Indiana Department of Transportation

Materials and Tests Division

120 South Shortridge Road P. O. Box 19389
Indianapolis, Indiana 46219-0389
Phone: (317) 610-7251 Fax: (317) 356-9351

December 18, 2003

Mr. Gary Mroczka, Chief
Division of Design
Room N642 - IGCN

Attention: Ms. Hollie Pratt

Subject: Des No: 9738260
Geotechnical Investigation – In House
New Bridge Construction
Structure No: 641-84-8397
Project No: STP – 291 - 1 (005)
Proposed SR 641 over Woodsmall Drive
in Vigo County

Gentlemen:

The subject project involves construction of a single Span twin-bridge structure over Woodsmall Drive for the North and Southbound SR 641. Mechanically Stabilized Earth Walls (MSE) will be built along the north and south abutments. The proposed bridge is located on Line "CX" at Station 6+370.

Six structure borings and six retaining wall borings with split spoon sampling were done during the field investigation. A boring log was prepared for each boring which shows soil classifications and stratification as well as other pertinent data. Copies of the boring logs, laboratory results and Boring Location Plan are transmitted with the report.

The following are the recommendations of the INDOT Geotechnical Section.

BRIDGE STRUCTURE

Based on the soil conditions encountered in soil borings TB-1, TB-2, TB-3, TB-4, TB-5 & TB-6, we recommend that the new bridge structures should be supported on HP steel piles at both bents driven into sound bedrock. We estimate that Steel HP piles could develop design loads of 356 kN, 490 kN & 622 kN with ultimate loads of 712 kN, 980 kN & 1244 kN at refusal into shale bedrock. The boring logs show that sandstone/shale was encountered in this project. A tabulation of the approximate sandstone/shale elevations is shown in the following table:

APPROXIMATE BEDROCK ELEVATIONS/PILE TIP ELEVATIONS

	Northbound Bridge			Southbound Bridge		
Location	Bent 1		Bent 2	Bent 1	Bent 2	
Soil boring	TB-1	TB-2	TB-4	TB-3	TB-5	TB-6
Approximate Bedrock/ Pile Tip Elevations	159.00	159.00	159.00	159.00	159.00	159.00

For locations, offsets and for more detailed information please refer to the specific boring logs.

1. H-Piles driven to the ultimate capacity into sandstone/shale could support the structure at all bents. It is important that penetration of H-Piles at all bents should be governed by driving to the ultimate capacity into bedrock.

2. Pile tip elevations should be verified with the approximate bedrock elevation as shown in the above table.

3. It should be noted that sandstone/shale elevations may vary along the length of the bridge bents. The sandstone/shale elevations given are only approximate elevations determined at the exact boring locations and should be used only as a guide.

4. Hardened pile tips should be used to protect the piles from high stresses during driving on the sandstone/shale.

5. The selection of the size of steel HP piles should be based on the allowable combined axial and bending stresses. In addition, the minimum pile lengths should be 3.0 m (10.0 ft) into the existing natural ground.

6. Piles driven into shale should be spaced a minimum of 1.8 m center to center. This is necessary because shale may fracture with every subsequent pile driven into the shale, and the fracturing of the shale will relax the pile tip of the previously driven piles in that group. This is needed to avoid achieving lower pile capacities during restrike, and further driving down each pile may create the similar situation as explained earlier.

7. Due to the presence of soft and medium stiff subgrade soils down to an approximate elevation of 166.00 a total long term settlement of up to 96 mm is estimated, and will cause the down drag friction loads to be added to the pile loadings.

8. There is some variability in the weathered and un-weathered shale within the soil borings. (Relaxation of the pile tip was observed during the pile driving and re-strikes of the Phase-I bridges)

Hence, dynamic pile testing (PDA) should be the preferred method of pile testing for this bridge. A minimum of two (2) test piles are needed for the PDA testing. These should be located one each at the north bent of southbound lanes and at the south bent of northbound lanes respectively. The restrike for the dynamic testing should be done after a minimum waiting period of 7 days.

9. We recommend that the pile driving contractor should be required to restrike all production piles in all groups a minimum of 7 days after all the piles in that group have been driven, to check for relaxation that may occur in shales due to fracturing of shale. If necessary, these piles should be redriven to the required ultimate capacities.

In view of the anticipated down drag forces, we are recommending several alternate methods concerning the time frame for driving the piles:

METHOD -I

This method does not include any ground modifications to expedite the consolidation process of the soft subgrade soils. The ultimate capacity must be adequate to handle the downdrag friction.

1. Our calculations indicate vertical settlements of 96 mm. The time calculated for the 90 percent consolidation of the soft foundation soils is 290 days (9.67 months).

2. Each individual pile should be designed to carry an additional load of 142 kN due to downdrag. This is based on an assumption that a 310 x 79 HP steel pile will be used. If different pile sections are used, then the Geotechnical section should be contacted for new downdrag loads.

3. If **METHOD I** is chosen for design then the following pile loading table should be used.

Pile Loading for 356 kN/490 kN/622 kN

BENT	#1	#2
	Loading (kN)	
DESIGN LOAD	356/490/622	356/490/622
FACTOR OF SAFETY	2.0	2.0
FACTORED DESIGN LOAD	712/980/1244	712/980/1244
FRICTION IN SCOUR ZONE	N/A	N/A
DOWN DRAG FRICTION	284.00	284.00
ULTIMATE LOAD	996/1264/1528	996/1264/1528
TESTING METHOD	Standard Specification Section 701.c (PDA)	

4. Sleeves should be placed around these piles before fill is placed, to prevent additional negative skin friction on the piles. Sleeves should extend to the bottom of the excavation.

5. If this method is used, then wherever the contact pressure from the MSE wall on the foundation soils exceeds the net allowable 2200 psf bearing pressure some undercutting will be necessary in order to install geogrids and raise the allowable bearing pressure.

METHOD II:

If piles are driven first, but the bridge is not built until after 90% of the vertical settlement occurs, then no down drag friction is to be added to the pile design and following are the recommendations:

1. Our calculations indicate total primary vertical settlements of 96 mm. The time calculated for the 90 percent consolidation of the soft foundation soils is 290 days (9.67 months).

2. In order to accelerate this consolidation, wick drains may be used for ground modification. As described on the next page, wick drains can reduce the waiting period (after fill placement and before bridge construction) to as little as 41 days.

3. With modifications discussed under this method, our calculations indicate vertical settlements of 10.0 mm will take place after the construction of the bridge.

4. Piles at both the abutments may be installed before any ground modification is done. Sleeves should be placed around these piles before fill is placed, to prevent additional negative skin friction on the piles. Sleeves should extend to the bottom of the excavation. However, no additional dead load or live loads shall be added to the piles before the required waiting period is complete.

5. There will be no downdrag friction in this option, and the pile loading table shown in **METHOD III** should be used.

METHOD III:

If the soft soils are removed, there will be no downdrag friction, and no wick drains or waiting period will be necessary.

1. As an alternate, the soft soils below the proposed fill can be removed to the depths shown in the table below and replaced with compacted B Borrow:

Soil borings along the South abutment		**Soil borings along the North abutment**	
Soil Boring	Limit of Removal and Replacement	Soil Boring	Limit of Removal and Replacement
RW-1	N/A	RW-4	N/A
TB-1	166.00	TB-4	166.00
TB-2	166.00	RW-5	166.00
RW-2	166.00	TB-5	166.00
TB-3	166.00	TB-6	166.60
RW-3	N/A	RW-6*	167.90*

* ***In soil boring RW-6, coal and wood fragments were encountered down to elevation 167.90.***

2. The lateral extent of removal and replacement shall be at least 10.0 ft outside the perimeter of the wall envelope and outside the line of 15.0 ft fill height. After this excavation is complete, the exposed soils should be proofrolled to see if additional excavation is necessary.

3. If **METHOD III** is chosen for the design then the following pile loading table should be used:

Pile Loading for 356 kN/490 kN/622 kN

BENT	#1	#2
	Loading (kN)	
DESIGN LOAD	356/490/622	356/490/622
FACTOR OF SAFETY	2.0	2.0
FACTORED DESIGN LOAD	712/980/1244	712/980/1244
FRICTION IN SCOUR ZONE	N/A	N/A
DOWN DRAG FRICTION	N/A	N/A
ULTIMATE LOAD	712/980/1244	712/980/1244
TESTING METHOD	Standard Specification Section 701.c (PDA)	

WICK DRAINS

To expedite the process of consolidation of the existing soft soils under **METHOD II**, wick drains are proposed on this project. Wick drains are recommended if the subject project has a time limitation and the minimum required waiting period cannot be fulfilled as per the geotechnical design. The following recommendations should be followed:

Triangular Spacing of Wick Drains (ft)	No. of Days required for 90% Consolidation of soft soils	Tip Elevation of the Wick Drains (m)
4.0	41	165.00
5.0	70	165.00
6.0	110	165.00

a) Wick drains should be installed at a triangular spacing as per the table above.

b) Wick drains should be installed in the MSE wall areas and the embankment fill areas where more than 15.0 ft of fill is proposed. .

c) Wick drains should be installed, starting from 10.0 ft outside the face of the North and South MSE abutments and should extend 10.0 ft outside the line of 15.0 ft fill height.

d) After the embankment is complete, with the wick drains, it will take approximately 41 or 70 or 110 days for the foundation soils to consolidate to the point where only 10 mm of future settlement remains.

