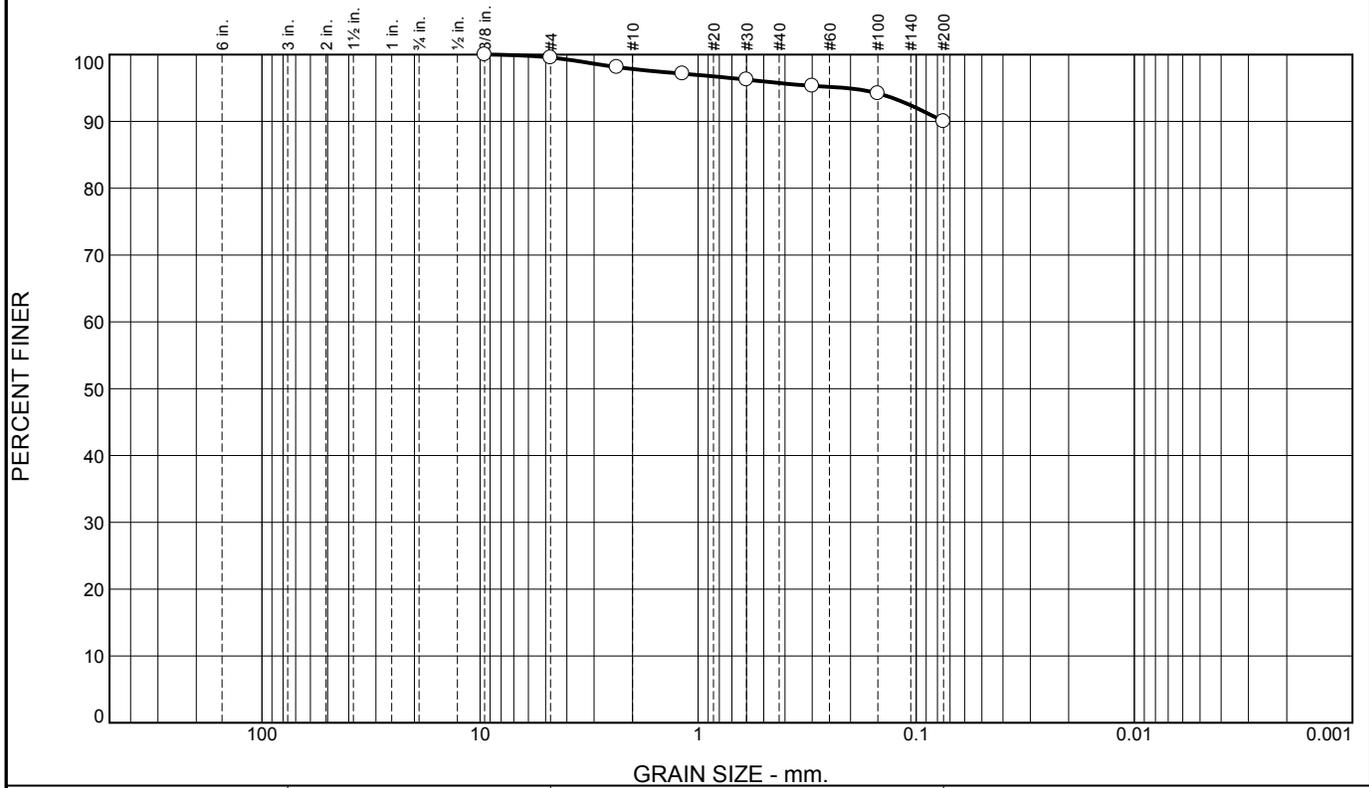
MOLDED			SOAKED			CBR	(%)	PEN.	SWELL	
DENS.	% MAX	% MOIST.	DENS.	% MAX	% MOIST.					0.1 IN.
107.1	90.0	10.2	101.5	85.3	11.9	1.0	0.9	10	5.235	
MATERIAL DESCRIPTION						USCS	MAX. DEN.	OPT. MOIST.	LL	PI
Sandy lean clay with a little gravel, brown						CL	119.0	10.0	N/A	N/A

PROJECT #:	37-02843	Boring No.:	B-5, 1.3-4.5'	Test Descr. / Remarks
PROJECT:	Highway 1804 Williston, ND			CBR PER ASTM D1883
DATE:	12/4/2015			PROCTOR PER ASTM D1557



BEARING RATIO TEST REPORT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.4	1.8	2.1	5.7	90.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
#4	99.6		
#8	98.1		
#16	97.1		
#30	96.2		
#50	95.3		
#100	94.2		
#200	90.0		

Material Description

fat clay

Atterberg Limits
 PL= 22 LL= 69 PI= 47

Coefficients
 D₉₀= 0.0750 D₈₅= D₆₀=
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= CH AASHTO= A-7-6(47)

Remarks
 Sampled by DOWL

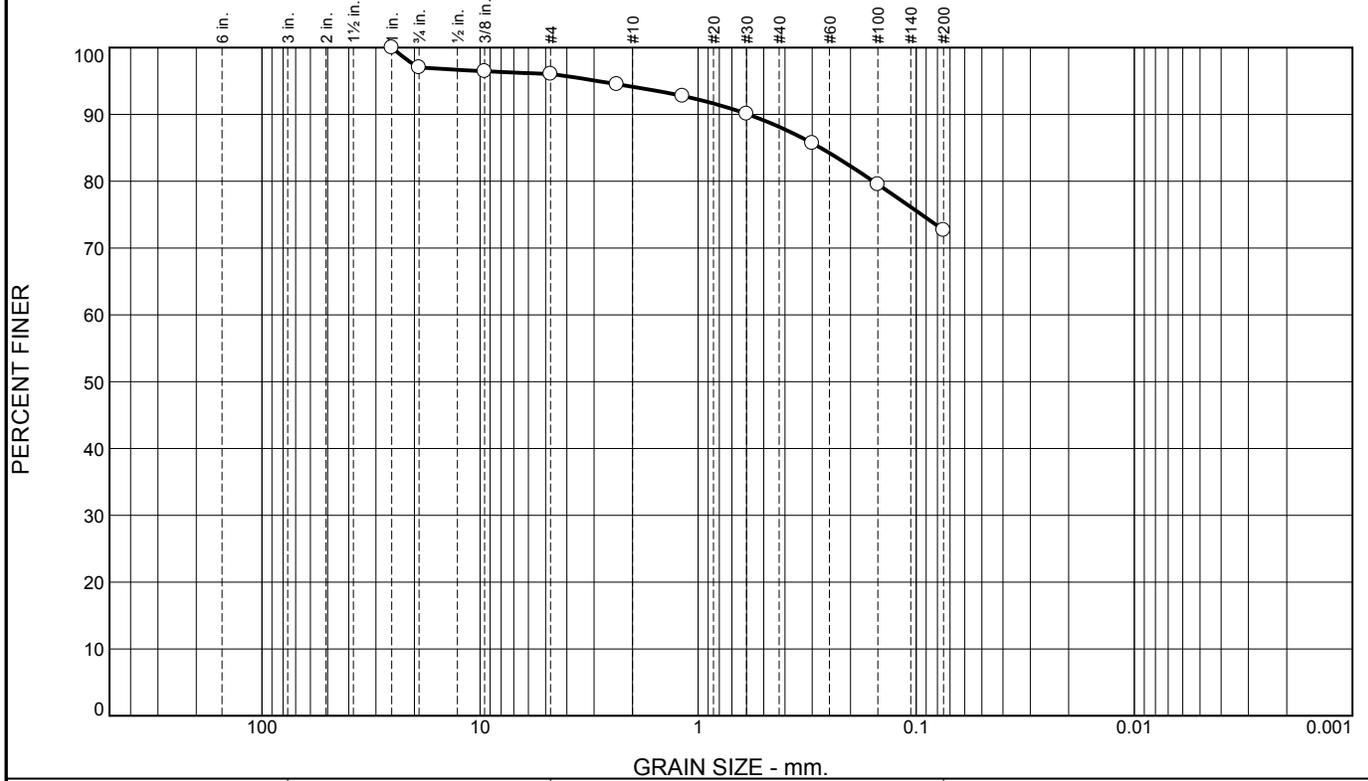
* (no specification provided)

Source of Sample: B-5 Depth: 4.5 - 6.0 ft Date: 11/24/2015
 Sample Number: 15109

	<p>Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01</p>
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Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	3.0	1.0	1.9	6.0	15.4	72.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	97.0		
3/8"	96.5		
#4	96.0		
#8	94.5		
#16	92.8		
#30	90.1		
#50	85.7		
#100	79.5		
#200	72.7		

Material Description

lean clay with sand

Atterberg Limits
 PL= 20 LL= 46 PI= 26

Coefficients
 D₈₅= 0.2749 D₆₀=
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= CL AASHTO= A-7-6(18)

Remarks
 Sampled by DOWL

* (no specification provided)

Source of Sample: B-5A Depth: 6.5 - 8.0 ft Date: 12/2/2015
 Sample Number: 15105

	Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01	Figure
---	---	--------

Tested By: LM Checked By: LM



American Engineering Testing, Inc.
 Dickinson | Williston
 99 26th Street East | 5051 Owan Ind. Park Rd.
 Dickinson, ND 58602 | Bldg. 2, Unit 2
 (701)483-4288 | Williston, ND 58801
 www.amengtest.com | (701)774-6610
 Toll Free: (800)972-6364

Proctor Report

Report No: PTR:37-02843-W1-S3
Issue No: 1

Client: DOWL **CC:** Greg Underhill
Project: 37-02843
 Highway 1804 Phase I, Williston ND

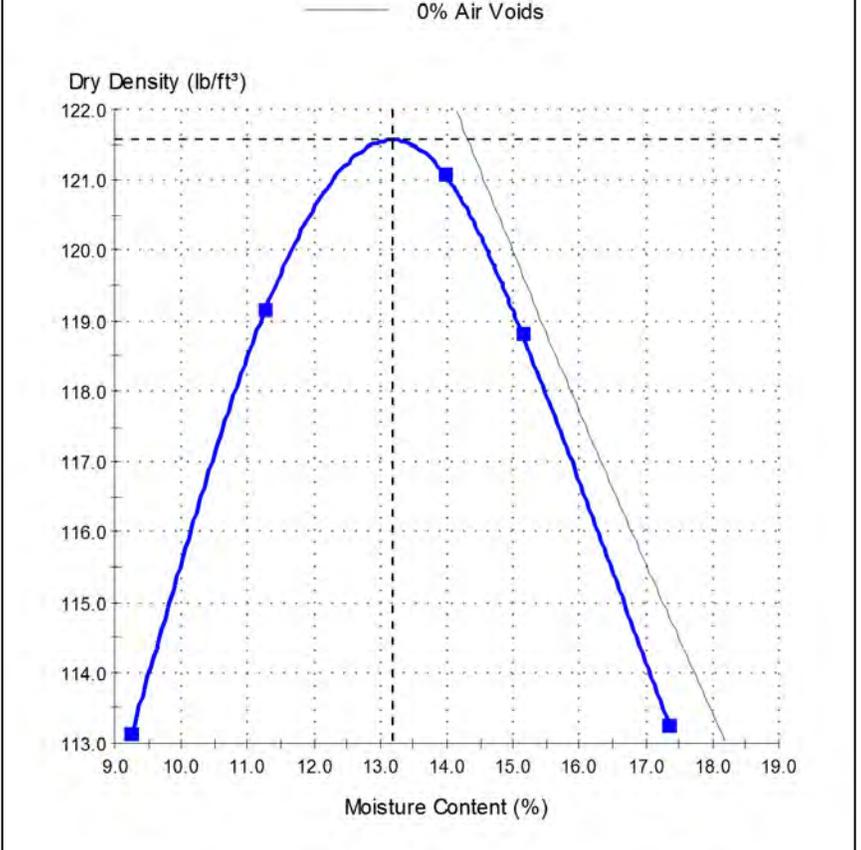
This document shall not be reproduced, except in full, without written approval from American Engineering Testing, Inc.

Date of Issue: 11/24/2015
Reviewed By: ALEC HOVICK
 North Dakota Manager

Sample Details

Sample ID: 37-02843-W1-S3 **Date Sampled:** 11/11/2015
Sampling Method: Auger Flight
Source: On-Site Material
Material: Proctor 3: Sandy Lean Clay with a Little Gravel, Brown (CL)
Specification: N/A
Location: B-7, 0.5' - 4.5'
Tested By: THOMAS EVANS **Date Tested:** 11/13/2015

Dry Density - Moisture Content Relationship



Test Results

____ AASHTO T 180 - 2011 _____
Maximum Dry Density (lb/ft³): 122
Optimum Moisture Content (%): 13.2
 Method: A
 _____ AASHTO T 224 _____
Corrected Maximum Dry Density (lb/ft³): 122
Corrected Optimum Moisture Content (%): 13.2

Comments



American Engineering Testing, Inc.
 Dickinson | Williston
 99 26th Street East | 5051 Owan Ind. Park Rd.
 Dickinson, ND 58602 | Bldg. 2, Unit 2
 (701)483-4288 | Williston, ND 58801
 www.amengtest.com | (701)774-6610
 Toll Free: (800)972-6364

Material Test Report

Report No: MAT:37-02843-W1-S3
 Issue No: 1

Client: DOWL
 Project: 37-02843
 Highway 1804 Phase I, Williston ND

CC: Greg Underhill

Draft Report - Subject to
 change pending final
 review

Date of Issue: 11/24/2015

Sample Details

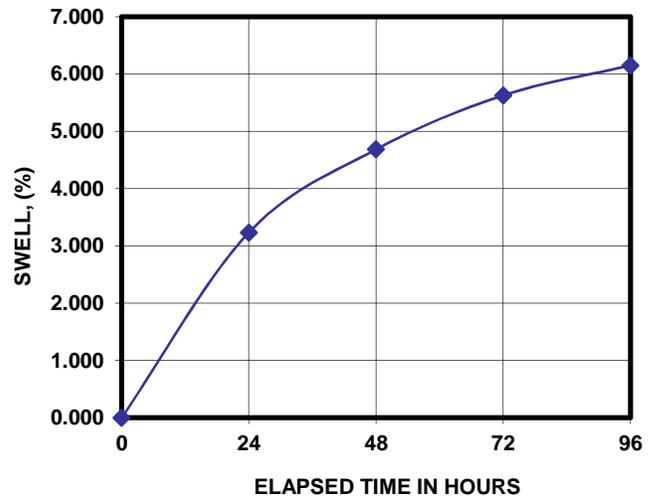
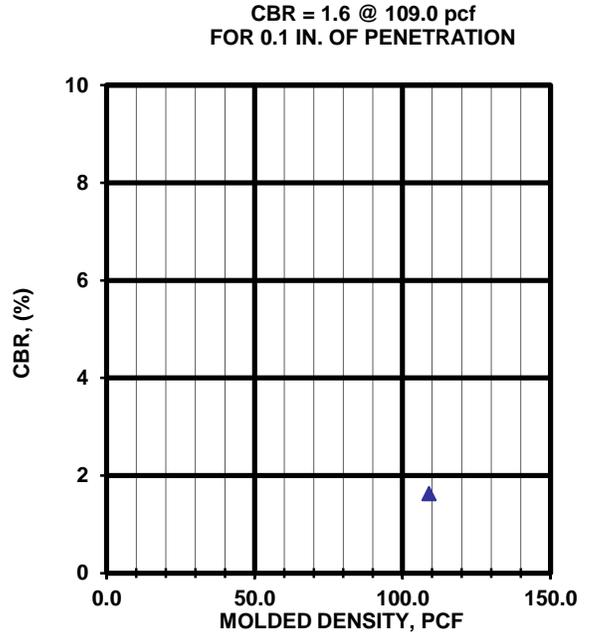
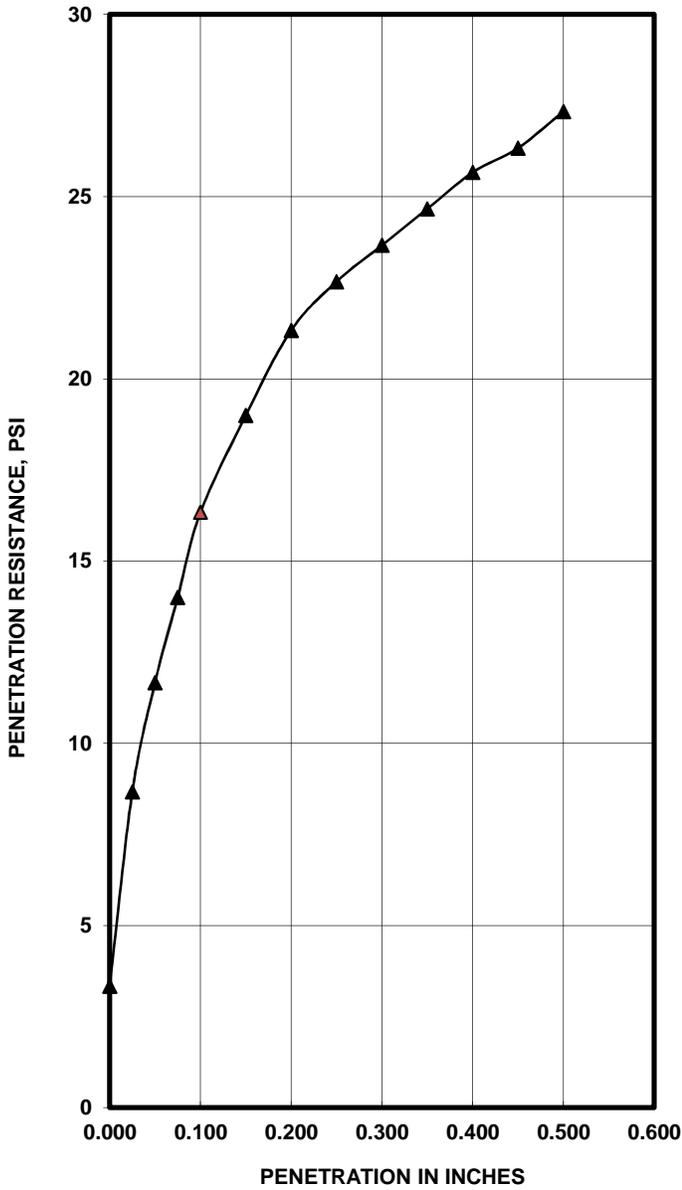
Sample ID 37-02843-W1-S3
 Field Sample ID 3
 Date Sampled 11/11/2015
 Source On-Site Material
 Material Proctor 3: Sandy Lean Clay with a Little Gravel, Brown (CL)
 Specification N/A
 Sampling Method Auger Flight
 Location B-7, 0.5' - 4.5'
 Date Submitted 11/11/2015

Test Results

Description	Method	Result	Limits
Maximum Dry Density (lb/ft ³)	AASHTO T 180 - 2011	122	
Corrected Maximum Dry Density (lb/ft ³)		122	
Optimum Moisture Content (%)		13.2	
Corrected Optimum Moisture Content (%)		13.2	
Method		A	
Date Tested		11/13/2015	
Moisture Content (%)	AASHTO T 255 - 2000	16.7	
Date Tested		11/11/2015	

Comments

N/A



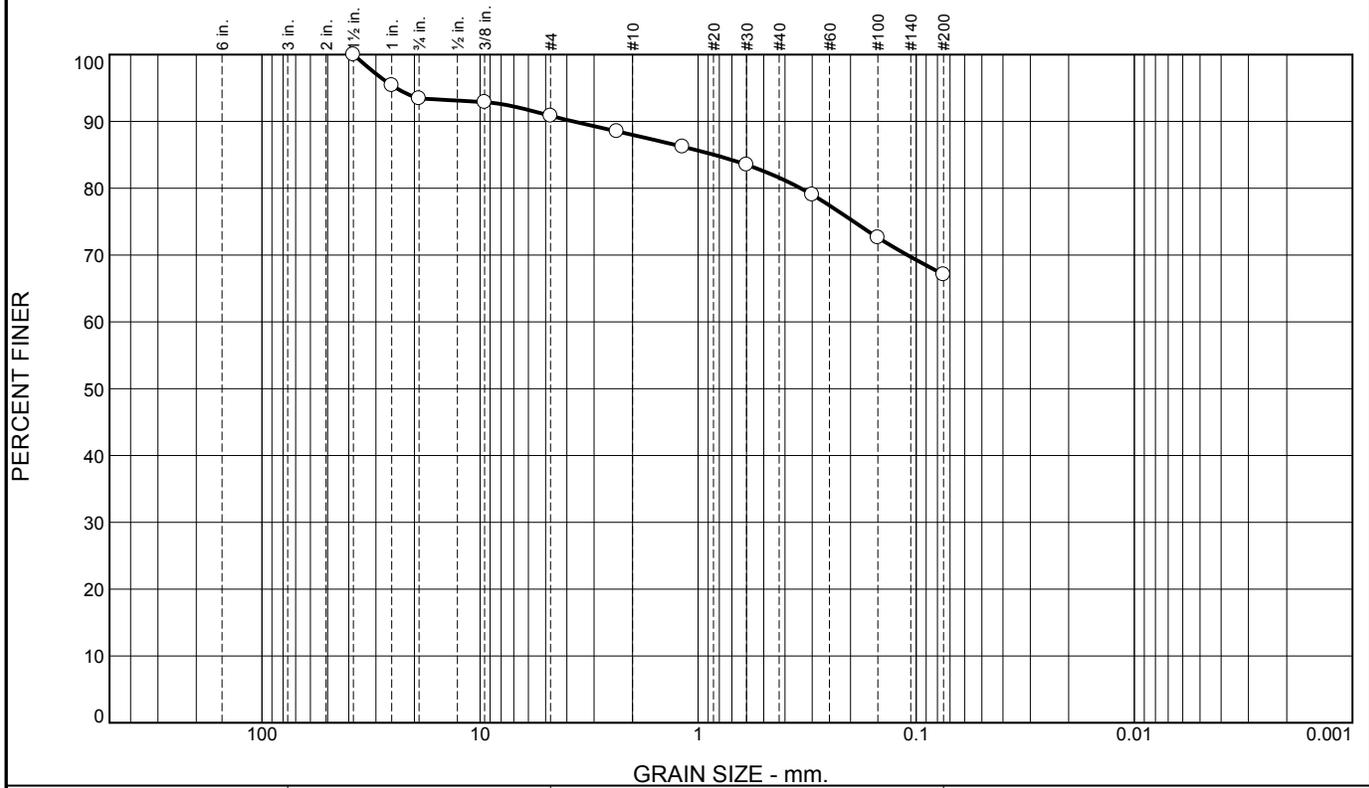
MOLDED			SOAKED			CBR	(%)	PEN.	SWELL	
DENS.	% MAX	% MOIST.	DENS.	% MAX	% MOIST.	0.1 IN.	0.2 IN.	SURCHG	%	
109.0	89.7	13.3	102.3	84.2	18.5	1.6	1.4	10	6.148	
MATERIAL DESCRIPTION						USCS	MAX. DEN.	OPT. MOIST.	LL	PI
Sandy lean clay with a little gravel, brown						CL	121.5	13.2	N/A	N/A

PROJECT #:	37-02843	Boring No.	Proctor 3, B-7	Test Descr. / Remarks
PROJECT:	Highway 1804 New Town, ND			CBR PER ASTM D1883
DATE:	11/20/2015			PROCTOR PER ASTM D1557



BEARING RATIO TEST REPORT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	6.6	2.6	2.8	6.4	14.5	67.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	95.4		
3/4"	93.4		
3/8"	92.9		
#4	90.8		
#8	88.5		
#16	86.2		
#30	83.5		
#50	79.0		
#100	72.6		
#200	67.1		

Material Description

PL= **Atterberg Limits** PI=

 LL=

D₉₀= 3.7417 **Coefficients** D₆₀=

D₅₀= D₈₅= 0.8455 D₁₅=

D₁₀= C_u= C_c=

USCS= **Classification** AASHTO=

Remarks

Sampled by DOWL

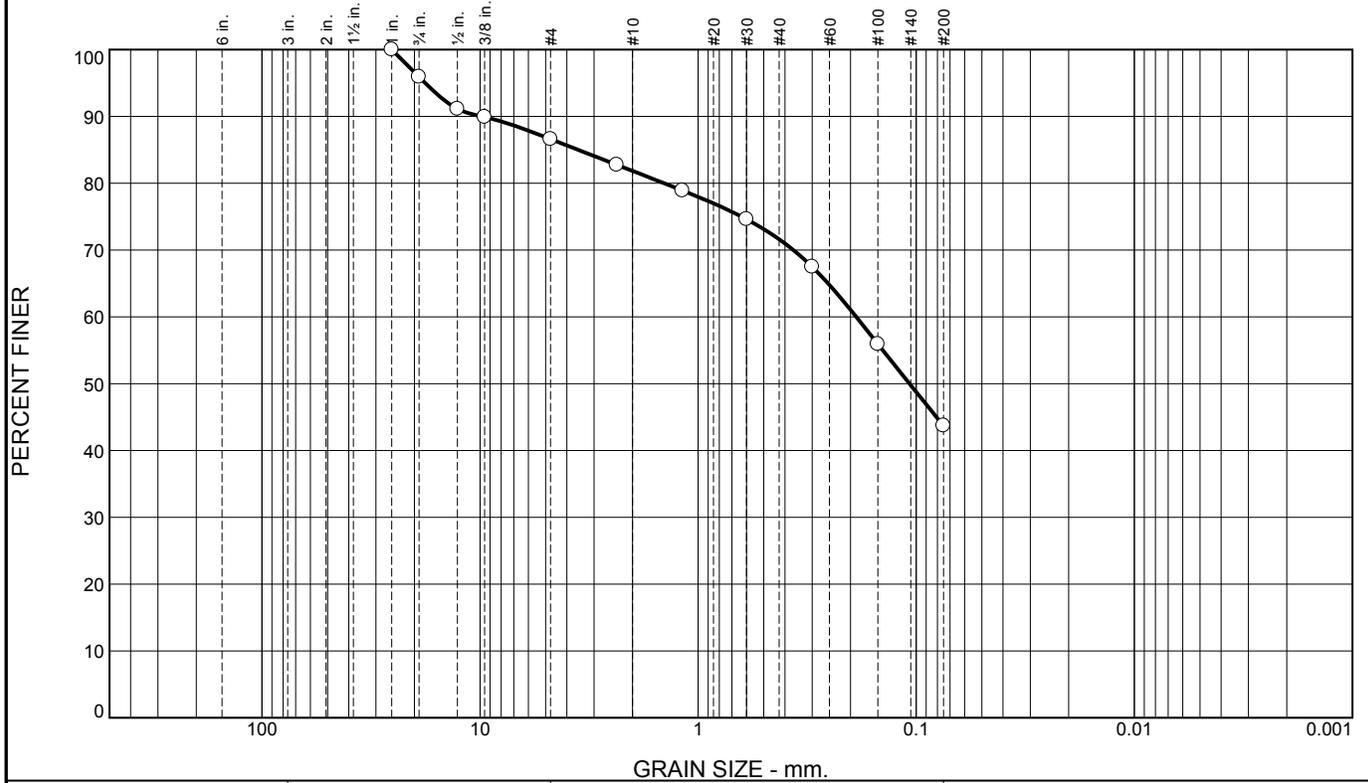
* (no specification provided)

Source of Sample: B-8 Depth: 1.0 - 2.0 ft Date: 12/1/2015
 Sample Number: 15117

	<p>Client: NDDOT</p> <p>Project: NDDOT HWY 1804 Geo Exploration</p> <p>Project No: 6024.20997.01</p> <p style="text-align: right;">Figure</p>
--	---

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.1	9.3	4.8	10.2	27.9	43.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	95.9		
1/2"	91.1		
3/8"	89.9		
#4	86.6		
#8	82.7		
#16	78.9		
#30	74.6		
#50	67.5		
#100	55.9		
#200	43.7		

Material Description

clayey sand

Atterberg Limits
 PL= 12 LL= 31 PI= 19

Coefficients
 D₈₅= 3.5541 D₆₀= 0.1885
 D₅₀= 0.1074 D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= SC AASHTO= A-6(4)

Remarks
 Sampled by DOWL

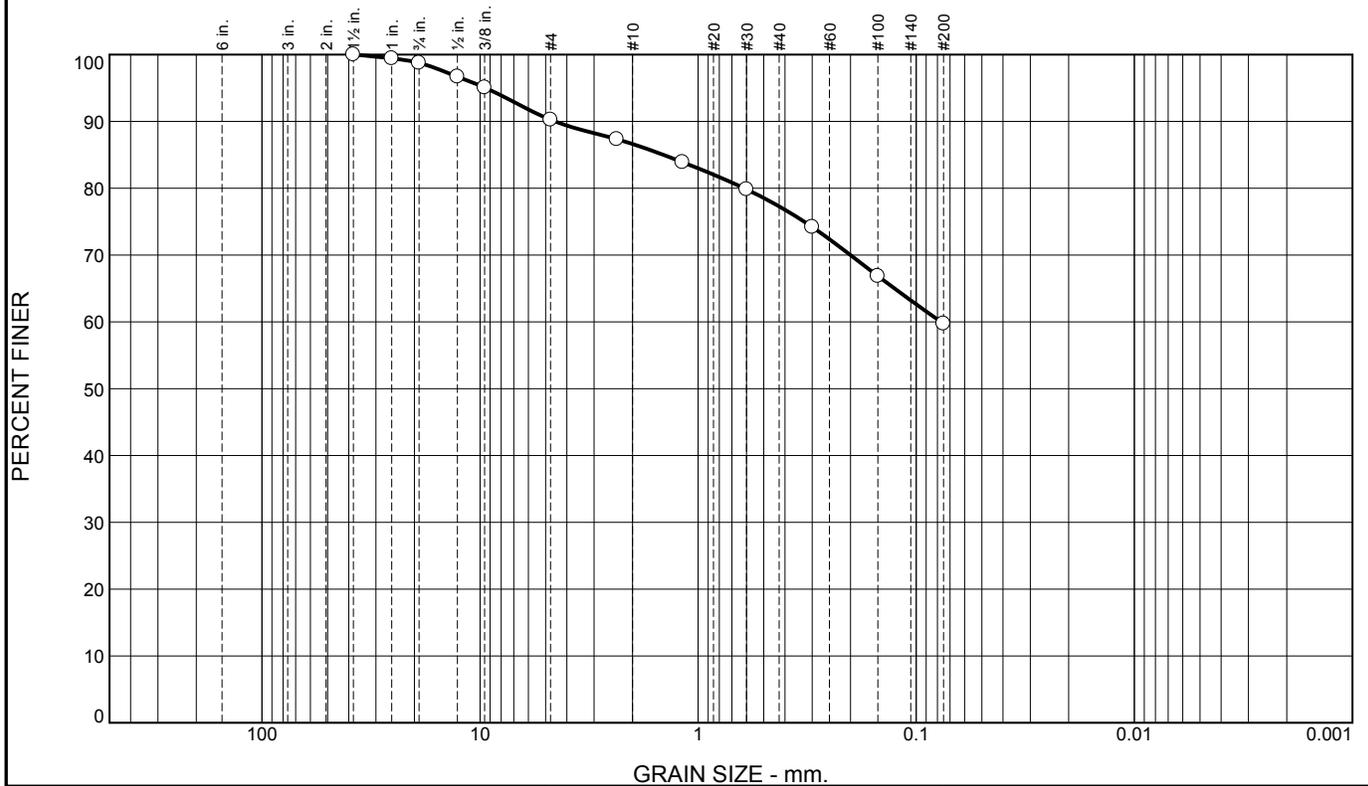
* (no specification provided)

Source of Sample: B-8 Depth: 2.0 - 3.0 ft Date: 12/2/2015
 Sample Number: 15118

	<p>Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01</p>
---	---

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.2	8.6	3.6	9.3	17.6	59.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1"	99.4		
3/4"	98.8		
1/2"	96.7		
3/8"	95.1		
#4	90.2		
#8	87.3		
#16	83.9		
#30	79.8		
#50	74.2		
#100	66.9		
#200	59.7		

Material Description

sandy lean clay

Atterberg Limits
 PL= 13 LL= 35 PI= 22

Coefficients
 D₉₀= 4.5421 D₈₅= 1.4472 D₆₀= 0.0771
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= CL AASHTO= A-6(10)

Remarks
 Sampled by DOWL

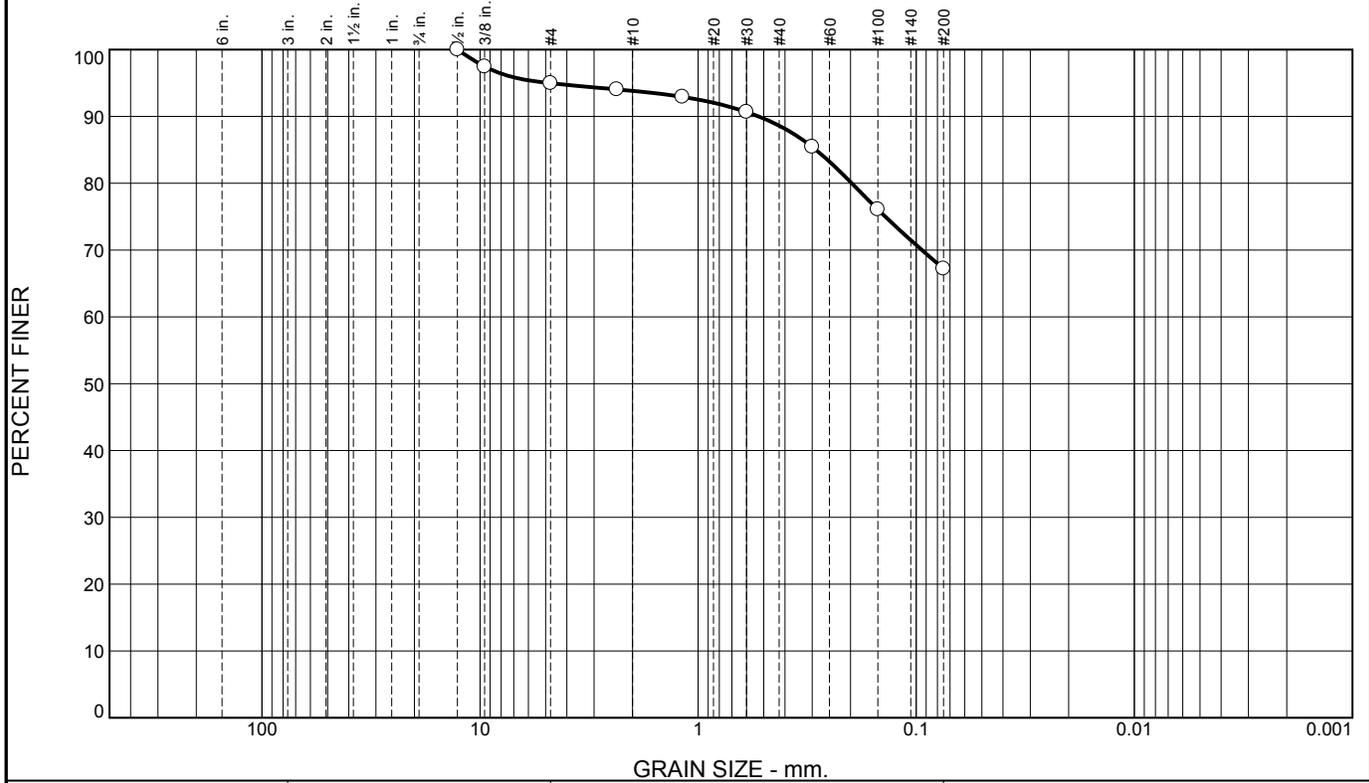
* (no specification provided)

Source of Sample: B-8 Depth: 1.0 - 4.5 ft Date: 11/30/2015
 Sample Number: 15119

	<p>Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01</p>
	Figure

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	5.0	1.2	5.2	21.4	67.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100.0		
3/8"	97.5		
#4	95.0		
#8	94.0		
#16	92.9		
#30	90.7		
#50	85.4		
#100	76.1		
#200	67.2		

Material Description

sandy lean clay

Atterberg Limits
 PL= 14 LL= 37 PI= 23

Coefficients
 D₈₅= 0.2886 D₆₀=
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= CL AASHTO= A-6(13)

Remarks
 Sampled by DOWL

* (no specification provided)

Source of Sample: B-8 Depth: 4.5 - 6.0 ft Date: 11/25/15
 Sample Number: 15120

	<p>Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01</p>
	Figure

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	5.2	5.9	2.1	5.2	19.0	62.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.0	100.0		
3/4"	94.8		
1/2"	90.1		
3/8"	89.7		
#4	88.9		
#8	87.2		
#16	85.5		
#30	83.2		
#50	78.9		
#100	70.4		
#200	62.6		

Material Description

sandy lean clay

Atterberg Limits
 PL= 13 LL= 37 PI= 24

Coefficients
 D₉₀= 11.4885 D₈₅= 0.9990 D₆₀=
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= CL AASHTO= A-6(12)

Remarks
 Sampled by DOWL

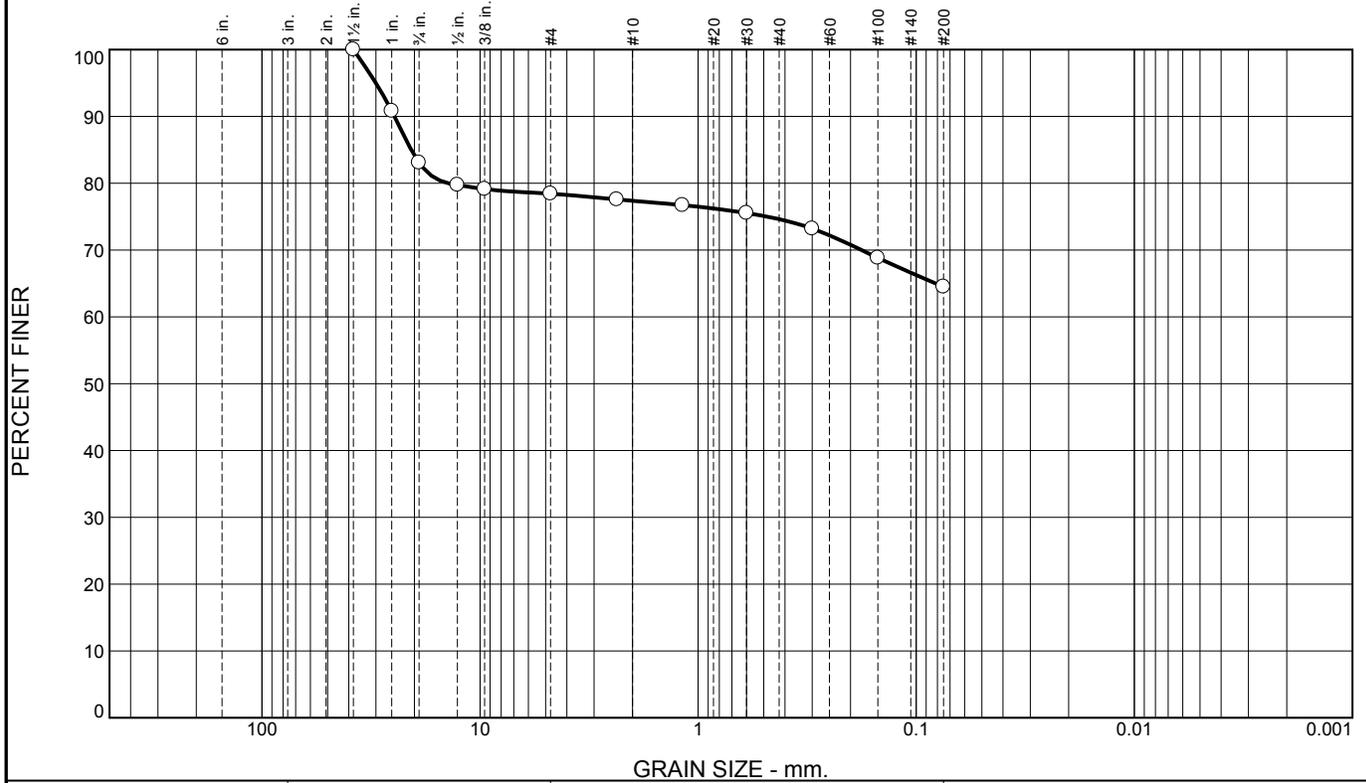
* (no specification provided)

Source of Sample: B-8 Depth: 9.5 - 11.0 ft Date: 12/2/2015
 Sample Number: 15121

	<p>Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01</p>
	Figure

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	16.9	4.7	1.0	2.8	10.1	64.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	90.8		
3/4"	83.1		
1/2"	79.7		
3/8"	79.1		
#4	78.4		
#8	77.6		
#16	76.7		
#30	75.5		
#50	73.2		
#100	68.8		
#200	64.5		

Material Description

PL= **Atterberg Limits** PI=

LL= PI=

Coefficients

D₉₀= 24.6777 D₈₅= 20.6811 D₆₀=

D₅₀= D₃₀= D₁₅=

D₁₀= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sampled by DOWL

* (no specification provided)

Source of Sample: B-9 Depth: 4.5 - 6.0
 Sample Number: 15123

Date: 12/1/2015

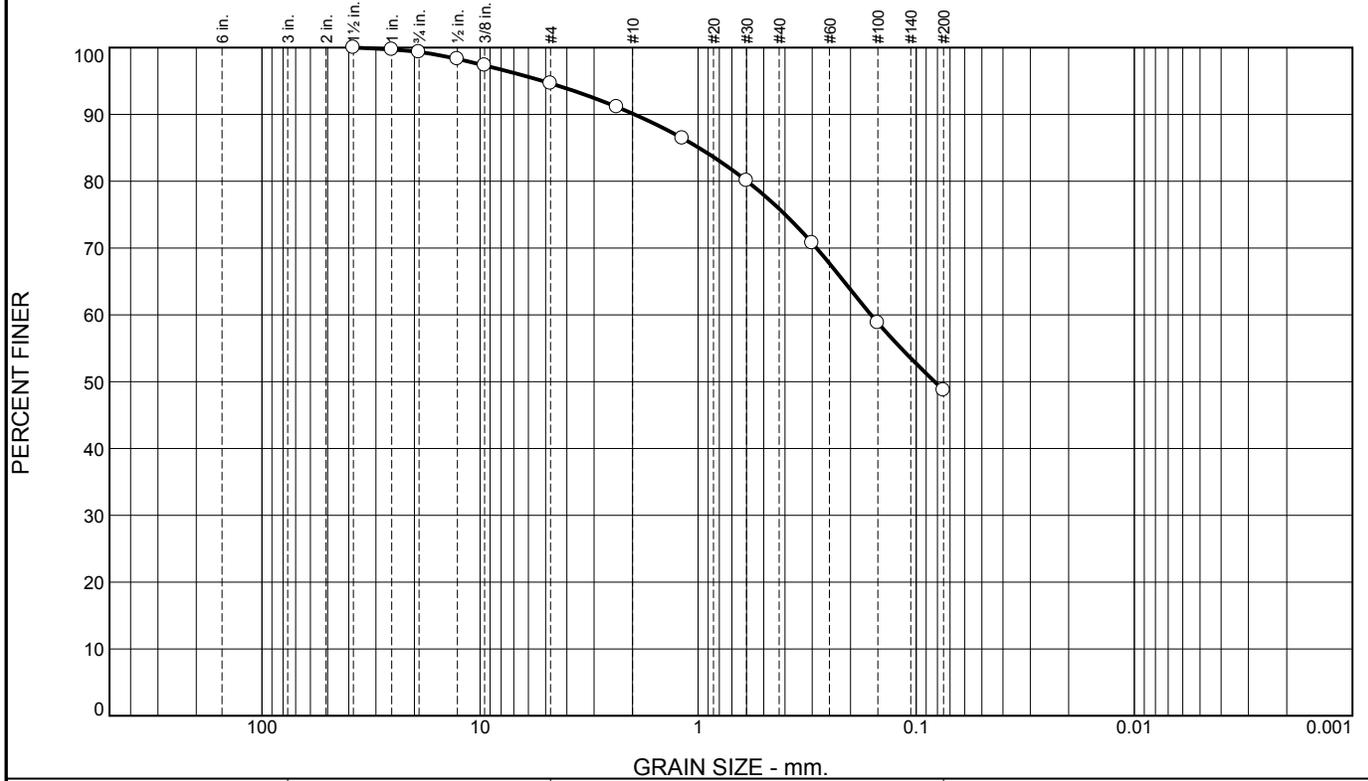


Client: NDDOT
 Project: NDDOT HWY 1804 Geo Exploration
 Project No: 6024.20997.01

Figure

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.7	4.7	4.5	14.2	27.2	48.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	99.7		
3/4"	99.3		
1/2"	98.3		
3/8"	97.3		
#4	94.6		
#8	91.1		
#16	86.4		
#30	80.1		
#50	70.7		
#100	58.8		
#200	48.7		

Material Description

silty, clayey sand

Atterberg Limits

PL= 18 LL= 24 PI= 6

Coefficients

D₉₀= 1.9610 D₈₅= 0.9931 D₆₀= 0.1611
D₅₀= 0.0823 D₃₀= D₁₅=
D₁₀= C_u= C_c=

Classification

USCS= SC-SM AASHTO= A-4(0)

Remarks

Sampled by DOWL

* (no specification provided)

Source of Sample: B-9 Depth: 1.5 - 4.5 Date: 12/2/2015
Sample Number: 15124

	<p>Client: NDDOT</p> <p>Project: NDDOT HWY 1804 Geo Exploration</p> <p>Project No: 6024.20997.01</p> <p style="text-align: right;">Figure</p>
---	---

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.3	2.5	2.7	10.0	20.4	64.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	99.8		
1/2	99.3		
3/8	98.8		
#4	97.2		
#8	95.2		
#16	92.0		
#30	87.5		
#50	80.7		
#100	71.8		
#200	64.1		

Material Description

sandy lean clay

Atterberg Limits
 PL= 17 LL= 26 PI= 9

Coefficients
 D₉₀= 0.8515 D₈₅= 0.4505 D₆₀=
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= CL AASHTO= A-4(3)

Remarks

* (no specification provided)

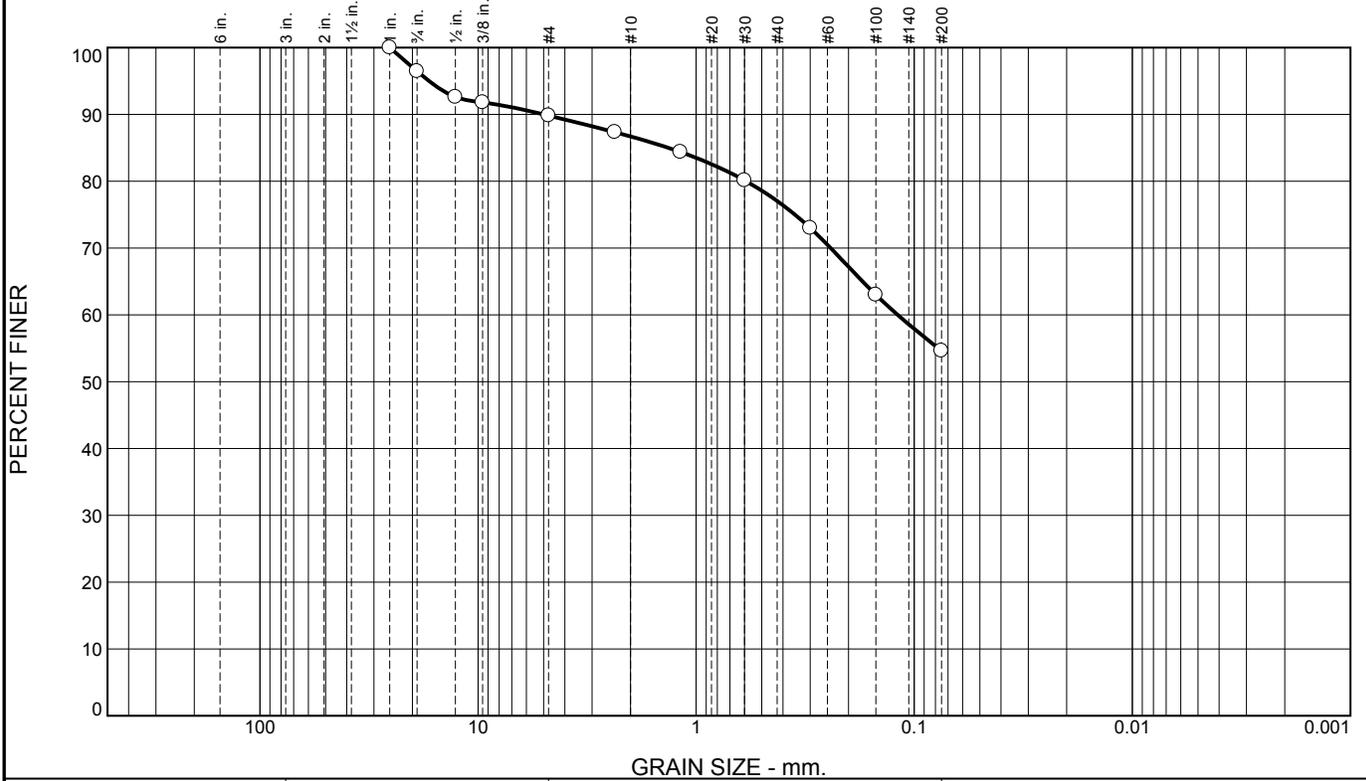
Source of Sample: B-10 Depth: 1.3 - 4.5 ft
 Sample Number: 15127

Date:

	<p>Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01</p>
	Figure

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	3.5	6.7	3.1	9.7	22.4	54.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	96.5		
1/2"	92.6		
3/8"	91.8		
#4	89.8		
#8	87.3		
#16	84.4		
#30	80.1		
#50	73.0		
#100	63.0		
#200	54.6		

Material Description

sandy lean clay

Atterberg Limits
 PL= 15 LL= 24 PI= 9

Coefficients
 D₉₀= 5.0134 D₈₅= 1.3435 D₆₀= 0.1191
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= CL AASHTO= A-4(2)

Remarks
 Sampled by DOWL

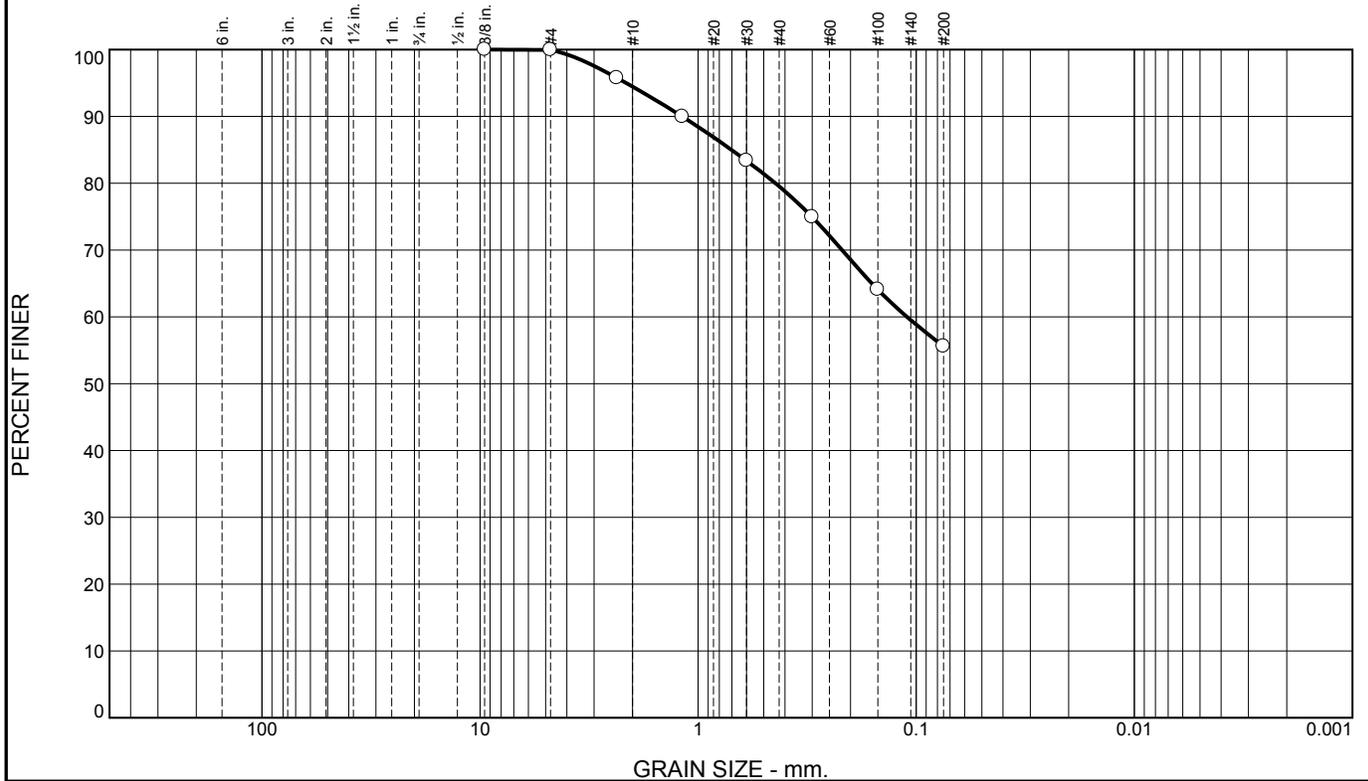
* (no specification provided)

Source of Sample: B-10 Depth: 2.2 - 3.2 ft Date: 12/2/2015
 Sample Number: 15126

	<p>Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01</p>
---	---

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	5.4	15.0	23.9	55.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8	100.0		
#4	99.9		
#8	95.8		
#16	90.0		
#30	83.4		
#50	74.9		
#100	64.1		
#200	55.6		

Material Description

sandy lean clay

Atterberg Limits
 PL= 16 LL= 26 PI= 10

Coefficients
 D₉₀= 1.1856 D₈₅= 0.7036 D₆₀= 0.1103
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= CL AASHTO= A-4(3)

Remarks

* (no specification provided)

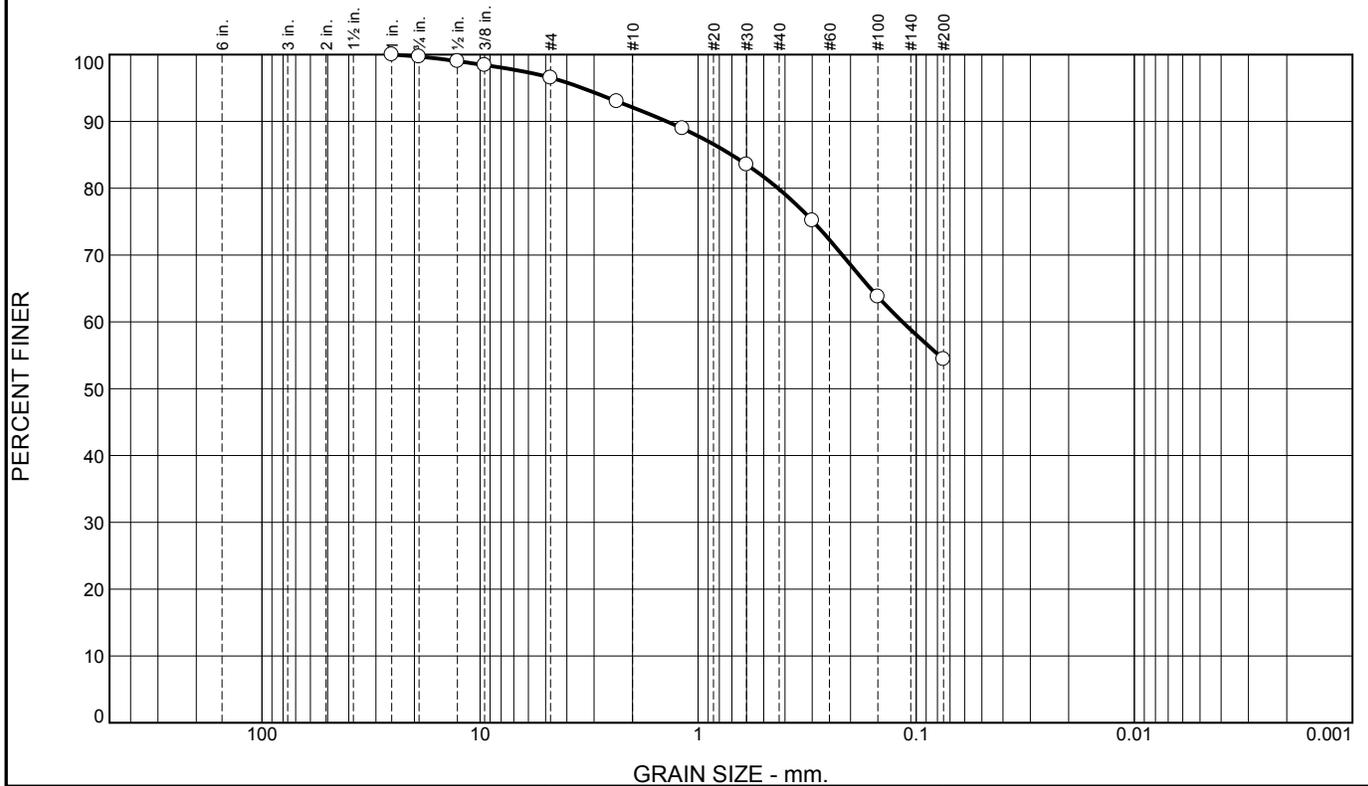
Source of Sample: B-11 Depth: 1.7 - 4.5 ft
 Sample Number: 15131

Date:

	<p>Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01</p>
	Figure

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.3	3.2	4.4	12.3	25.4	54.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	99.7		
1/2"	99.0		
3/8"	98.4		
#4	96.5		
#8	93.0		
#16	88.9		
#30	83.5		
#50	75.2		
#100	63.8		
#200	54.4		

Material Description

sandy lean clay

Atterberg Limits
 PL= 14 LL= 30 PI= 16

Coefficients
 D₉₀= 1.3938 D₈₅= 0.7038 D₆₀= 0.1157
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= CL AASHTO= A-6(5)

Remarks
 Sampled by DOWL

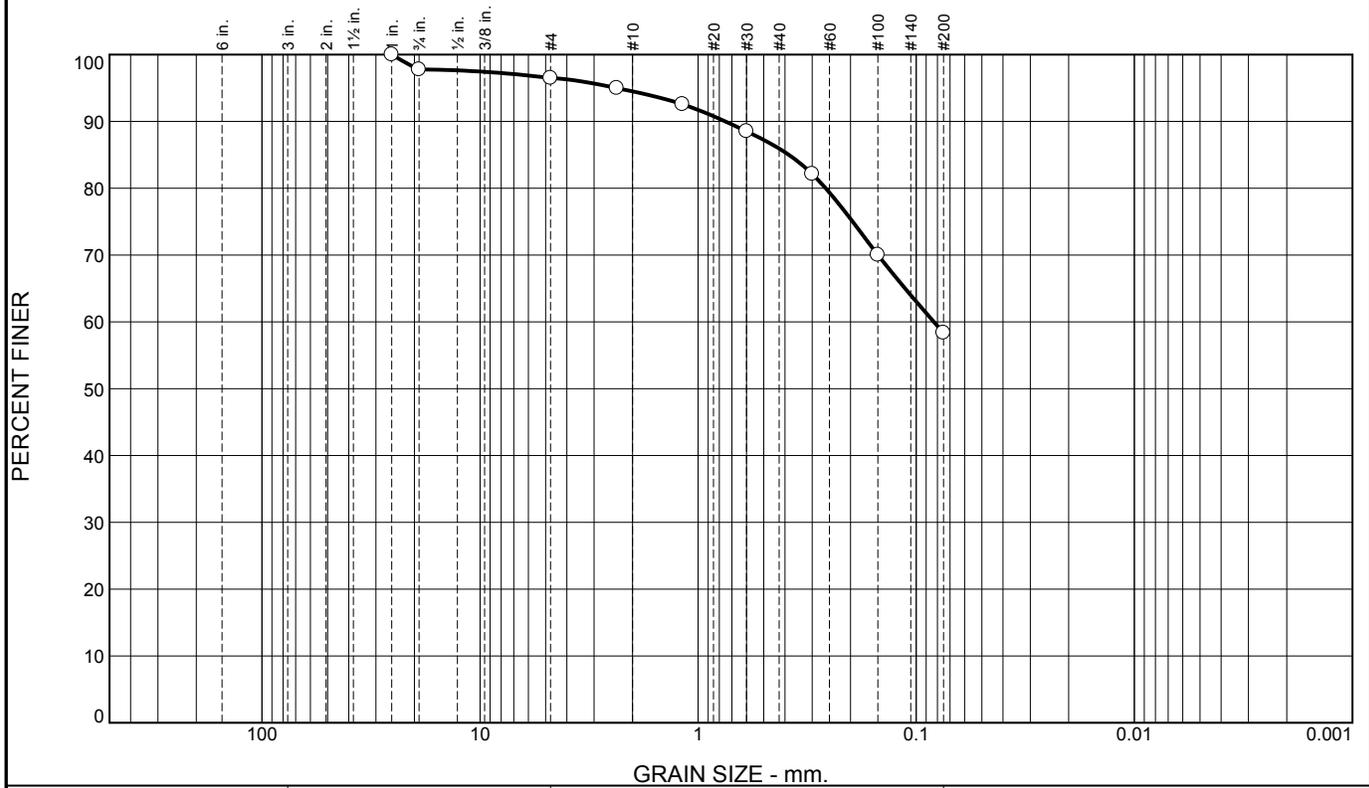
* (no specification provided)

Source of Sample: B-12 Depth: 1.7 - 4.5 ft Date: 12/2/2015
 Sample Number: 15134

	Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01	Figure
---	---	--------

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	2.2	1.3	2.0	8.6	27.5	58.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	97.8		
#4	96.5		
#8	95.0		
#16	92.6		
#30	88.5		
#50	82.1		
#100	70.0		
#200	58.4		

Material Description

sandy lean clay

Atterberg Limits
 PL= 16 LL= 25 PI= 9

Coefficients
 D₉₀= 0.7517 D₈₅= 0.3839 D₆₀= 0.0830
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= CL AASHTO= A-4(2)

Remarks
 Sampled by DOWL

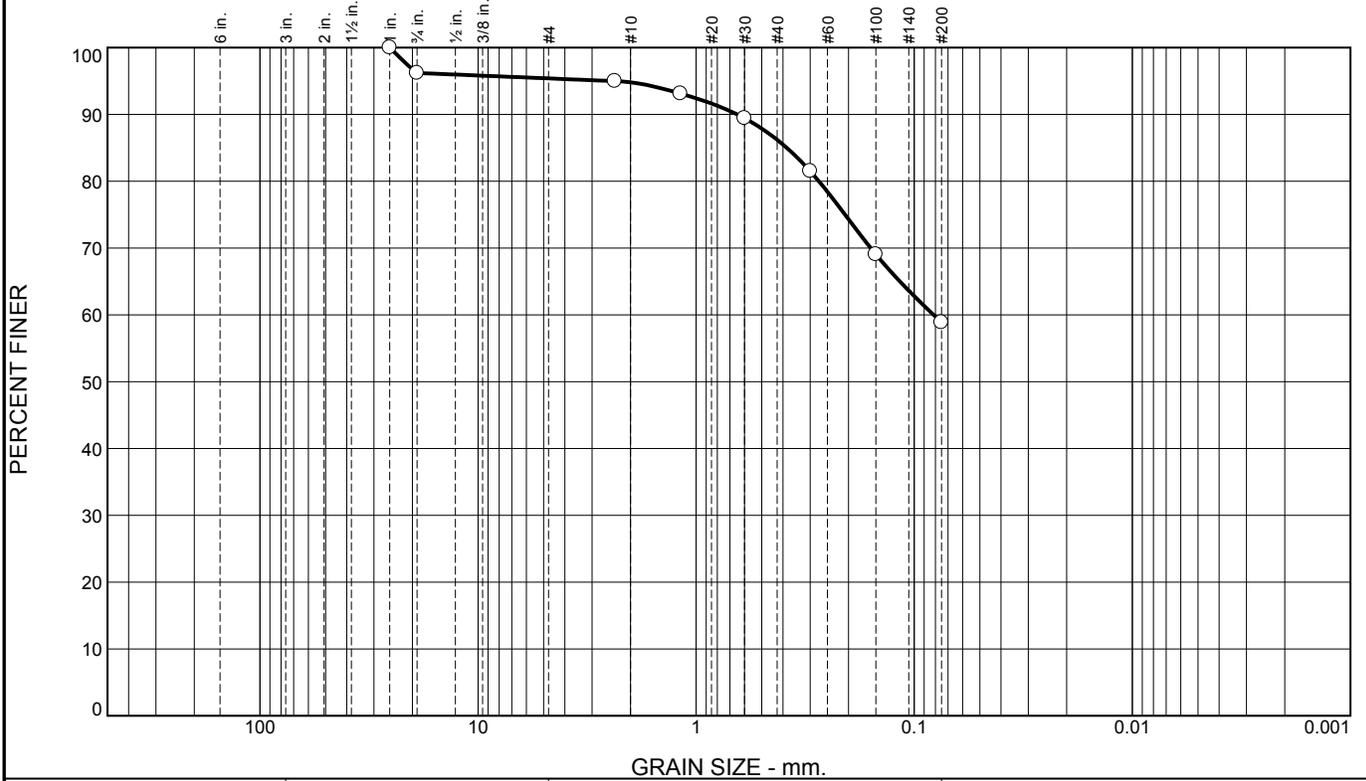
* (no specification provided)

Source of Sample: B-12 Depth: 4.5 - 6.0 ft Date: 11/25/2015
 Sample Number: 15135

	<p>Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01</p>
	Figure

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	3.8	0.8	0.6	8.6	27.3	58.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	96.2		
#8	95.0		
#16	93.1		
#30	89.4		
#50	81.5		
#100	69.1		
#200	58.9		

Material Description

PL= **Atterberg Limits** PI=

LL=

Coefficients

D₉₀= 0.6488 D₈₅= 0.3842 D₆₀= 0.0815

D₅₀= D₃₀= D₁₅=

D₁₀= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sampled by DOWL

* (no specification provided)

Source of Sample: B-13 Depth: 1.3 - 2.3 ft Date: 11/18/2015

Sample Number: 15136

	<p>Client: NDDOT</p> <p>Project: NDDOT HWY 1804 Geo Exploration</p> <p>Project No: 6024.20997.01</p>	<p>Figure Summary</p>
---	---	---------------------------------

Tested By: LM Checked By: LM



American Engineering Testing, Inc.
 Dickinson | Williston
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 Dickinson, ND 58602 | Bldg. 2, Unit 2
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 www.amengtest.com | (701)774-6610
 Toll Free: (800)972-6364

Proctor Report

Report No: PTR:37-02843-W1-S2
 Issue No: 1

Client: DOWL
 Project: 37-02843
 Highway 1804 Phase I, Williston ND
 CC: Greg Underhill

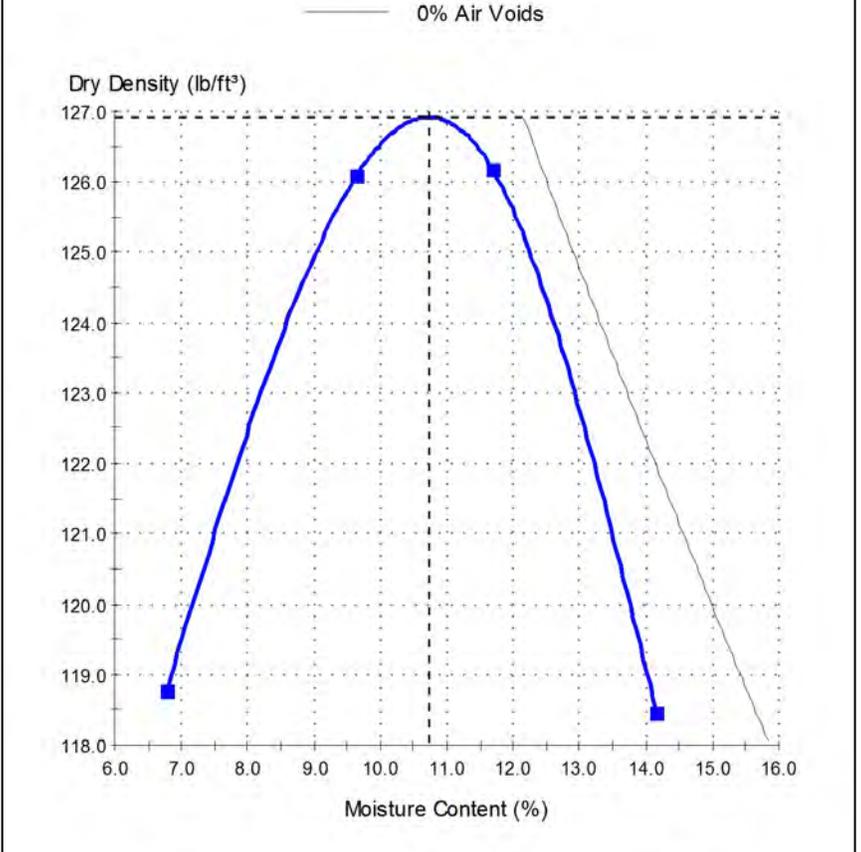
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 Date of Issue: 11/24/2015
 Reviewed By: ALEC HOVICK
 North Dakota Manager

Sample Details

Sample ID: 37-02843-W1-S2
 Date Sampled: 11/11/2015
 Sampling Method: Auger Flight
 Source: On-Site Material
 Material: Proctor 2: Clayey Sand with a Little Gravel, Dark Brown (SC)
 Specification: N/A
 Location: B-13, 1.3' - 4.5'
 Tested By: KRYSTLE BOKS
 Date Tested: 11/13/2015

Dry Density - Moisture Content Relationship



Test Results

____ AASHTO T 180 - 2011 ____
 Maximum Dry Density (lb/ft³): 127
 Optimum Moisture Content (%): 10.7
 Method: A
 ____ AASHTO T 224 ____
 Corrected Maximum Dry Density (lb/ft³): 127
 Corrected Optimum Moisture Content (%): 10.7

Comments



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 Toll Free: (800)972-6364

Material Test Report

Report No: MAT:37-02843-W1-S2
 Issue No: 1

Client: DOWL
 Project: 37-02843
 Highway 1804 Phase I, Williston ND
 CC: Greg Underhill

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 Date of Issue: 11/24/2015
 Reviewed By: ALEC HOVICK
 North Dakota Manager

Sample Details

Sample ID	37-02843-W1-S2
Field Sample ID	2
Date Sampled	11/11/2015
Source	On-Site Material
Material	Proctor 2: Clayey Sand with a Little Gravel, Dark Brown (SC)
Specification	N/A
Sampling Method	Auger Flight
Location	B-13, 1.3' - 4.5'
Date Submitted	11/11/2015

Particle Size Distribution

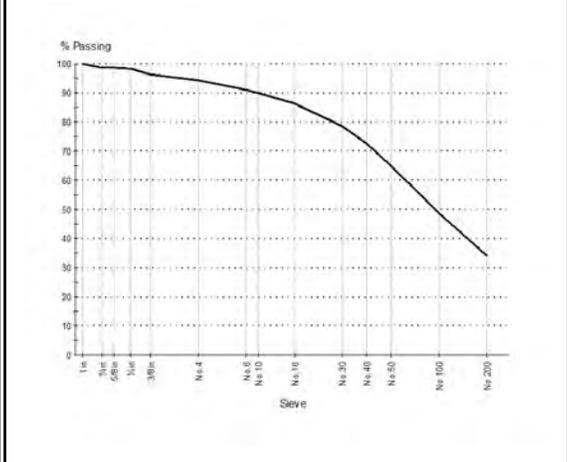
Method: AASHTO T 27 - 2011
 Date Tested: 11/18/2015

Sieve Size	% Passing	Limits
1in (25.0mm)	100	
3/4in (19.0mm)	99	
5/8in (16.0mm)	99	
1/2in (12.5mm)	98	
3/8in (9.5mm)	96	
No.4 (4.75mm)	94	
No.8 (2.36mm)	91	
No.10 (2.0mm)	90	
No.16 (1.18mm)	86	
No.30 (600µm)	79	
No.40 (425µm)	73	
No.50 (300µm)	65	
No.100 (150µm)	49	
No.200 (75µm)	34.0	

Other Test Results

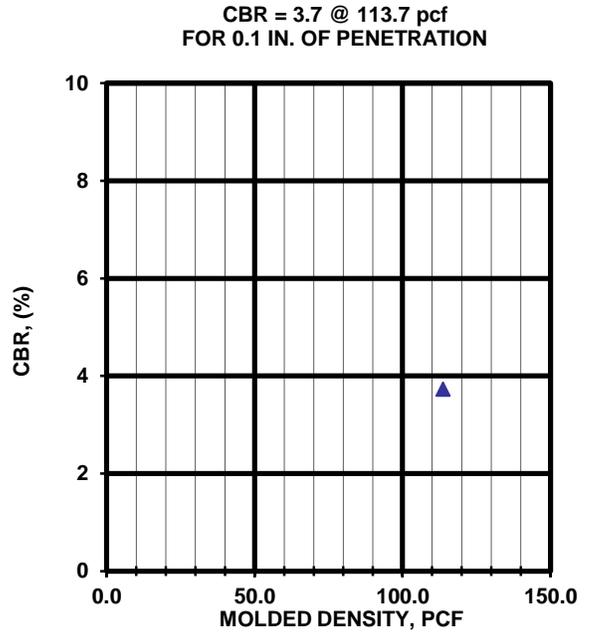
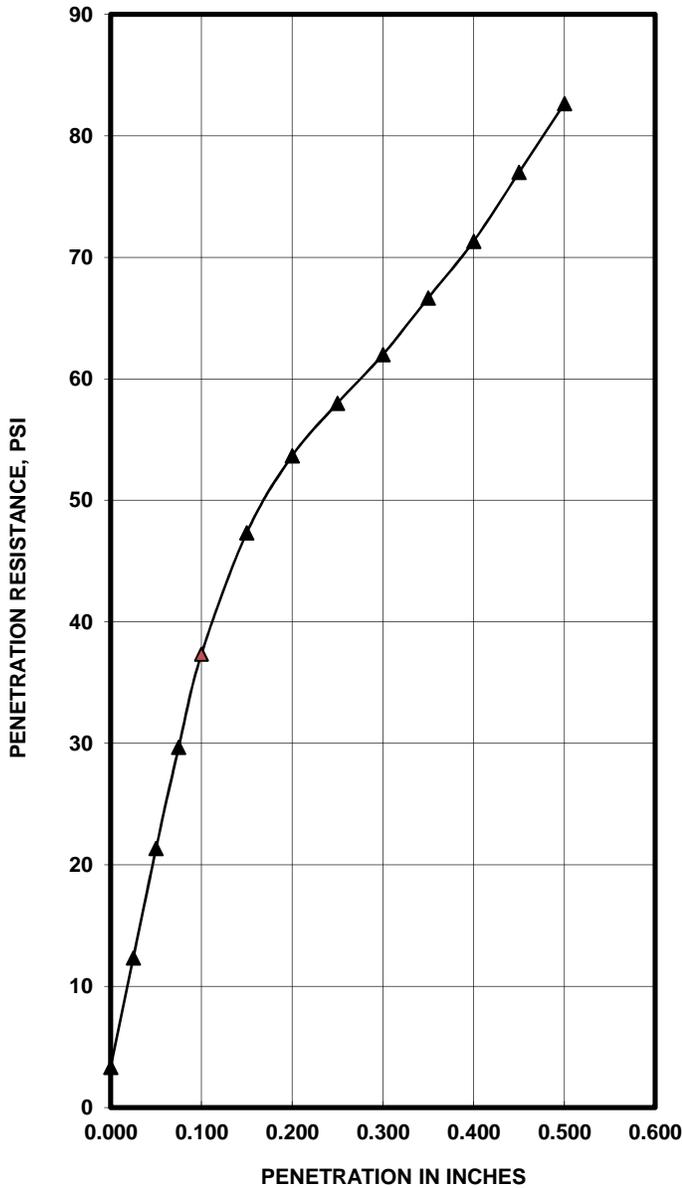
Description	Method	Result	Limits
Maximum Dry Density (lb/ft³)	AASHTO T 180 - 2011	127	
Corrected Maximum Dry Density (lb/ft³)		127	
Optimum Moisture Content (%)		10.7	
Corrected Optimum Moisture Content (%)		10.7	
Method		A	
Date Tested		11/13/2015	
Moisture Content (%)	AASHTO T 255 - 2000	11.0	
Date Tested		11/11/2015	
Liquid Limit (%)	AASHTO T 89-10	26	
Plastic Limit (%)	AASHTO T 90-00	16	
Plasticity Index	AASHTO T 90-00	10	
Tested By		KRYSTLE BOKS	
Date Tested		11/13/2015	

Chart



Comments

N/A



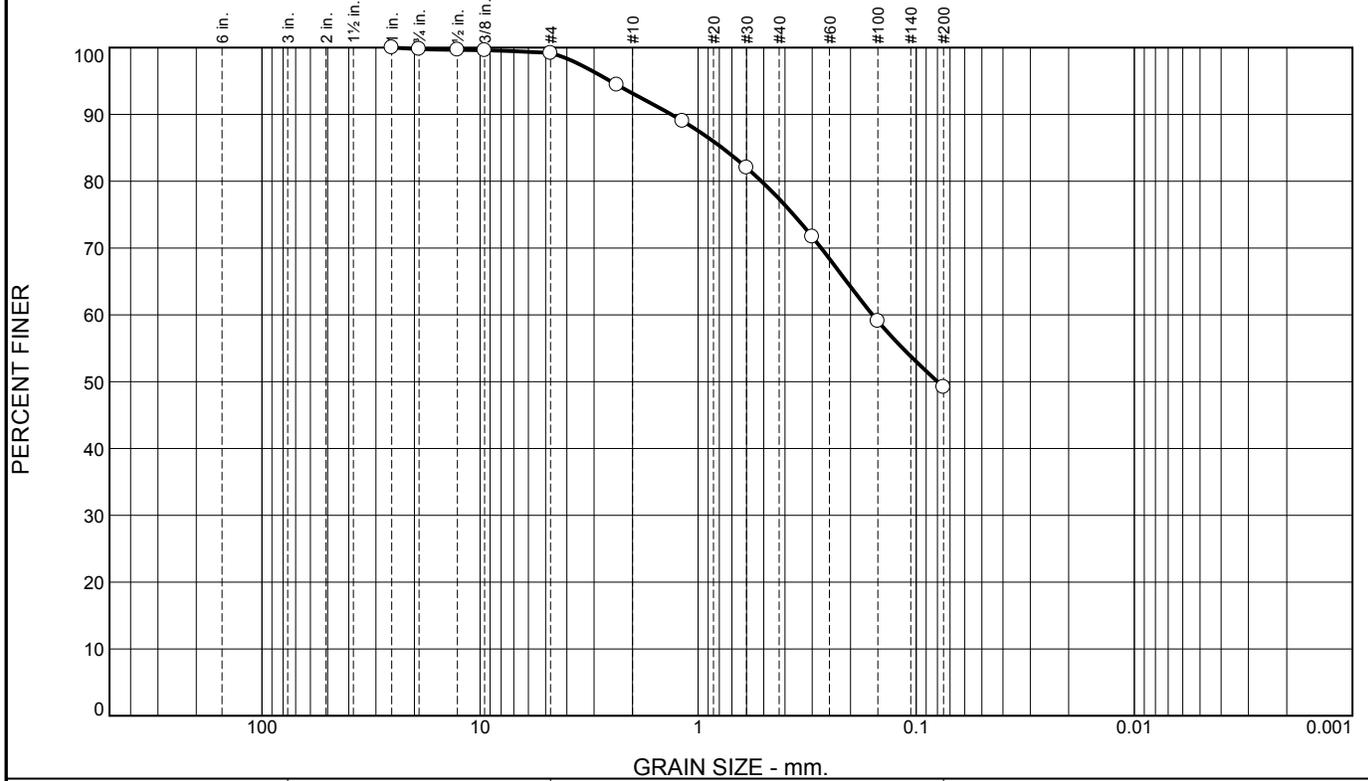
MOLDED			SOAKED			CBR	(%)	PEN.	SWELL	
DENS.	% MAX	% MOIST.	DENS.	% MAX	% MOIST.					0.1 IN.
113.7	89.7	10.8	111.6	88.0	15.6	3.7	3.6	10	1.801	
MATERIAL DESCRIPTION						USCS	MAX. DEN.	OPT. MOIST.	LL	PI
Clayey sand with a little gravel, dark brown						SC	126.8	10.7	26	10

PROJECT #:	37-02843	Boring No.	Proctor 2, B-13	Test Descr. / Remarks
PROJECT:	Highway 1804 New Town, ND			CBR PER ASTM D1883
DATE:	11/20/2015			PROCTOR PER ASTM D1557



BEARING RATIO TEST REPORT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.2	0.6	6.0	15.9	28.1	49.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	99.8		
1/2"	99.7		
3/8"	99.6		
#4	99.2		
#8	94.4		
#16	89.0		
#30	82.0		
#50	71.7		
#100	59.1		
#200	49.2		

Material Description

clayey sand

Atterberg Limits
 PL= 14 LL= 27 PI= 13

Coefficients
 D₉₀= 1.3286 D₈₅= 0.7761 D₆₀= 0.1585
 D₅₀= 0.0799 D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= SC AASHTO= A-6(3)

Remarks
 Sampled by DOWL

* (no specification provided)

Source of Sample: B-16 Depth: 1.5 - 4.5 ft
 Sample Number: 15150

Date:

	<p>Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01</p>
	Figure

Tested By: LM Checked By: LM



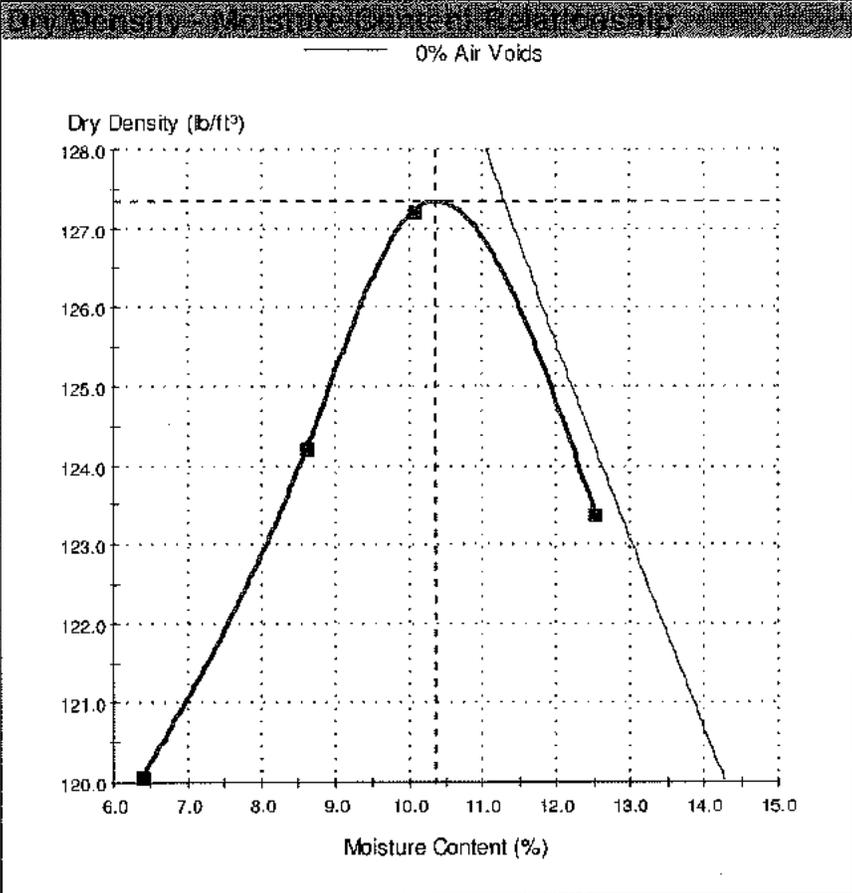
Proctor Report

Client: DOWL **CC:** Greg Underhill
Project: 37-02843
Highway 1804 Phase I, Williston ND

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Date of Issue: 11/24/2015
Reviewed By: ALEC HOVICK
North Dakota Manager

Sample ID:	37-02843-W1-S1	Date Sampled:	11/11/2015
Sampling Method:	Auger Flight		
Source:	On-Site Material		
Material:	Proctor 1: Sandy Lean Clay with a Little Gravel, Brown (CL)		
Specification:	N/A		
Location:	B-18, 1' - 2.5'		
Tested By:	KRYSTLE BOKS	Date Tested:	11/13/2015



AASHTO T 180 - 2011	
Maximum Dry Density (lb/ft³):	127
Optimum Moisture Content (%):	10.4
Method:	A
AASHTO T 224	
Corrected Maximum Dry Density (lb/ft³):	127
Corrected Optimum Moisture Content (%):	10.4