The Special Provisions for use of wick drains are enclosed with this report.

A minimum 600 mm thick drainage blanket (permeable material) should be used over the entire areas where wick drains are recommended. The drainage material should be "B-Borrow". This drainage blanket should have sufficient peripheral drainage for gravity drainage and it should be daylighted to at least one end and the base of the blanket should be graded towards that end for positive drainage.

MSE WALL RECOMMENDATIONS

In addition to the pile foundations, MSE wall abutments will be used for the bridge structures over Woodsmall Drive. The 24 Hour Reading of the groundwater elevations in the soil borings recorded at the locations of the proposed MSE walls ranges from 168.34 to 165.81.

The soils encountered within the subgrade for the abutment walls are Silty Clay (A-7-6), Silty Clay Loam (A-7-6 & A-6), Silt (A-4) and Silty loam (A-4). The consistency of these soils ranges from soft to medium stiff to hard underlain by very dense weathered shale and hard shale bedrock.

MSE wall borings along the South abutment	MSE wall borings along the North abutment
RW-1, TB-1, TB-2, RW-2, TB-3 and RW-3	RW-4, TB-4, RW-5, TB-5, TB-6 and RW-6

Wall Heights Considered in the Design:

A. The cross-sections along the MSE wall abutments provided have been used to arrive at the maximum height of the MSE wall section to be analyzed. The maximum height of the proposed MSE wall from the existing ground elevation is 6.596 m (21.63 ft). The profile grade elevations at the bridge deck for the northbound and southbound lanes are given as 176.705 and 176.441 respectively.

B. The maximum height considered in the design of the MSE wall is 7.506 m (24.62 ft) and is taken from the leveling pad elevation. The maximum wall height is taken from the northbound lanes, from the cross-sections at the East end of the abutment wall line. The top elevation of wall (175.433) is taken as the high elevation and leveling pad elevation (167.927) is taken at 0.91 m (3.0 ft) below the existing low ground elevation at that section.

The recommendations for the MSE walls are as follows:

1. All topsoil should be removed before any new fill is placed. Due to the presence of farms and fields the topsoil may be at least 1.0 m deep in some areas of the project. Any loose soil encountered should be compacted with a heavy vibratory roller.

2. The soils within the subgrade have high silt content A-4 soils and there is a high potential of pumping in these foundation soils. Achieving compaction within these high silt soils will be difficult and is dependent on the seasonal variability of infiltration and natural moisture content of the virgin soils. In certain areas construction platform may be needed to place fills on the virgin soil and it should be done as per Section 203.

3. Soft soils with very high content of 67 to 84 percent silts are encountered within the immediate subgrade. Soft soils encountered below the retaining wall should be removed replaced with "B Borrow" down to the elevations shown in the table under recommendations No. 1 under **METHOD III**.

4. The lateral extent of removal and replacement shall be as mentioned under recommendations No. 2 under **METHOD III**. After this excavation is complete, the exposed soils should be proofrolled to see if additional excavation is necessary.

5. After the soil modification (**METHOD II**) or backfilling and compaction (**METHOD III**), a net allowable bearing pressure of 215 kPa (4500 psf) may be used. Where no excavation is done (**METHOD I**) or MSE wall is placed on fill, a net allowable bearing pressure of 105 kPa (2200 psf) may be used.

6. If **METHOD I** is used, in some areas, the contact pressure on the foundation soils will exceed the net allowable bearing pressure 2200 psf. In these areas, the foundation soils must be reinforced as described below.

   a. Undercut the subgrade soils down to 1.2 m beneath the proposed leveling pad elevation of the walls.

   b. Replace with compacted B borrow and place uniaxial geogrids Type-II. The first layer of geogrid should be placed 150 mm above the bottom of excavation. Three layers of geogrid should be placed perpendicular to the face of the wall and 300 mm apart vertically. The modification of the foundation subgrade, with undercut and replacement should be done as per the attached Sketch.

7. Some of these excavations are below the groundwater elevations mentioned on page 6 of this report. In borings TB-1, RW-2 & RW-5, groundwater was encountered 0.4 m above the bottom of the leveling pad for MSE wall excavation. Where groundwater is encountered during construction, water levels should be maintained below the bottom of excavation. Where sand or silt is encountered below the water table, it may be impossible to de-water with a sump pump. It may be necessary to use well points or a cofferdam. Any dewatering program should consider the potential for damage to the

existing structures in the vicinity. These borings were performed in April 2003. The water table may be higher at the time of construction.

8. There may be some differential settlement along the face of the wall. Rectangular facing panels with continuous vertical joints should be used to accommodate this settlement.

9. In evaluating the design for a "gravity type" MSE retaining wall, the external and internal stability should be analyzed. For external stability, the following four standard modes of failure are typically addressed:

    a) Sliding [minimum factor of safety FS 1.5].
    b) Overturning (FS 2.0)
    c) Bearing capacity, FS 2.5
    d) Global stability

    An analysis was performed for each of the external stability issues outlined above. Allowable bearing capacities are given above in this report.

10. To evaluate the internal stability, three standard modes of failure are typically addressed. These include:

    a) pull out of the strips;
    b) tensile overstress of the strip and wall/strip connection; and
    c) Corrosion of the steel reinforcement strip

    We understand that the MSE Wall manufacturer will address the internal stability considerations for this project.

11. Tracked construction equipment should not be operated directly on the strips. A minimum backfill thickness of 150 mm is required prior to operation of tracked vehicles over the strips. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the backfill and damaging the strips.

12. Rubber-tired equipment may pass over the reinforcement at slow speeds, less than 10 km/hr. Sudden braking and sharp turning should be avoided.

13. The backfill should consist of a relatively clean free-draining granular backfill.

14. The minimum length of reinforcing strips should be 70% of the height of the wall and it should not be less than 2.44 m (8.0 ft).

15. Behind the reinforced soil mass, additional "B" Borrow backfill should be placed. The "B" Borrow should rise from the heel of the MSE wall (the tail end of the lowest reinforcing strip) on a 1:1 slope.

16. The internal stability design will be based on an angle of internal friction of 34°□ for wall backfill material. Therefore, this backfill material must be tested to insure compliance with this design criterion and any additional design criteria as per INDOT's Specifications.

General soil strata descriptions and indicated boundaries are based on an engineering interpretation of all available subsurface information by the Geotechnical Section of the INDOT and may not necessarily reflect the actual variation in subsurface conditions between borings and samples. Detailed data and field interpretation of conditions encountered in individual borings are shown on the boring logs.

The observed water levels and/or conditions indicated on the boring logs are as recorded at the time of exploration. These water levels and/or conditions may vary considerably with time, according to the prevailing climate, rainfall or other factors and are otherwise dependent on the duration of, and methods used, in the exploration program.

If you have any questions concerning this matter, please contact us.

Very truly yours,

Athar Khan, P.E.
Chief Geotechnical Engineer

Mir Zaheer, P.E.
Senior Geotechnical Engineer

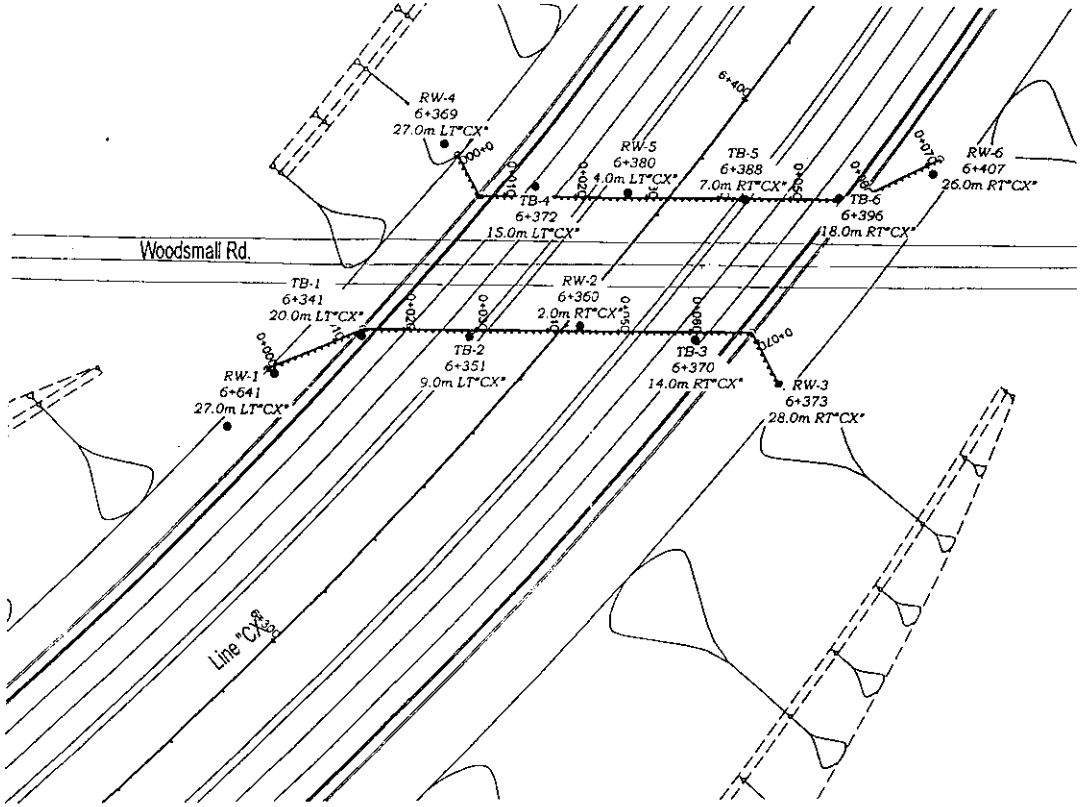
Reviewer: Steve Morris, P.E. SM

MZ/

cc: Mrs. Anne Rearick - Attn: Mr. Greg Klevitsky - Attachments
Mr. Elmo Gonzalez - Attn: Mr. Bruce Conrad - Attachments (2)
Ms. J. Somers - Attachments
Mr. D. Cohen – Attachments
File