American Engineering Testing, Inc.
 Dickinson | Williston
 99 26th Street East | 5051 Owan Ind. Park Rd.
 Dickinson, ND 58602 | Bldg. 2, Unit 2
 (701)483-4288 | Williston, ND 58801
 www.amengtest.com | (701)774-6610
 Toll Free: (800)972-6364

Material Test Report

Report No: MAT:37-02843-W1-S1
 Issue No: 1

Client: DOWL
 Project: 37-02843
 Highway 1804 Phase I, Williston ND

CC: Greg Underhill

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[Signature]

Date of Issue: 11/24/2015
 Reviewed By: ALEC HOVICK
 North Dakota Manager

Sample Details

Sample ID: 37-02843-W1-S1
 Field Sample ID: 1
 Date Sampled: 11/11/2015
 Source: On-Site Material
 Material: Proctor 1: Sandy Lean Clay with a Little Gravel, Brown (CL)
 Specification: N/A
 Sampling Method: Auger Flight
 Location: B-18, 1' - 2.5'
 Date Submitted: 11/11/2015

Particle Size Distribution

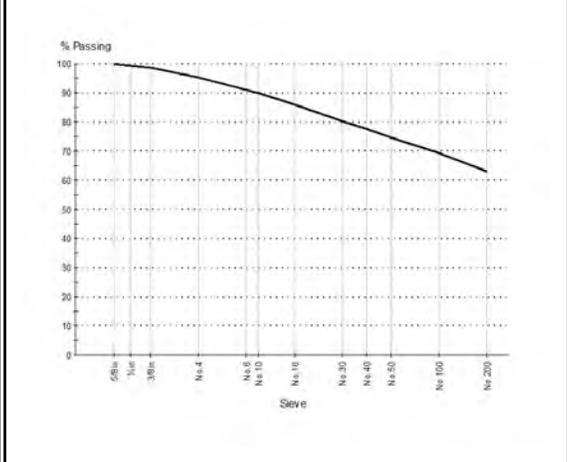
Method: AASHTO T 27 - 2011
 Date Tested: 11/18/2015

Sieve Size	% Passing	Limits
5/8in (16.0mm)	100	
1/2in (12.5mm)	99	
3/8in (9.5mm)	99	
No.4 (4.75mm)	95	
No.8 (2.36mm)	91	
No.10 (2.0mm)	90	
No.16 (1.18mm)	86	
No.30 (600µm)	80	
No.40 (425µm)	78	
No.50 (300µm)	75	
No.100 (150µm)	69	
No.200 (75µm)	63.2	

Other Test Results

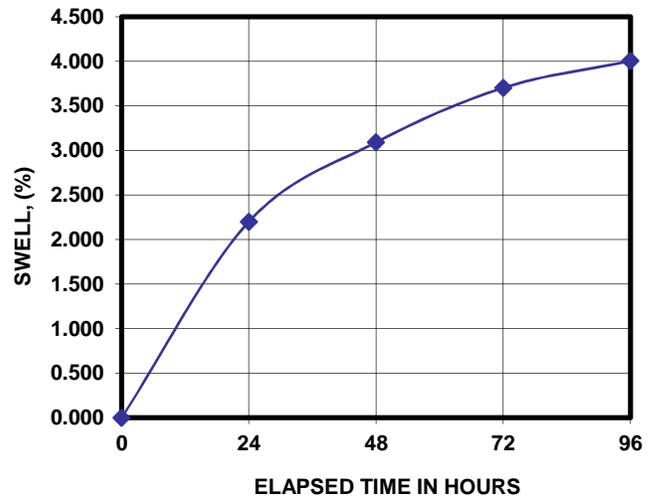
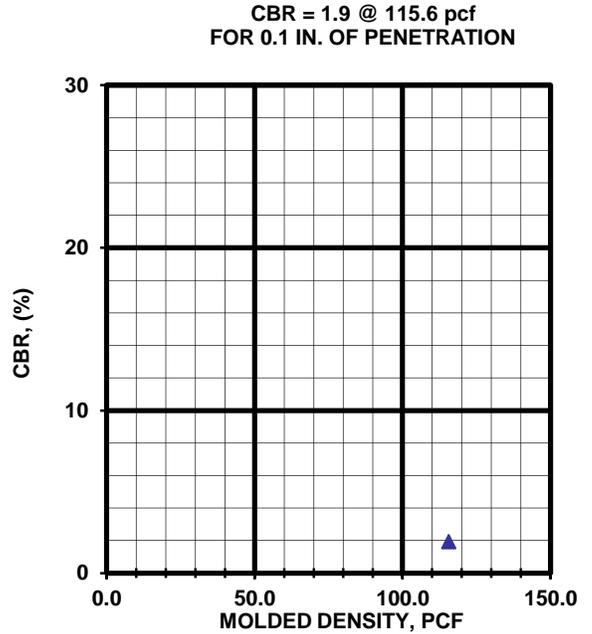
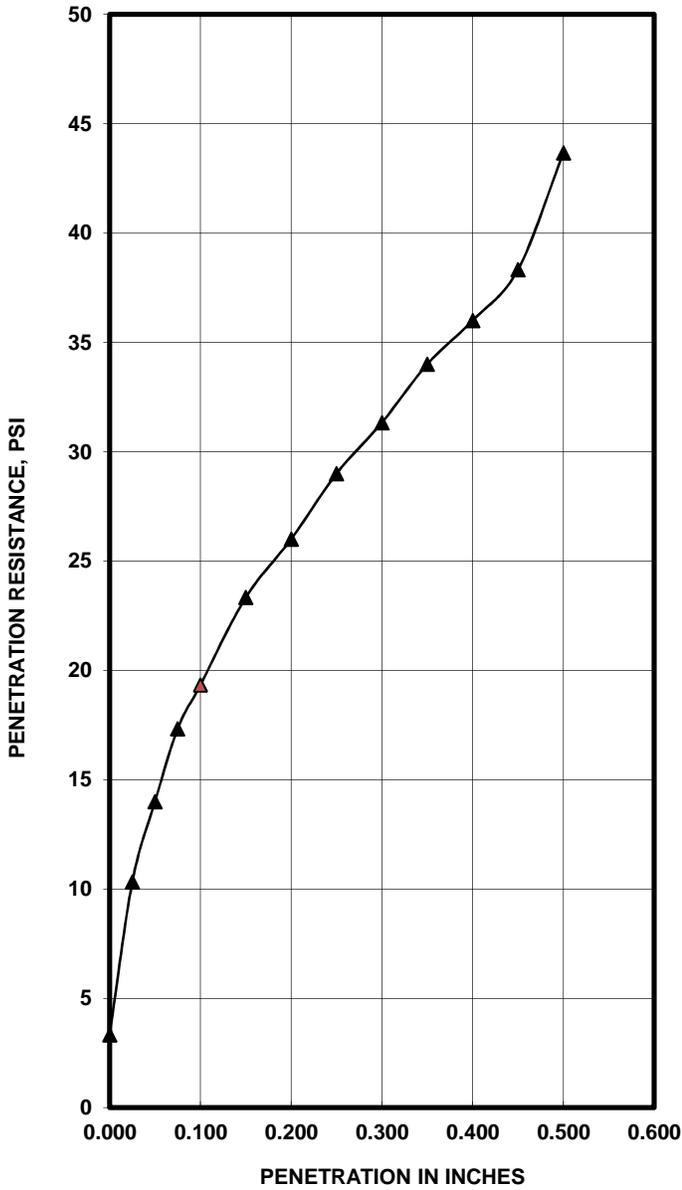
Description	Method	Result	Limits
Maximum Dry Density (lb/ft³)	AASHTO T 180 - 2011	127	
Corrected Maximum Dry Density (lb/ft³)		127	
Optimum Moisture Content (%)		10.4	
Corrected Optimum Moisture Content (%)		10.4	
Method		A	
Date Tested		11/13/2015	
Moisture Content (%)	AASHTO T 255 - 2000	17.6	
Date Tested		11/11/2015	
Liquid Limit (%)	AASHTO T 89-10	46	
Plastic Limit (%)	AASHTO T 90-00	18	
Plasticity Index	AASHTO T 90-00	28	
Tested By	THOMAS EVANS		
Date Tested		11/13/2015	

Chart



Comments

N/A



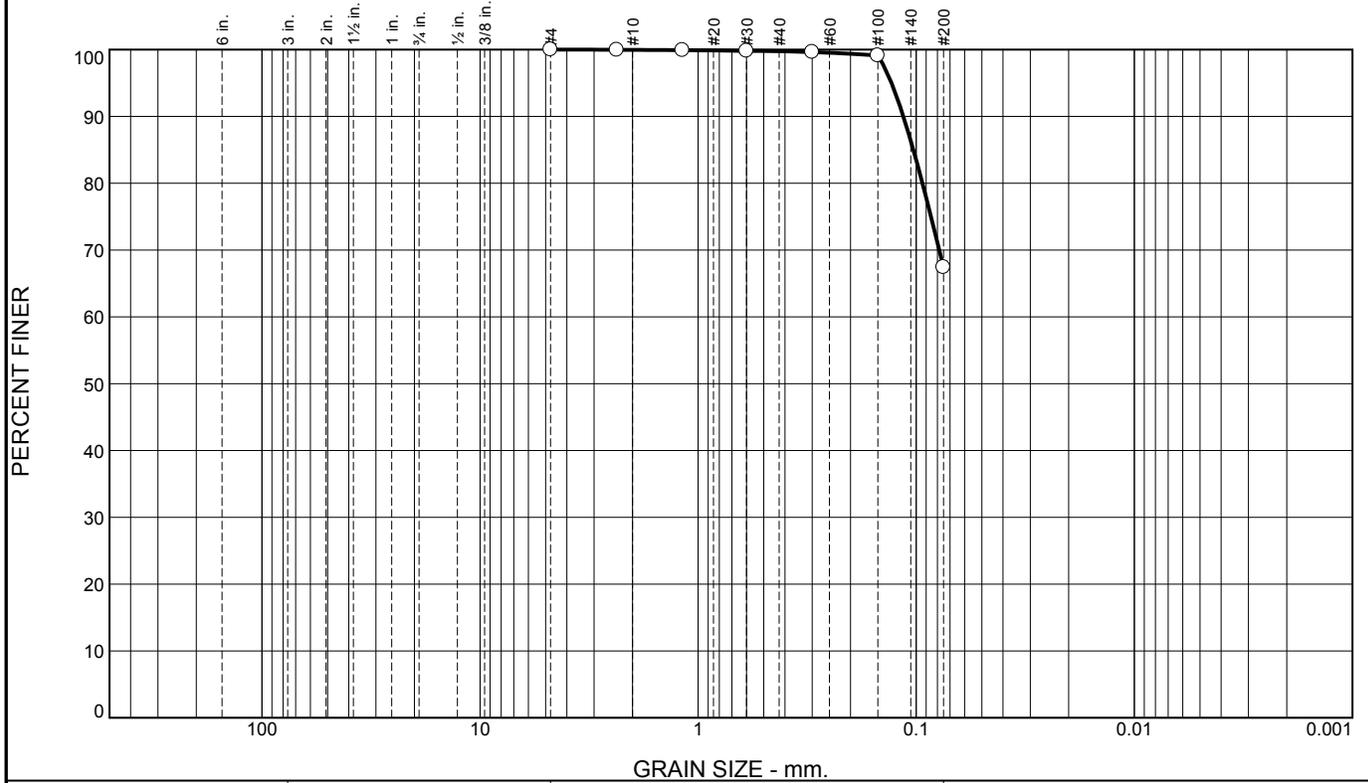
MOLDED			SOAKED			CBR	(%)	PEN.	SWELL	
DENS.	% MAX	% MOIST.	DENS.	% MAX	% MOIST.					0.1 IN.
115.6	90.4	10.9	111.0	86.8	16.5	1.9	1.7	10	4.003	
MATERIAL DESCRIPTION						USCS	MAX. DEN.	OPT. MOIST.	LL	PI
Sandy lean clay with a little gravel, brown						CL	127.9	10.7	46	28

PROJECT #:	37-02843	Boring No.	Proctor 1, B-18	Test Descr. / Remarks
PROJECT:	Highway 1804 New Town, ND			CBR PER ASTM D1883
DATE:	11/20/2015			PROCTOR PER ASTM D1557



BEARING RATIO TEST REPORT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.1	32.4	67.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	100.0		
#16	99.9		
#30	99.8		
#50	99.6		
#100	99.1		
#200	67.4		

Material Description

sandy silt

Atterberg Limits
 PL= NP LL= NV PI= NP

Coefficients
 D₉₀= 0.1146 D₈₅= 0.1031 D₆₀=
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= ML AASHTO= A-4(0)

Remarks
 Sampled by DOWL

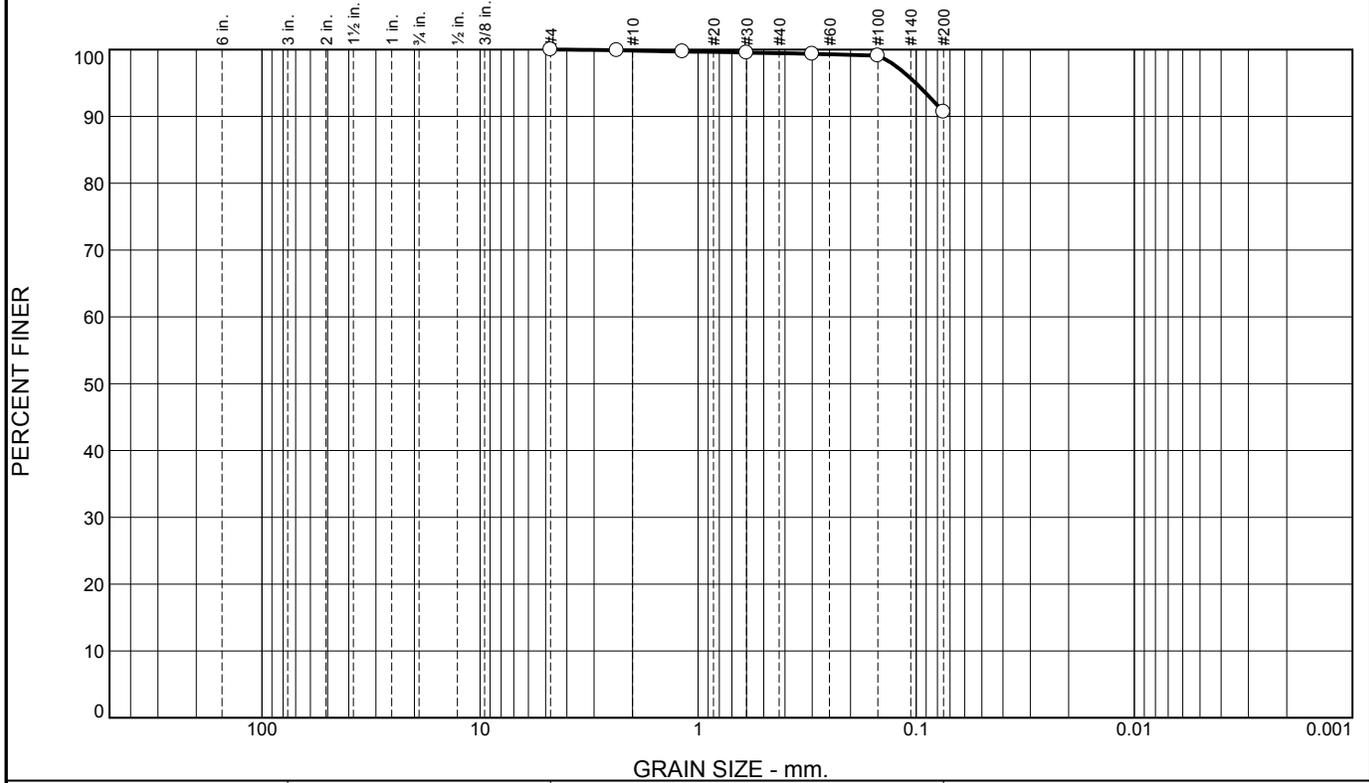
* (no specification provided)

Source of Sample: B-19 Depth: 17.0 - 18.5 ft Date: 11/25/2015
 Sample Number: 15166

	Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01	Figure
---	---	--------

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	0.3	8.8	90.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.9		
#16	99.7		
#30	99.5		
#50	99.4		
#100	99.1		
#200	90.7		

Material Description

fat clay

PL= 20 **Atterberg Limits** LL= 53 PI= 33

Coefficients

D₉₀= D₈₅= D₆₀=
D₅₀= D₃₀= D₁₅=
D₁₀= C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(32)

Remarks

Sampled by DOWL

* (no specification provided)

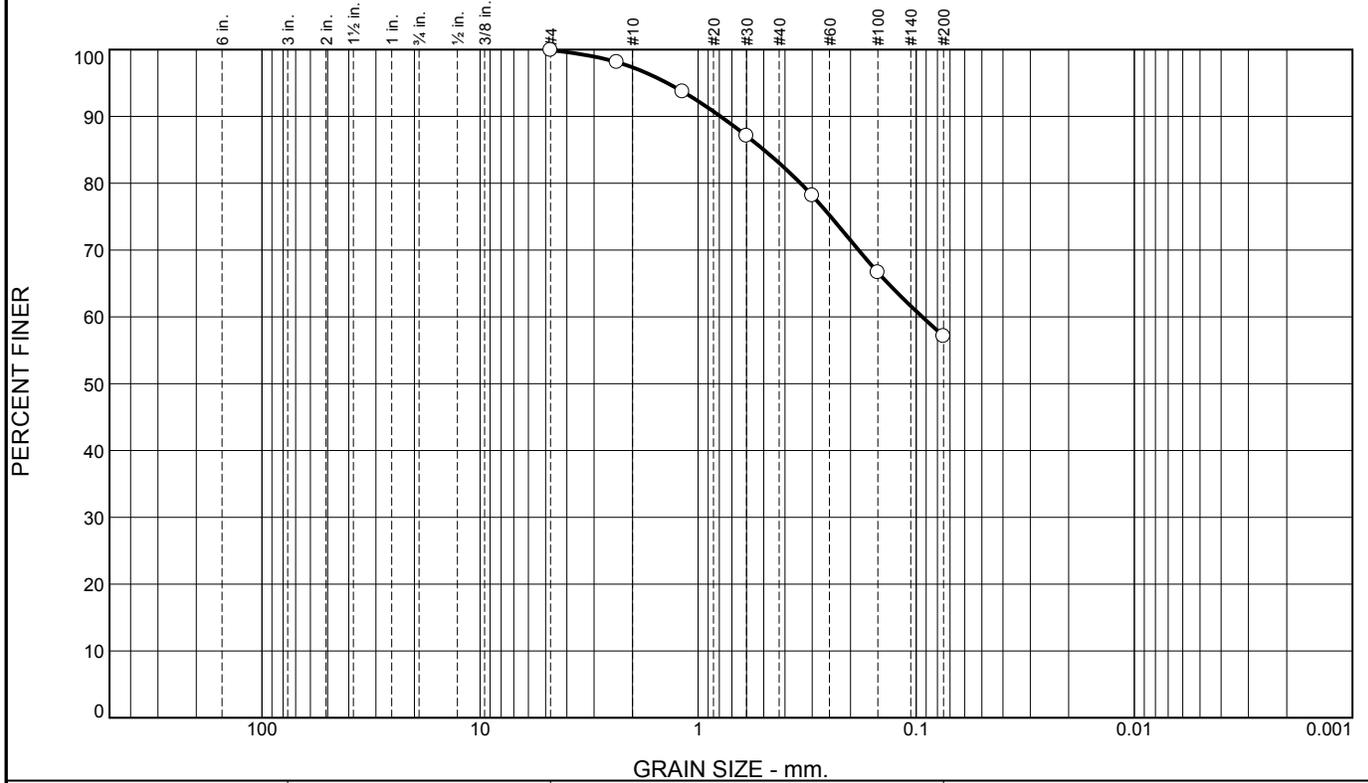
Source of Sample: B-20 Depth: 4.5 - 6.0 ft
Sample Number: 15172

Date: 11/23/2015

	<p>Client: NDDOT</p> <p>Project: NDDOT HWY 1804 Geo Exploration</p> <p>Project No: 6024.20997.01</p>
	Figure

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
			2.6	14.3	25.9	57.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	99.9		
#8	98.1		
#16	93.7		
#30	87.1		
#50	78.2		
#100	66.7		
#200	57.1		

Material Description

sandy elastic silt

Atterberg Limits
 PL= 35 LL= 52 PI= 17

Coefficients
 D₉₀= 0.7895 D₈₅= 0.4999 D₆₀= 0.0938
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= MH AASHTO= A-7-5(9)

Remarks
 Sampled by DOWL

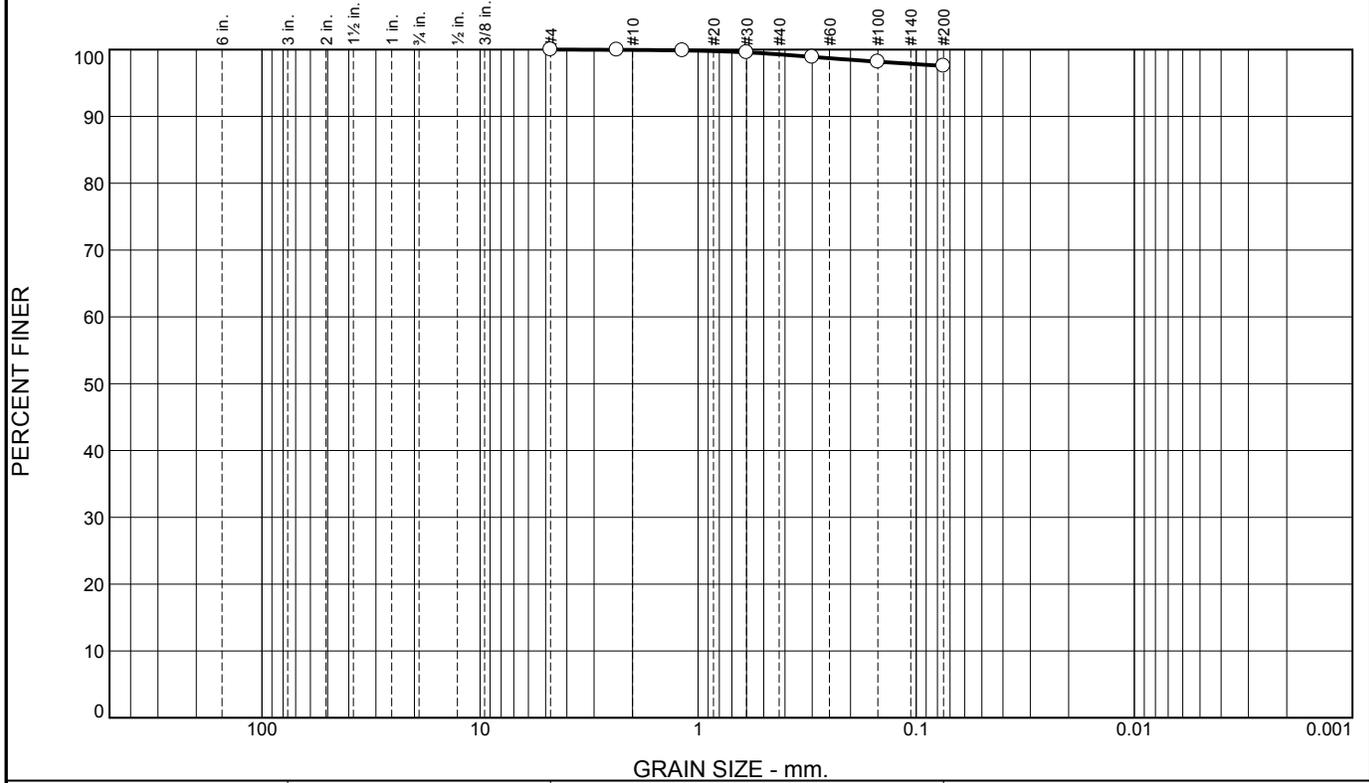
* (no specification provided)

Source of Sample: B-20 Depth: 14.5 - 16.0 ft Date: 11/24/2015
 Sample Number: 15176

	Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01	Figure
---	---	--------

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.6	1.7	97.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	100.0		
#16	99.9		
#30	99.6		
#50	98.9		
#100	98.2		
#200	97.6		

Material Description

fat clay

Atterberg Limits
 PL= 24 LL= 58 PI= 34

Coefficients
 D₉₀= D₈₅= D₆₀=
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= CH AASHTO= A-7-6(38)

Remarks
 Sampled by DOWL

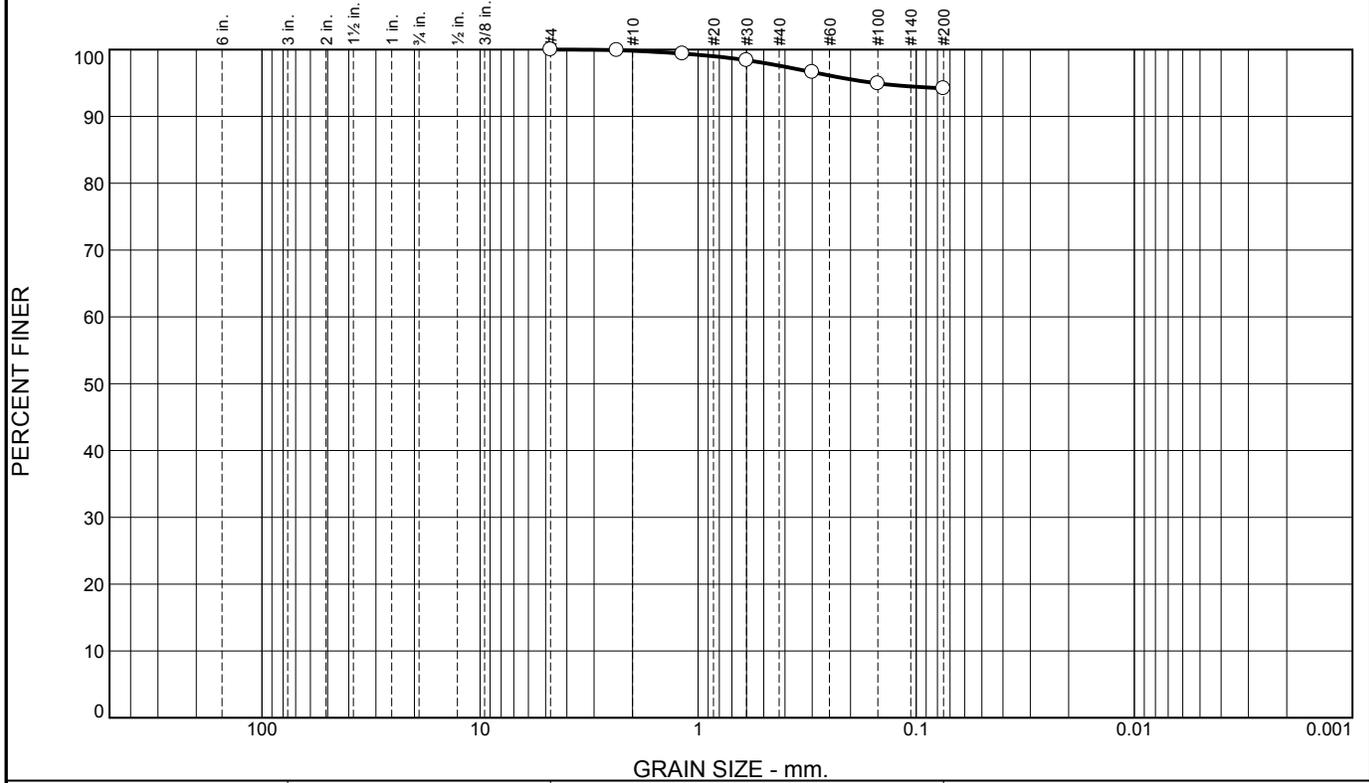
* (no specification provided)

Source of Sample: B-20 Depth: 19.5 - 21.0 ft Date: 12/2/2015
 Sample Number: 15178

	Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01	Figure
---	---	--------

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	2.2	3.4	94.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.9		
#16	99.4		
#30	98.4		
#50	96.6		
#100	94.9		
#200	94.2		

Material Description

fat clay

Atterberg Limits
 PL= 21 LL= 52 PI= 31

Coefficients
 D₉₀= D₈₅= D₆₀=
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= CH AASHTO= A-7-6(32)

Remarks
 Sampled by DOWL

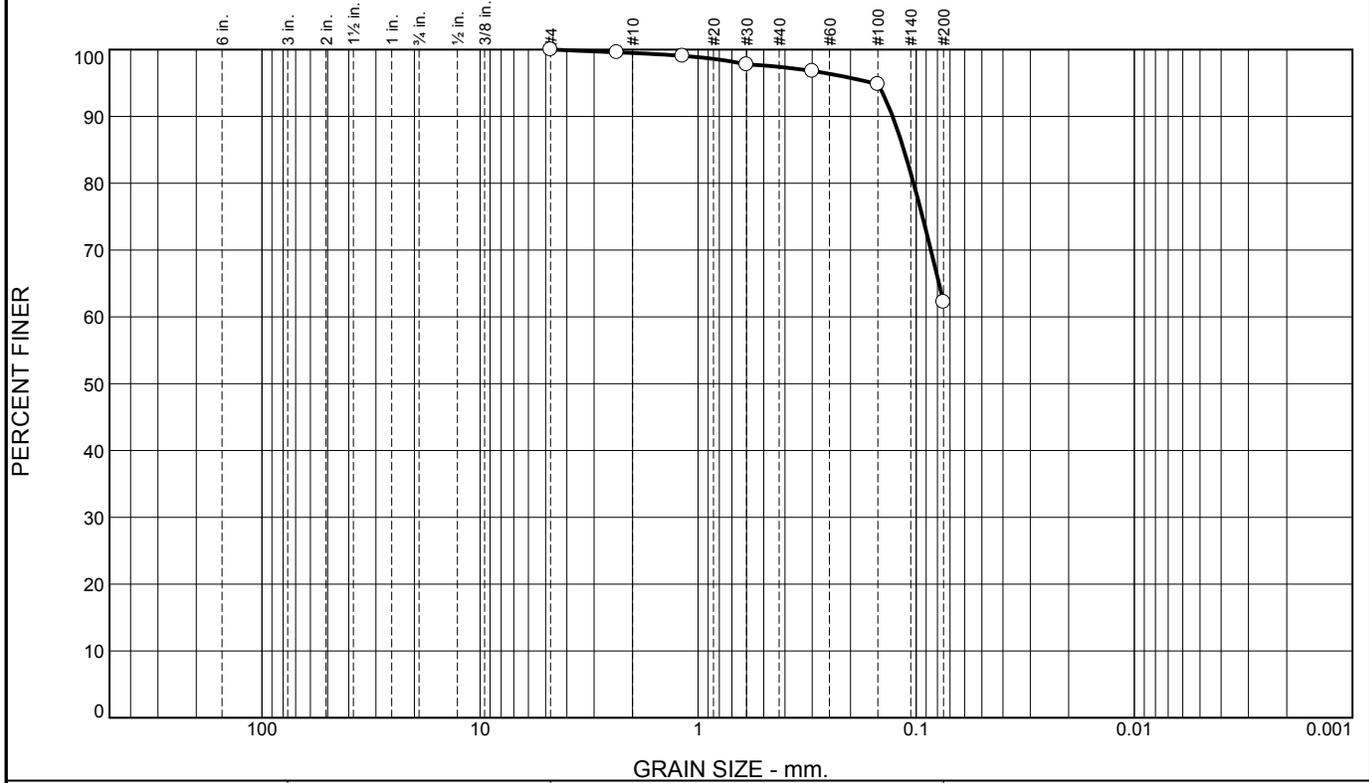
* (no specification provided)

Source of Sample: B-20 Depth: 20.0 - 22.5 ft Date: 12/2/2015
 Sample Number: 15179

	Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01	Figure
---	---	--------

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.5	2.1	35.2	62.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.6		
#16	99.1		
#30	97.8		
#50	96.8		
#100	94.8		
#200	62.2		

Material Description

sandy silt

Atterberg Limits
 PL= NP LL= NV PI= NP

Coefficients
 D₉₀= 0.1283 D₈₅= 0.1139 D₆₀=
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= ML AASHTO= A-4(0)

Remarks
 Sampled by DOWL

* (no specification provided)

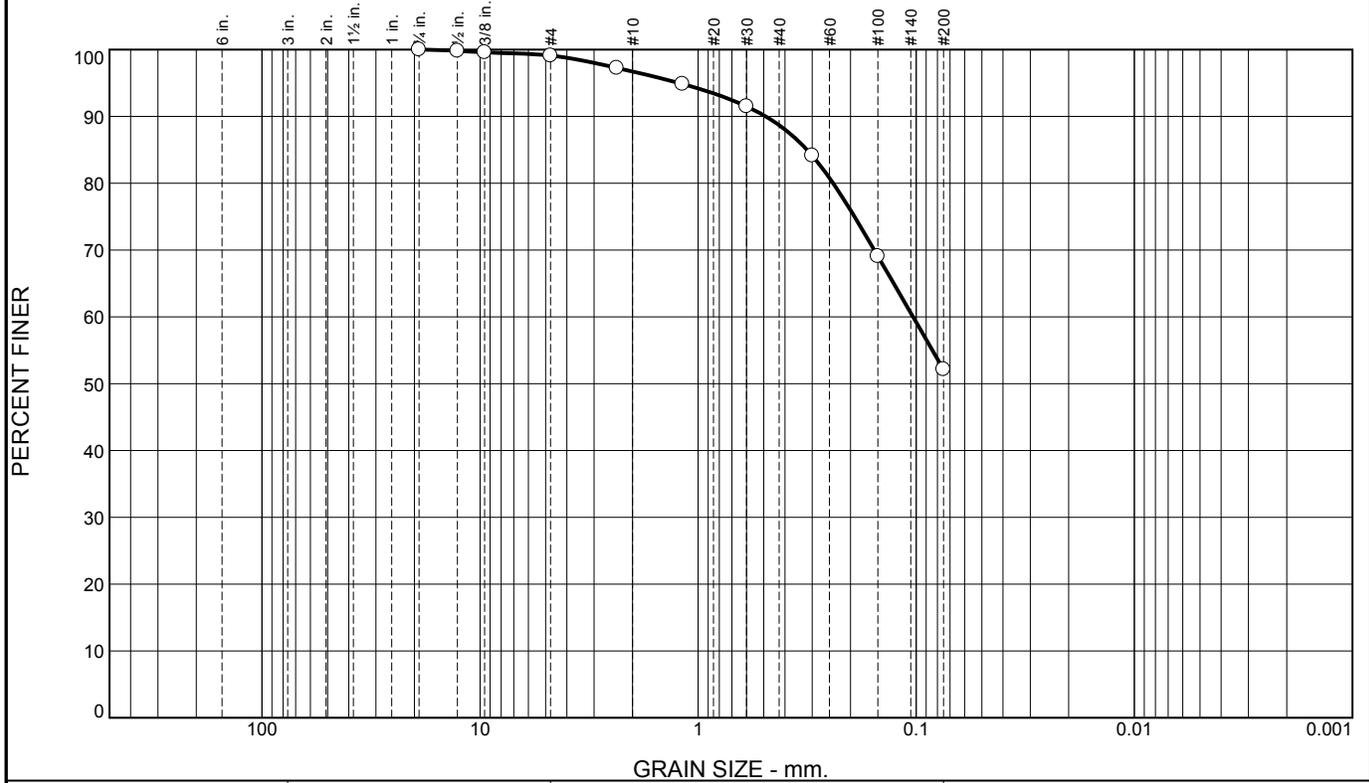
Source of Sample: B-20 Depth: 27.5 - 29.0 ft
 Sample Number: 15182

Date:

	Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01	Figure
---	---	--------

Tested By: LM Checked By: LM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.9	2.4	8.0	36.6	52.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	99.8		
3/8"	99.6		
#4	99.1		
#8	97.3		
#16	94.9		
#30	91.5		
#50	84.1		
#100	69.1		
#200	52.1		

Material Description

sandy silt

Atterberg Limits
 PL= 18 LL= 20 PI= 2

Coefficients
 D₉₀= 0.4905 D₈₅= 0.3169 D₆₀= 0.1034
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= ML AASHTO= A-4(0)

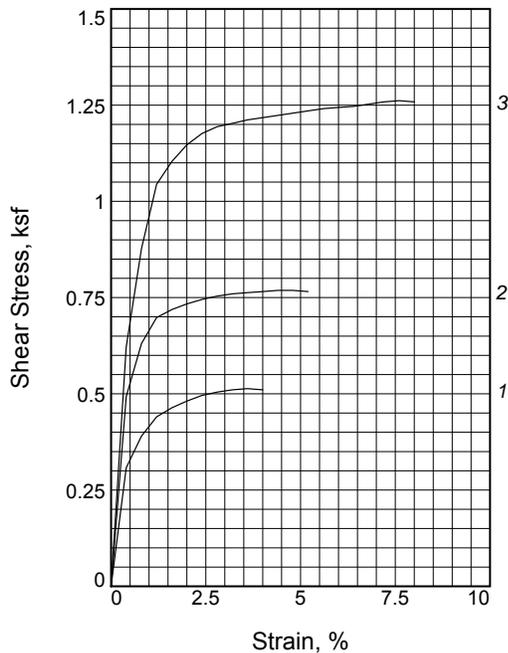
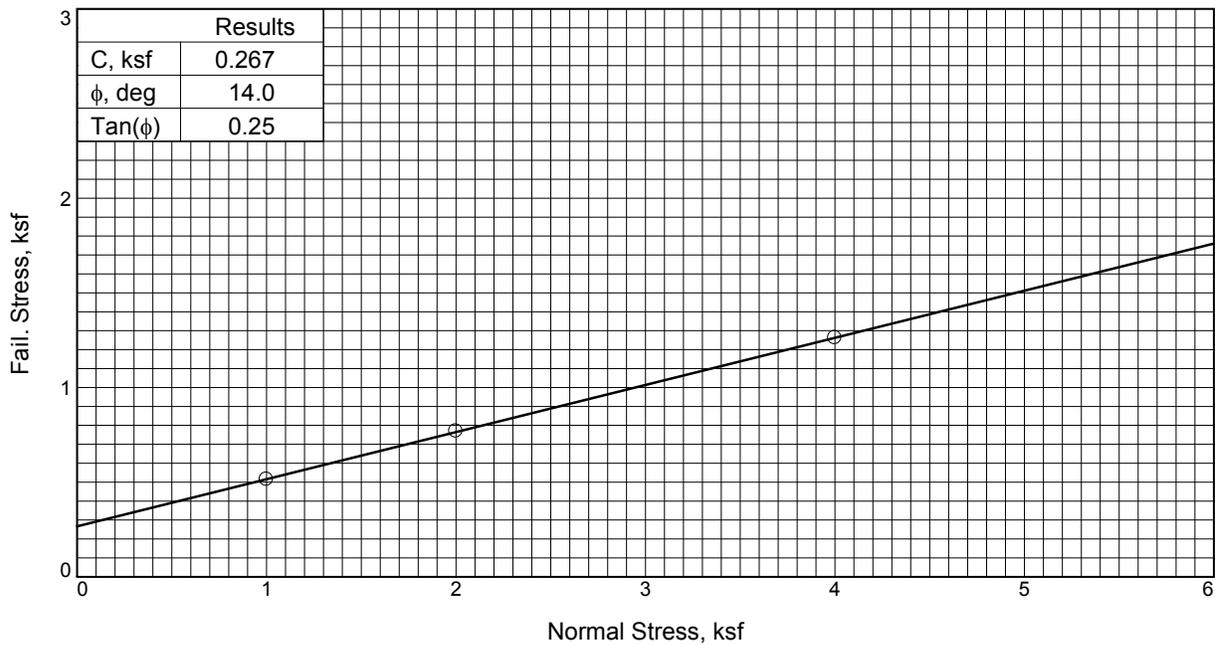
Remarks
 Sampled by DOWL

* (no specification provided)

Source of Sample: B-21 Depth: 1.5 - 4.5 ft Date: 12/1/2015
 Sample Number: 15188

	<p>Client: NDDOT Project: NDDOT HWY 1804 Geo Exploration Project No: 6024.20997.01</p>
	Figure

Tested By: LM Checked By: LM



Sample No.	1	2	3	
Initial	Water Content, %	32.7	33.2	33.2
	Dry Density, pcf	94.8	93.6	92.5
	Saturation, %	116.3	114.6	111.5
	Void Ratio	0.7442	0.7670	0.7883
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.500	0.500	0.500
At Test	Water Content, %	26.0	27.1	25.4
	Dry Density, pcf	96.6	93.9	97.0
	Saturation, %	96.6	94.5	95.4
	Void Ratio	0.7128	0.7617	0.7054
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.491	0.499	0.477
Normal Stress, ksf	1.000	2.000	4.000	
Fail. Stress, ksf	0.513	0.769	1.261	
Strain, %	3.6	4.4	7.6	
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.	0.004	0.004	0.004	

Sample Type: Undisturbed

Description: Fat CLAY

LL= 65

PL= 18

PI= 47

Specific Gravity= 2.65

Remarks:

Figure _____

Client: DOWL

Project: NDDOT-1804 Reconstruction

Source of Sample: B-63

Depth: 29.5'-31.5'

Sample Number: 30930

Proj. No.: 6024.20997.01

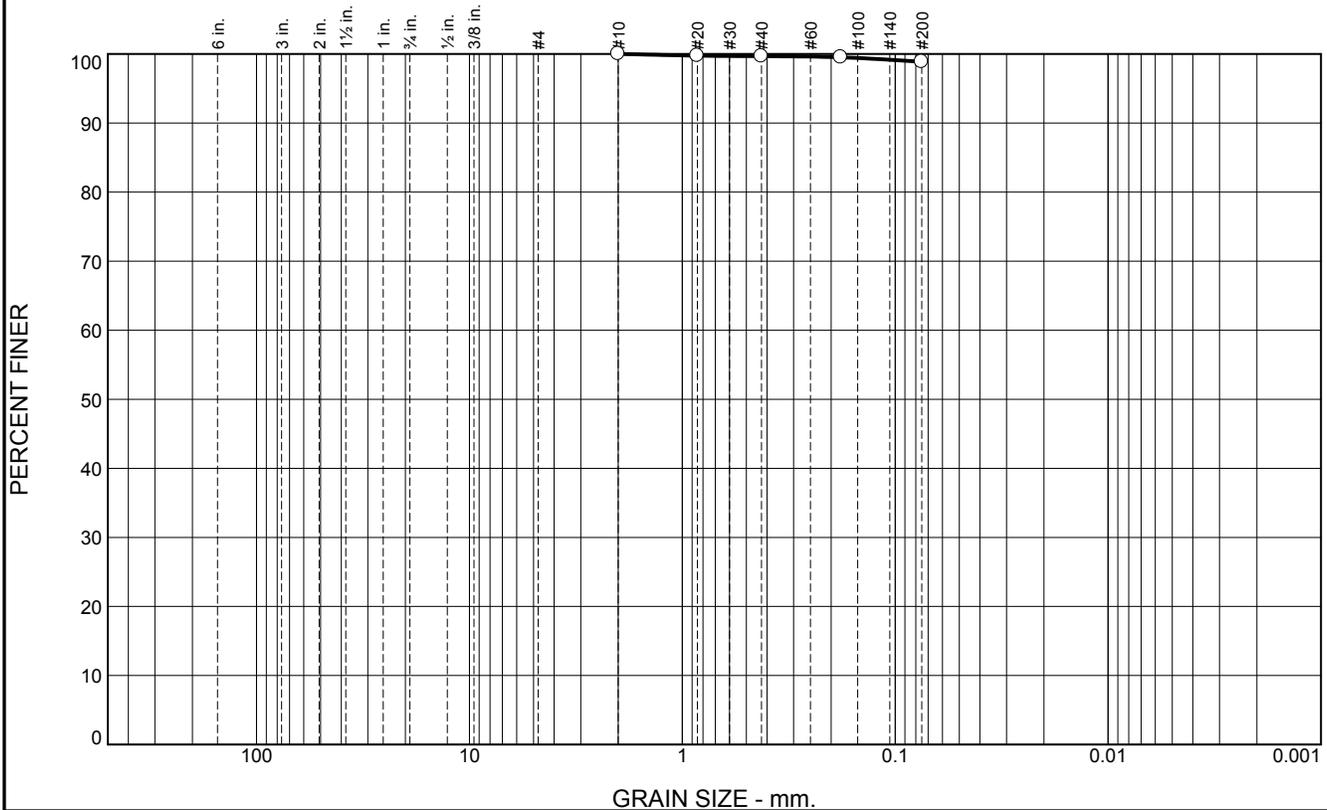
Date Sampled:

DIRECT SHEAR TEST REPORT

Tetra Tech

Billings, MT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.3	0.9	98.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.8		
#40	99.7		
#80	99.5		
#200	98.8		

Soil Description
Fat CLAY

Atterberg Limits
PL= 18 LL= 65 PI= 47

Coefficients
D₉₀= D₈₅= D₆₀=
D₅₀= D₃₀= D₁₅=
D₁₀= C_u= C_c=

Classification
USCS= CH AASHTO= A-7-6(52)

Remarks

* (no specification provided)

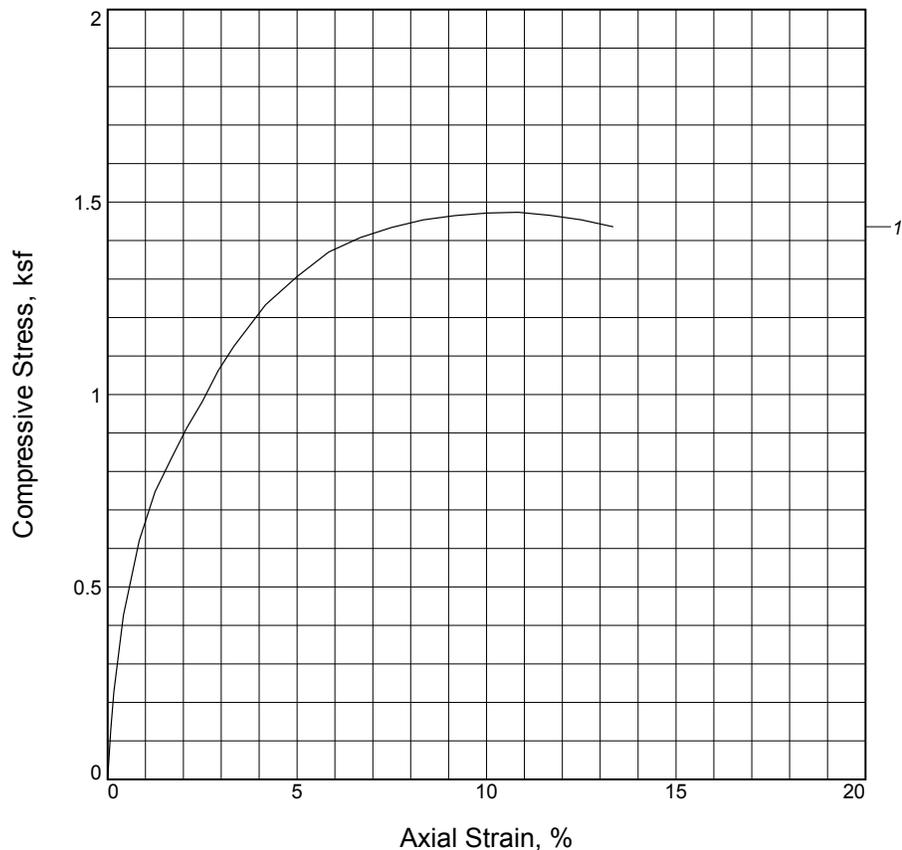
Source of Sample: B-63
Sample Number: 30930

Depth: 29.5'-31.5'

Date:

Tetra Tech Billings, MT	Client: DOWL Project: NDDOT-1804 Reconstruction Project No: 6024.20997.01
Figure	

UNCONFINED COMPRESSION TEST



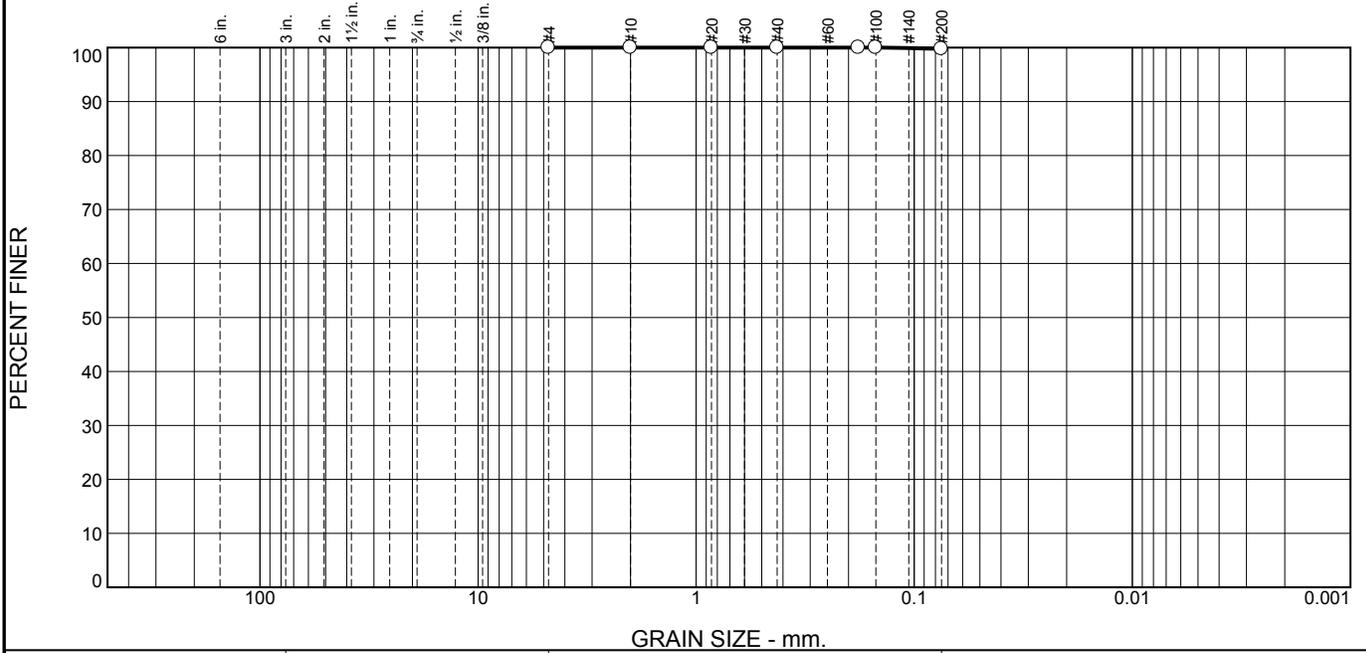
Sample No.	1		
Unconfined strength, ksf	1.474		
Undrained shear strength, ksf	0.737		
Failure strain, %	10.8		
Strain rate, in./min.	0.060		
Water content, %	33.2		
Wet density, pcf	122.3		
Dry density, pcf	91.9		
Saturation, %	109.8		
Void ratio	0.8005		
Specimen diameter, in.	2.875		
Specimen height, in.	6.000		
Height/diameter ratio	2.09		

Description: Fat CLAY

LL = 65	PL = 18	PI = 47	GS = 2.65	Type: Undisturbed
----------------	----------------	----------------	------------------	--------------------------

<p>Project No.: 6024.20997.01</p> <p>Date Sampled:</p> <p>Remarks:</p> <p>Figure _____</p>	<p>Client: DOWL</p> <p>Project: NDDOT-1804 Reconstruction</p> <p>Source of Sample: B-63 Depth: 29.5'-31.5'</p> <p>Sample Number: 30930</p> <hr/> <p style="text-align: center;">UNCONFINED COMPRESSION TEST Tetra Tech Billings, MT</p>
--	---

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	0.3	99.7	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	100.0		
#20	100.0		
#40	100.0		
#80	100.0		
#100	100.0		
#200	99.7		

Material Description

fat clay

Atterberg Limits (ASTM D 4318)

PL= 20 LL= 64 PI= 44

Classification

USCS (D 2487)= CH AASHTO (M 145)= A-7-6(50)

Coefficients

D₉₀= D₈₅= D₆₀=
D₅₀= D₃₀= D₁₅=
D₁₀= C_u= C_c=

Remarks

Sampled By: DOWL
F.M.=0.00

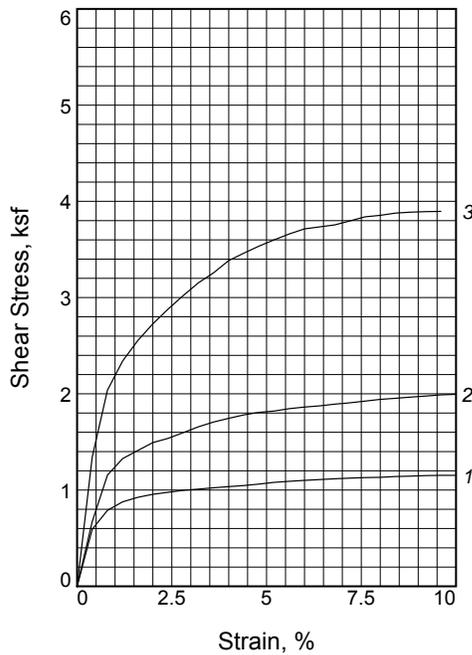
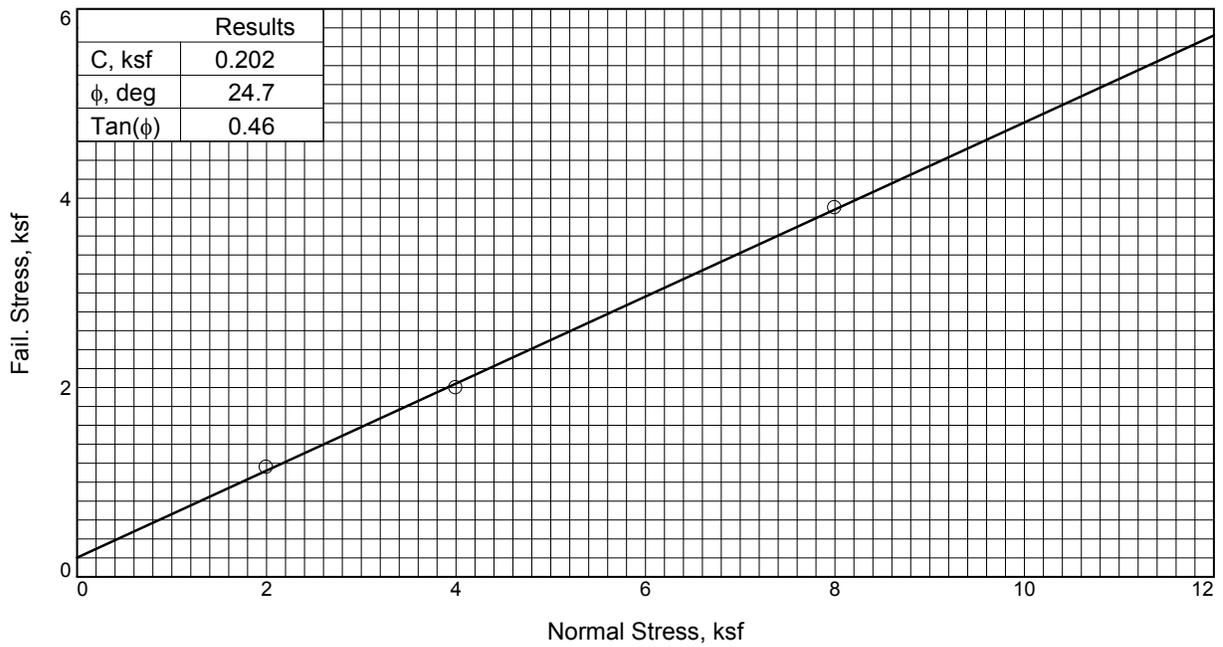
Date Received: _____ Date Tested: _____
Tested By: JM
Checked By: MC
Title: Lab Manager

* (no specification provided)

Location: B-63 Sample Number: 30931 Depth: 70.0-70.5' Date Sampled: _____

	<p>Client: North Dakota Department of Transportation Project: ND 1804 Project No: 6024.20997.01</p>
--	---

Tested By: _____ Checked By: _____



Sample No.	1	2	3	
Initial	Water Content, %	29.0	29.0	29.0
	Dry Density, pcf	99.3	99.1	98.6
	Saturation, %	109.5	108.9	107.8
	Void Ratio	0.7288	0.7328	0.7406
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.500	0.500	0.500
At Test	Water Content, %	28.9	30.3	19.0
	Dry Density, pcf	100.2	105.8	112.2
	Saturation, %	111.6	134.1	98.8
	Void Ratio	0.7129	0.6226	0.5303
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.495	0.468	0.440
Normal Stress, ksf	2.000	4.000	8.000	
Fail. Stress, ksf	1.153	1.995	3.896	
Strain, %	9.6	10.0	9.6	
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.	0.004	0.004	0.004	

Sample Type: Undisturbed

Description: Fat CLAY

LL= 60

PL= 18

PI= 42

Specific Gravity= 2.75

Remarks:

Figure _____

Client: DOWL

Project: NDDOT-1804 Reconstruction

Source of Sample: B-64

Depth: 44.5'-46.5'

Sample Number: 30932

Proj. No.: 6024.20997.01

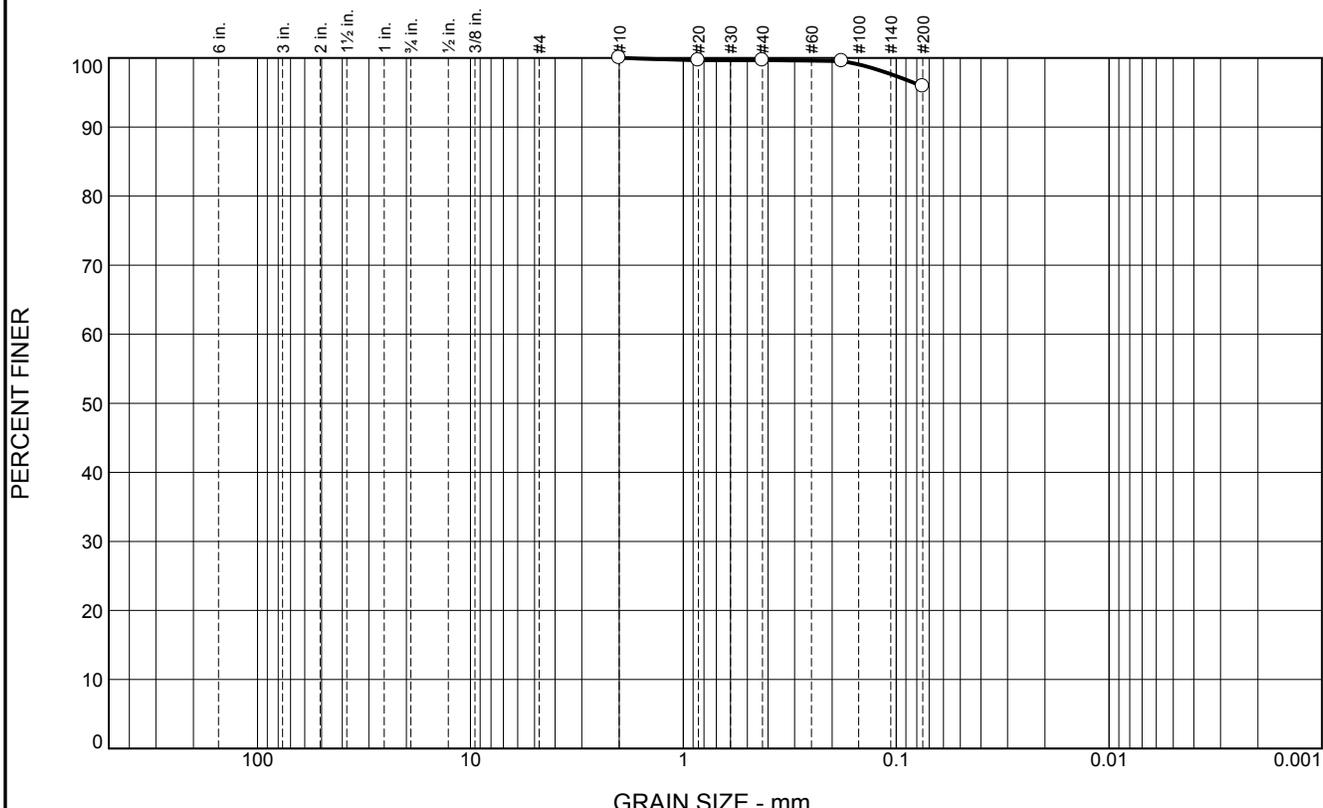
Date Sampled:

DIRECT SHEAR TEST REPORT

Tetra Tech

Billings, MT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.3	3.8	95.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.7		
#40	99.7		
#80	99.5		
#200	95.9		

Soil Description

Fat CLAY

Atterberg Limits

PL= 18 LL= 60 PI= 42

Coefficients

D₉₀= D₈₅= D₆₀=
D₅₀= D₃₀= D₁₅=
D₁₀= C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(44)

Remarks

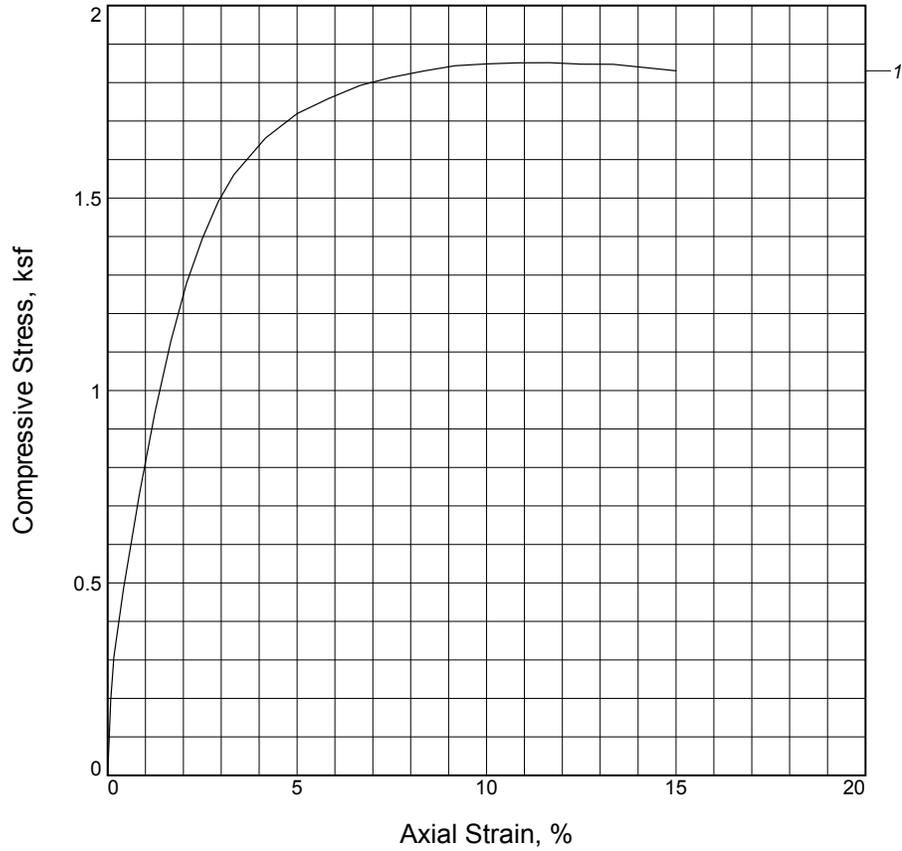
* (no specification provided)

Source of Sample: B-64 Depth: 44.5'-46.5' Date:

Sample Number: 30932

Tetra Tech Billings, MT	Client: DOWL Project: NDDOT-1804 Reconstruction Project No: 6024.20997.01
Figure	

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, ksf	1.852			
Undrained shear strength, ksf	0.926			
Failure strain, %	11.7			
Strain rate, in./min.	0.060			
Water content, %	29.0			
Wet density, pcf	118.9			
Dry density, pcf	92.2			
Saturation, %	96.7			
Void ratio	0.7952			
Specimen diameter, in.	2.875			
Specimen height, in.	6.000			
Height/diameter ratio	2.09			

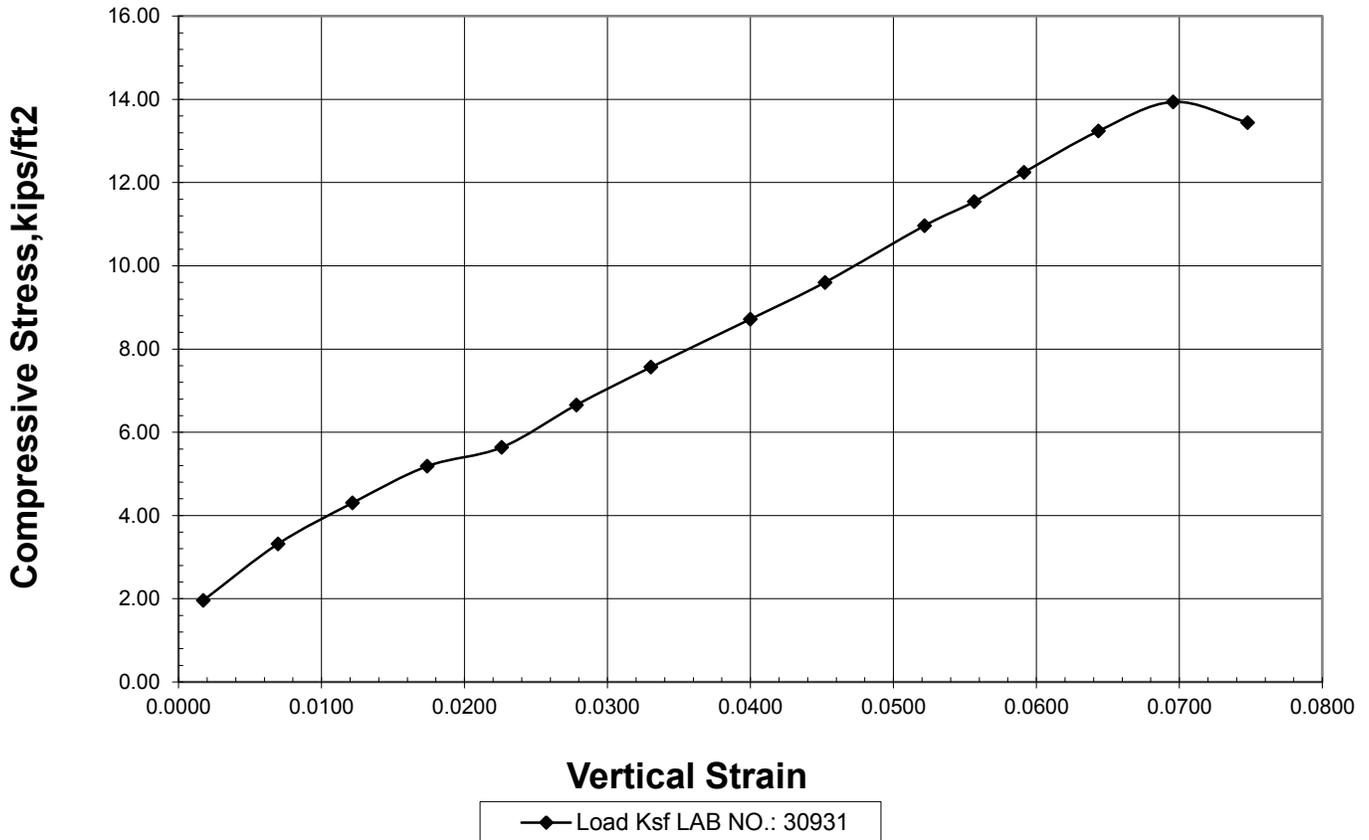
Description: Fat CLAY

LL = 60	PL = 18	PI = 42	GS = 2.65	Type: Undisturbed
----------------	----------------	----------------	------------------	--------------------------

<p>Project No.: 6024.20997.01</p> <p>Date Sampled:</p> <p>Remarks:</p> <p>Figure _____</p>	<p>Client: DOWL</p> <p>Project: NDDOT-1804 Reconstruction</p> <p>Source of Sample: B-64 Depth: 44.5'-46.5'</p> <p>Sample Number: 30932</p> <hr/> <p style="text-align: center;">UNCONFINED COMPRESSION TEST Tetra Tech Billings, MT</p>
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UNCONFINED COMPRESSION TEST

SAMPLE UNIT LOAD - KSF



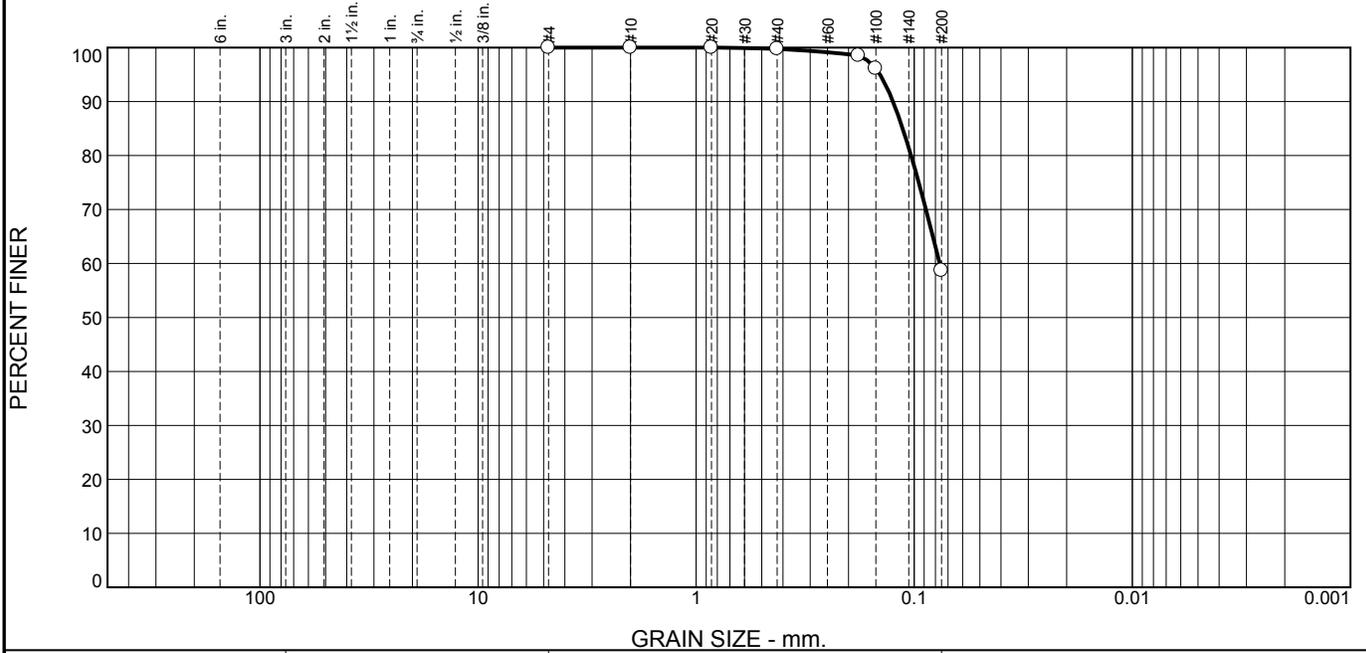
TYPE OF BREAK	GRADATION		ATTERBERG LIMITS	
	SIEVE	% PASSING	LIQUID LIMIT	64
	#4	100	PLASTIC LIMIT	20
	#10	100	PLASTIC INDEX	44
	#20	100	CLASSIFICATION	
	#40	100.0	USCS	CH
	#80	100.0	AASHTO	A-7-6(50)
	#100	100.0	DESCRIPTION	
	#200	99.7	FAT CLAY	
% MOISTURE	17.1 %	SPECIFIC GRAVITY		
WET UNIT WT.	132.6 PCF	NT		
DRY UNIT WT.	113.2 PCF			
U.C. STRENGTH, qu	13.9 KSF			
COHESION (qu/2)	7.0 KSF			

PROJECT: NNDOT 1804 Reconstruction
 PROJECT NO.: 6024.20997.01
 LOCATION: B-64
 DEPTH: 44.5-46.5'
 DIA. to HT. RATIO: 3.06

LAB NO.: 30931
 SAMPLED BY: DOWL
 DATE SAMPLED: 10/23/2015
 DATE TESTED: 11/5/2015
 PLATE NO.: 01

DOWL

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.3	41.0	58.7	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	100.0		
#20	100.0		
#40	99.7		
#80	98.5		
#100	96.1		
#200	58.7		

Material Description

sandy fat clay

Atterberg Limits (ASTM D 4318)

PL= 21 LL= 101 PI= 80

Classification

USCS (D 2487)= CH AASHTO (M 145)= A-7-6(43)

Coefficients

D₉₀= 0.1251 D₈₅= 0.1129 D₆₀= 0.0764
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Remarks

Sampled By: DOWL
F.M.=0.05

Date Received: _____ **Date Tested:** _____

Tested By: JM _____

Checked By: MC _____

Title: Lab Manager _____

* (no specification provided)

Location: B-64 **Sample Number:** 30934 **Depth:** 65.5-66.0'

Date Sampled: _____



Client: North Dakota Department of Transportation
Project: ND 1804

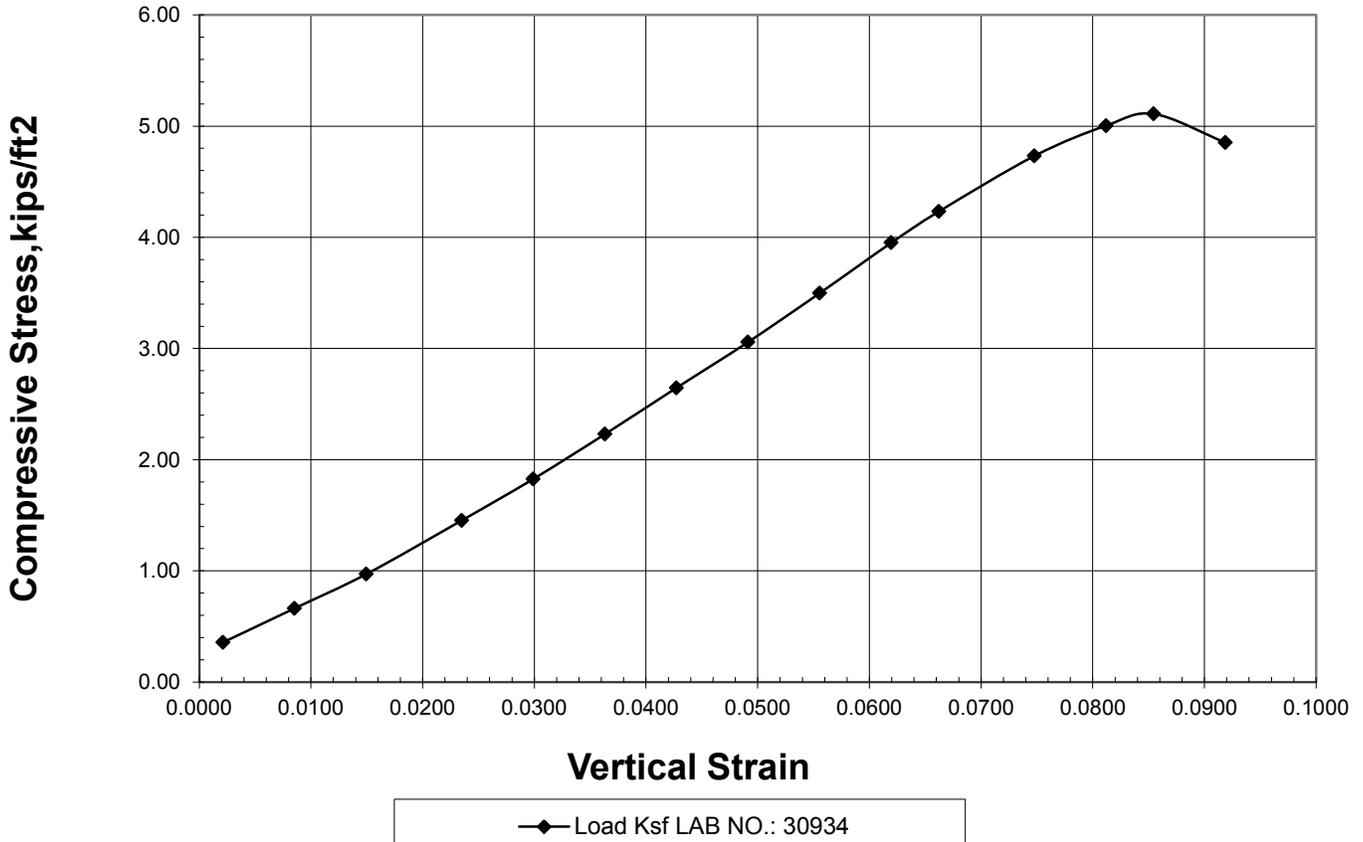
Project No: 6024.20997.01

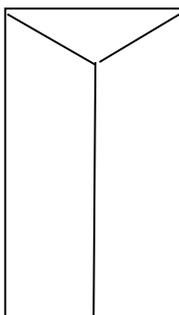
Figure 03

Tested By: _____ **Checked By:** _____

UNCONFINED COMPRESSION TEST

SAMPLE UNIT LOAD - KSF



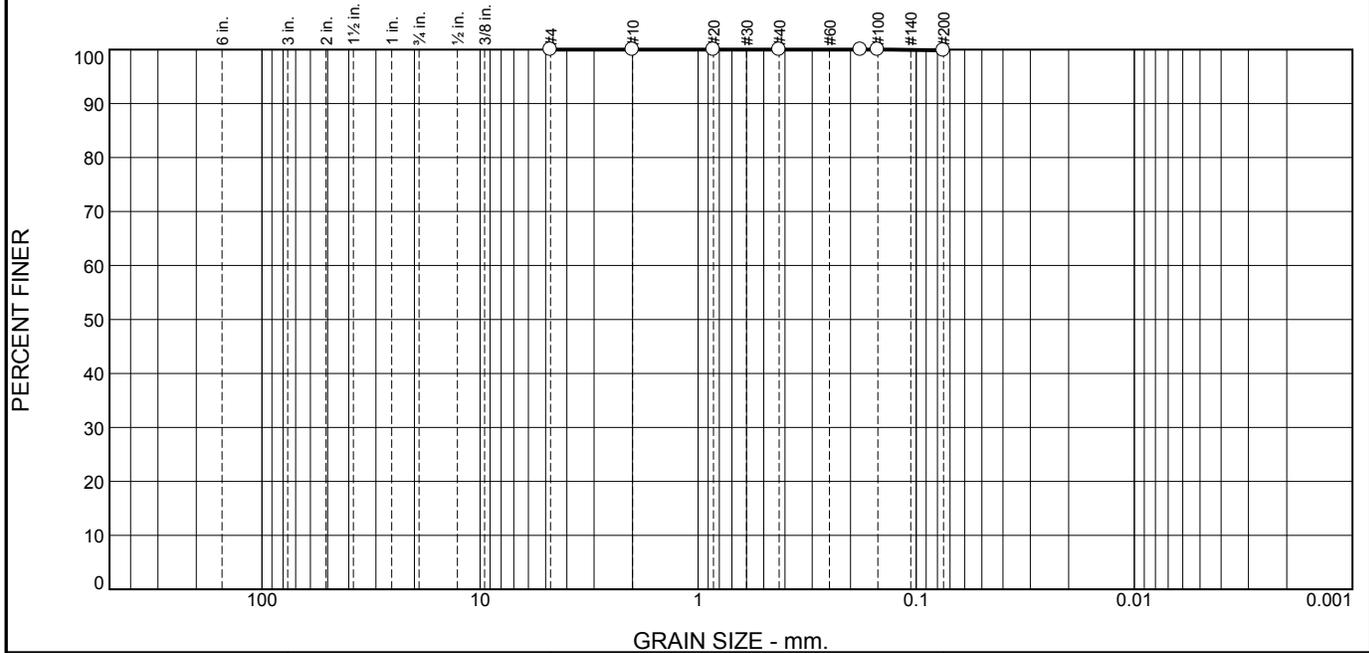
TYPE OF BREAK	GRADATION		ATTERBERG LIMITS	
	SIEVE	% PASSING	LIQUID LIMIT	101
	#4	100	PLASTIC LIMIT	21
	#10	100	PLASTIC INDEX	80
	#20	100	CLASSIFICATION USCS CH AASHTO A-7-6(43)	
	#40	99.7		
	#80	98.5		
	#100	96.1		
			#200	58.7
% MOISTURE	21.0 %		DESCRIPTION	
WET UNIT WT.	134.0 PCF		SANDY FAT CLAY	
DRY UNIT WT.	110.8 PCF		SPECIFIC GRAVITY	
U.C. STRENGTH, qu	5.11 KSF		NT	
COHESION (qu/2)	2.56 KSF			

PROJECT: NNDOT 1804 Reconstruction
 PROJECT NO.: 6024.20997.01
 LOCATION: B-64
 DEPTH: 65.5-66.0'
 DIA. to HT. RATIO: 2.49

LAB NO.: 30934
 SAMPLED BY: DOWL
 DATE SAMPLED: 10/23/2015
 DATE TESTED: 11/5/2015
 PLATE NO.: 02

DOWL

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	0.2	99.8	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	100.0		
#20	100.0		
#40	100.0		
#80	100.0		
#100	100.0		
#200	99.8		

Material Description

fat clay

Atterberg Limits (ASTM D 4318)

PL= 24 LL= 84 PI= 60

Classification

USCS (D 2487)= CH AASHTO (M 145)= A-7-6(70)

Coefficients

D₉₀= D₈₅= D₆₀=
D₅₀= D₃₀= D₁₅=
D₁₀= C_u= C_c=

Remarks

Sampled By: DOWL
F.M.=0.00

Date Received: _____ Date Tested: _____
Tested By: JM
Checked By: MC
Title: Lab Manager

* (no specification provided)

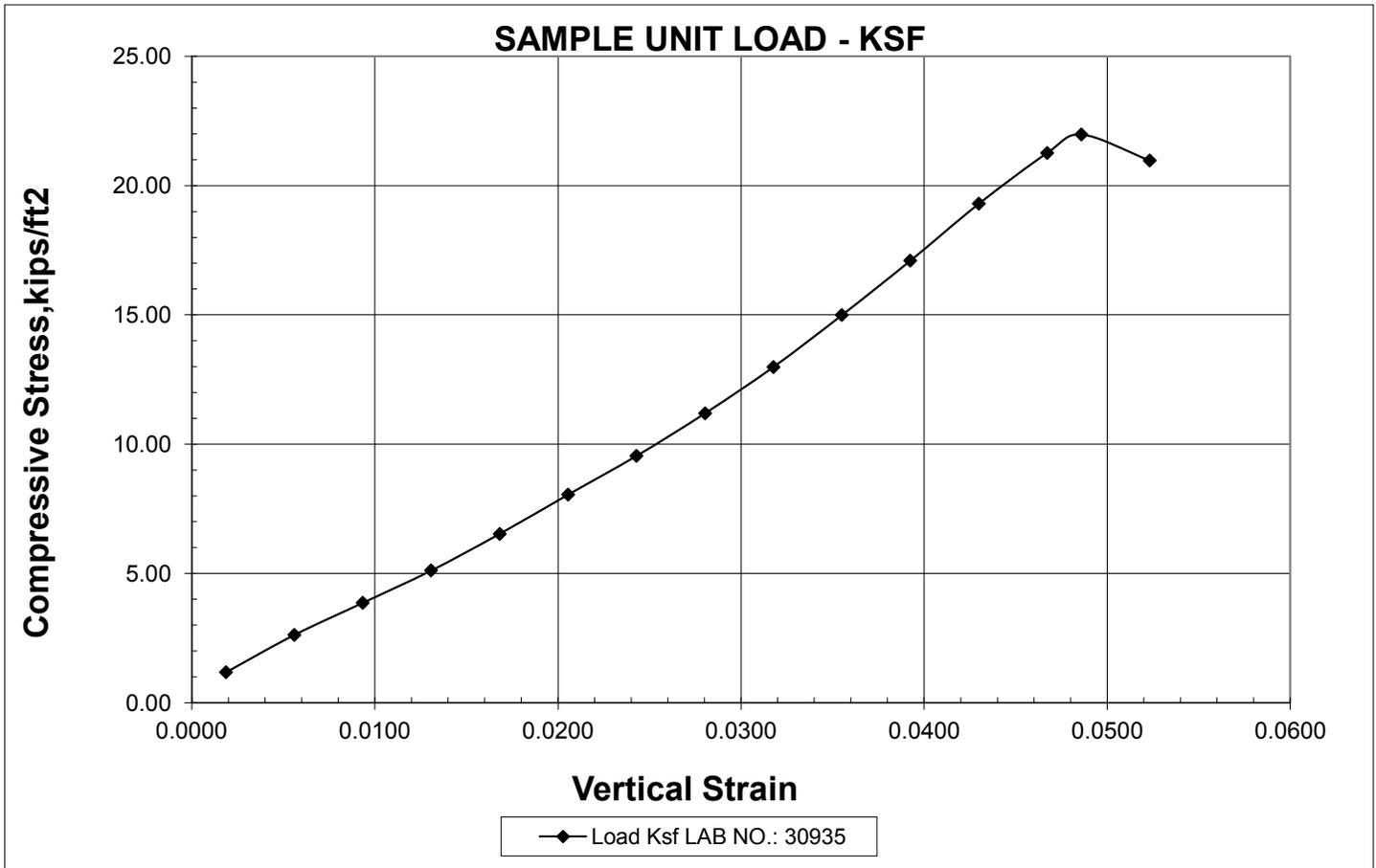
Location: B-64 Date Sampled: _____
Sample Number: 30935 Depth: 94.5-99.0'