Attachments

BORING LOCATION PLAN



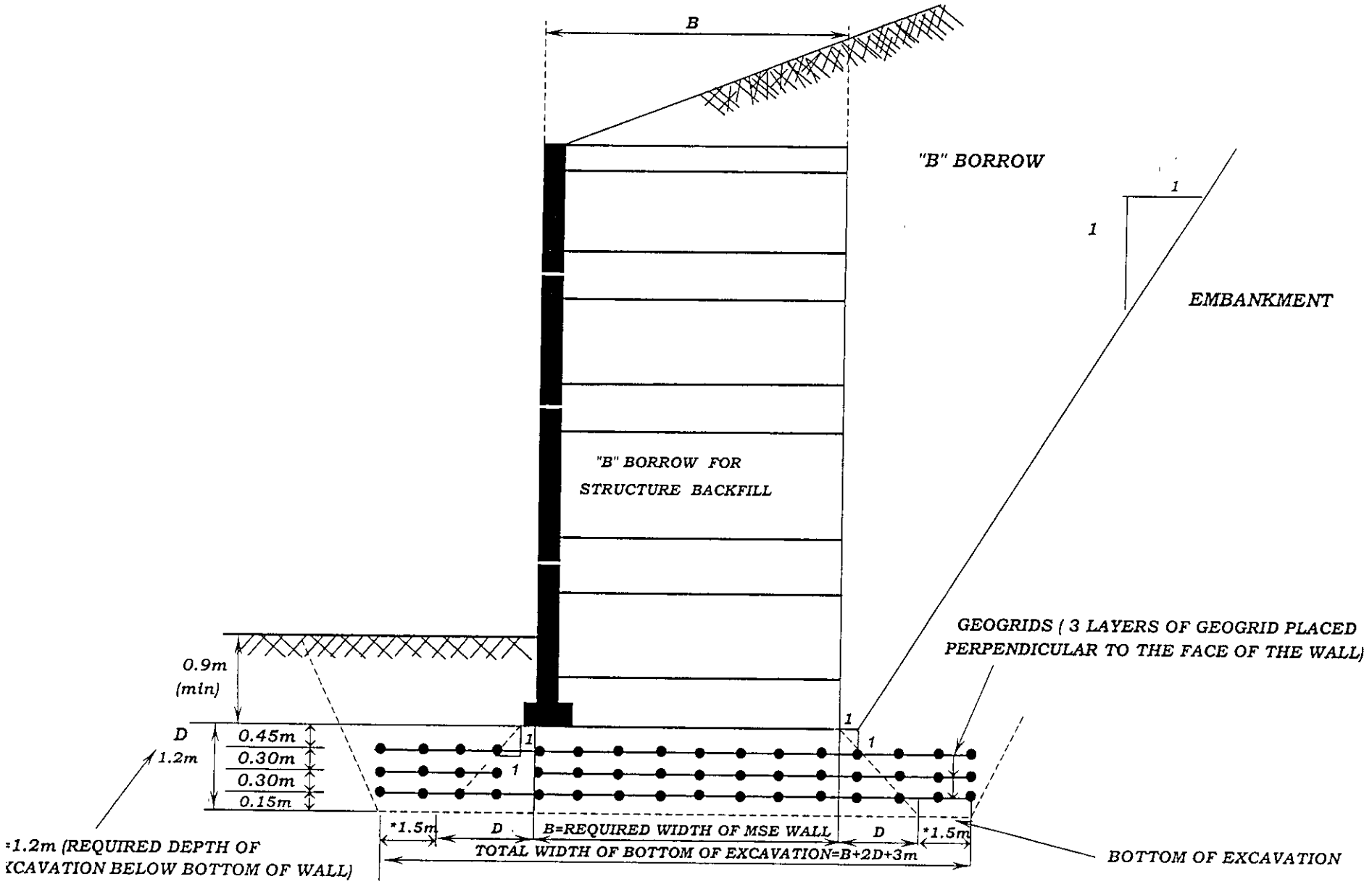
NORTH

DES NO: 9738260
PROJECT NO: STP-291-1(005)
STRUCTURE NO: 641-84-8397
LOCATION: S.R.641 OVER WOODSMALL ROAD.
COUNTY: VIGO

NOT TO SCALE

PREPARED BY: R.C.W.
CHECKED BY: M.Z.
DATE: 06/23/2003

UNDERCUTTING BELOW BOTTOM OF MSE WALL



* 1.5m EMBEDMENT LENGTH

DES NO: 9738260
PROJECT NO: STP-291-1(005)
STRUCTURE NO: 641-84-8397
LOCATION: S.R.641 OVER WOODSMALL ROAD
COUNTY: VIGO

PREPARED BY: R.C.W.
CHECKED BY: M.Z.
DATE: /2003

/03

SUMMARY OF CLASSIFICATION TEST RESULTS

DES. NO. 9738260
PROJECT NO. STP-291-1 (005)
STRUCTURE NO. 641-84-8397
COUNTY VIGO

RATORY MBER	PART	BORING NUMBER	STATION	OFFSET LINE	SAMPLE NUMBER	SAMPLE DEPTH	TEXTURAL/ UNIFIED	AASHTO	NO. 10	NO. 40	NO. 200	GRAVEL 76.2 - 2.00 mm	SAND 2.00- 0.074 mm	SILT 0.074- 0.002 mm	CLAY BELOW 0.002 mm	BELOW 0.001 mm	LL	PL	PI
9201045		RW-2	6+360	2m RT LINE CX	SS 2 T	3.5-5.0	SILT	A-4(2)	100.0	100.0	96.3	0.0	3.7	84.3	12.0	10.8	25.5	22.8	2.7
9201069		TB-2	6+360	2m RT LINE CX	SS 5 T	13.5-15.0	CLAY LOAM	A-6(7)	98.8	95.6	69.8	1.2	29.0	49.4	20.4	18.6	30.4	16.5	13.9
9201083		RW-3	6+373	28m RT LINE CX	SS 3 T	6.0-7.5	SILTY LOAM	A-4(8)	99.8	99.1	92.9	0.2	6.9	73.6	19.3	16.6	30.2	21.3	8.9
9201218		RW-5	6+380	4m LT LINE CX	SS 1 T	1.0-2.5	SILTY CLAY LOAM	A-6(19)	100.0	100.0	99.6	0.0	0.4	74.4	25.2	22.3	39.0	21.6	17.4
9201234		TB-5	6+388	7m RT LINE CX	SS 1 T	1.0-2.5	SILTY CLAY	A-7-6(28)	100.0	100.0	99.6	0.0	0.4	66.8	32.8	28.9	47.4	22.8	24.6
9201251		RW-6	6+407	26m RT LINE CX	SS 2 T	3.5-5.0	SILTY CLAY LOAM	A-6(17)	100.0	100.0	98.4	0.0	1.6	72.4	26.0	23.9	38.2	22.2	16.0
9200666		RW-1	NA	NA	SS 2 T	3.5-5.0	SILT	A-4(0)	100.0	100.0	99.5	0.0	0.5	84.7	14.8	13.6	N.P.	N.P.	N.P.
9200680		TB-1	NA	NA	SS 1 T	1.0-2.5	SILTY CLAY	A-7-6(25)	100.0	99.9	97.4	0.0	2.6	67.2	30.2	27.1	44.2	20.4	23.8
9200777		TB-2		LINE A	SS 5 T	13.5-15.0	SANDY CLAY LOAM	A-6(4)	97.9	88.9	46.3	2.1	51.6	25.1	21.2	18.9	30.7	15.0	15.7