Client: North Dakota Department of Transportation
Project: ND 1804
Project No: 6024.20997.01 Figure 04

Tested By: _____ Checked By: _____

UNCONFINED COMPRESSION TEST



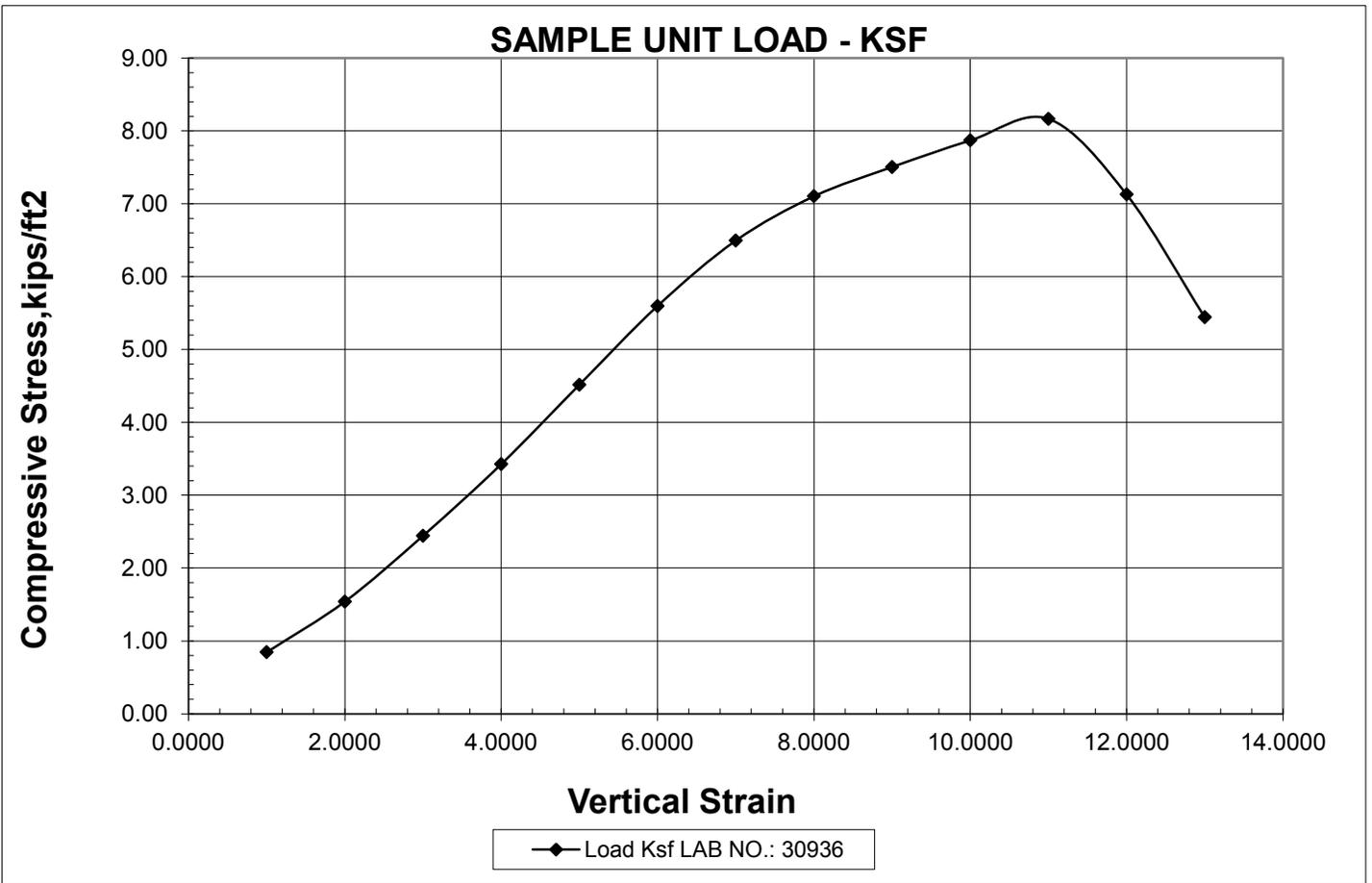
TYPE OF BREAK	GRADATION		ATTERBERG LIMITS	
	SIEVE	% PASSING	LIQUID LIMIT	84
	#4	100	PLASTIC LIMIT	24
	#10	100	PLASTIC INDEX	60
	#20	100.0	CLASSIFICATION	
	#40	100.0	USCS	CH
	#80	100.0	AASHTO	A-7-6(70)
	#100	100.0	DESCRIPTION	
	#200	99.8	FAT CLAY	
% MOISTURE	18.4 %		SPECIFIC GRAVITY	
WET UNIT WT.	135.3 PCF		NT	
DRY UNIT WT.	114.3 PCF			
U.C. STRENGTH, qu	21.98 KSF			
COHESION (qu/2)	10.99 KSF			

PROJECT: NNDOT 1804 Reconstruction
 PROJECT NO.: 6024.20997.01
 LOCATION: B-64
 DEPTH: 94.5-99.0'
 DIA. to HT. RATIO: 3.02

LAB NO.: 30935
 SAMPLED BY: DOWL
 DATE SAMPLED: 10/23/2015
 DATE TESTED: 11/5/2015
 PLATE NO.: 03

DOWL

UNCONFINED COMPRESSION TEST

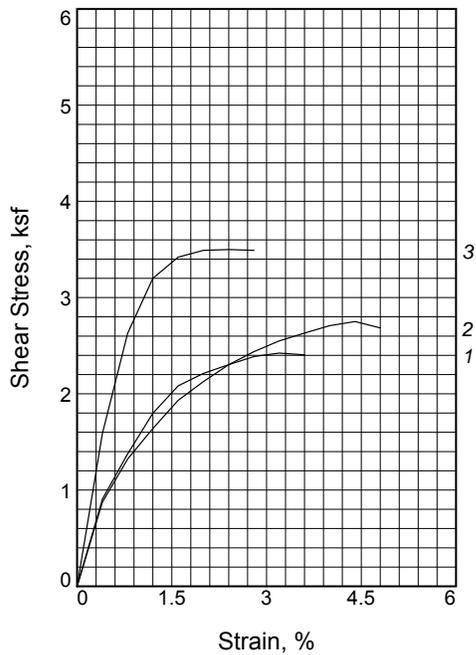
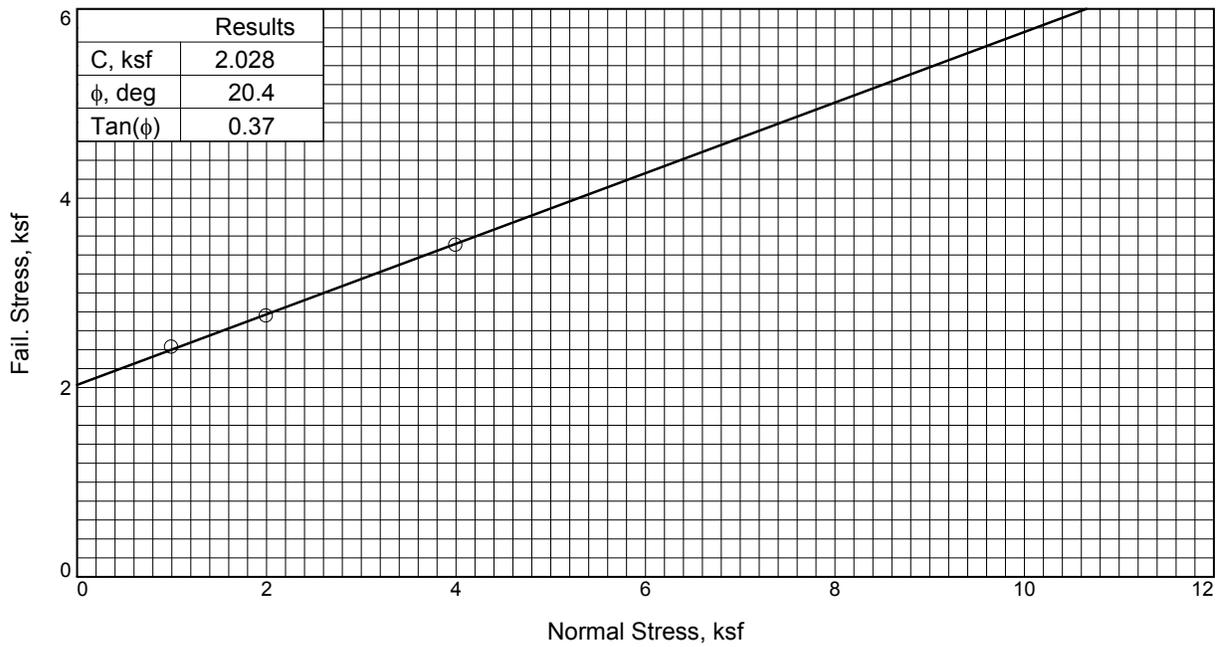


TYPE OF BREAK	GRADATION		ATTERBERG LIMITS	
	SIEVE	% PASSING	LIQUID LIMIT	69
	#4		PLASTIC LIMIT	24
	#10		PLASTIC INDEX	45
	#20		CLASSIFICATION	
	#40		USCS	_____
	#80		AASHTO	_____
	#100		DESCRIPTION	
	#200		SPECIFIC GRAVITY	
% MOISTURE	24.6 %		NT	
WET UNIT WT.	121.8 PCF			
DRY UNIT WT.	97.7 PCF			
U.C. STRENGTH, qu	8.17 KSF			
COHESION (qu/2)	4.09 KSF			

PROJECT: NNDOT 1804 Reconstruction
 PROJECT NO.: 6024.20997.01
 LOCATION: B-76
 DEPTH: 12.5-14.5'
 DIA. to HT. RATIO: 2.06

LAB NO.: 30936
 SAMPLED BY: DOWL
 DATE SAMPLED: 10/23/2015
 DATE TESTED: 11/8/2015
 PLATE NO.: 04

DOWL



Sample No.	1	2	3	
Initial	Water Content, %	28.4	28.6	28.4
	Dry Density, pcf	101.6	101.8	102.9
	Saturation, %	113.3	114.5	116.9
	Void Ratio	0.6898	0.6861	0.6686
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.500	0.500	0.500
At Test	Water Content, %	28.3	27.9	27.1
	Dry Density, pcf	102.6	103.6	105.9
	Saturation, %	115.6	116.7	119.9
	Void Ratio	0.6729	0.6578	0.6212
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.495	0.492	0.486
Normal Stress, ksf	1.000	2.000	4.000	
Fail. Stress, ksf	2.423	2.752	3.500	
Strain, %	3.2	4.4	2.4	
Ult. Stress, ksf				
Strain, %				
Strain rate, in./min.	0.004	0.004	0.004	

Sample Type: Undisturbed

Description: Fat CLAY

LL= 87

PL= 22

PI= 65

Specific Gravity= 2.75

Remarks:

Client: DOWL

Project: NDDOT - 1804 Reconstruction

Source of Sample: B-79

Depth: 19.5'-21.5'

Sample Number: 30940

Proj. No.: 6024.20997.01

Date Sampled:

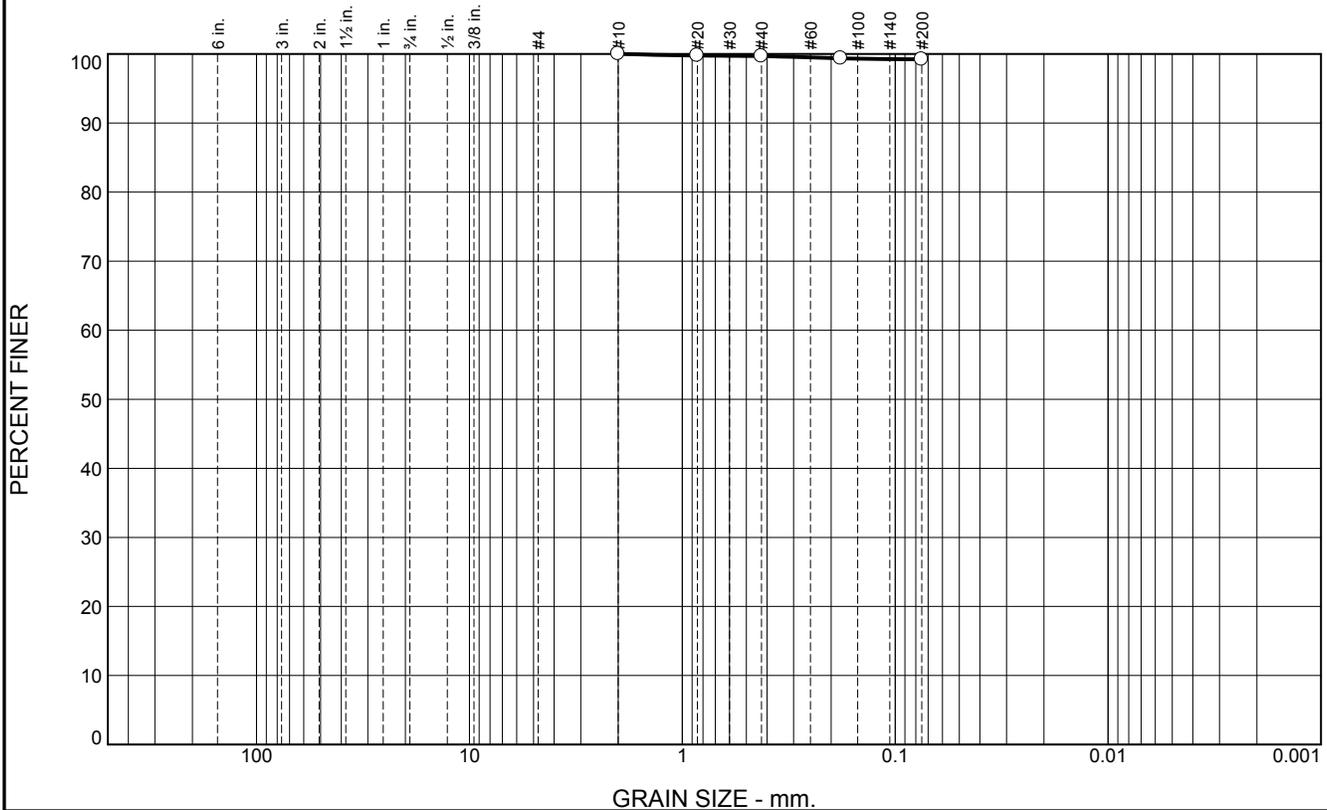
DIRECT SHEAR TEST REPORT

Tetra Tech

Billings, MT

Figure _____

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.3	0.5	99.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.8		
#40	99.7		
#80	99.4		
#200	99.2		

Soil Description
Fat CLAY

Atterberg Limits
PL= 22 LL= 87 PI= 65

Coefficients
D₉₀= D₈₅= D₆₀=
D₅₀= D₃₀= D₁₅=
D₁₀= C_u= C_c=

Classification
USCS= CH AASHTO= A-7-6(74)

Remarks

* (no specification provided)

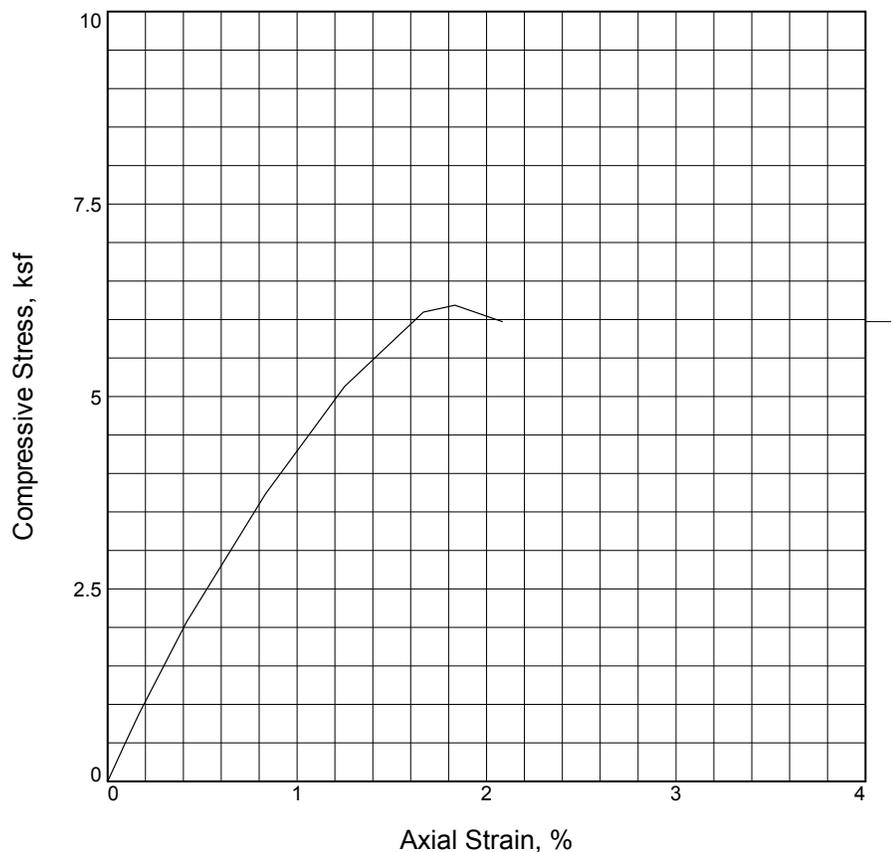
Source of Sample: B-79
Sample Number: 30940

Depth: 19.5'-21.5'

Date:

Tetra Tech Billings, MT	Client: DOWL Project: NDDOT-1804 Reconstruction Project No: 6024.20997.01
Figure	

UNCONFINED COMPRESSION TEST



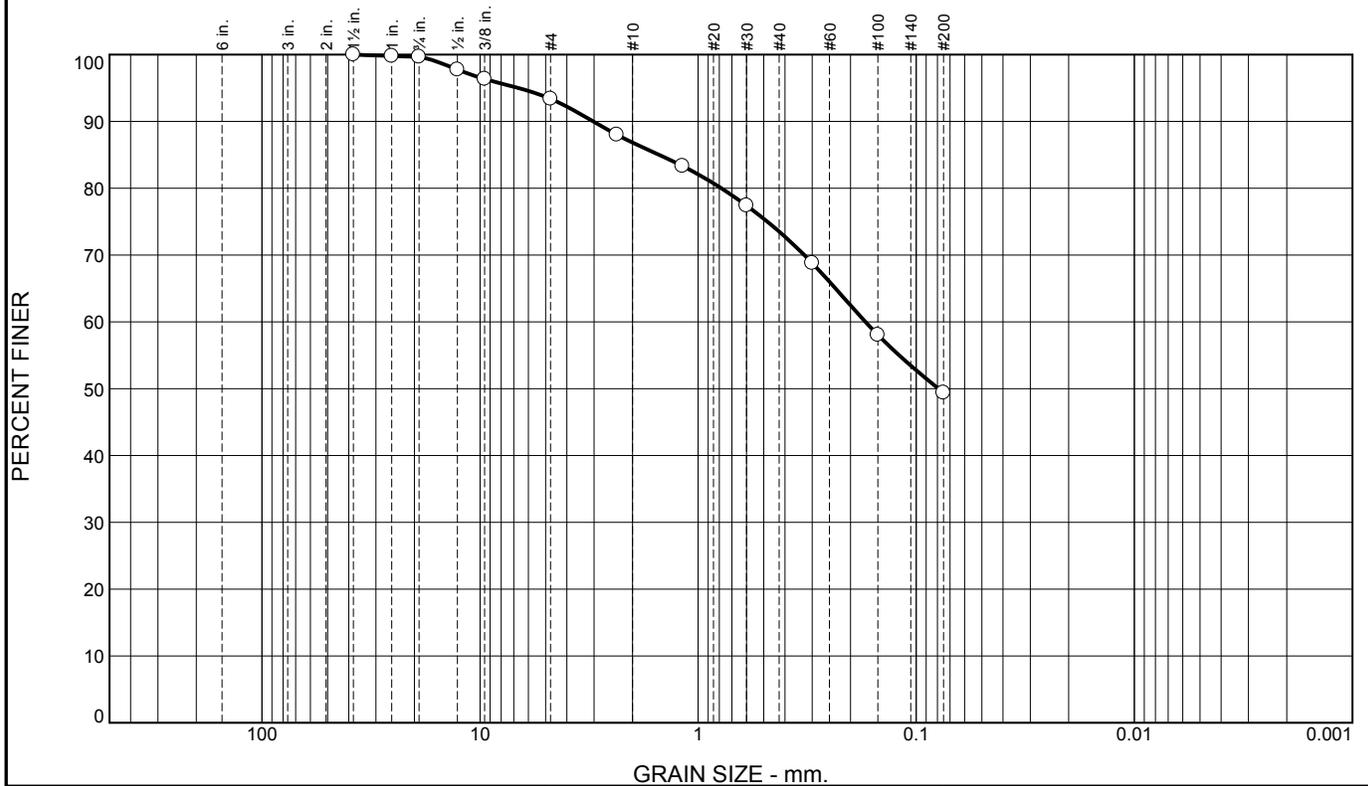
Sample No.	1		
Unconfined strength, ksf	6.186		
Undrained shear strength, ksf	3.093		
Failure strain, %	1.8		
Strain rate, in./min.	0.060		
Water content, %	28.4		
Wet density, pcf	123.2		
Dry density, pcf	95.9		
Saturation, %	104.0		
Void ratio	0.7242		
Specimen diameter, in.	2.875		
Specimen height, in.	6.000		
Height/diameter ratio	2.09		

Description: Fat CLAY

LL = 87	PL = 22	PI = 65	GS = 2.65	Type: Undisturbed
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<p>Project No.: 6024.20997.01</p> <p>Date Sampled:</p> <p>Remarks:</p> <p>Figure _____</p>	<p>Client: DOWL</p> <p>Project: NDDOT-1804 Reconstruction</p> <p>Source of Sample: B-79 Depth: 19.5'-21.5'</p> <p>Sample Number: 30940</p> <p style="text-align: center;">UNCONFINED COMPRESSION TEST Tetra Tech Billings, MT</p>
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Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.3	6.3	6.6	13.3	24.1	49.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1"	99.8		
3/4"	99.7		
1/2"	97.7		
3/8"	96.3		
#4	93.4		
#8	88.0		
#16	83.3		
#30	77.4		
#50	68.8		
#100	58.1		
#200	49.4		

Material Description

clayey sand

Atterberg Limits
 PL= 12 LL= 31 PI= 19

Coefficients
 D₉₀= 3.0291 D₈₅= 1.5139 D₆₀= 0.1709
 D₅₀= 0.0791 D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= SC AASHTO= A-6(5)

Remarks
 Sampled by DOWL

* (no specification provided)

Source of Sample: B-100 Depth: 1.4 - 4.5 ft Date: 11/19/2015
 Sample Number: 15195

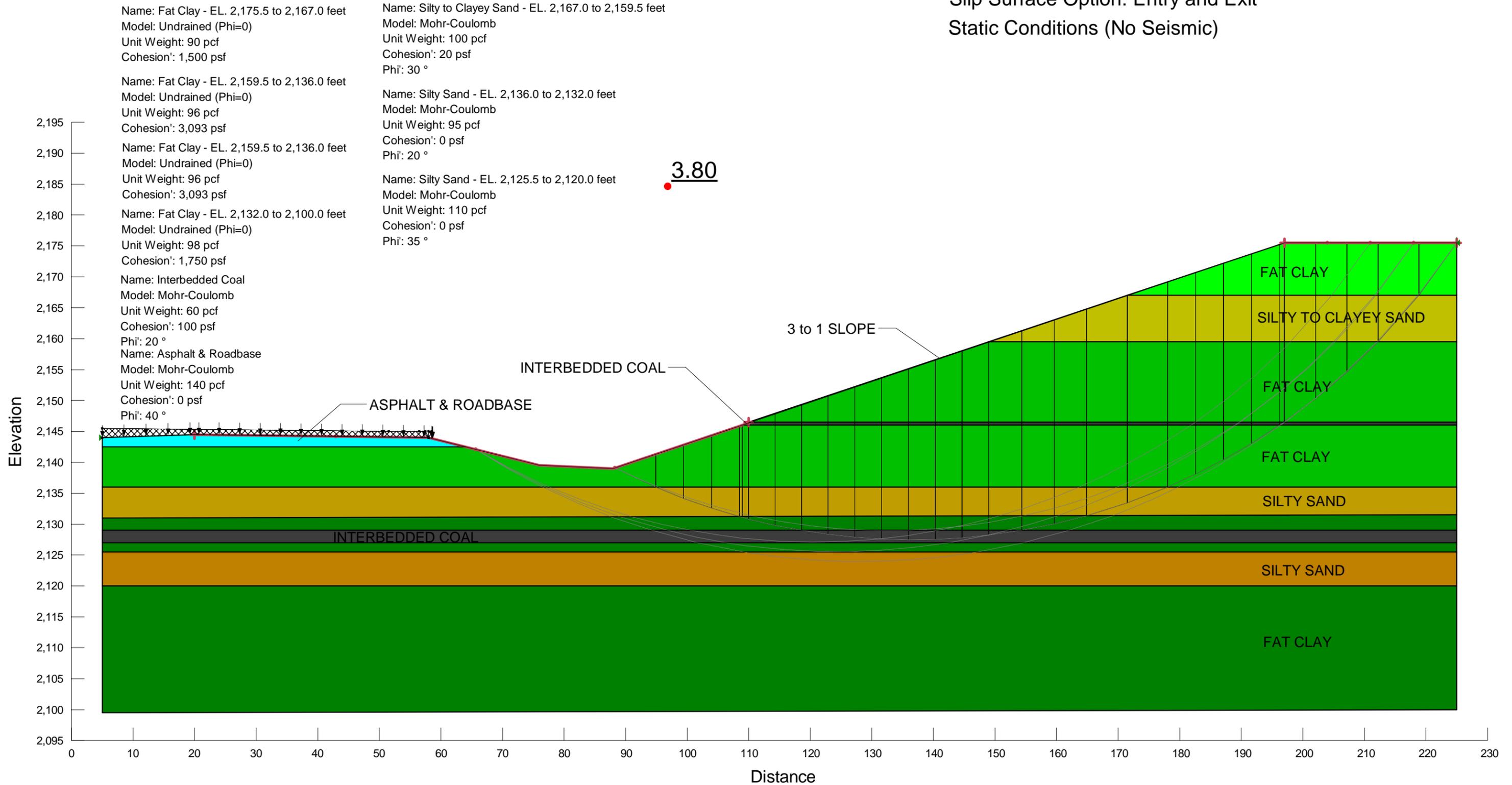
	<p>Client: NDDOT</p> <p>Project: NDDOT HWY 1804 Geo Exploration</p> <p>Project No: 6024.20997.01</p>
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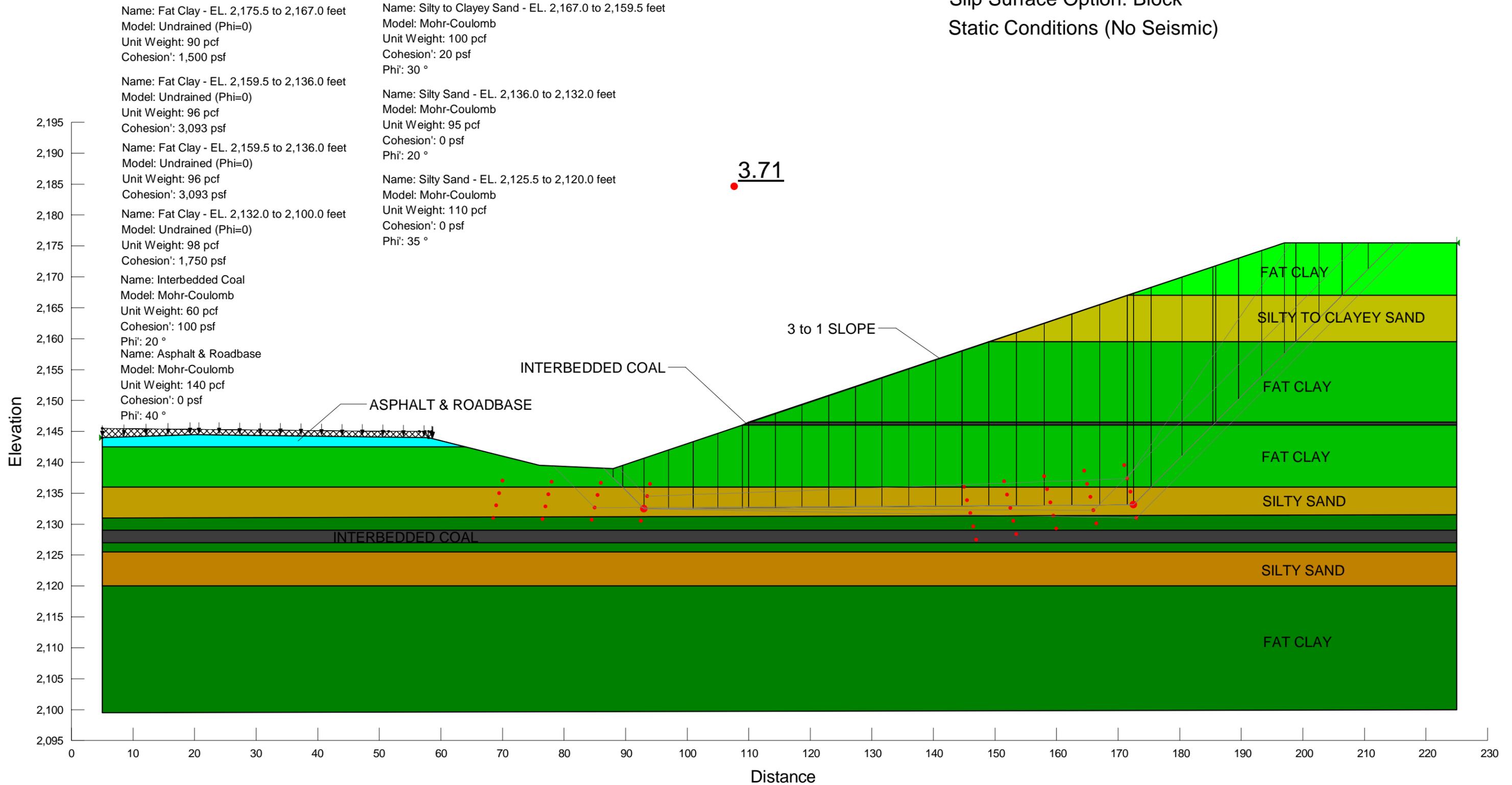
Tested By: LM Checked By: LM

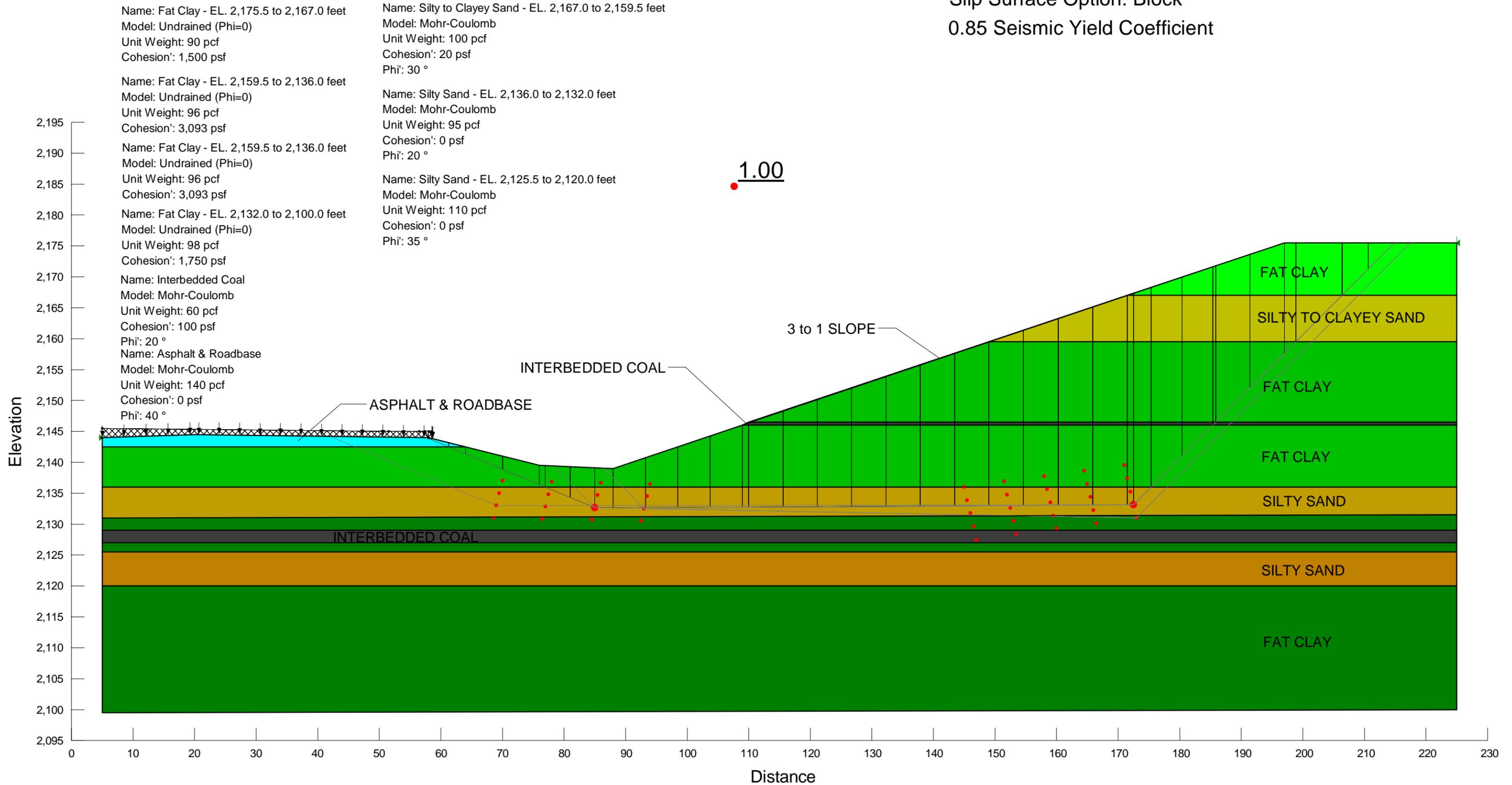
APPENDIX D

CUT SLOPE STABILITY ANALYSIS

Slip Surface Option: Entry and Exit
 Static Conditions (No Seismic)







Name: Fat Clay - EL. 2,158.0 to 2,144.0 feet
 Model: Undrained (Phi=0)
 Unit Weight: 98 pcf
 Cohesion: 4,085 psf

Name: Silty Sand - EL. 2,127.0 to 2,124.0 feet
 Model: Mohr-Coulomb
 Unit Weight: 105 pcf
 Cohesion: 0 psf
 Phi: 30 °

Name: Fat Clay - EL. 2,142.0 to 2,127.0 feet
 Model: Undrained (Phi=0)
 Unit Weight: 100 pcf
 Cohesion: 4,500 psf

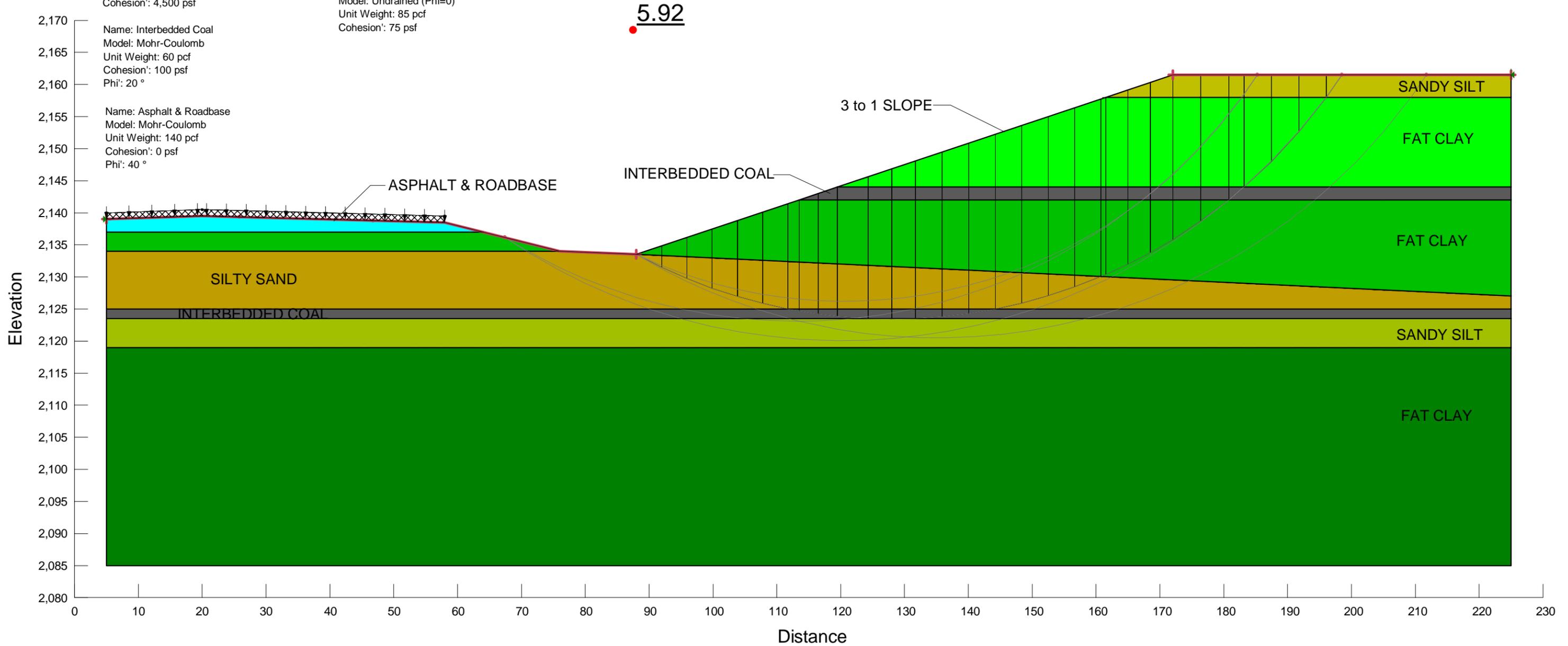
Name: Sandy Silt - EL. 2,124.0 to 2,119 feet
 Model: Mohr-Coulomb
 Unit Weight: 95 pcf
 Cohesion: 0 psf
 Phi: 35 °

Name: Fat Clay - EL. 2,119.0 to 2,085.0 feet
 Model: Undrained (Phi=0)
 Unit Weight: 100 pcf
 Cohesion: 4,500 psf

Name: Sandy Silt - EL. 2,161.5 to 2,158.0 feet
 Model: Undrained (Phi=0)
 Unit Weight: 85 pcf
 Cohesion: 75 psf

Name: Interbedded Coal
 Model: Mohr-Coulomb
 Unit Weight: 60 pcf
 Cohesion: 100 psf
 Phi: 20 °

Name: Asphalt & Roadbase
 Model: Mohr-Coulomb
 Unit Weight: 140 pcf
 Cohesion: 0 psf
 Phi: 40 °



Name: Fat Clay - EL. 2,158.0 to 2,144.0 feet
 Model: Undrained (Phi=0)
 Unit Weight: 98 pcf
 Cohesion: 4,085 psf

Name: Silty Sand - EL. 2,127.0 to 2,124.0 feet
 Model: Mohr-Coulomb
 Unit Weight: 105 pcf
 Cohesion: 0 psf
 Phi: 30 °

Name: Fat Clay - EL. 2,142.0 to 2,127.0 feet
 Model: Undrained (Phi=0)
 Unit Weight: 100 pcf
 Cohesion: 4,500 psf

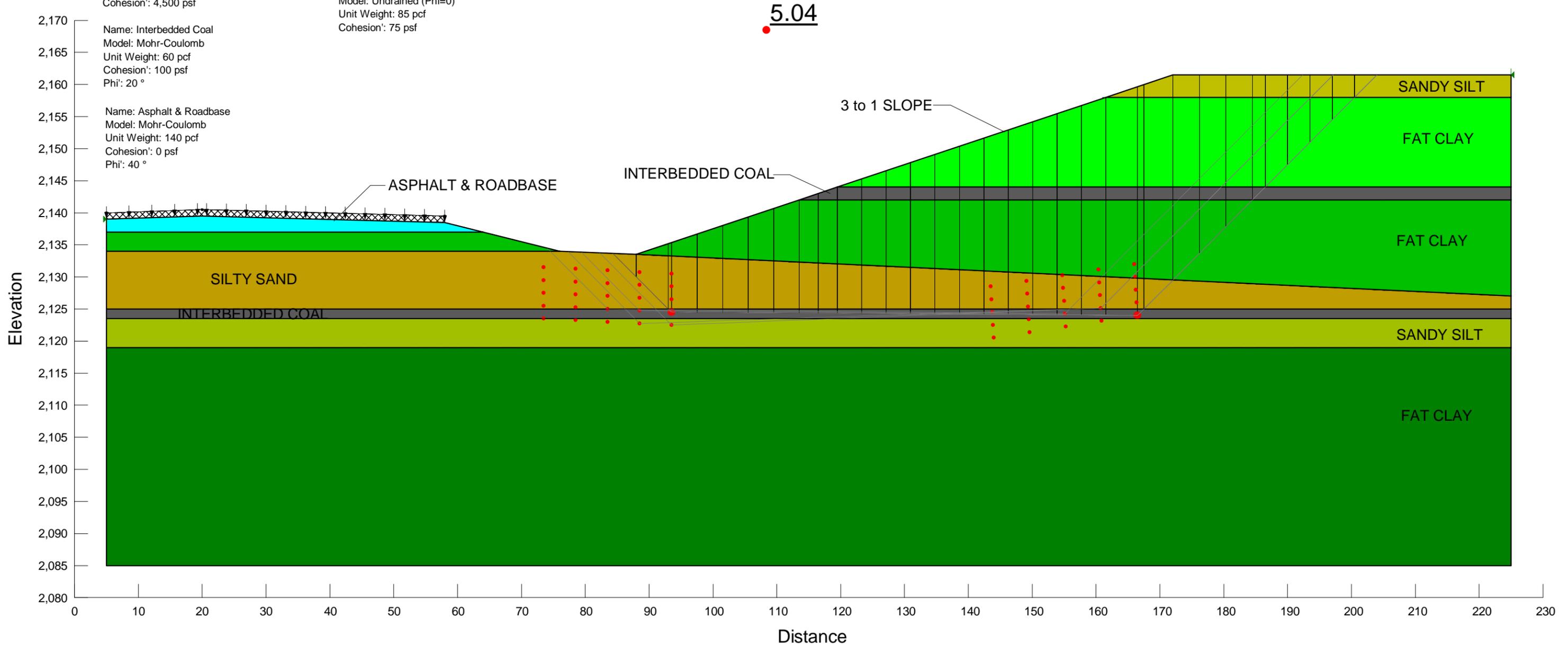
Name: Sandy Silt - EL. 2,124.0 to 2,119 feet
 Model: Mohr-Coulomb
 Unit Weight: 95 pcf
 Cohesion: 0 psf
 Phi: 35 °

Name: Fat Clay - EL. 2,119.0 to 2,085.0 feet
 Model: Undrained (Phi=0)
 Unit Weight: 100 pcf
 Cohesion: 4,500 psf

Name: Sandy Silt - EL. 2,161.5 to 2,158.0 feet
 Model: Undrained (Phi=0)
 Unit Weight: 85 pcf
 Cohesion: 75 psf

Name: Interbedded Coal
 Model: Mohr-Coulomb
 Unit Weight: 60 pcf
 Cohesion: 100 psf
 Phi: 20 °

Name: Asphalt & Roadbase
 Model: Mohr-Coulomb
 Unit Weight: 140 pcf
 Cohesion: 0 psf
 Phi: 40 °



APPENDIX E
GPR TRAVERSE REPORT

November 25, 2015

**RE: –GROUND PENETRATING RADAR SURVEY – NORTH DAKOTA 1804
RECONSTRUCTION PROJECT**

Summary / Conclusions

Approximately 18,000 feet of profile data were acquired. It is comprised of two profiles. One conducted within the ditch line on each side of the existing highway. Based on the ground penetrating radar data, the following general conclusions regarding the alignment can be made:

- Average depth of investigation 15-20 feet
- The large majority of profile data do not support the presence of voids.
- A small number of suspect locations are identified that may warrant further investigation. Further investigation could be limited to representative sites.