18/03

NO. 9738260

SUMMARY OF SPECIAL LABORATORY TEST RESULTS

DES. NO. 9738260
PROJECT NO. STP-291-1 (005)
STRUCTURE NO. 641-84-8397
COUNTY VIGO

BORATORY NUMBER	PART	BORING NUMBER	SAMPLE NUMBER	DEPTH	NATURAL WATER CONTENT (%)	pH VALUE	LOI (%)	CA & MG (%)	NATURAL WET DENSITY (pcf)	NATURAL DRY DENSITY (pcf)	MAX DRY DENSITY (pcf)	OPT. MOIST (%)	CBR @93%	CBR @97%	COHESION (Qu/2) (psf)
079201045		RW-2	SS 2 T	3.5-5.0	24.3	7.5									
079201061		TB-2	SS 1 T	1.0-2.5	25.6										
079201069		TB-2	SS 5 T	13.5-15.0	19.9	6.7									
079201079		RW-3	SS 1 T	1.0-2.5	25.3				123.4	98.5					1961
079201083		RW-3	SS 3 T	6.0-7.5		6.8									
079201084		RW-3	SS 3 B	6.0-7.5	23.2				131.6	106.8					791
079201095		RW-4	SS 1 T	1.0-2.5	26.6				122.9	97.1					2170
079201111		TB-4	SS 1 T	1.0-2.5	25.4										
079201119		TB-4	SS 5 T	13.5-15.0	19.9				131.5	109.7					801
079201120		TB-4	SS 5 B	13.5-15.0	20.9				130.1	107.6					1177
079201218		RW-5	SS 1 T	1.0-2.5	24.1	6.8									
079201234		TB-5	SS 1 T	1.0-2.5	24.9	4.9									
079201240		TB-5	SS 4 T	8.5-10.0	18.5				133.0	112.2					779
079201249		RW-6	SS 1 T	1.0-2.5	24.4										
079201251		RW-6	SS 2 T	3.5-5.0	26.0	4.3									
079201267		TB-6	SS 1 B	1.0-2.5	27.3										
079201271		TB-6	SS 3 B	6.0-7.5	19.6										

THE INDIANA DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISIONS

FOR

WICK DRAINS

Description:

This work shall consist of furnishing all necessary labor, equipment, and materials and performing all operations required for installation of prefabricated wick drains in accordance with the details shown on the plans and with the requirements of these specifications.

Material Requirements:

Prefabricated wick drains shall consist of a band-shaped plastic core which permits continuous vertical drainage, wrapped in a filter material and installed in the subsoils by displacement methods. Prefabricated wick drains acceptable for installation shall be the products known as Alidrain, Geodrain with polyester/cellulose filter, Mebradrain or Amerdrain or approved equal.

At least two weeks prior to construction, the Contractor shall submit documentation indicating the source of the drain materials. Prior to the delivery of the materials to the site, the Contractor shall present the Engineer with a vendor's purchase certificate for verification and a type "C" Certification.

Equipment:

Prefabricated drains shall be installed with approved modern equipment of a type which will cause a minimum of disturbance of the soil during the installation operation.

Each prefabricated drain shall be installed using a mandrel (or sleeve) which shall be advanced through the sand blanket and underlying soil.

The mandrel shall protect the drain from tears, cuts and abrasions during installation, and shall be retracted after each drain is installed. The mandrel shall be provided with an "anchor" rod or plate at the bottom to prevent the soils from entering the bottom of the mandrel during installation of the drain and to anchor the bottom of the drain at the required depth at the time of mandrel removal. The mandrel shall have a maximum cross sectional area of ten square inches. To minimize disturbance to the soil, the mandrel shall not be intruded into the soil using vibratory or impact methods.

At least two weeks prior to construction, the Contractor shall submit in writing to the Engineer for his review and approval, details of the sequence and method of installation. Approval by the Engineer will not relieve the Contractor of his responsibility to install the prefabricated drains in accordance with these specifications and manufacturer's recommendations.

Construction Methods:

Prior to installation of prefabricated drains within the areas designated on the plans, the Contractor shall demonstrate that his equipment, method, and materials produce a satisfactory drain installation in accordance with these specifications. For this purpose, the Contractor will be required to install up to ten trial drains in each test location as designated by the Engineer. The Contractor will be compensated for each trial drain if the installation satisfies the requirements of this specification. No compensation will be allowed for installing unsatisfactory trial drains.

Approval by the Engineer of the method and equipment used to install the trial drains shall not constitute, necessarily, acceptance of the method if the method of installation does not produce a drain which satisfies the project requirements. The Contractor shall alter his method and/or equipment as necessary to comply with these specifications.

The drains which do not require predrilling shall be installed following placement of the sand blanket as shown on the plans. The drains shall be installed to a depth corresponding to the bottom of the compressible layer shown on the drawings, or to such a depth where the soil resists further penetration under maximum effort of the installation equipment. The Engineer may vary the depths, spacing or the number of drains to be installed, and may revise the plan limits for this work as necessary.

The contractor shall be permitted to use augering or other methods to predrill or to loosen stiff upper soils prior to placement of the sand blanket. Placement of this sand blanket in areas where predrilling is required will follow placement of the wick drains.

The installation equipment shall be carefully checked for plumbness prior to advancing each drain. The plumbness of the mandrel shall not deviate more that one-eight ($^1/_8$) inch per foot from the vertical.

Drains that vary from their proper location by more than three inches or drains that are damaged during installation or subsequent construction, or drains that are improperly completed shall be rejected by the Engineer, and no compensation will be allowed for any materials furnished or for any work performed on such drains.

During installation, the Contractor shall provide the Engineer with suitable means of measuring the vertical length of prefabricated drain installed at a given location and deriving a tip elevation for each drain.

After installation, the Contractor shall cut each drain such that approximately six inches of drain material extends above the top of the sand blanket. The drain material shall be cut neatly at its upper end.

Prefabricated drains will be located, numbered, and staked out by the Contractor. The Contractor shall take all reasonable precautions to preserve the stakes. The locations of the drains shall not vary by more than three inches from the locations indicated on the drawing or as directed by the Engineer. Two weeks prior to construction, the Contractor shall submit shop drawings to the Engineer for his approval showing the method of field location, drain layout and numbering plan.

Where obstructions are encountered below the working surface which cannot be penetrated by the drain installation equipment, the Contractor shall complete the drain from the elevation of the obstruction to the working surface and notify the Engineer. At the direction of the Engineer, the Contractor shall attempt to install a new drain within an eighteen inch radius from the obstructed drain. A maximum of two additional attempts shall be made as directed by the Engineer. The Contractor will be compensated for each obstructed drain unless the drain is otherwise improperly installed, in which case no compensation will be allowed.

Documentation:

The Engineer shall keep a daily log which lists for each drain the date of installation, the top elevation, the tip elevation, and the pay length. A copy of each daily log shall be provided to the Contractor for his records.

Method of Measurement:

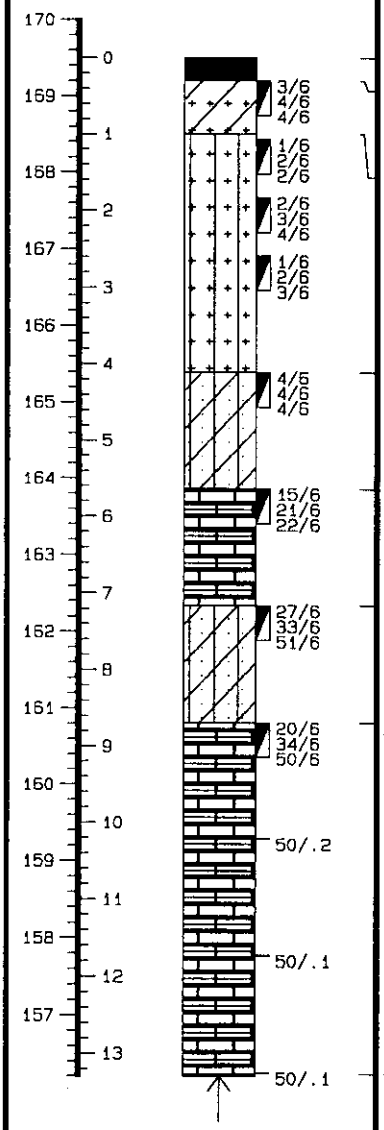
The quantity to be paid for under this item shall be the number of linear feet or linear meter of drain installed and accepted, computed from the top of the sand blanket to the tip elevation of the drains. In case of obstructions, the Contractor will be paid at the contract price for the number of linear feet or linear meter of drain measured from the top of the drainage blanket to the elevation at which the obstruction was encountered.

Basis of Payment:

The unit bid price per linear foot or linear meter for the item, "Wick Drain", shall include the cost of furnishing all tools, materials, labor and equipment necessary to complete the work in accordance with the Plans and Specifications. No payment shall be made for unacceptable drains, unacceptable trial drains, or delays or expenses incurred by the Contractor, through changes necessitated by improper or unacceptable material or equipment.

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 9738260 BORING No: TB-1
STRUCTURE NO: 641-84-8397 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: S.R.641 OVER WOODSMALL ROAD. ELEV: 169.5
STATION/OFFSET/LINE 6 + 341 20.0 m LT OF LINE "CX" START 03/20/03
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 03/20/03
WATER DEPTH @ COMP.2.74 m : AFTER 24 HRS: BACKFILLED CAVED: 2.93m



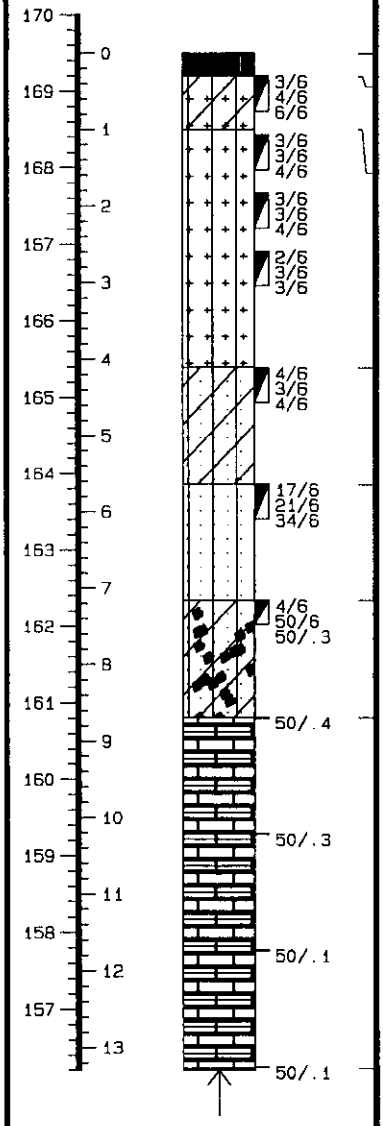
Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
BROWN, MOIST, MEDIUM STIFF, SILTY CLAY A-7-6(25) #03-0680		SS-1	90	
		SS-2	80	
BROWN, MOIST, SOFT TO MEDIUM STIFF, SILTY LOAM A-4 #03-1083		SS-3	65	
		SS-4	100	
BROWN, MOIST, MEDIUM STIFF, SANDY CLAY LOAM A-6 #03-0777	COAL FRAGMENTS IN SS-5T	SS-5	60	
REDDISH BROWN, SLI-MOIST, HIGHLY WEATHERED, SANDSTONE (VISUAL)		SS-6	70	
GRAY, SLIGHTLY MOIST, HARD, SANDY CLAY LOAM A-6 #03-0777		SS-7	100	
GRAY, SLI-MOIST TO DRY, HARD WEATHERED, SHALE (VISUAL)	WATER ON THE RODS AT 8.69m	SS-8	90	
		SS-9	10	
		SS-10	10	
BTH 13.29m(43.6')		SS-11	10	

DRILLER: DT INSPECTER: JL DATUM: USC & GS
WEATHER: PT.SUNNY TEMP: 59 F PAGE: OF

DIVISION OF MATERIALS AND TESTS

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 9738260 BORING No: TB-2
STRUCTURE NO: 641-84-8397 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: S.R.641 OVER WOODSMALL ROAD. ELEV: 169.5
STATION/OFFSET/LINE 6 + 351 9.0 m LT OF LINE "CX" START 03/27/03
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 03/27/03
WATER DEPTH @ COMP. 2.93 m : AFTER 24 HRS: BACKFILLED CAVED: 2.90m

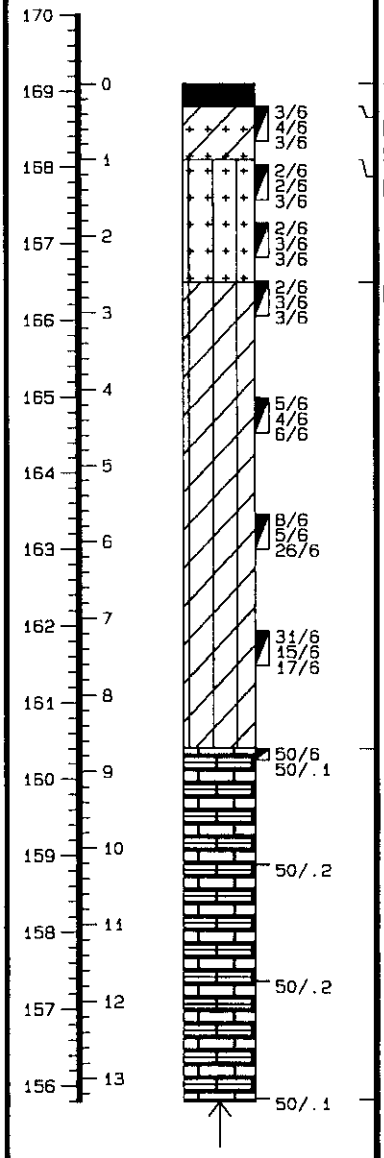


Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
BROWN, SLIGHTLY MOIST, MEDIUM STIFF, SILTY CLAY LOAM A-7-6 # 03-0680		SS-1	80	103.0
		SS-2	80	
BROWN, MOIST, MEDIUM STIFF, SILTY LOAM A-4 # 03-1083		SS-3	100	43.0
		SS-4	70	
REDDISH BROWN, SLIGHTLY MOIST, MEDIUM STIFF, SANDY CLAY LOAM A-6(4) #03-0777		SS-5	100	
BROWN, SLIGHTLY MOIST, VERY DENSE, SANDY LOAM (VISUAL)		SS-6	100	
GRAY, MOIST, HARD, SANDY CLAY LOAM W/TR GRAVEL A-6 # 03-0777	WATER ON RODS AT 7.16m	SS-7	80	
GRAY, DRY, HARD, SHALE (VISUAL)		SS-8	20	
		SS-9	20	
		SS-10	10	
BTH 13.29m(43.6')		SS-11	10	

DRILLER: DT INSPECTER: JL DATUM: USC & GS
WEATHER: PT.SUNNY TEMP: 50 F PAGE: OF

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 9738260 BORING No: TB-3
STRUCTURE NO: 641-84-8397 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: S.R.641 OVER WOODSMALL ROAD. ELEV: 169.1
STATION/OFFSET/LINE 6 + 370 14.0 mRT OF LINE "CX" START 04/08/03
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 04/08/03
WATER DEPTH @ COMP.5.94 m : AFTER 24 HRS: .76 m CAVED: 11.13 m



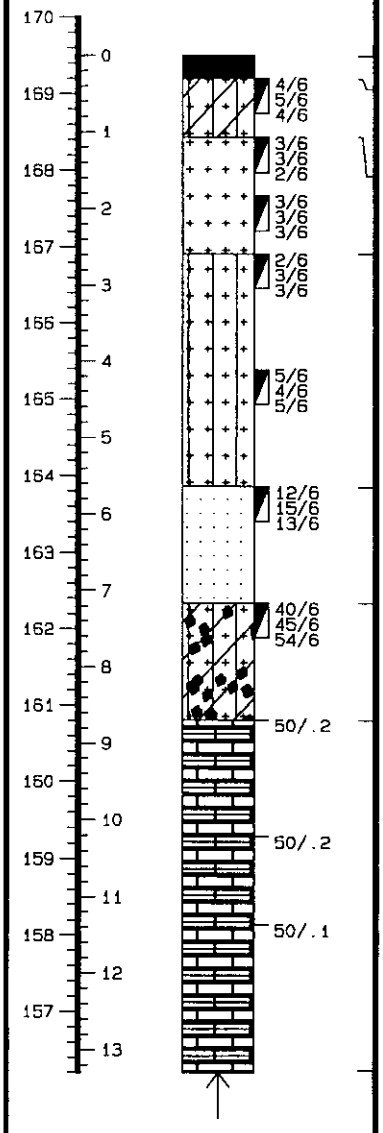
Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
BROWN, MOIST, MEDIUM STIFF, SILTY CLAY A-7-6 #03-1218		SS-1	80	
BROWN, MOIST, SOFT TO MEDIUM STIFF, SILTY LOAM A-4 # 03-1083		SS-2	80	
		SS-3	100	
REDDISH BROWN, MOIST, MEDIUM STIFF TO HARD, CLAY LOAM A-6(7) # 03-1069		SS-4	80	
		SS-5	90	
	OCCASIONAL SAND SEAMS 4.57-7.16m			
		SS-6	100	
	WATER ON RODS AT 7.16m	SS-7	80	
GRAY, DRY, HARD, SHALE (VISUAL)		SS-8	30	
		SS-9	20	
		SS-10	20	
BTH 13.29m(43.6')		SS-11	10	

DRILLER: DT INSPECTER: JL DATUM: USC & GS
WEATHER: CLOUDY TEMP: 43 F PAGE: OF

DIVISION OF MATERIALS AND TESTS

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 9738260 BORING No: TB-4
STRUCTURE NO: 641-84-8397 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: S.R.641 OVER WOODSMALL ROAD. ELEV: 169.5
STATION/OFFSET/LINE 6 + 372 15.0 m LT OF LINE "CX" START 04/09/03
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 04/09/03
WATER DEPTH @ COMP.N/A : AFTER 24 HRS: BACKFILLED CAVED: N/A



Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
BROWN, MOIST, MEDIUM STIFF, SILTY CLAY LOAM A-6 # 03-1218		SS-1	90	
		SS-2	50	
BROWN, MOIST, SOFT, SILTY LOAM A-4 # 03-1045		SS-3	80	
REDDISH BROWN, MOIST, MEDIUM STIFF, SILTY LOAM A-4 # 03-1083		SS-4	95	
		SS-5	95	
REDDISH BROWN, MOIST, MEDIUM DENSE, SAND (VISUAL)		SS-6	90	
GRAY, MOIST, HARD, SILTY CLAY LOAM W/TR GRAVEL (VISUAL)	WATER ON THE RODS AT 7.16m 0.5m HEAVE AT 7.16m	SS-7	100	
GRAY, SLIGHTLY MOIST, HARD, SHALE (VISUAL)		SS-8	20	
		SS-9	20	
		SS-10	10	
BTH 13.29m(43.6')				

DRILLER: DT INSPECTER: JL DATUM: USC & GS
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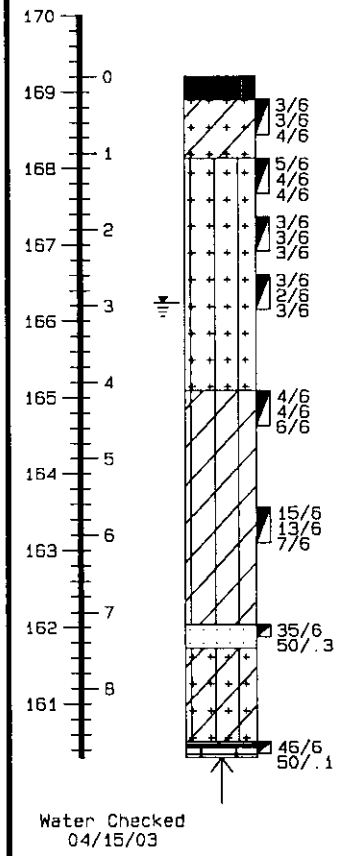
INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 9738260 BORING No: TB-5
STRUCTURE NO: 641-84-8397 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: S.R.641 OVER WOODSMALL ROAD. ELEV: 169.2
STATION/OFFSET/LINE 6 + 388 7.0 m RT OF LINE "CX" START 04/15/03
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 04/15/03
WATER DEPTH @ COMP.DRY : AFTER 24 HRS: 2.96 m CAVED: 7.50 m



Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
TAN, SLIGHTLY MOIST, MEDIUM STIFF, SILTY CLAY A-7-6 (28) # 03-1234		SS-1	70	
		SS-2	60	
TAN, SLIGHTLY MOIST, MEDIUM STIFF, SILTY LOAM A-4 # 03-1083		SS-3	65	
		SS-4	70	37kpa
BROWN, MOIST, MEDIUM STIFF, CLAY LOAM A-6 (7) # 03-1069		SS-5	65	
		SS-6	60	
GRAY, MOIST, DENSE, SAND (VISUAL)		SS-7	50	
GRAY, DRY, HARD, SILTY CLAY LOAM (VISUAL)				
GRAY, DRY, HARD, SHALE (VISUAL)	WATER ON THE RODS AT 8.69m	SS-8	30	
BTH 8.87m (29.1')				

DRILLER: DT INSPECTER: JL DATUM: USC & GS
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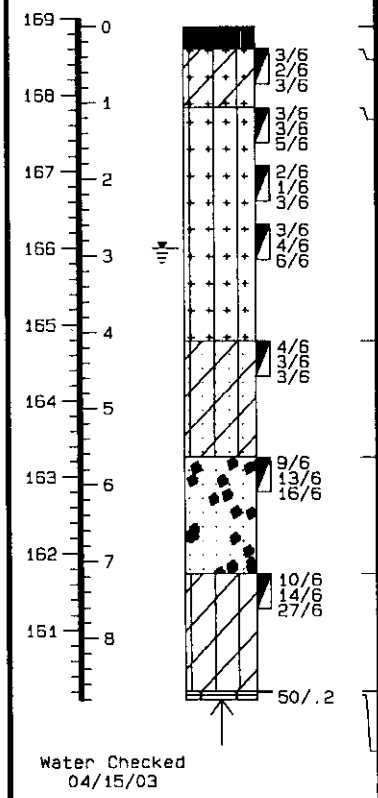
INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 9738260 BORING No: TB-6
STRUCTURE NO: 641-84-8397 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: S.R.641 OVER WOODSMALL ROAD. ELEV: 168.9
STATION/OFFSET/LINE 6 + 396 18.0 m RT OF LINE "CX" START 04/15/03
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 04/15/03
WATER DEPTH @ COMP.DRY : AFTER 24 HRS: 2.90 m CAVED: 5.03 m



ELEV. / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
0		TOPSOIL (VISUAL)				
1		BROWN, MOIST, SOFT, SILTY CLAY LOAM A-6 # 03-1251		SS-1	60	
		TAN/BROWN/GRAY MOTTLED, SLIGHTLY MOIST, MED.STIFF, SILTY LOAM A-4 # 03-1083		SS-2	80	
2				SS-3	100	
3				SS-4	90	
4		BROWN, SLIGHTLY MOIST, MEDIUM STIFF, SANDY CLAY LOAM A-6 # 03-0777		SS-5	100	
6		BROWN, MOIST, MEDIUM DENSE, SAND W/TR GVL (VISUAL)	WATER ON THE RODS AT 5.64m	SS-6	100	
7		GRAY, SLIGHTLY MOIST, HARD, CLAY LOAM A-6 # 03-1069	HEAVE AT 7.16m CLEAN OUT	SS-7	100	
8		GRAY, DRY, HARD, SHALE (VISUAL)		SS-8	10	
		BTH 8.69m (28.7')				

DRILLER: DT INSPECTER: JL DATUM: USC & GS
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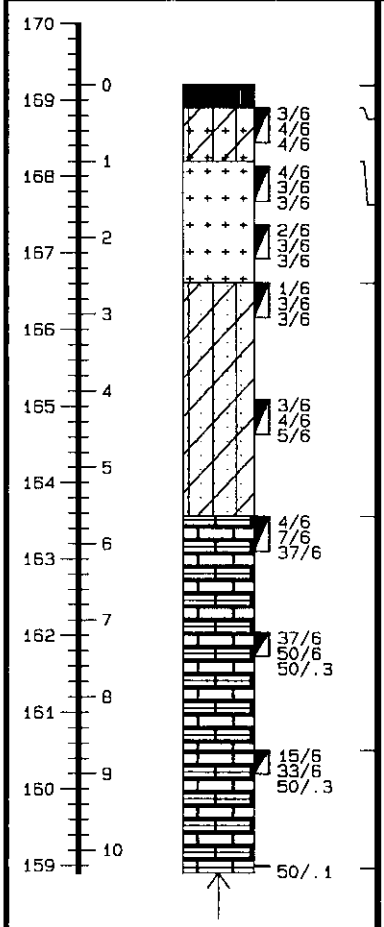
DIVISION OF MATERIALS AND TESTS

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 9738260 BORING No: RW-1
STRUCTURE NO: 641-84-8397 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: S.R.641 OVER WOODSMALL ROAD. ELEV: 169.2
STATION/OFFSET/LINE 6 + 327 27.0 m LT OF LINE "CX" START 03/19/03
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 03/19/03
WATER DEPTH @ COMP.N/A : AFTER 24 HRS: BACKFILLED CAVED: .30 m



Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
TAN/BROWN MOTTLED, WET, MEDIUM STIFF, SILTY CLAY A-7-6 # 03-0680		SS-1	80	
		SS-2	80	
BROWN, MOIST, LOOSE, SILT A-4 (0) # 03-0666		SS-3	80	
REDDISH BROWN, MOIST, MEDIUM STIFF, SANDY CLAY LOAM A-6 # 03-0777		SS-4	70	
	WATER WAS FLOWING OUT OF BORING AT 3.8 m	SS-6	70	
REDDISH BROWN, SLI-MOIST, HARD, HI-WEATHERD SANDSTONE W/SA-CL-LO SEAMS (VISUAL)		SS-6	90	
	WATER ON RODS AT 7.16m	SS-7	90	
GRAY, DRY, HARD, WEATHERED, SHALE (VISUAL)		SS-8	30	
BTH 10.24m (33.6')		SS-9	10	

DRILLER: DT INSPECTER: JL DATUM: USC & GS
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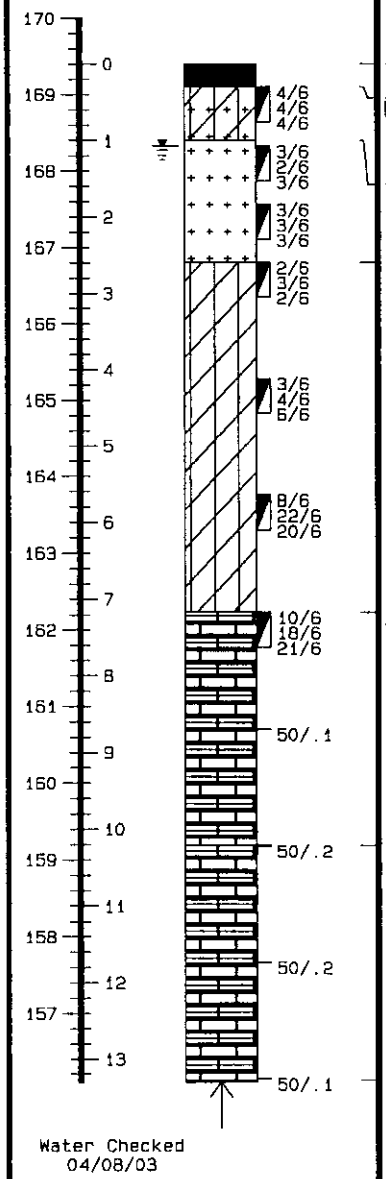
INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 9738260 BORING No: RW-2
STRUCTURE NO: 641-84-8397 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: S.R.641 OVER WOODSMALL ROAD. ELEV: 169.4
STATION/OFFSET/LINE 6 + 360 2.0m RT OF LINE "CX" START 04/08/03
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 04/08/03
WATER DEPTH @ COMP.DRY : AFTER 24 HRS: 1.07 m CAVED: 2.90 m



Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
BROWN, MOIST, MEDIUM STIFF, SILTY CLAY LOAM A-6 # 03-1218		SS-1	90	
		SS-2	90	
BROWN, MOIST, SOFT, SILT A-4(2) # 03-1045		SS-3	70	
REDDISH BROWN, MOIST, SOFT TO HARD, CLAY LOAM A-6 # 03-1069		SS-4	90	
		SS-5	100	
		SS-6	80	
GRAY, SLIGHTLY MOIST, HARD, HIGHLY WEATHERED, SHALE (VISUAL)	WATER ON THE RODS AT 7.16m	SS-7	60	
	POOR RECOVERY ROCK IN SS	SS-8	10	
GRAY, DRY, HARD, SHALE (VISUAL)		SS-9	20	
		SS-10	20	
BTH 13.29m(43.6')		SS-11	10	

DRILLER: DT INSPECTER: JL DATUM: USC & GS
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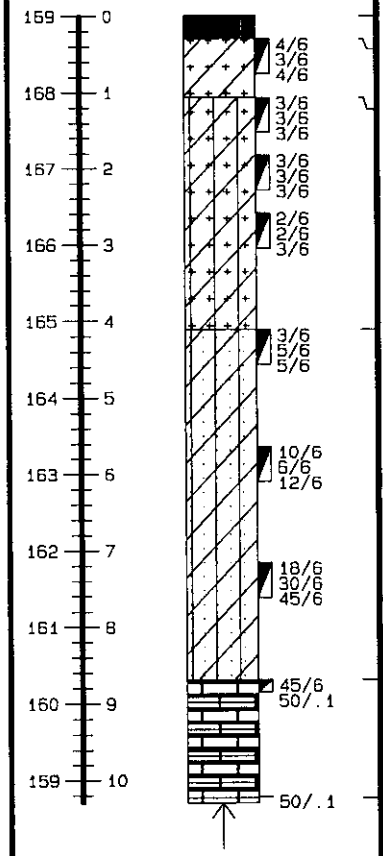
INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 9738260 BORING No: RW-3
STRUCTURE NO: 641-84-8397 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: S.R.641 OVER WOODSMALL ROAD. ELEV: 169.0
STATION/OFFSET/LINE 6 + 373 28.0 m RT OF LINE "CX" START 04/08/03
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 04/08/03
WATER DEPTH @ COMP.DRY : AFTER 24 HRS: BACKFILLED CAVED: 1.22 m



Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
BROWN, MOIST, MEDIUM STIFF, SILTY CLAY A-7-6 #03-1234		SS-1	80	94.0
		SS-2	100	
TAN/BROWN, MOIST, MEDIUM STIFF, SILTY CLAY LOAM A-6 #03-1251		SS-3	60	38.0
		SS-4	100	
ORANGE/BROWN/GRAY MOTTLED, MOIST, MEDIUM STIFF, SANDY CLAY LOAM A-6 #03-0777		SS-5	100	
	WATER ON THE RODS AT 5.64m	SS-6	80	
	GRAVEL AT 7.16m	SS-7	70	
GRAY, DRY, HARD, SHALE (VISUAL)		SS-8	30	
BTH 10.24m (33.6')		SS-9	10	

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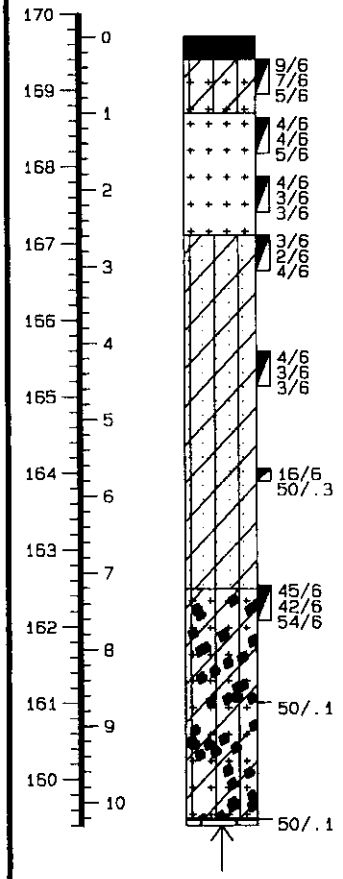
DIVISION OF MATERIALS AND TESTS

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 9738260 BORING No: RW-4
STRUCTURE NO: 641-84-8397 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: S.R.641 OVER WOODSMALL ROAD. ELEV: 169.7
STATION/OFFSET/LINE 6 + 369 27.0 m LT OF LINE "CX" START 04/09/03
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 04/09/03
WATER DEPTH @ COMP.2.74 m : AFTER 24 HRS: BACKFILLED CAVED: 2.80 m



Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
BROWN, MOIST, MEDIUM STIFF, SILTY CLAY LOAM A-7-6 # 03-0680		SS-1	70	104.0
		SS-2	80	
BROWN, MOIST, MEDIUM STIFF, SILT A-4 # 03-0666		SS-3	65	
BROWN, MOIST, MEDIUM STIFF TO HARD, SANDY CLAY LOAM A-6 # 03-0777		SS-4	65	
		SS-5	80	
		SS-6	50	
GRAY, MOIST, HARD, SILTY CLAY LOAM W/TR GRAVEL (VISUAL)	GRAY, DENSE SAND SEAM @ 7.16m WATER ON THE RODS AT 7.16m	SS-7	70	
		SS-8	10	
GRAY, DRY, HARD, SHALE (VISUAL)		SS-9	10	
BTH 10.24m (33.6')				

DRILLER: DT INSPECTER: JL DATUM: USC & GS
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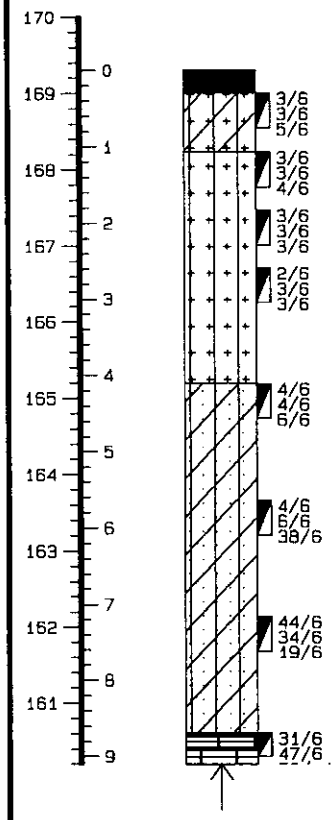
INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 9738260 BORING No: RW-5
STRUCTURE NO: 641-84-8397 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: S.R.641 OVER WOODSMALL ROAD. ELEV: 169.3
STATION/OFFSET/LINE 6 + 380 4.0 m LT OF LINE "CX" START 04/15/03
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 04/15/03
WATER DEPTH @ COMP.DRY : AFTER 24 HRS: .98m CAVED: 5.21m



ELEV. / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
		TOPSOIL (VISUAL)				
		BROWN, MOIST, MEDIUM STIFF, SILTY CLAY LOAM A-6 (19) # 03-1218		SS-1	80	
				SS-2	70	
		REDDISH BROWN, MOIST, MEDIUM STIFF, SILTY LOAM A-4 # 03-1083		SS-3	80	
				SS-4	80	
		GRAY/TAN, MOIST, MEDIUM STIFF TO HARD, SANDY CLAY LOAM A-6 # 03-0777		SS-5	100	
				SS-6	70	
				SS-7	90	
		GRAY, DRY, HARD, SHALE (VISUAL)		SS-8	65	
		BTH 9.02m (29.6')				