Scope and Technical Approach – Ground Penetrating Radar (GPR)

The GPR method utilizes a reflected electromagnetic pulse to identify subsurface features. An impulse is transmitted from an antenna on the surface. The impulse travels into the subsurface is then reflected off of underground features and objects with electrical properties that differ from the surrounding materials including both metal and non-metal objects and from any interface where the electrical properties vary from the surround material including voids. The reflected pulse is received back at the surface and is recorded and displayed for analysis.

The choice of the appropriate antenna is important to the success of meeting project objectives. There is a tradeoff between the depth of investigation and resolution. Longer wavelengths (low frequencies) can travel to greater depths, but are unable to resolve small or thin features. A low frequency antenna will tend to blur or smear results. Short wavelengths will not travel as far, but can resolve smaller features and maintain signal character. High frequencies will typically produce a clearer image, but with a more limited depth of investigation.



Figure 1. GPR Antenna

GPR performance can vary dramatically based on site specific conditions, primarily the amount of clay and soil moisture. To choose the appropriate antenna, a short test profile near the project alignment was surveyed to evaluate the effectiveness of two frequency antenna, a 100 MHz antenna and 270 MHz antenna. The test location was positioned over an area known to have voids, but at an unreported depth. Data were acquired using a GSSI SIR-2000 an integrated survey wheel for profile positioning.

Based on a qualitative judgement, the 100 MHz antenna was chosen as generating better results providing a marginally greater depth of investigation. Figure 3

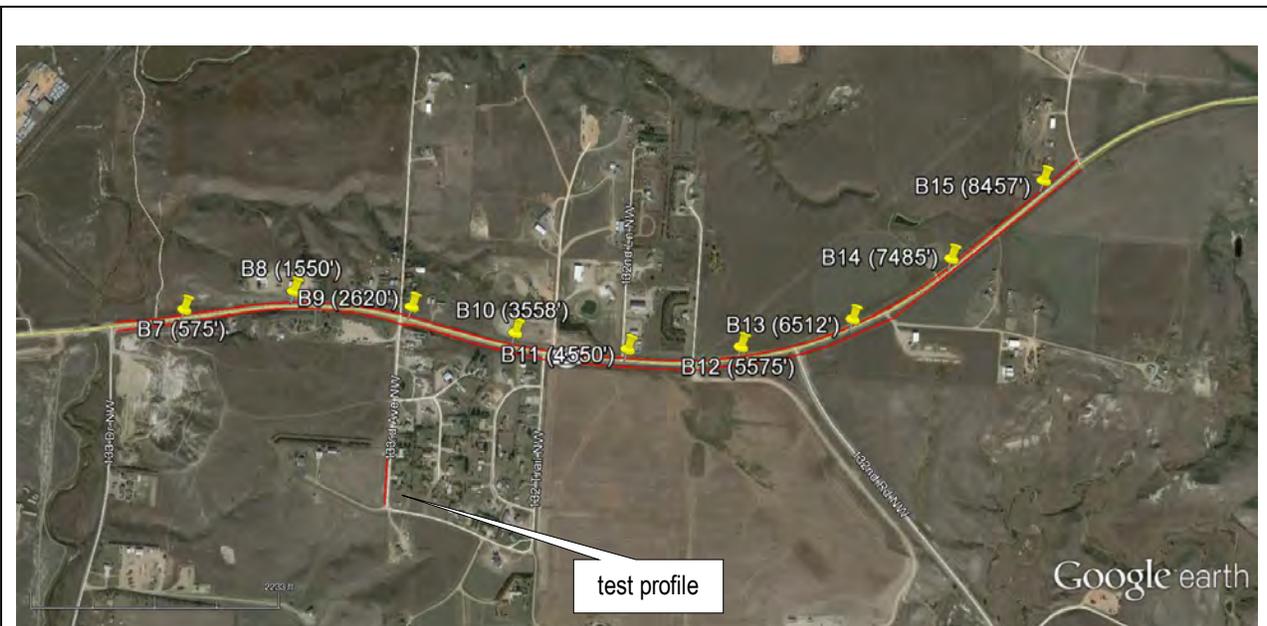


Figure 2. Project location, Google earth image

270 MHz. Antenna Test

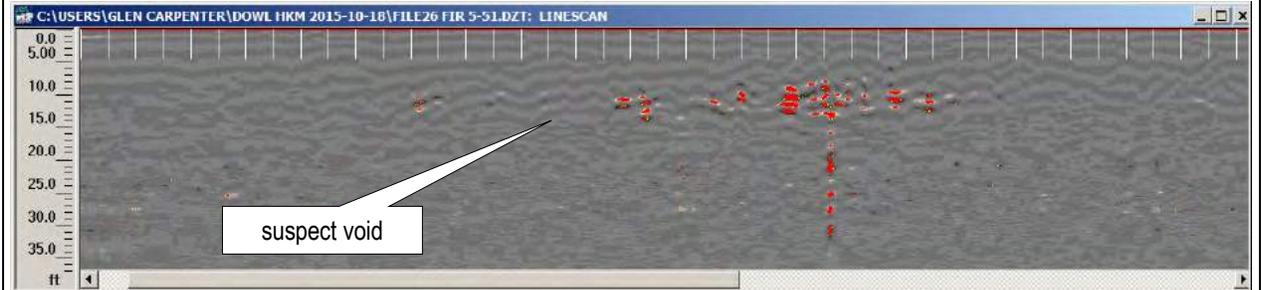


Figure 3a Test profile, 270 MHz antenna

100 MHz. Antenna Test

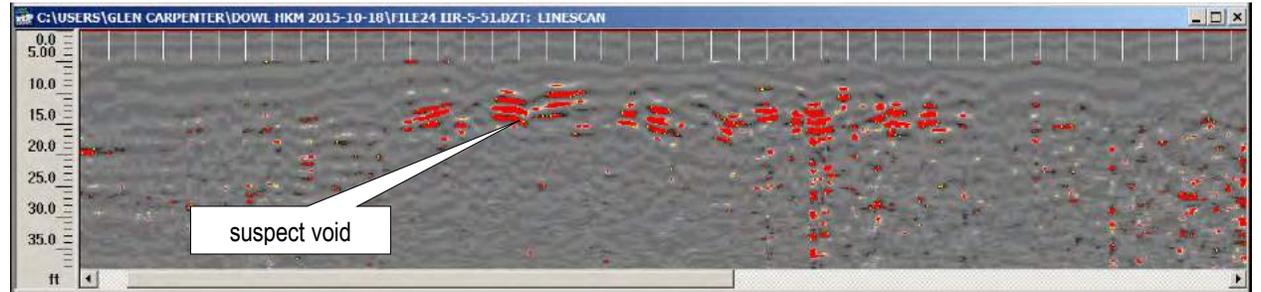
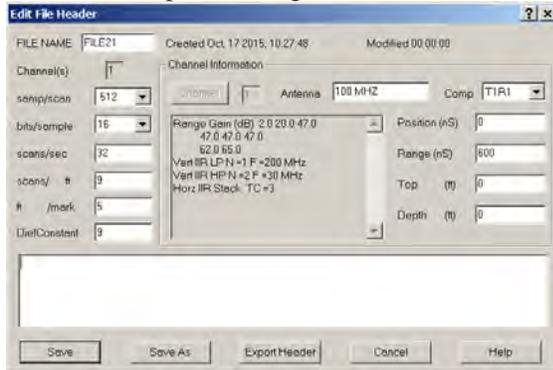


Figure 3b. Test profile, 100 MHz antenna

Discussion

Data were acquired using a 100 MHz antenna with the following acquisition parameters.

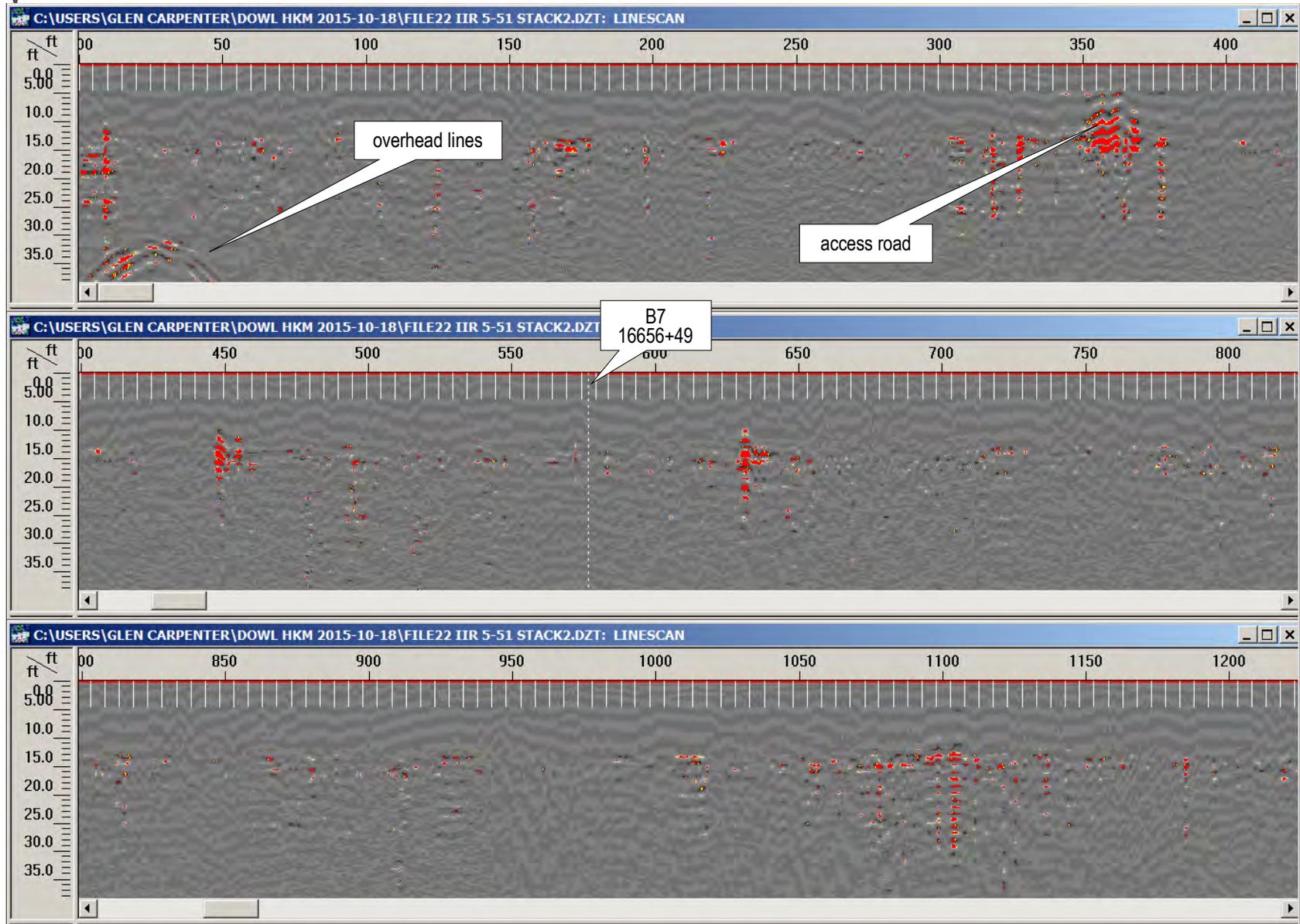


Processing was limited to the application of a background removal filter to removed short period anomalies to remove “chatter” and very long period features to emphasize anomalous zones. All records were processed, gained, and identical color scales applied to allow for comparisons along the profile and between the North and South profiles. Red was applied to the highest amplitude reflections to emphasize those peak anomalies.

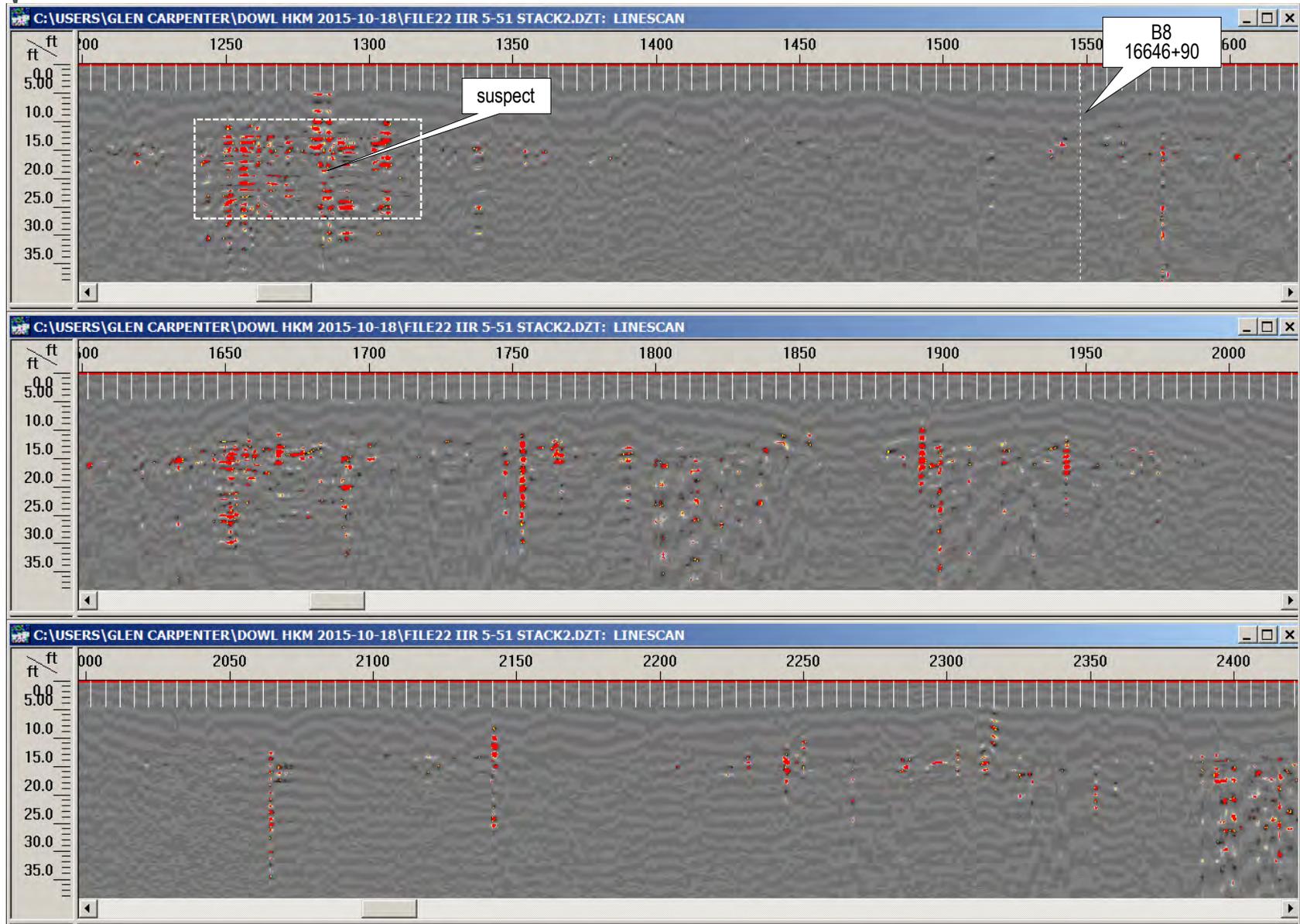
In the following figures, short tick marks at the top of the figure are distance measurements. Distance is shown across the top. Each tick is spaced five feet apart. The estimated depth scale (ft) is on the left. The body of the figure is a gray scale relative reflection relative. Red is applied to the highest amplitude reflections. Long tick marks show the location of project test holes. Test hole locations should be used to calibrate profile location. Locations should be measured from the nearest test hole.

The most notable anomalies having the character that may indicate a void are labeled. These locations may warrant further investigation.

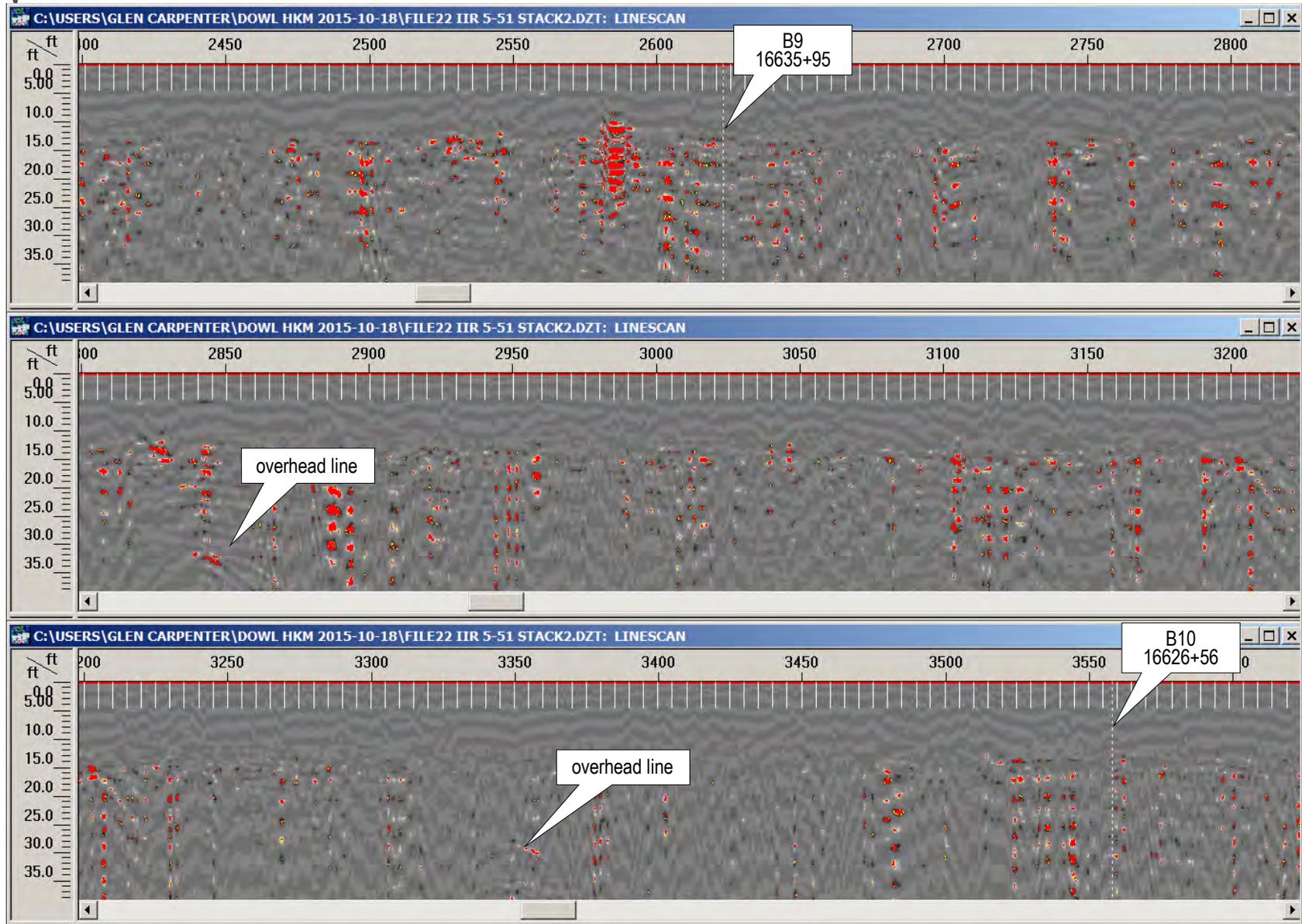
NORTH PROFILE



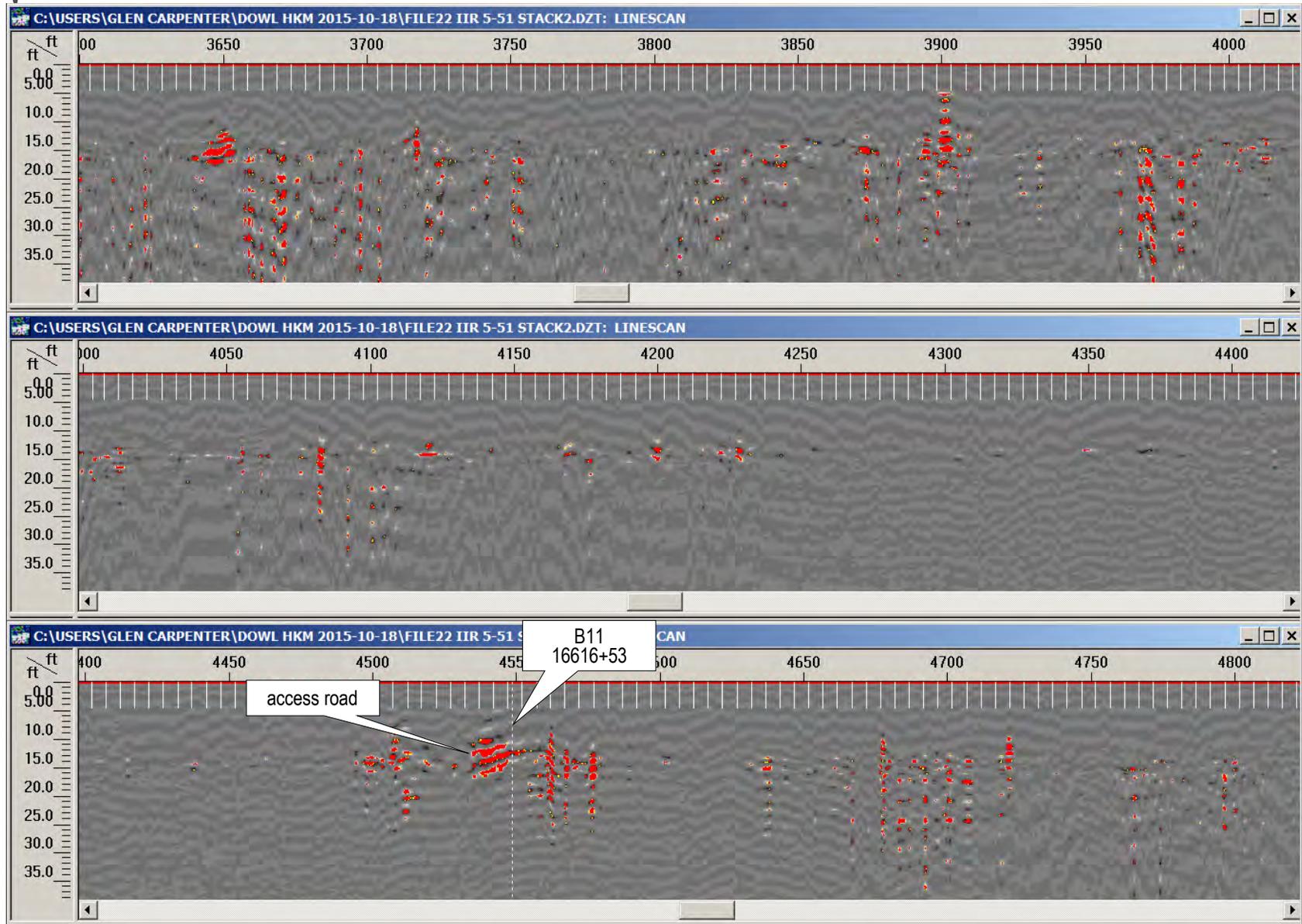
NORTH PROFILE



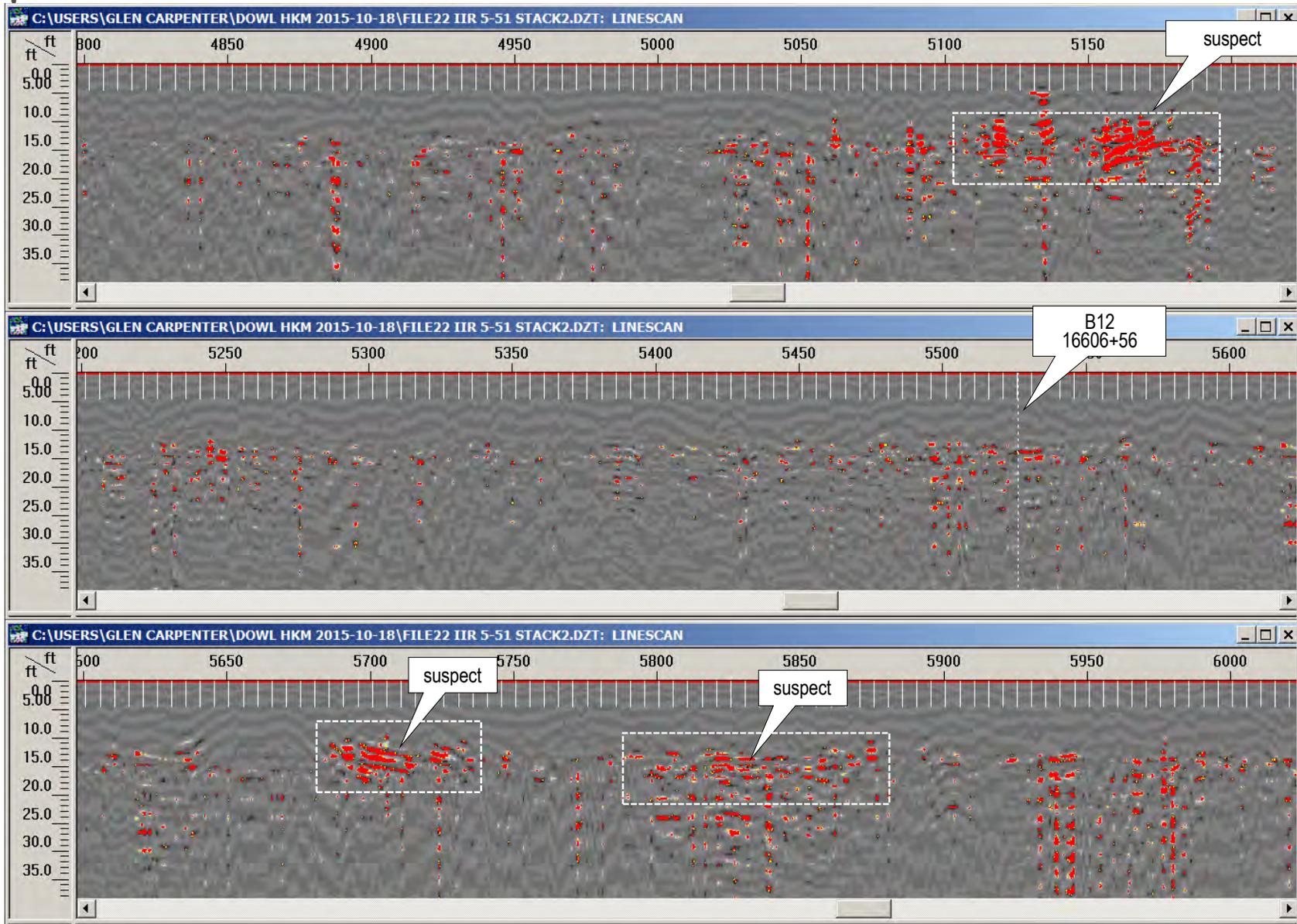
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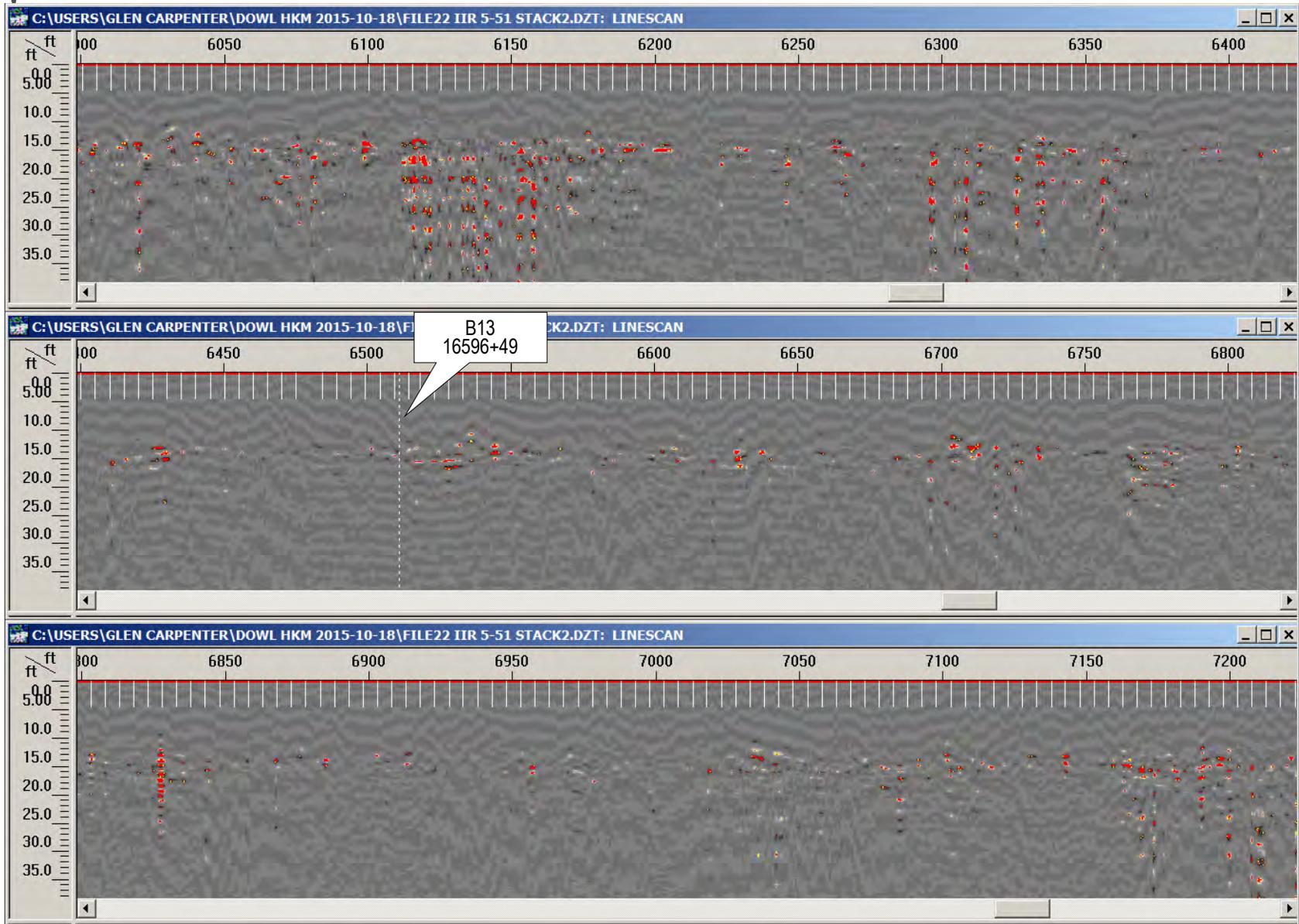
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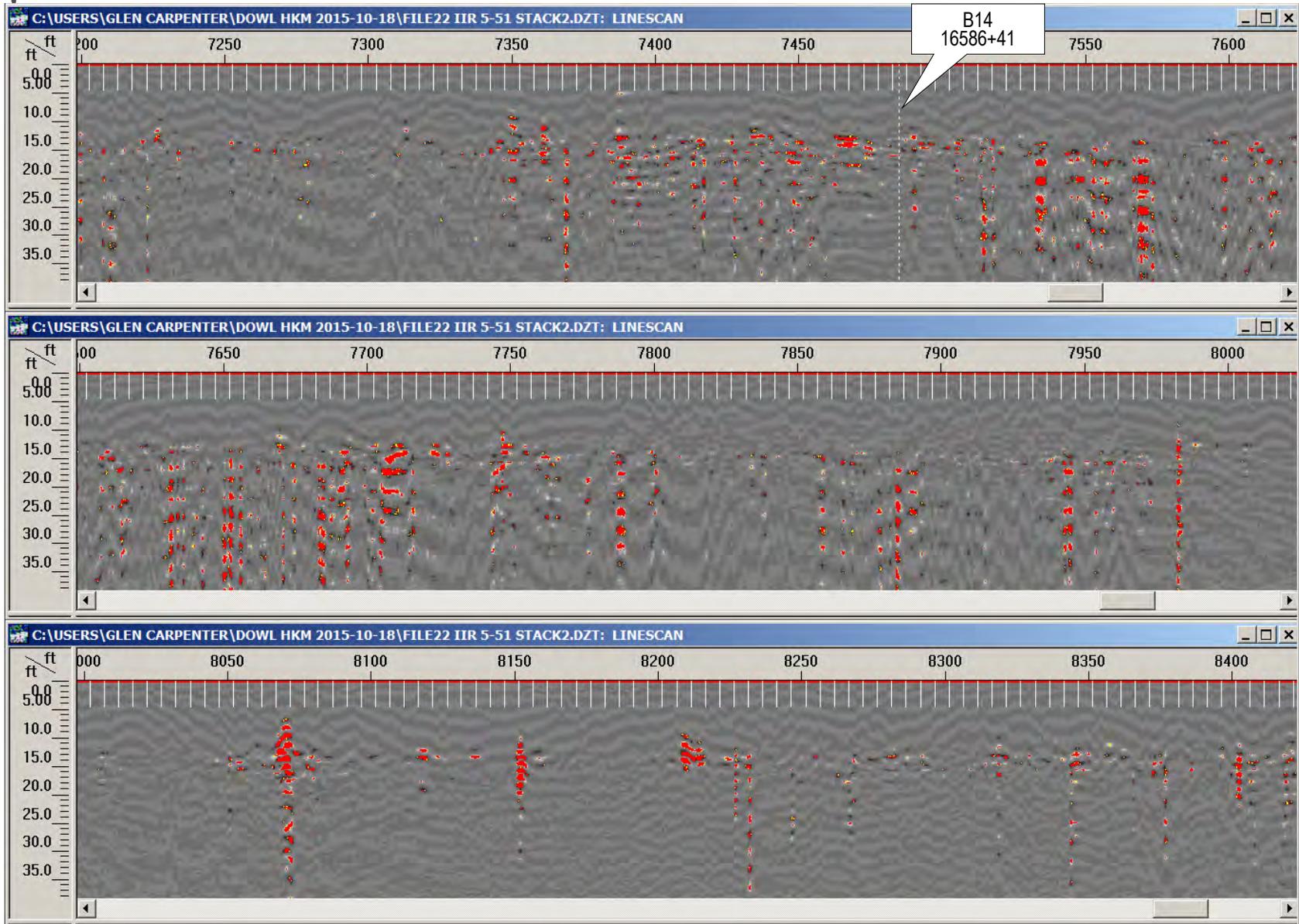
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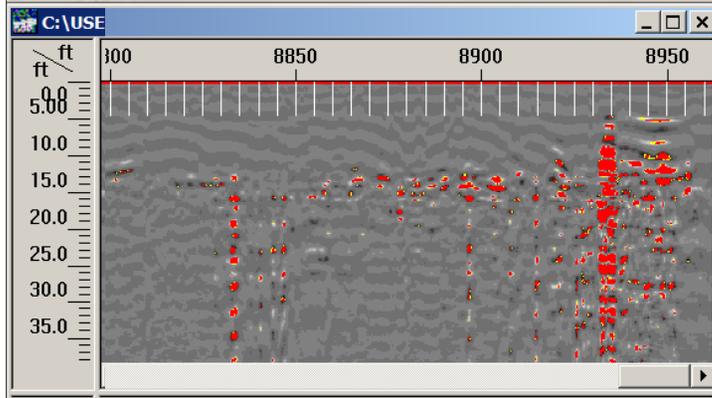
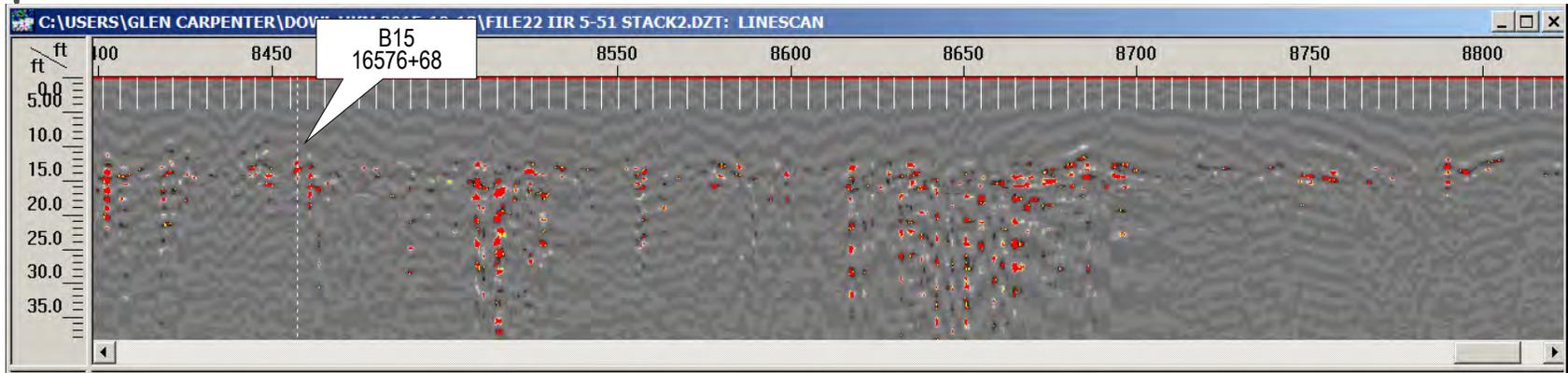
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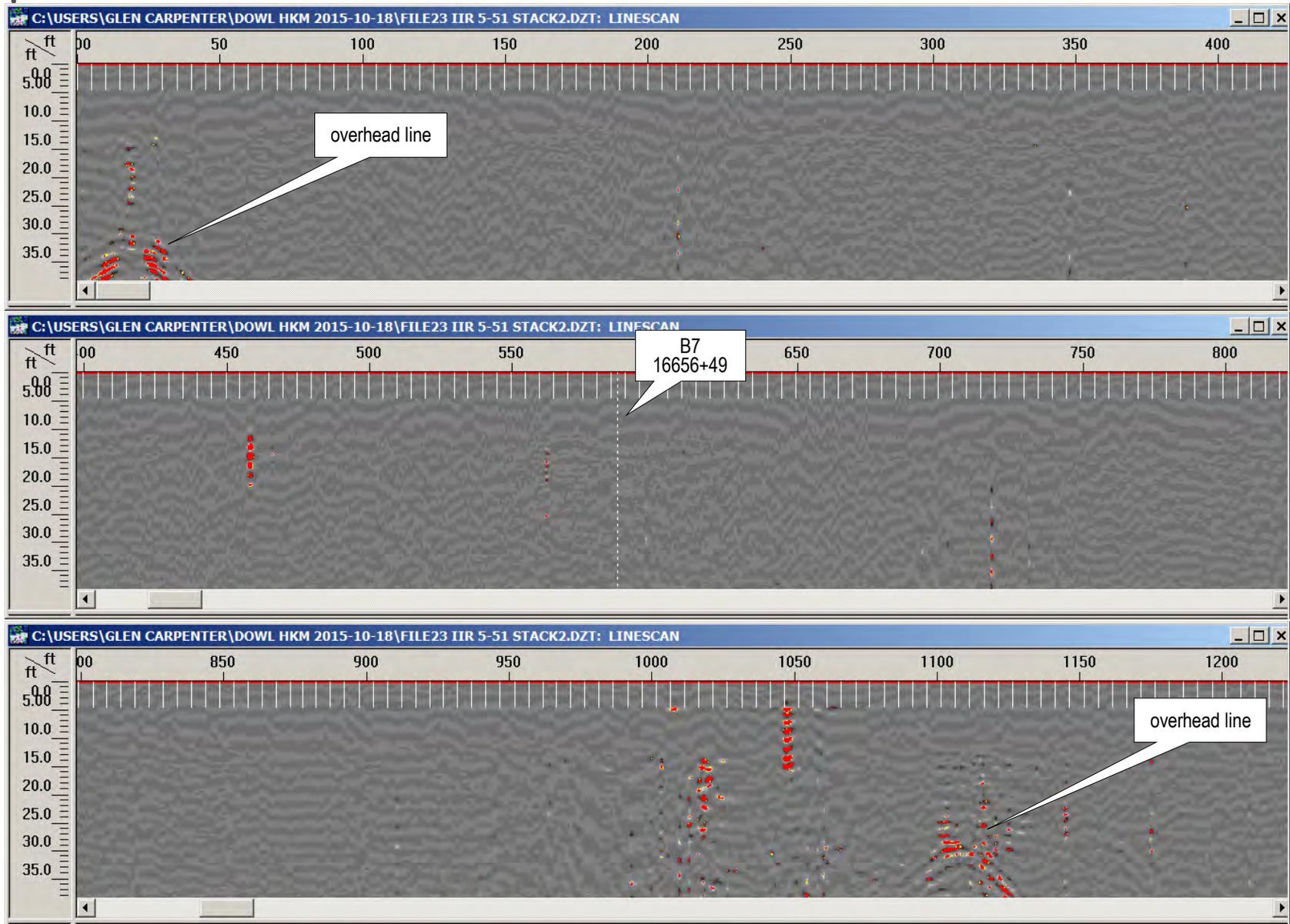
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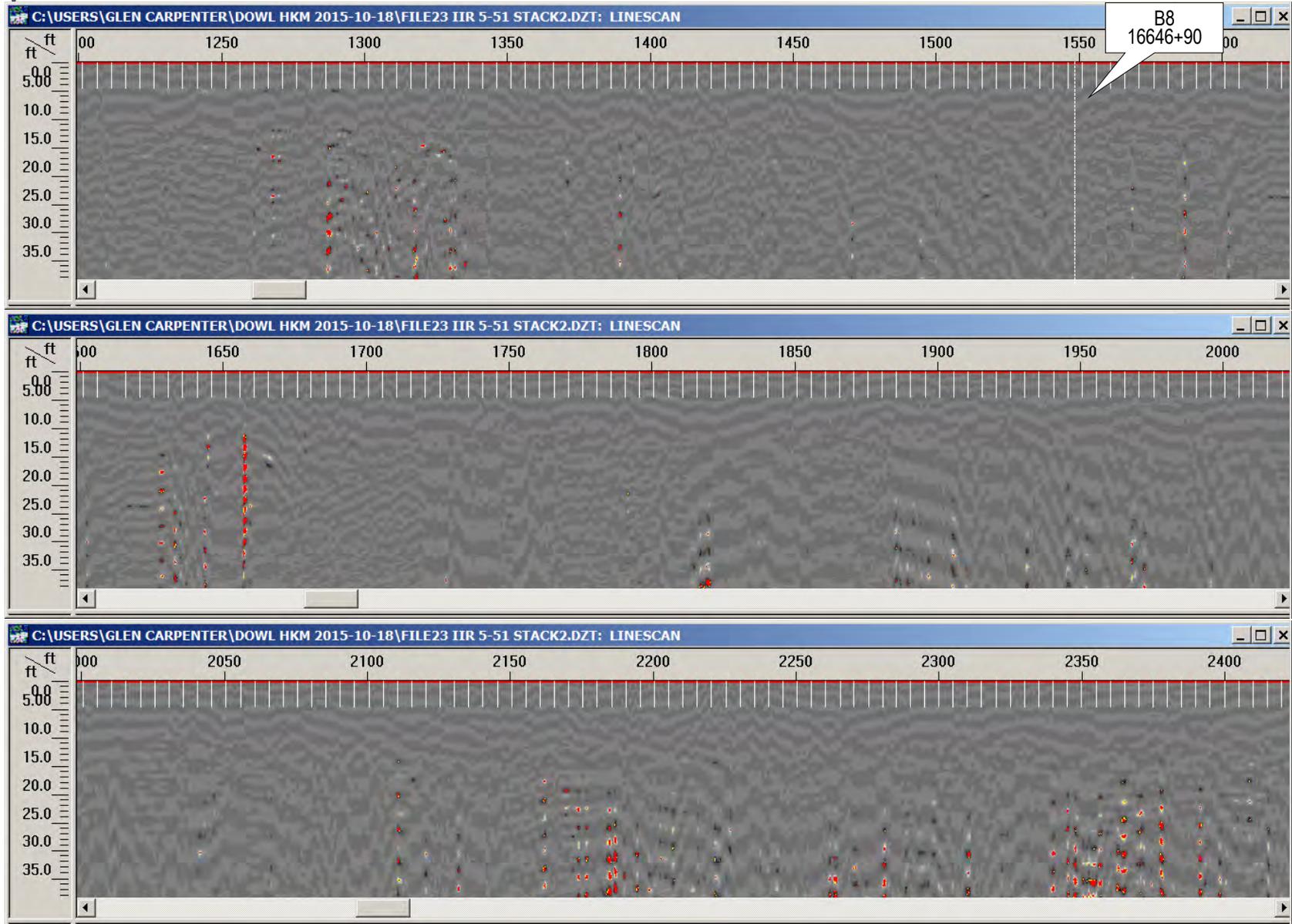
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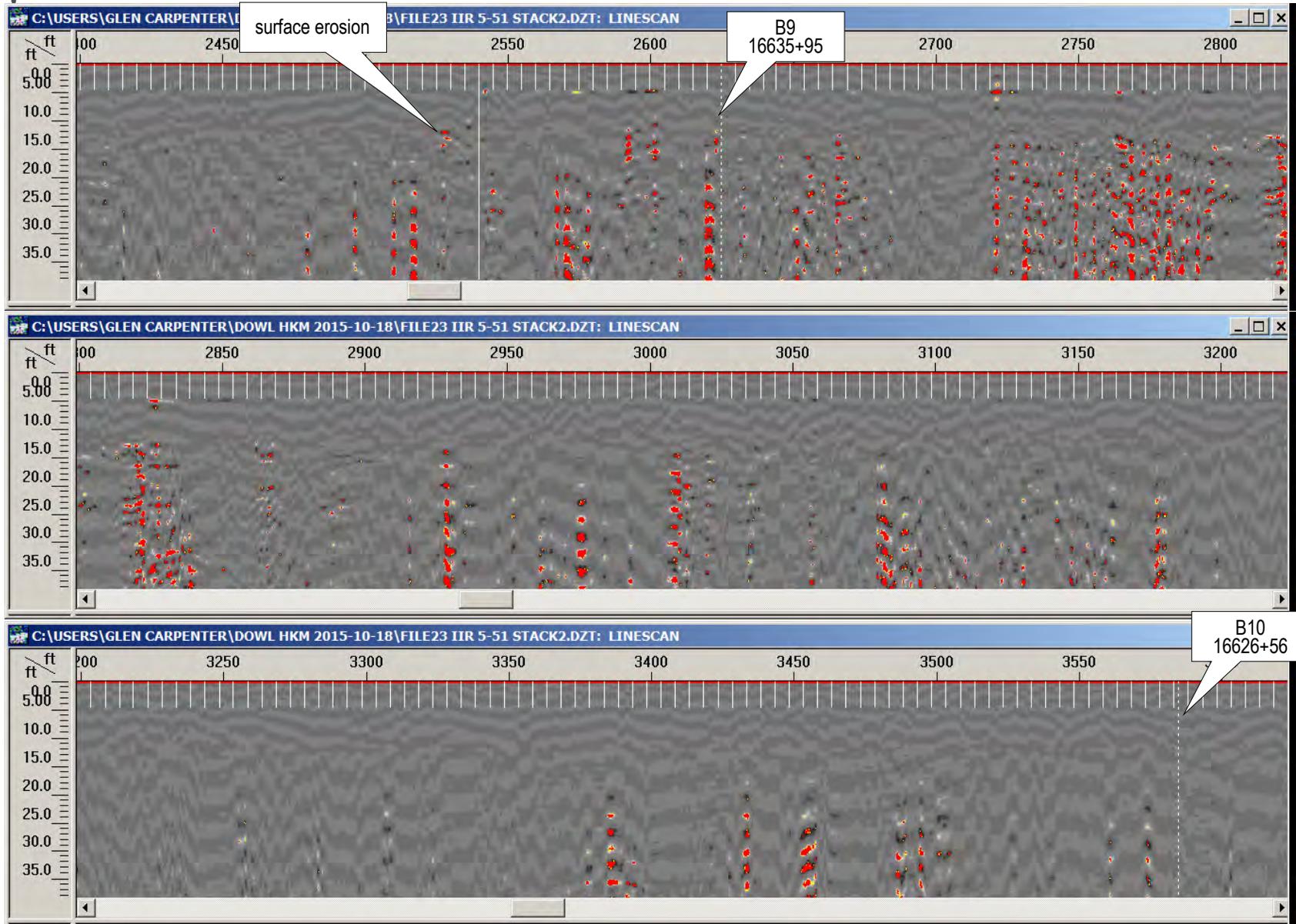
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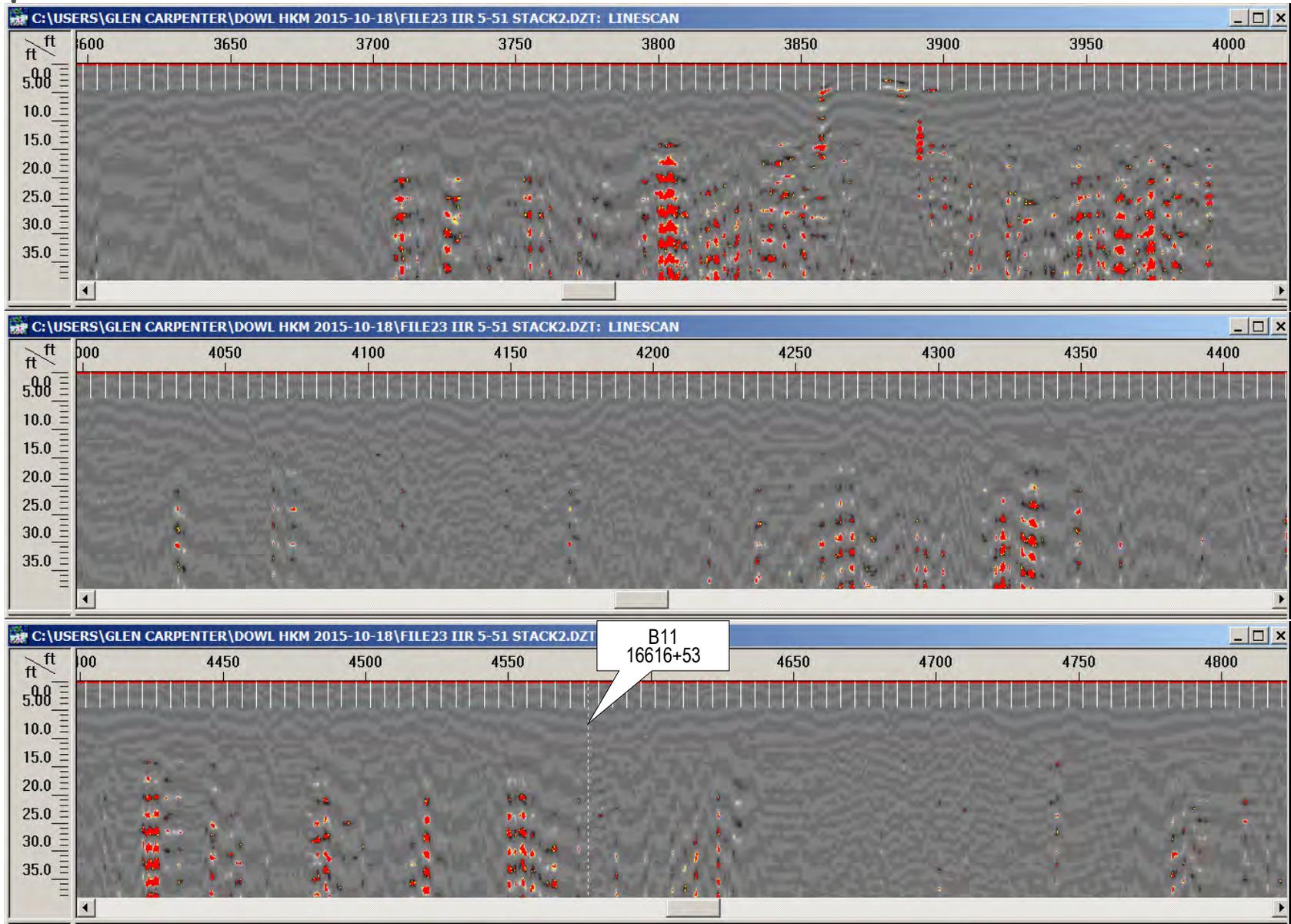
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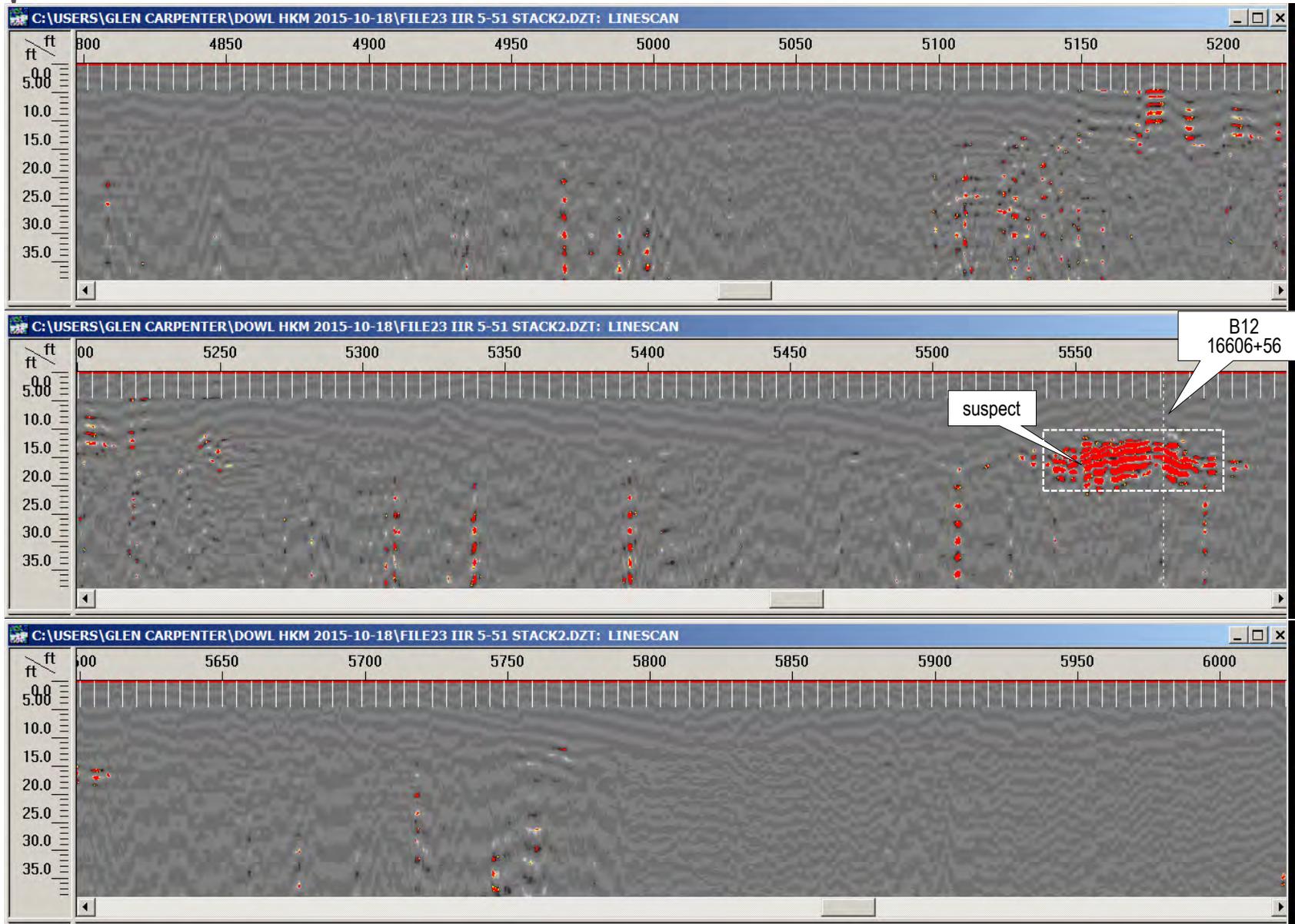
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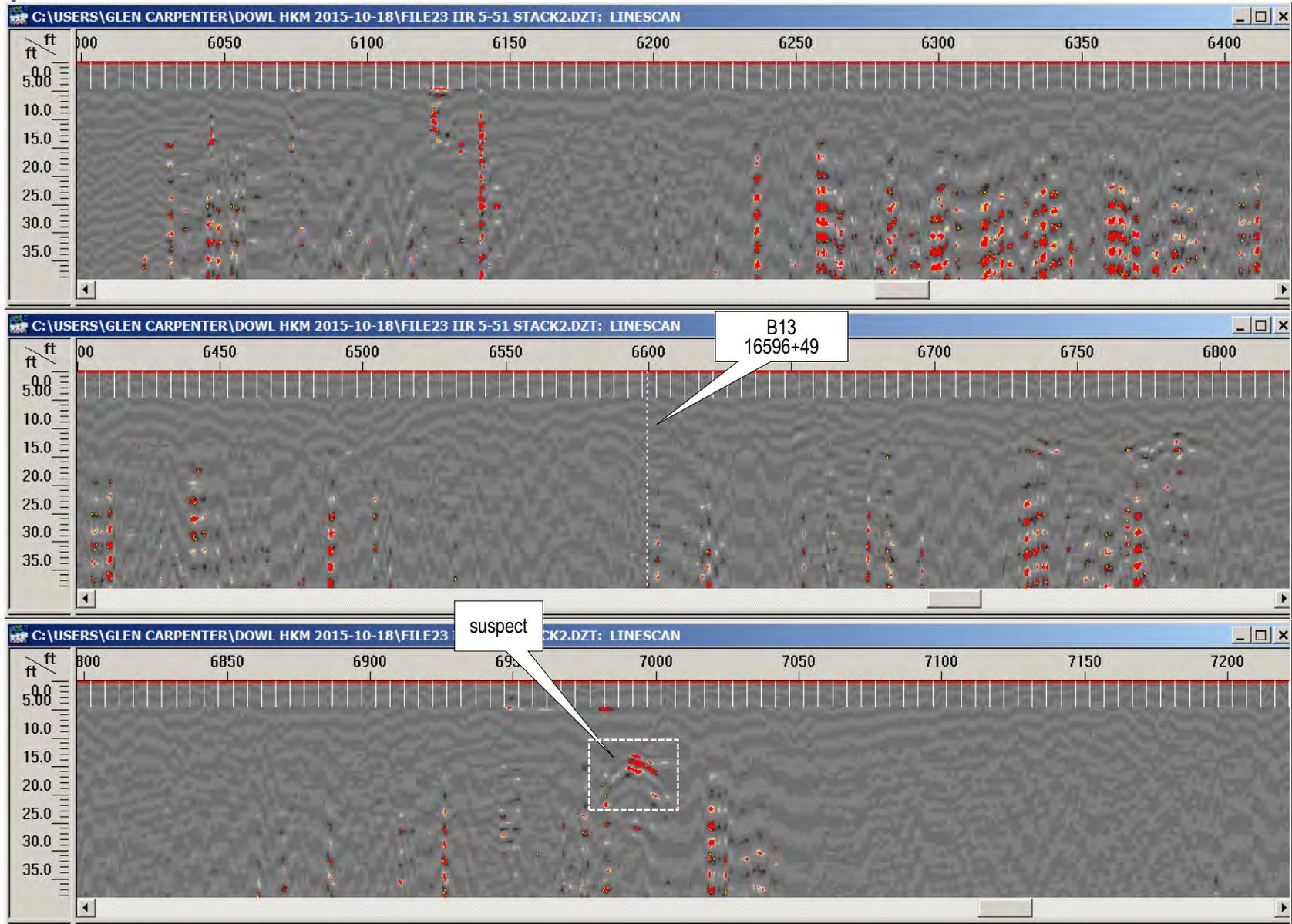
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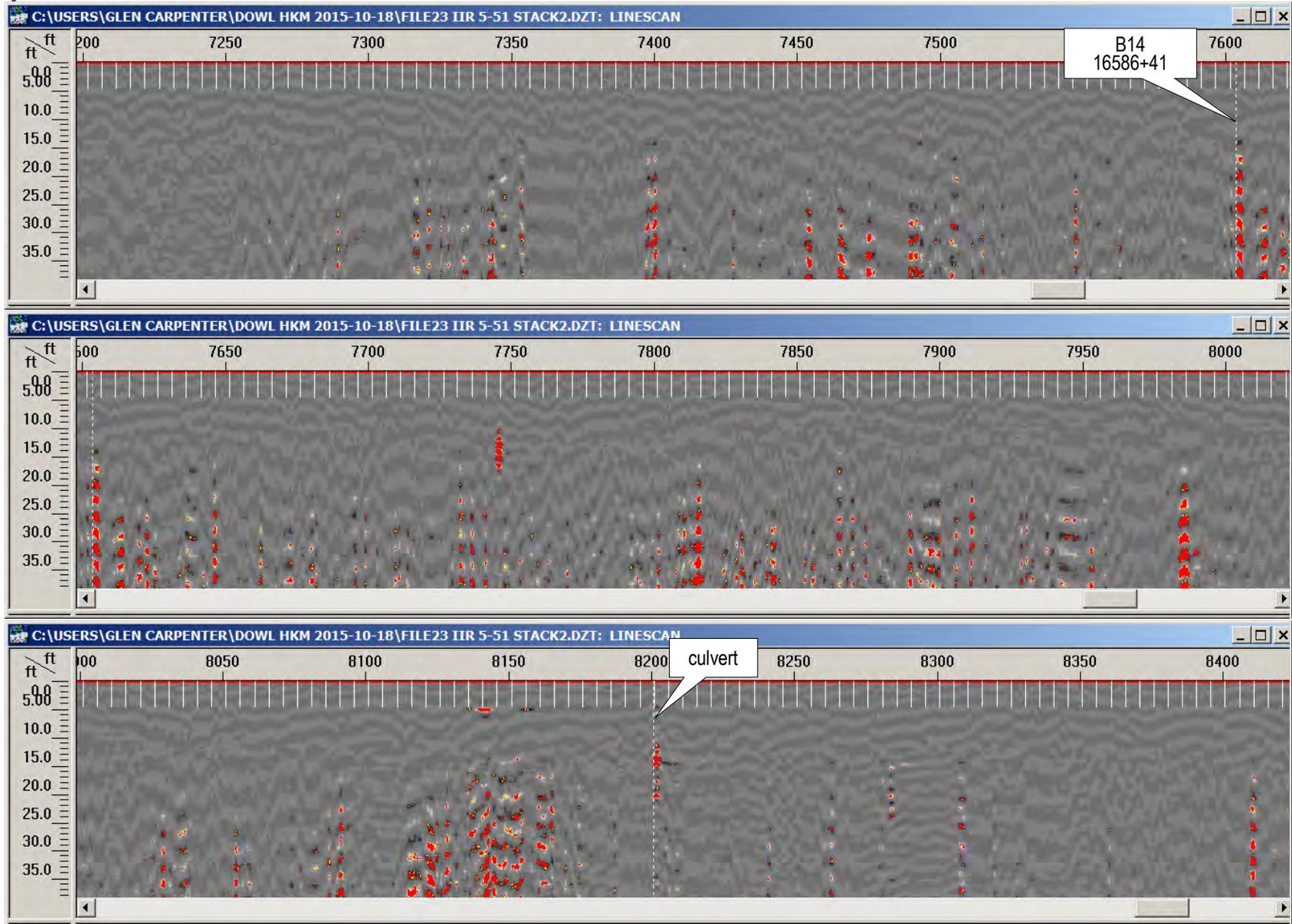
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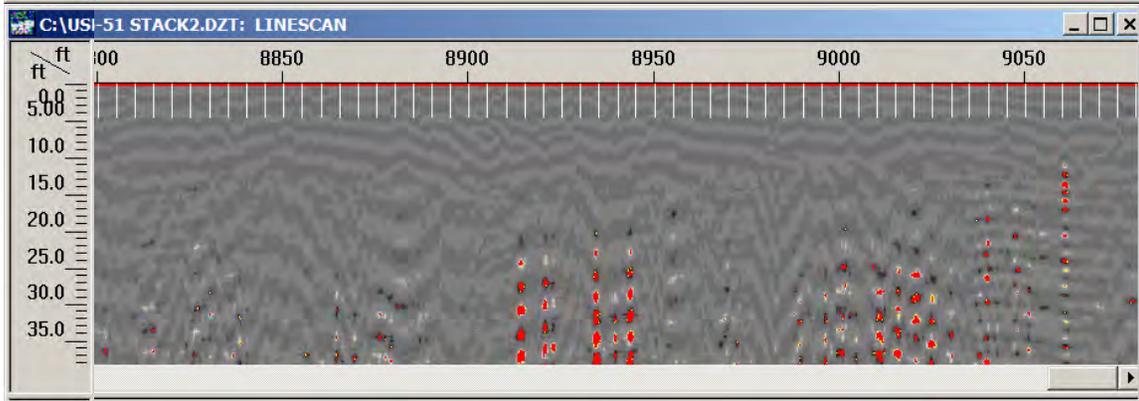
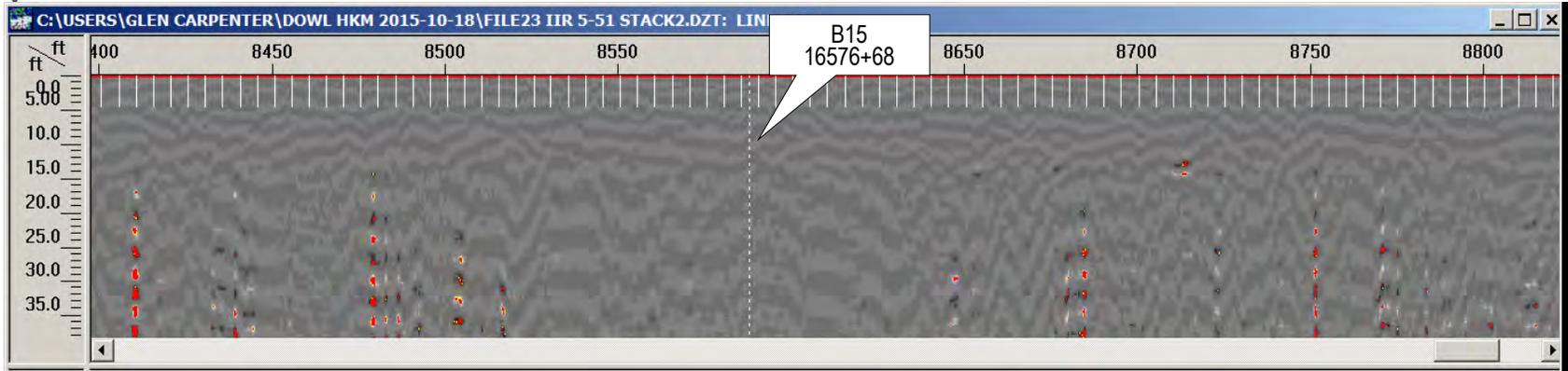
SOUTH PROFILE



SOUTH PROFILE



SOUTH PROFILE



APPENDIX F

GEO TECHNICAL BORING LOCATION PHOTOGRAPHS



Boring B-1 Location – View East



Boring B-1 Location – View Southwest



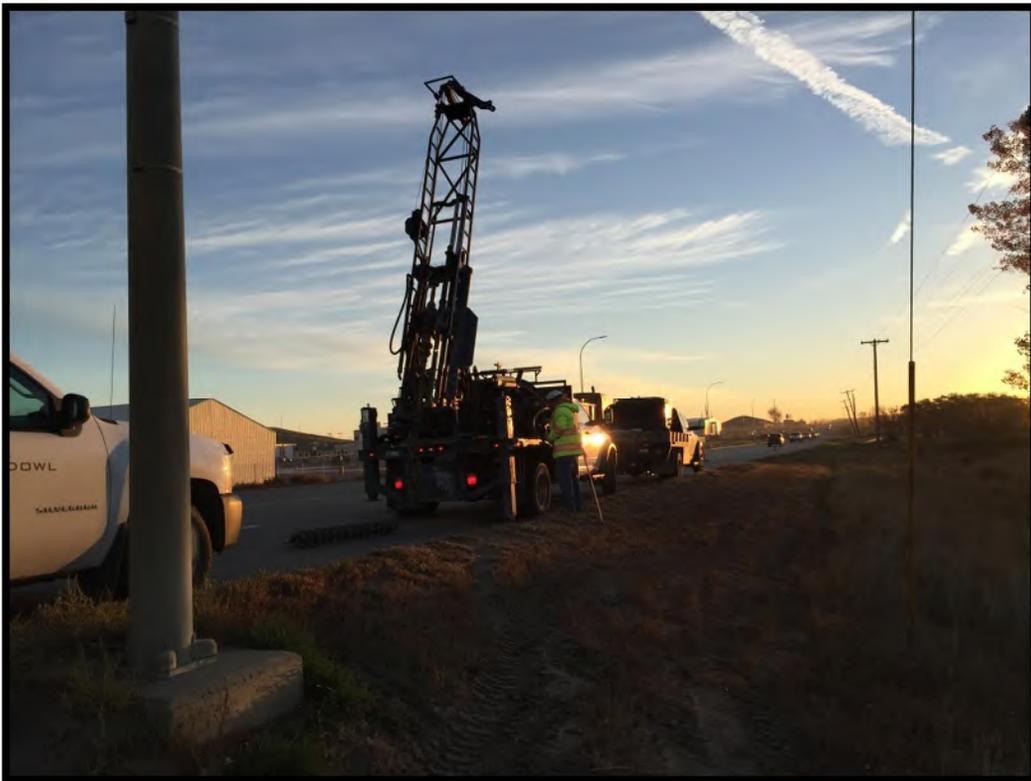
Drilling Boring B-1 – View East



Boring B-1A Location – View East



Boring B-1 Location – View West



Drilling Boring B-1 – View East



Boring B-2 Location – View East



Boring B-2 Location – View West



Drilling Boring B-2 – View East



Boring B-3 Location – View West



Boring B-3 Location – View East



Drilling Boring B-3 – View Northeast



Boring B-4 Location – View East



Boring B-4 Location – View West



Drilling Boring B-4 – View East



Boring B-5 Location – View West



Boring B-5 Location – View East



Drilling Boring B-5 – View East



Boring B-5A Location – View West



Boring B-5A Location – View East



Drilling Boring B-5A – View East



Boring B-6 Location – View West



Drilling Boring B-6 – View East



Boring B-7 Location – View East



Boring B-7 Location – View West



Drilling Boring B-7 – View East



Boring B-8 Location – View Southeast



Boring B-8 Location – View Southwest



Drilling Boring B-8 – View South



Boring B-9 Location – View North



Boring B-9 Location – View East



Drilling Boring B-9 – View North



Boring B-10 Location – View East



Boring B-10 Location – View West



Drilling Boring B-10 – View South



Boring B-11 Location – View East



Boring B-11 Location – View West



Drilling Boring B-11 – View Northeast



Boring B-12 Location – View East



Boring B-12 Location – View West



Drilling Boring B-12 – View Southeast



Boring B-13 Location – View West



Boring B-13 Location – View East



Drilling Boring B-13 – View North



Boring B-14 Location – View West



Boring B-14 Location – View East



Drilling Boring B-14 – View Southeast



Boring B-15 Location – View East



Boring B-15 Location – View West



Drilling Boring B-15 – View Northeast



Boring B-16 Location – View West



Boring B-16 Location – View East



Drilling Boring B-16 – View Southeast



Boring B-17 Location – View East



Boring B-17 Location – View West



Drilling Boring B-17 – View North



Boring B-18 Location – View West



Boring B-18 Location – View East



Drilling Boring B-18 – View Southeast



Boring B-19 Location – View East



Boring B-19 Location – View West



Drilling Boring B-19 – View North



Boring B-20 Location – View West



Boring B-20 Location – View East



Drilling Boring B-20 – View South



Boring B-21 Location – View East



Boring B-21 Location – View West



Drilling Boring B-21 – View North



Boring B-63 Location – View North



Boring B-63 Location – View Northwest



Drilling Boring B-63 – View East



Boring B-64 Location – View East



Boring B-64 Location – View West



Drilling Boring B-64 – View West



Boring B-64 Hard Clay Core – 94.5 to 99.5 feet



Boring B-64 Hard Clay Core – 99.5 to 104.5 feet



Boring B-76 Location – View East



Boring B-76 Location – View West



Drilling Boring B-76 – View West



Boring B-79 Location – View West



Boring B-79 Location – View East



Drilling Boring B-79 – View West



Boring B-100 Location– View North



Boring B-100 Location – View Northwest



Drilling Boring B-100 – View West



Boring B-103 Location – View West



Boring B-103 Location – View East



Drilling Boring B-103 – View South

APPENDIX G

GEOSYNTHETIC STABILIZATION FABRIC INFORMATION

CULVERT SETTLEMENT CALCULATIONS

APPENDIX G

GEOSYNTHETIC STABILIZATION FABRIC INFORMATION

GEOSYNTHETICS USED IN SUBGRADE STABILIZATION

Prepared by:

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July, 2013

General

This document is prepared to help ensure the geosynthetic soil reinforcement, once installed, will perform its intended design functions. To do so, the geosynthetic must be identified, handled, stored and installed in such a way that its physical property values are not affected and the design conditions are ultimately met as intended. This document does not account for every possible construction scenario. However, this document contains information consistent with generally accepted practices of identifying, handling, storing and installing geosynthetic materials for most roadway applications. If you have questions regarding a specific project or encounter conditions other than those described herein, call 888-795-0808. Failure to follow these guidelines may result in the unnecessary failure of the geosynthetic in a properly designed application.

Material Identification, Storage and Handling

The geosynthetic shall be rolled on cores having strength sufficient to avoid collapse or other damage from normal use. Each roll shall be wrapped with a plastic covering to protect the geosynthetic from damage during shipping and handling. Each roll shall be identified with a durable gummed label or the equivalent, clearly legible on the outside of the roll wrapping. The label shall indicate the manufacturer's name, the style number and the roll number.

Upon delivery, check the TenCate Mirafi® geosynthetic roll labels to verify the correct product has been received. Immediately inspect the geosynthetic to ensure it is free of any flaws or damage that might have occurred during shipping or handling.

While unloading or transferring the geosynthetic from one location to another, prevent damage to the wrapping, core, label or the geosynthetic itself. If the geosynthetic is to be stored for an extended period of time, the geosynthetic shall be located and placed in a manner that ensures the integrity of the wrapping, core and label as well as the physical properties of the geosynthetic. This can be accomplished by elevating the geosynthetic off the ground on dunnage and ensuring that it is adequately covered and protected from ultraviolet radiation, chemicals that are strong acids or strong bases, fire or flames including welding sparks, temperatures in excess of 140° F (60° C), and human or animal destruction.

Geosynthetic Placement and Overlap



Image 1 – Subgrade Preparation

Clear, grub and excavate (as required) to the plan subgrade or undercut elevation, stripping topsoil, deleterious debris and unsuitable material from the site. Cut stumps and other projecting vegetation as close and even to the ground surface as practical. Specialized equipment with low ground pressure, as directed by the Engineer, may be required for very soft soils ($CBR \leq 1.5\%$) to minimize subgrade disturbance. In addition, it may also be beneficial to leave root mats in place in such instances. The surface of the subgrade should be relatively smooth and level (Image 1), and depressions or humps greater than 6 inches (15 cm) should be graded out (i.e., back bladed/back dragged).

The geosynthetic reinforcement shall be placed directly on the prepared subgrade (Image 2). It should be rolled out flat and tight with no folds or wrinkles. Unroll the geosynthetic in the direction of travel so that the machine direction (i.e., long axis) of the roll is parallel with channelized traffic patterns. Adjacent rolls should be overlapped along their sides and ends as a function of subgrade strength as follows:



Image 2 – Geosynthetic Deployment

CBR $\geq 3\%$	12" to 18" (30-45 cm) overlap
$1\% \leq CBR < 3\%$	24" to 36" (60-90 cm) overlap
$0.5\% \leq CBR < 1\%$	36" (90 cm+) or Sewn*
CBR $< 0.5\%$	Sewn*

* Please contact your local TenCate Geosynthetics representative for recommended sewing practices.

If the need for 40" inches (1M) of overlap is reached, it is strongly suggested that the overlap is sewn or otherwise adhered to limit the potential formation of a slip plane between the overlapped panels. *Note: very heavy loading and very soft subgrades will also warrant sewn seams instead of overlapping panels.* Prior to fill placement, the geosynthetic can be held in place using U-shaped sod staples or simply by strategically placing shovelfuls of the fill to weigh down the geosynthetic. Overlap ("shingle") the geosynthetics in the direction fill will be spread to avoid peeling-back of the geosynthetic at overlaps by the advancing fill, just as shingles on a roof are installed to prevent water flowing beneath the adjacent row of shingles below.

Cut and overlap the geosynthetic to accommodate curves. Cutting may be done with sharp shears, razor knives or handheld power (i.e., "cutoff") saws. Cut the geosynthetic to conform to immovable protrusions, such as manhole covers and vertical utilities.

Fill Placement

Aggregate fill, as specified, should be placed directly over the geosynthetic in 8 - 12 (20-30 cm) inch loose lifts. Typically, if the design section thickness is ≤ 16 inches (40 cm), the entire section should be placed and compacted in one single lift to minimize further degradation of the subgrade.



Image 3 – End dumping aggregate

On relatively competent subgrades (CBR $\geq 4\%$), standard, highway-legal, rubber-tired vehicles (end dumps and belly dumps) may be driven over the exposed geosynthetic at slow speeds (less than 5 mph [8 km/hr]), and in straight paths. These vehicles can dump aggregate fill as they advance, provided this construction traffic will not cause significant rutting upon bare subgrade. Sudden braking, sudden starting and sharp turning should be avoided. Tracked construction equipment must not be operated directly upon the exposed geosynthetic. A minimum aggregate fill thickness of 6 inches (15 cm) is required

prior to operation of tracked equipment on the geosynthetic. In addition, turning of tracked equipment should be kept to a minimum to prevent tracks from displacing the fill and damaging the geosynthetic.

Over softer subgrades (CBR < 4%), aggregate fill should be end-dumped from the edge of the previously placed material (Image 3), spreading from the middle outward (Image 4).

Compaction

Standard compaction methods may be used unless the soils are very soft (CBR ≤ 1.5%). In such cases, static compaction with a light smooth drum roller is considered prudent (Image 5).

Once a stable working platform has been achieved, compact aggregate fill to project specifications, after it has been graded smooth and before it is subjected to accumulated traffic.

Aggregate Fill Considerations

Preferred (not required) fill gradation for roadway applications is well-graded crushed aggregate fill with a maximum particle size of 1½ inches (40 mm) and less than 10% fines (passing #200 sieve). For unpaved applications, most clean granular fills, including sands are acceptable.

Installation and Repairs for Utility Cuts or Damaged Areas

Repairs to roadway reinforcement geosynthetics can be made in the field by placing a repair panel or patch over the damaged area. The repair panel should extend a minimum of 3 ft (0.9 m) beyond the edges of the damaged geosynthetics as shown in Image 6. Pullout and/or direct sliding calculations should be performed by the project engineer to verify the minimum required overlap length to meet a specific project's requirements.



Image 4 – Spreading aggregate over geosynthetic



Image 5 – Smooth Drum Roller

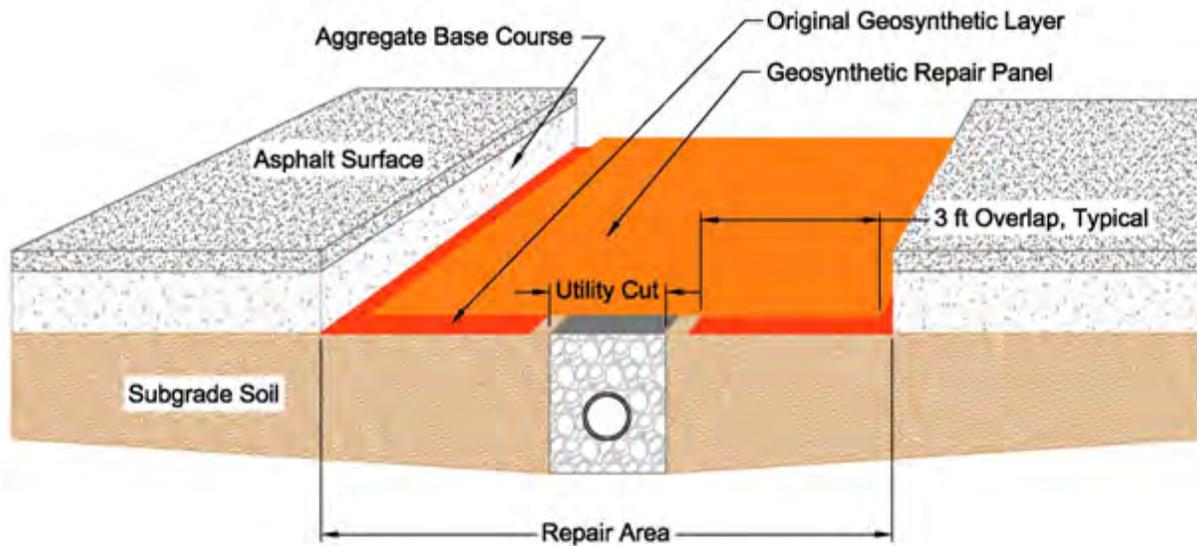


Image 6 – Typical Utility Cut Geosynthetic Repair Detail (NTS)

When placing roadway reinforcement geosynthetics in trenches or against excavations that terminate at existing curb and gutter, the geosynthetic can be wrapped up the sides of the excavation as shown in Image 7. Doing so provides extra embedment for the geosynthetic to resist pullout and sliding forces by sandwiching the material between the vertical faces of the existing materials and the newly compacted fill.



Image 7–Extending the Geosynthetic Reinforcement up a Vertical Face

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Project Name:
Project Number:

Section 31 32 19

Specification for Geotextile Used in Subgrade Stabilization/Restraint and Base Reinforcement Applications

1. GENERAL

1.1 SECTION INCLUDES

- A. Geotextile to stabilize and reinforce an aggregate cover material (subbase, base, select embankment, etc.) of an unpaved or paved roadway.

1.2 RELATED SECTIONS

- A. Section 02 50 00 - Site Remediation
- B. Section 01 89 13 - Site Preparation Performance Requirements
- C. Section 31 00 00 - Earthwork
- D. Section 32 10 00 - Bases, Ballasts, Pavements, and Appurtenances

1.3 UNIT PRICES

- A. Method of Measurement: By the square yard (or square meter - as indicated in contract documents) including seams, overlaps, and wastage.
- B. Basis of Payment: By the square yard (or square meter - as indicated in contract documents) installed.

1.4 REFERENCES

- A. AASHTO Standards:
 - 1. T088-10-UL - Particle Size Analysis of Soils
 - 2. T090-00-UL - Determining the Plastic Limit and Plasticity Index of Soils
 - 3. T099-10-UL - The Moisture-Density Relations of Soils Using a 5.5lb (2.5 kg) Rammer and a 12in (305 mm) Drop.
 - 4. M288-06 - Geotextile Specification for Highway Applications
- B. American Society for Testing and Materials (ASTM):
 - 1. D123 - Standard Terminology Relating to Textiles

2. D276 - Test Method for Identification of Fibers in Textiles
3. D422 - Standard Test Method for Particle-Size Analysis of Soils
4. D4354 - Practice for Sampling of Geosynthetics for Testing
5. D4355 - Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
6. D4439 - Terminology for Geotextiles
7. D4491 - Test Methods for Water Permeability of Geotextiles by Permittivity
8. D4595 - Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
9. D4751 - Test Method for Determining Apparent Opening Size of a Geotextile
10. D4759 - Practice for Determining the Specification Conformance of Geosynthetics
11. D4884 - Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles
12. D4873 - Guide for Identification, Storage, and Handling of Geotextiles
13. D5321 - Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
14. D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
15. D6706 - Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil

C. American Association for Laboratory Accreditation (A2LA)

D. Geosynthetic Accreditation Institute (GAI) - Laboratory Accreditation Program (LAP)

E. International Standards Organization (ISO) - 9001:2008

F. National Transportation Product Evaluation Program (NTPEP)

1.5 DEFINITIONS

A. Minimum Average Roll Value (MARV): Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing will exceed value reported.

B.

1.6 SUBMITTALS

A. Submit the following:

1. Certification: The contractor shall provide to the Engineer a certificate stating the name of the manufacturer, product name, style number, and chemical composition of the filaments or yarns and other pertinent

information to fully describe the geotextile. The Certification shall state that the furnished geotextile meets MARV requirements of the specification as evaluated under the Manufacturer's quality control program. The Certification shall be attested to by a person having legal authority to bind the Manufacturer. Certifications from Private Label distributors will not be accepted.

2. If an alternate product is submitted full scale performance testing performed by an Independent testing agency shall be provided that quantifies the structural benefit of the geotextile. The benefit must meet or exceed the benefit of the design geotextile.
3. Coefficient of Interaction (C_1) test results performed by a lab with GRI and/or A2La accreditation should be provided to confirm conformance to the specified value.
4. Manufacturer's installation Guidelines shall be provided.
5. One 1' x 1' sample shall be provided.
6. Quality Standards: The contractor shall provide to the Engineer the Manufacturer's Quality Control Plan along with their current A2LA, GAI-LAP, and ISO 9001:2008 certificates.
7. Alternate products must be submitted 15 days prior to bid date to engineer and should include information on five similar projects in size and scope.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. The geotextile Manufacturer shall have all of the following credentials:
 - a. ISO 9001:2008 Quality Management System
 - b. Geosynthetic Accreditation Institute (GAI) Laboratory Accreditation Program (LAP)
 - c. American Association for Laboratory Accreditation (A2LA)
- B. The geotextile Manufacturer shall have a GAI-LAP and A2LA accredited laboratory at the location of production capable of performing the ASTM tests as outlined in the specification.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Geotextile labeling, shipment, and storage shall follow ASTM D4873. Product labels shall be color-coded to specifically identify each product and clearly show the Manufacturer's name, style name, and roll number.
- B. Each geotextile roll shall be wrapped with a material that will protect the geotextile from damage due to shipment, water, sunlight, and contaminants.
- C. During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, excess temperatures, and any other environmental conditions that may damage the physical property values of the geotextile.

2. PRODUCTS

2.1 MANUFACTURERS

- A. TenCate Geosynthetics Americas
365 South Holland Drive
Pendergrass, GA, USA 30567
1-800-685-9990
1-706-693-2226
1-706-693-4400, fax
www.mirafi.com

2.2 MATERIALS

- A. Geotextile:
 - 1. The geotextile shall be woven from super high-tenacity polypropylene yarns with a weave pattern to maximize strength, water flow, soil interaction and soil retention. The yarns shall be from high-tenacity long-chain synthetic polymers composed of at least 95 percent by weight of polyolefins or polyesters. They shall form a stable network such that the filaments or yarns retain their dimensional stability relative to each other, including selvages.
 - 2. The geotextile shall meet the requirements of Table 1. All numeric values in Table 1 except AOS represent Minimum, MARV or Typical in the specified direction. Values for AOS represent maximum average roll values.

3. All geotextile products shall have a separation factor of 0.9 or higher per ASTM D422, Modified.

TABLE 1 - SUBGRADE STABILIZATION GEOTEXTILE

Performance Properties	Test Method	Unit	Typical Roll Value	Minimum Average Roll Value
Tensile Modulus @ 2% strain (CD)	ASTM D4595	lbs/ft (kN/m)	108,000 (1576)	90,000 (1313)
Tensile Modulus @ 5% strain (CD)	ASTM D4595	lbs/ft (kN/m)	100,800 (1471)	87,600 (1279)
Flow Rate	ASTM D4491	gal/min/ft ² (l/min/m ²)	90 (3667)	75 (3056) ³
Permittivity	ASTM D4491	sec ⁻¹	1.2	1.0 ³
Pore Size 0 ₉₅	ASTM D6767	microns	350	
Pore Size 0 ₅₀	ASTM D6767	microns	185	
Interaction Coefficient ¹	ASTM D5321	--		0.9 ³
Index Properties	Test Method	Unit	Typical Roll Value	Minimum Average Roll Value
Apparent Opening Size (AOS)	ASTM D4751	U.S Sieve (mm)	50 (0.30)	40 (0.425) ²
Factory Seam Strength	ASTM D4884	lbs/ft (kN/m)		3000 (43.8) ³
UV Resistance (at 500 hours)	ASTM D4355	% strength retained		90 ³

¹ Interaction Coefficient value is for sand or gravel based on testing conducted by SGI Testing Services.

² ASTM D4751: AOS is a Maximum Opening Diameter Value

³ Minimum Test Value

When sewn seams are required refer to **Section 3 - Execution**.

4. Approved geotextiles are as follows:

Mirafi® RS580i

2.3 QUALITY CONTROL

- A. Manufacturing Quality Control: Testing shall be performed at an on-site laboratory accredited by GAI-LAP and A2LA for tests required for the geotextile, at frequency meeting or exceeding ASTM D4354.
- B. Manufacturer's certifications and testing of quality assurance samples obtained using Procedure B of ASTM D4354. A lot size for conformance or quality assurance sampling shall be considered to be the shipment quantity of the given product or a truckload of the given product, whichever is smaller.

3. EXECUTION

- 3.1** See Manufacturer's Installation guidelines provided in the submittal.

END OF SECTION

Mirafi[®] RS580*i*



This is to certify that Mirafi[®] RS580*i* is a revolutionary geotextile created from super high-tenacity polypropylene filaments formed into an innovative weave to provide superior reinforcement strength and soil interaction integrated with high water flow and soil retention capabilities.

TenCate Geosynthetics Americas quality control testing laboratories are accredited by a2La (The American Association for Laboratory Accreditation) and Geosynthetic Accreditation Institute Laboratory Accreditation Program (GAI-LAP).

Performance Properties	Test Method	Unit	Typical Roll Value	Minimum Average Roll Value
Tensile Modulus @ 2% strain (CD)	ASTM D4595	lbs/ft (kN/m)	108,000 (1576)	90,000 (1313)
Tensile Modulus @ 5% strain (CD)	ASTM D4595	lbs/ft (kN/m)	100,800 (1471)	87,600 (1279)
Flow Rate	ASTM D4491	gal/min/ft ² (l/min/m ²)	90 (3667)	75 (3056) ³
Permittivity	ASTM D4491	sec ⁻¹	1.2	1.0 ³
Pore Size O ₉₅	ASTM D6767	microns	350	
Pore Size O ₅₀	ASTM D6767	microns	185	
Interaction Coefficient ¹	ASTM D5321	--		0.9 ³
Index Properties	Test Method	Unit	Typical Roll Value	Minimum Average Roll Value
Apparent Opening Size (AOS)	ASTM D4751	U.S Sieve (mm)	50 (0.30)	40 (0.425) ²
Factory Seam Strength	ASTM D4884	lbs/ft (kN/m)	3000 (43.8) ³	
UV Resistance (at 500 hours)	ASTM D4355	% strength retained	90 ³	

¹ Interaction Coefficient value is for sand or gravel based on testing conducted by SGI Testing Services.

² ASTM D4751: AOS is a Maximum Opening Diameter Value

³ Minimum Test Value

Physical Properties	Unit	Roll Sizes	
Roll Dimensions (width x length)	ft (m)	15 x 300 (4.6 x 91)	17 x 300 (5.2 x 91)
Roll Area	yd ² (m ²)	500 (418)	567 (474)

Interaction Coefficient (ASTM D6706) is not covered by our current A2LA accreditation.

U.S. Patent 8,333,220 and 8,598,054

TenCate, Mirafi, and the color ORANGE used in connection with geosynthetic or geotextile products are registered and/or unregistered trademarks of Nicolon Corporation.

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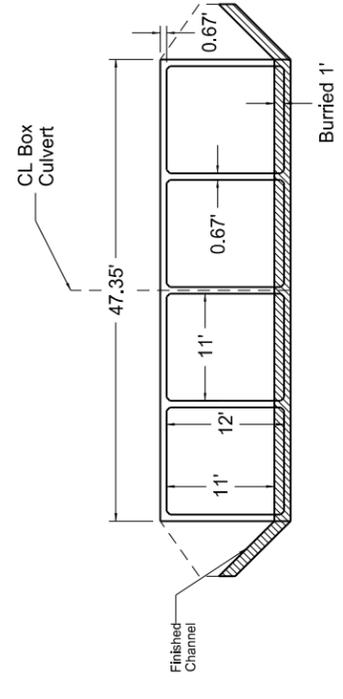
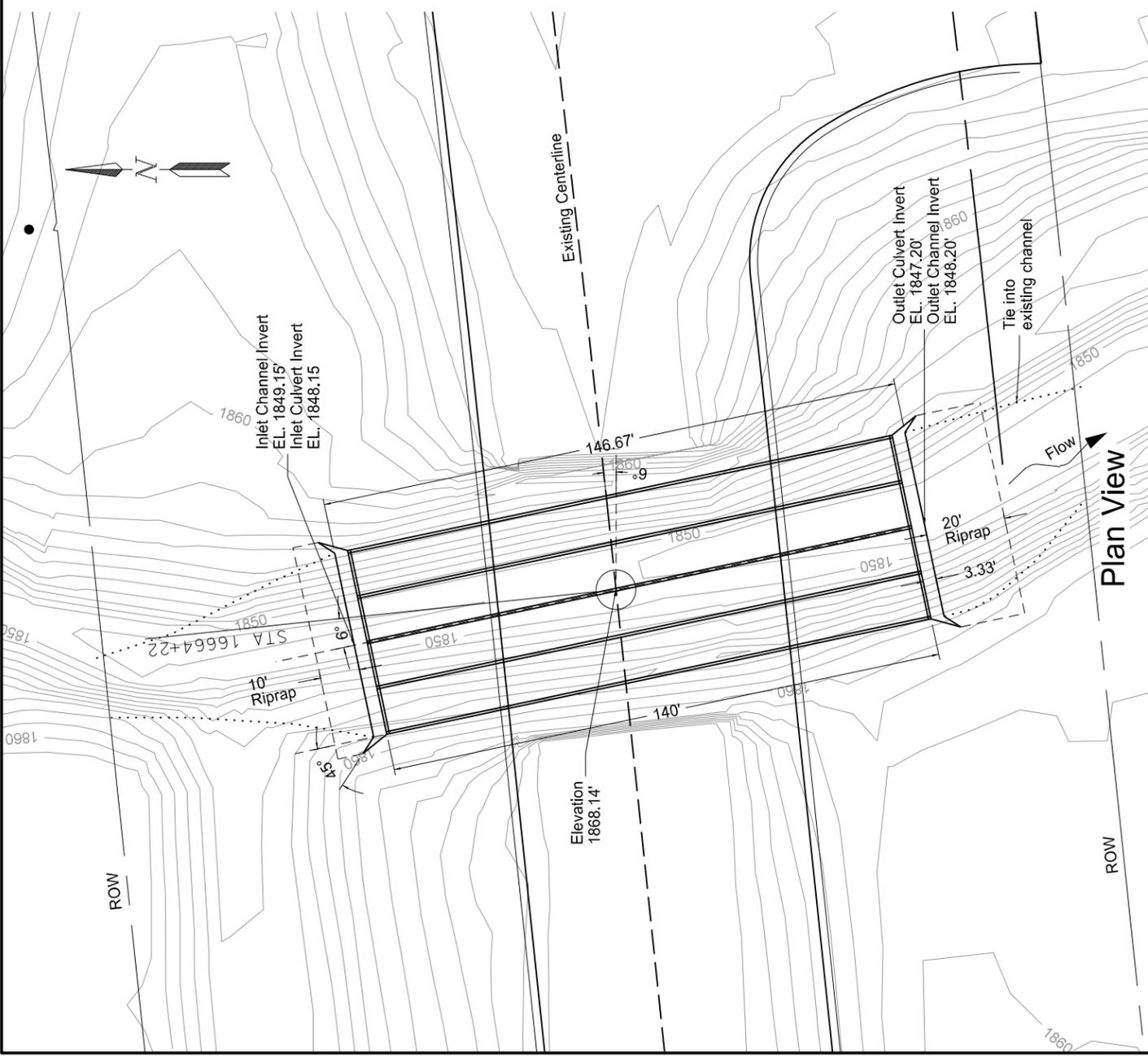
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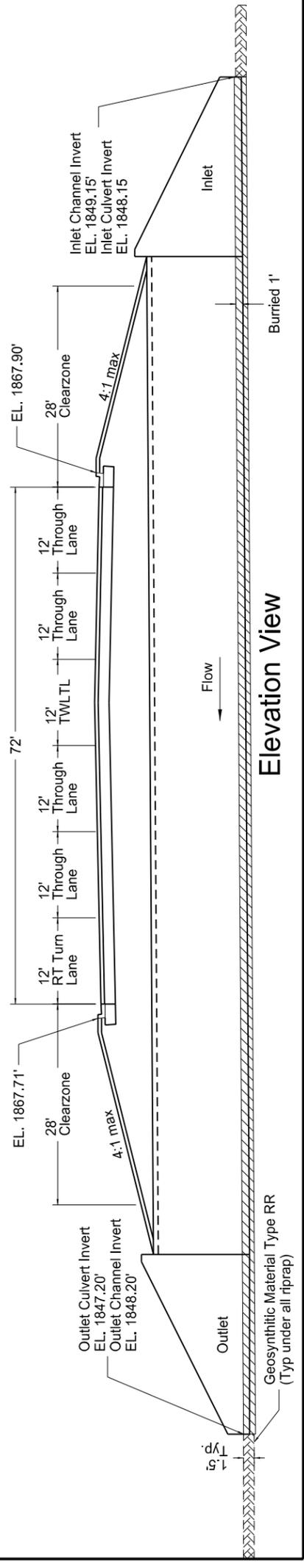
APPENDIX G

CULVERT SETTLEMENT CALCULATIONS

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	SS-7-804(055)304		



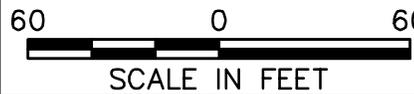
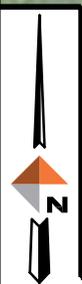
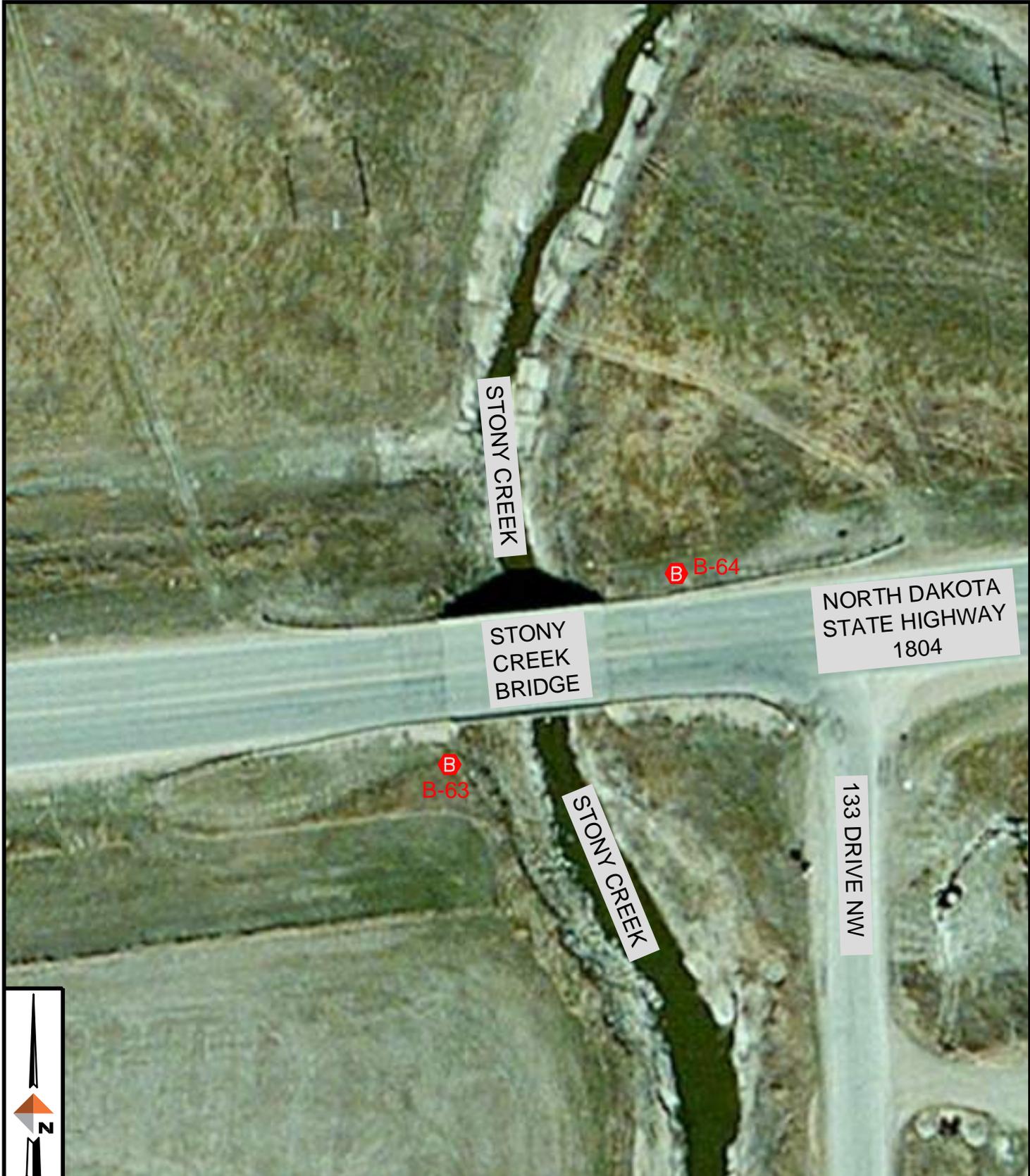
End View



Elevation View

ND 1804 Reconstruction
Stony Creek Box Culvert Alternative 1
Figure 6

Q:\24\20997\Slope Stability\Stoney Creek Bridge\Stoney Creek Bridge Boring Location Map.dwg PLOT DATE 2015-11-06 15:17 SAVED DATE 2015-11-06 15:17 USER: abarrick



LEGEND

B B-63 GEOTECHNICAL BORING LOCATION

DOWL
[WWW.DOWL.COM](http://www.dowl.com)
 2090 Stadium Drive
 Bozeman, Montana 59715
 406-586-8834

NORTH DAKOTA 1804 RECONSTRUCTION
 STONY CREEK BRIDGE
 GEOTECHNICAL BORING LOCATION MAP

PROJECT	6024.20997.01
DATE	11/06/2015

FIGURE #1



LOG OF BORING

Boring B-63

Top of Final Fill 1866.9

SW Bridge abutment Sheet 1 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50 Hammer: Auto	Boring Location N: 433309.5 ft Coordinates E: 1218654.51 ft	Station: 16664 + 74 Offset: 58 ft L
Project Number: 7-804(055)304	UPN:	Boring Diameter: 6"	System: Local Coordinates Datum: NAD83	Top of Boring Elevation: 1861.3 ft
Date Started: 10/22/15	Date Finished: 10/22/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Jared Zak Logger: David Barrick		Abandonment Method: Backfilled with Cuttings	Township, Range, and Section: 154N 100W 20 - C	

(2) MDT LOG OF BORING - MDT, REVISED 2009-HCPT, IMPORT, GDT - 12/21/15 1:53:36 - Q:\2423097\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Depth (ft) Elev. (ft)	Operation Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
0.3 1861.0	X	53		3-4-4	TOPSOIL, Sandy Lean CLAY (CL), Boulders, moist to wet, black.								
20.3 1856.3	X	20		3-3-2	Sandy Lean CLAY (CL), medium stiff to soft, moist to wet, brown, [A-7]. organic roots and occasional gravel, cobbles and boulders.								
40.3 1856.3	X	40		2-2-2	Clayey SAND (SC), very loose, moist to wet, brown, fine grained, [A-2].								
53.3 1852.9	X	53		1-1-1	Silty SAND (SM), very loose to loose, moist to wet, brown, medium grained, [A-3].								
60.3 1851.3	X	60		WH-1-1									
60.3 1847.3	X	60		3-2-4									
73.3 1846.3	X	73		2-3-4	Poorly-Graded SAND (SP), loose, wet, brown, fine to coarse grained, [A-2].								Stream bottom Down Abutment 1847.3
18.2 1843.1	X	60		3-3-6	Clayey GRAVEL with sand (GC), loose, wet, gray, fine to coarse grained, subrounded to subangular, [A-2].								
19.5 1841.8	X	47		3-3-2	Poorly-Graded SAND with gravel (SP), loose, wet, gray, fine to coarse grained, subrounded to rounded, [A-2].								
22.0 1839.3	X				Fat CLAY (CH), soft, moist, gray, [A-7].								
25.3 1836.3	X	93		2-1-3									
30.0 1831.3	X	100			Fat CLAY (CH), soft to medium stiff, moist, dark gray to brown, [A-7]. dark green with gray mottling at 44.5 feet.		33	65	18	89	92		UCS: 1,474 ksf Direct Shear: 14.0 deg Cohesion: 0.267 ksf
35.3 1826.3	X	100		1-2-1									

Water Level Observations	<input checked="" type="checkbox"/> During Drilling: 13.5 ft (1847.8 ft) <input type="checkbox"/> After Drilling: 0	Remarks:
--------------------------	--	----------



LOG OF BORING

Boring B-63

Sheet 2 of 3

Project: ND 1804 Reconstruction		Rig: Diedrich D-50	Boring Location N: 433309.5 ft	Station: 16664 + 74
Project Number: 7-804(055)304		Hammer: Auto	Coordinates E: 1218654.51 ft	Offset: 58 ft L
UPN:		Boring Diameter: 6"	System: Local Coordinates	Top of Boring Elevation: 1861.3 ft
Date Started: 10/22/15	Date Finished: 10/22/15	Drilling Fluid: None	Location Source: Handheld GPS, Uncorrected	Elevation Source: Plans
Driller: Jared Zak		Abandonment Method: Backfilled with Cuttings		Township, Range, and Section: 154N 100W 20 - C
Logger: David Barrick				

(2) MDT LOG OF BORING - MDT REVISED 2009+(OPT. IMPORT) GDT - 12/24/15 15:36 - C:\242097\BORING LOGS\1804 RECONSTRUCTION - CENTERLINE SOIL SURVEY LOGS.GPJ

Depth (ft) Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
40 1821.3			120		1-2-1									
45 1816.3			120		2-3-2									
50 1811.3			87		14-19-21		Poorly-Graded GRAVEL with sand (GP), dense, wet, brown to gray, fine to coarse grained, rounded to subrounded, [A-1]. intermittent 2 to 3 inch thick silty sand layers.	48.0 1813.3						
55 1806.3			80		6-9-11		Silty SAND (SM), medium dense, moist, gray to black, medium grained, [A-3]. coal fragments.	54.0 1807.3						
60 1801.3			100		6-11-15		Fat CLAY (CH), very stiff to hard, moist, bluish gray to black, [A-7]. black lignite layering.	58.0 1803.3						
65 1796.3			93		13-20-29									
70 1791.3			93		12-22-31				17	64	20	100	113	UCS: 13.9 ksf

Water Level Observations		<input checked="" type="checkbox"/> During Drilling: 13.5 ft (1847.8 ft)	Remarks:
<input checked="" type="checkbox"/> After Drilling: 0		<input checked="" type="checkbox"/> After Drilling: 0	

COMPUTATIONS		Project #: 602011
Client Name: HODOT		Sheet <u>2</u> of <u>2</u>
Prepared by: [Signature]	Date: [Date]	Checked by: [Signature]
		Date: [Date]

Project Name: 1952 - Stony Creek

Calculate potential Settlement Under Stony Creek Box Culvert

Assume No Consolidation tests were performed on Fat Clay.

$C_c = 0.3$

7' of Engineered fill above box culvert

Ground = 122.36 feet

fat clay

↳ Dry unit weight = 92 pcf

$\gamma = 132 pcf$

$72 \times 132 = 9504$
pcf

Parameters of Box Culvert

Total length = 3,554,480 pounds

width (B) = 48'

Length (L) = 147'

pressure at bottom of box culvert = $\frac{3,554,480 \text{ lbs}}{48' \times 147'} = 503.75 \text{ psf}$

Bottom E.L. of Box Culvert = 1,846.6 feet

Water height

Fat Clay Layer Extends from Elevation 1,846.6 to 1,813.3 feet

↳ middle of Fat Clay = 16.65 feet

↳ Depth = 33.3 feet

Consolidation Equation From Bowles

$$\Delta H = \frac{H \times C_c}{(1 - C_c)} \log \left(\frac{p_0' + \Delta p}{p_0'} \right)$$

$H = 33.3 \text{ feet}$

$C_c = 0.3$

$C_o = 1.027$ (assumed)

$p_0' = \text{effective stress at } 16.65 \text{ feet} = (122.36 \text{ pcf} + 92 \text{ pcf})(16.65 \text{ feet})$
 $= 1998.3 \text{ pcf}$

$\Delta p = \text{Increased stress at } 16.65' \text{ below culvert.}$

⇒ Next Page

COMPUTATIONS		Project #: <u>62134</u>
Client Name: <u>1225</u>		Sheet <u> </u> of <u> </u>
Prepared by: <u> </u>	Date: <u> </u>	Checked by: <u> </u>
		Date: <u> </u>

Project Name: 1665 - 1665 - 1665

Cont.

Δp : Increased stress at 16.65' below bar column.

7 feet of Enginered Fill above column.

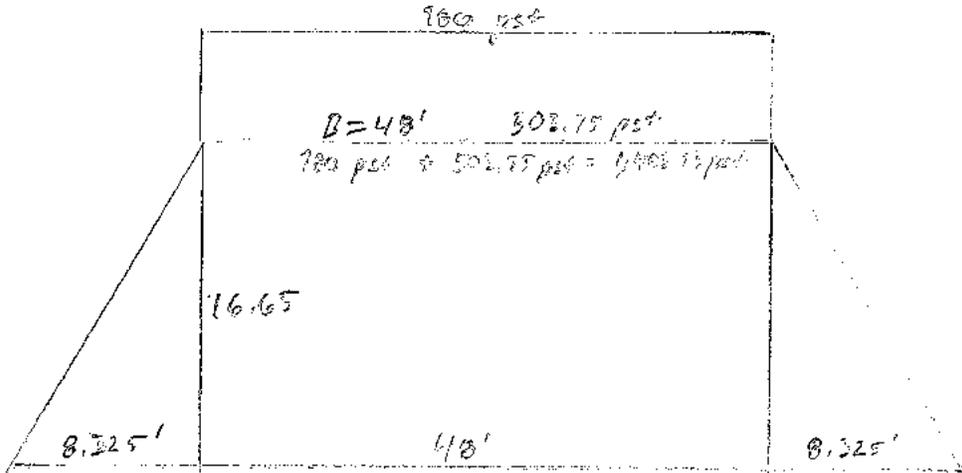
↳ stress at column at Enginered Fill (top of column)

150' Enginered fill weighs 140 pcf

140 pcf x 7 feet = 980 pcf

Reason this weight transfer to bottom of column

190 pcf + 302.75 pcf = 492.75 pcf



New pcf with load at 16.65' below column = $492.75 \text{ pcf} \left(\frac{10'}{64.65} \right) = 1,101.62 \text{ pcf}$

$\Delta p = 1,101.62 \text{ pcf}$

$$\Delta H = \frac{H \times C_c}{(1 + e_0)} \times \log \left(\frac{p_{20} + \Delta p}{p_{10}} \right)$$

$$\Delta H = \frac{333 \times 0.2}{(1 + 1.022)} \times \log \left(\frac{(1,432.04 \text{ pcf} + 1,101.62 \text{ pcf})}{1,429.04 \text{ pcf}} \right)$$

$$\Delta H = 4.928 \times 0.2469 = 1.22 \text{ feet} = \underline{14.6 \text{ inches}}$$

File Name: Stony Creek Box Culvert Settlement Placed on Loose Sand.gsz

Date: 12/28/2015

Kind: SIGMA/W

Name: Insitu

Method: Insitu

Initial PWP: Water Table

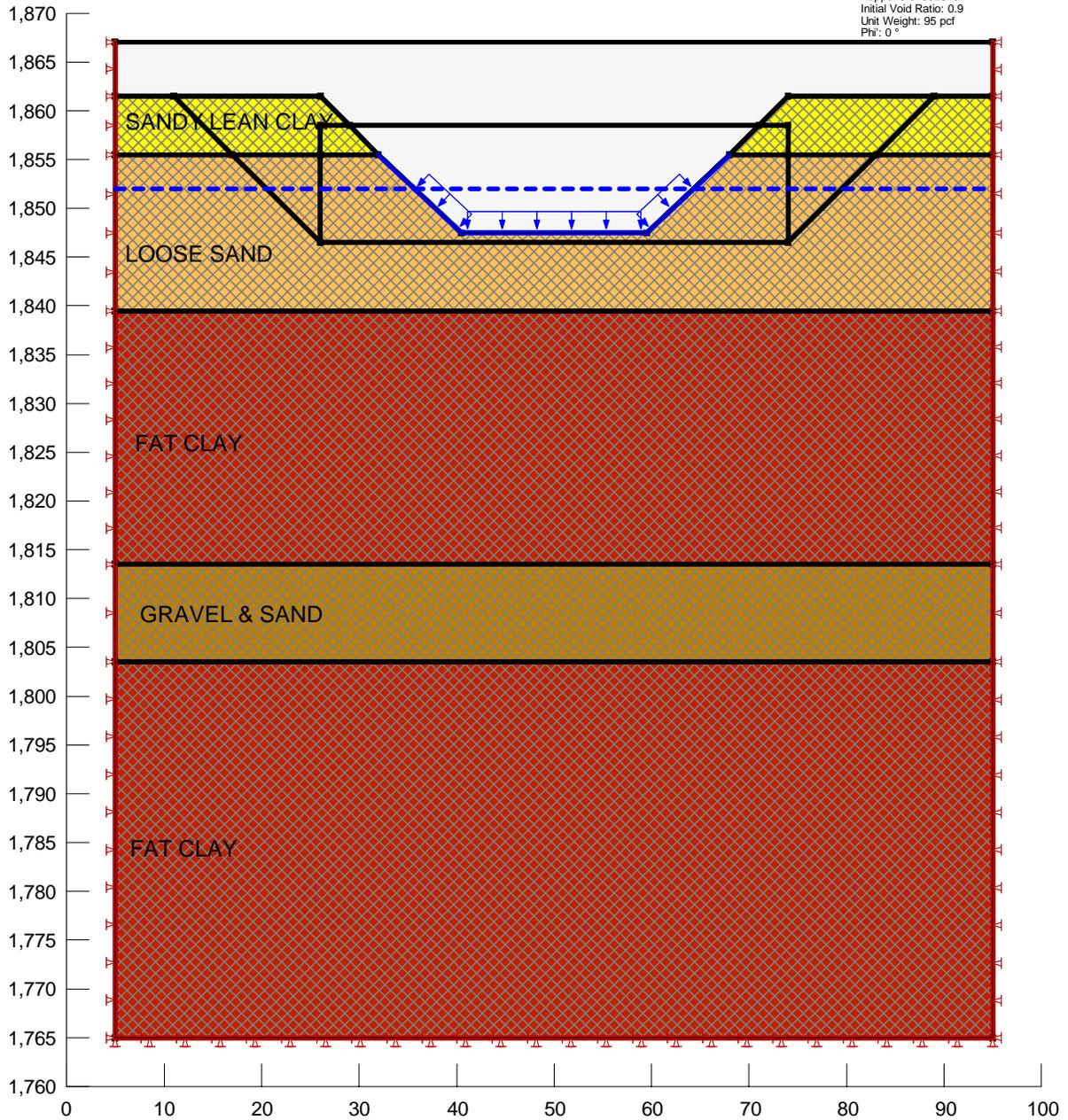
Duration: 0 days

Name: Fat Clay
Model: Soft Clay (MCC w/ PWP Change)
O.C. Ratio: 1
Poisson's Ratio: 0.3
Insitu Ko: 0.42857143
Lambda: 0.13026487
Kappa: 0.013026487
Initial Void Ratio: 1.027
Unit Weight: 92 pcf
Phi: 0°

Name: Gravel and Sand
Model: Linear Elastic (w/ PWP Change)
Effective Young's Modulus (E): 864,000 psf
Unit Weight: 120 pcf
Poisson's Ratio: 0.3
Insitu Ko: 0.42857143

Name: Loose Sand
Model: Linear Elastic (w/ PWP Change)
Effective Young's Modulus (E): 132,000 psf
Unit Weight: 105 pcf
Poisson's Ratio: 0.3
Insitu Ko: 0.42857143

Name: Sandy Lean Clay
Model: Soft Clay (MCC Effective)
O.C. Ratio: 1
Poisson's Ratio: 0.3
Insitu Ko: 0.42857143
Lambda: 0.140686
Kappa: 0.013026487
Initial Void Ratio: 0.9
Unit Weight: 95 pcf
Phi: 0°



File Name: Stony Creek Box Culvert Settlement Placed on Loose Sand.gsz
 Date: 12/28/2015
 Kind: SIGMA/W
 Name: Coupled Stress/PWP - Culvert Install
 Method: Coupled Stress/PWP
 Initial PWP: Parent Analysis
 Duration: 2 days
 Settlement: 0.632 inches
 Culvert Installation Only

Model: Linear Elastic (Total)
 Young's Modulus (E): 1,000,000 psf
 Unit Weight: 42 pcf
 Poisson's Ratio: 0.3

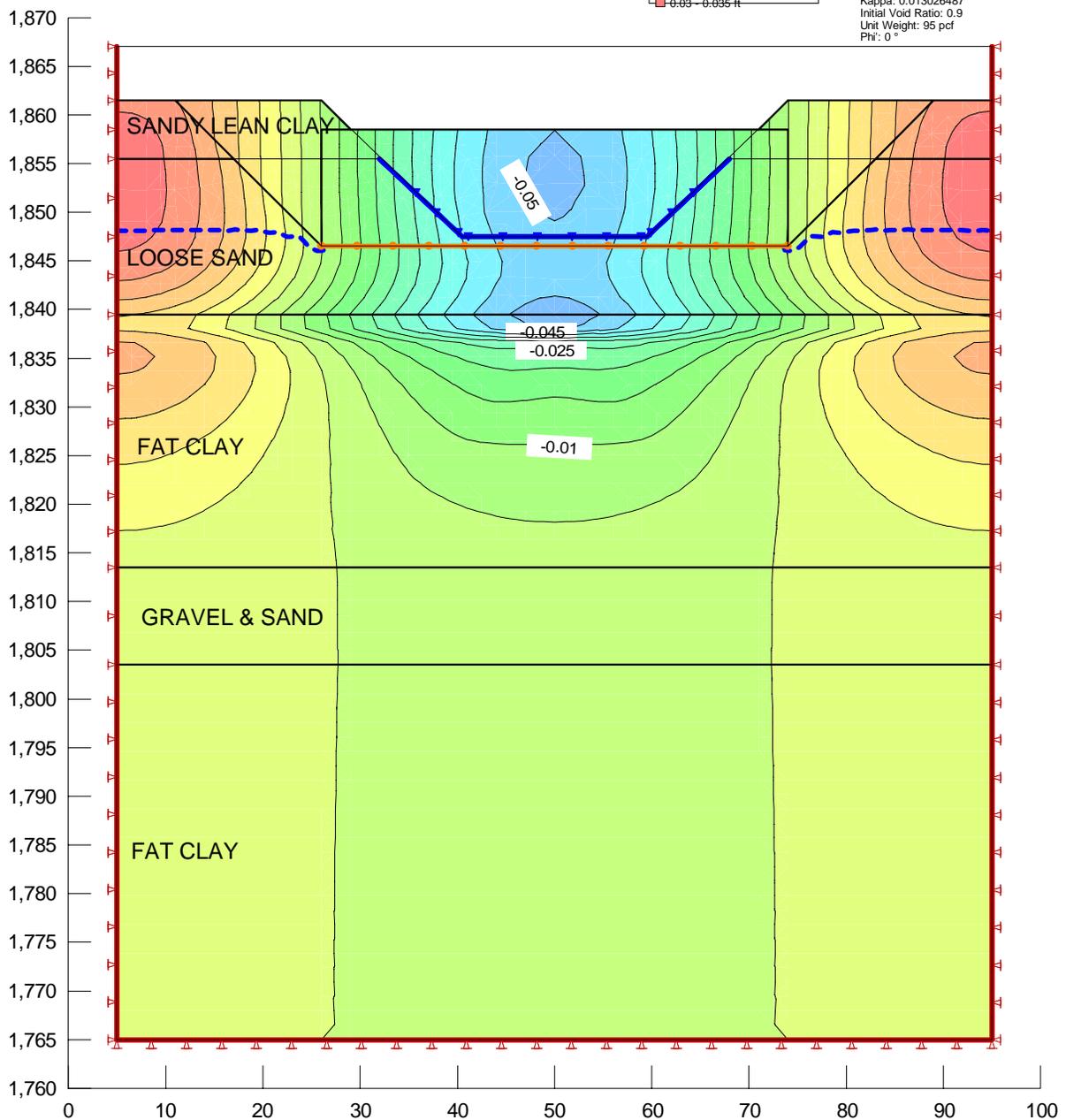
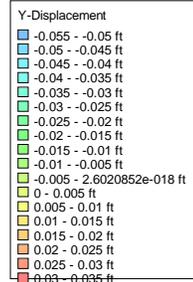
 Name: Box Culvert Engineered Fill
 Model: Linear Elastic (Effective)
 Effective Young's Modulus (E): 800,000 psf
 Unit Weight: 140 pcf
 Poisson's Ratio: 0.3

 Name: Fat Clay
 Model: Soft Clay (MCC w/ PWP Change)
 O.C. Ratio: 1
 Poisson's Ratio: 0.3
 Lambda: 0.13026487
 Kappa: 0.013026487
 Initial Void Ratio: 1.027
 Unit Weight: 92 pcf
 Phi: 0°

 Name: Gravel and Sand
 Model: Linear Elastic (w/ PWP Change)
 Effective Young's Modulus (E): 864,000 psf
 Unit Weight: 120 pcf
 Poisson's Ratio: 0.3

 Name: Loose Sand
 Model: Linear Elastic (w/ PWP Change)
 Effective Young's Modulus (E): 132,000 psf
 Unit Weight: 105 pcf
 Poisson's Ratio: 0.3

 Name: Sandy Lean Clay
 Model: Soft Clay (MCC Effective)
 O.C. Ratio: 1
 Poisson's Ratio: 0.3
 Lambda: 0.140686
 Kappa: 0.013026487
 Initial Void Ratio: 0.9
 Unit Weight: 95 pcf
 Phi: 0°



File Name: Stony Creek Box Culvert Settlement Placed on Loose Sand.gsz

Date: 12/28/2015

Kind: SIGMA/W

Name: Coupled Stress/PWP

Method: Coupled Stress/PWP

Initial PWP: Parent Analysis

Duration: 728 days

Settlement: 7.979 inches

Fill Placed Over Culvert

Name: Box Culvert
 Model: Linear Elastic (Total)
 Young's Modulus (E): 1,000,000 psf
 Unit Weight: 42 pcf
 Poisson's Ratio: 0.3

Name: Box Culvert Engineered Fill
 Model: Linear Elastic (Effective)
 Effective Young's Modulus (E): 800,000 psf
 Unit Weight: 140 pcf
 Poisson's Ratio: 0.3

Name: Fat Clay
 Model: Soft Clay (MCC w/ PWP Change)
 O.C. Ratio: 1
 Poisson's Ratio: 0.3
 Lambda: 0.13026487
 Kappa: 0.013026487
 Initial Void Ratio: 1.027
 Unit Weight: 92 pcf
 Phi: 0°

Name: Gravel and Sand
 Model: Linear Elastic (w/ PWP Change)
 Effective Young's Modulus (E): 864,000 psf
 Unit Weight: 120 pcf
 Poisson's Ratio: 0.3

Name: Loose Sand
 Model: Linear Elastic (w/ PWP Change)
 Effective Young's Modulus (E): 132,000 psf
 Unit Weight: 105 pcf
 Poisson's Ratio: 0.3

Name: Sandy Lean Clay
 Model: Soft Clay (MCC Effective)
 O.C. Ratio: 1
 Poisson's Ratio: 0.3
 Lambda: 0.140686
 Kappa: 0.013026487
 Initial Void Ratio: 0.9
 Unit Weight: 95 pcf
 Phi: 0°