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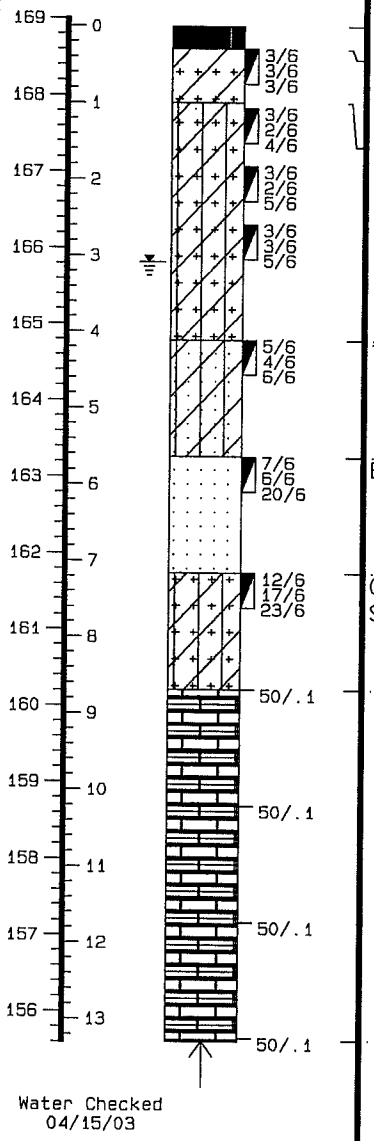
INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 9738260 BORING No: RW-6
STRUCTURE NO: 641-84-8397 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: S.R.641 OVER WOODSMALL ROAD. ELEV: 168.9
STATION/OFFSET/LINE 6 + 407 26.0 m RT OF LINE "CX" START 04/15/03
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 04/15/03
WATER DEPTH @ COMP.3.75 m : AFTER 24 HRS: 3.08 m CAVED: 7.71 m



Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
GRAY, DRY, HARD, SILTY CLAY W/COAL & WOOD FRAGS A-7-6 # 03-1234		SS-1	70	
		SS-2	90	
BROWN, SLIGHTLY MOIST, MEDIUM STIFF, SILTY CLAY LOAM A-6(7) # 03-1251		SS-3	70	
		SS-4	80	
TAN/BROWN, SLIGHTLY MOIST, MEDIUM STIFF, SANDY CLAY LOAM A-6 # 03-0777		SS-5	80	
BROWN, MOIST, MEDIUM DENSE, SAND (VISUAL)	WATER ON THE RODS AT 5.64m	SS-6	30	
GRAY, SLIGHTLY MOIST, HARD, SILTY CLAY LOAM (VISUAL)		SS-7	70	
GRAY, DRY, HARD, SHALE (VISUAL)		SS-8	10	
		SS-9	10	
		SS-10	10	
BTH 13.29m(43.6')		SS-11	10	

DRILLER: DT INSPECTER: JL DATUM: USC & GS
WEATHER: SUNNY TEMP: 82 F PAGE: OF

DIVISION OF MATERIALS AND TESTS

DES NO: 9738290

PROJECT NO: STP-291- 1(005)

STRUCTURE NO: 8

BRIDGE NO. 641-84-8400 – S.R. 641 OVER CSX RAIL ROAD

VIGO COUNTY, INDIANA

A & W PROJECT NO: 02IN1012

PREPARED FOR

INDIANA DEPARTMENT OF TRANSPORTATION

INDIANAPOLIS, INDIANA

JANUARY 14, 2004

Alt & Witzig Engineering, Inc.
4105 West 99th Street • Carmel, Indiana 46032
(317) 875-7000 • Fax (317) 876-3705

January 14, 2004

Indiana Department of Transportation
120 South Shortridge Road
P.O. Box 19389
Indianapolis, Indiana 46219-0389
ATTN: Mr. Athar A. Khan

RE: Subsurface Investigation
and Recommendations
Des No: 9738290
Project No: STP-291-1 (005)
Structure 8
Bridge No. 641-84-8400
S.R. 641 over CSX Rail Road
Vigo County, Indiana
Alt & Witzig File: 02IN1012

Gentlemen:

In compliance with your request, we have completed the geotechnical investigation at the above referenced site. It is our pleasure to transmit herewith a copy of the report.

Purpose and Procedures

This report presents the results of a geotechnical investigation for the S.R. 641 Bridge over SOO/CSX railroad in Vigo County, Indiana for Phase II of the SR 641 Project. The site of the proposed project is southeast of Terre Haute, Indiana between McDaniel and Feree Roads. The bridge is one of several structures proposed for the S.R. 641 Project. This investigation was conducted for the Indiana Department of Transportation.

The purpose of this foundation investigation was to determine the various soils profile components, the engineering characteristics of the foundation materials and to provide criteria for use by the design engineers in preparing roadway, retaining wall, and bridge design.

The field investigations to determine the engineering characteristics of the foundation materials included a reconnaissance of the project site, drilling borings as shown on the soil profile drawings, performing standard penetration tests, and obtaining soil samples retained in the standard split-spoon sampler. The apparent groundwater level and the ground surface elevation at the boring locations were also determined. The field investigation was started on March 4, 2003, and completed on November 21, 2003.

SUMMARY OF RECOMMENDATIONS

DES NO: 9738290

PROJECT NO: STP-291-1 (005)

STRUCTURE NO: 8

BRIDGE NO. 641-84-8400– S.R. 641 OVER CSX RAIL ROAD

VIGO COUNTY, INDIANA

A foundation investigation has been performed for the proposed new S.R. 641 Bridge over CSX Rail Road in Vigo County, Indiana. Design plans indicate that two span bridge structure is to be constructed with this project. The following approximate table illustrates the approximate bedrock (shale) elevations:

Bent	Boring Number	Station	Offset "CX"	Ground Surface Elevation, m (ft)	Approximate Shale Elevation, m (ft)
1NB	TB-15	9+158	7mRT	153.8 (504.5)	137.3 (450.5)
1SB	TB-16	9+163	19mLT	153.6 (503.8)	138.0 (452.8)
3NB	TB-19	9+202	7mRT	155.1 (508.7)	135.1 (443.2)
3SB	TB-20	9+207	19mLT	156.4 (513.0)	137.5 (451.0)

Table 1. Parameters for Pile Driving

The bents for this new bridge may be founded on steel H-piles driven into the competent shale bedrock at approximate elevations as shown in Table 1. Protective tips should be used on the piles. The final tip elevation should be determined by dynamic pile load testing using the methods outlined in Section 701.06 (c) of the INDOT Standard Specifications.

The MSE Walls at both abutments should have adequate factors of safety against overturning, sliding, bearing capacity, and global stability if minimum strip lengths of 0.70H are utilized. However, to meet required factors of safety for sliding and bearing capacity of the walls, it is recommended that the soft soils be undercut ten (10) feet (3m) and replaced with compacted B-Borrow. Alternatively, four (4) feet (1.2 m) may be undercut beneath the proposed leveling pad elevations of the wall and replaced with "B" Borrow and three layers of uniaxial geogrid Type-H. The first layer of geogrid should be placed 150 mm above the bottom of the excavation. Three (3) layers of geogrid should be placed perpendicular to the face of the wall and 300 mm apart vertically. For the design of the foundation pad, [redacted] psf can be used if placed upon compacted B-Borrow or geogrid reinforced soils. The calculations of our analyses are presented in the Appendix of the report.

The shallow, natural soils encountered over most of the project site were predominantly Silty Loam (A-4) and Clay (A-7-5). Specific subgrade recommendations for roadway construction will be provided under separate cover to this report.

The soil borings were performed with a drilling rig equipped with a rotary head. Conventional hollow-stem augers were used to advance the holes. Representative samples were obtained employing split-spoon sampling and Shelby tube sampling procedures in accordance with ASTM Procedures D-1586 and D-1587, respectively.

During the sampling procedure, standard penetration tests were performed at regular intervals to obtain the standard penetration value of the soil. The standard penetration value is defined as the number of blows a 140 lb hammer, falling 30 inches, required to advance the split-spoon sampler 12 inches into the soil. The results of the standard penetration tests indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

In addition to the field investigations, a supplemental laboratory investigation was conducted to ascertain additional pertinent engineering characteristics of the subsurface materials necessary in analyzing the behavior of the proposed bridge structure. All phases of the laboratory investigation were conducted in general accordance with applicable AASHTO Specifications and INDOT Exhibit "C". The laboratory-testing program included supplementary visual classification on all samples, unit weight tests, moisture content tests, and unconfined compression strength test were performed on selected soil samples.

Proposed Bridge Structure

Design plans indicate that two-span bridge structures are to be constructed in both North and South bounds with this project. The bridges are to be constructed of prestressed concrete I-beams with a span of 21.85m (71.7ft) at a skew of 10°30' Rt. The borings drilled for this new structure indicated the presence of shale bedrock (auger refusal) beneath approximately fifty-one (51) to sixty-five and one-half (65½) feet of mostly medium stiff to hard, Silty Loam or Clay soils and weathered shale. The bents for this new bridge may be founded on steel H-piles driven into the competent shale bedrock. Hardened pile tip protectors should be used for this project. The approximate bedrock (shale) elevations are shown in Table 1.

Table 1: Summary of Approximate Shale and Pile Tip Elevations

Bent	Boring Number	Station	Offset "CX"	Ground Surface Elevation, m (ft)	Approximate Shale Elevation, m (ft)
1NB	TB-15	9+158	7mRT	153.8 (504.5)	137.3 (450.5)
1SB	TB-16	9+163	19mLT	153.6 (503.8)	138.0 (452.8)
3NB	TB-19	9+202	7mRT	155.1 (508.7)	135.1 (443.2)
3SB	TB-20	9+207	19mLT	156.4 (513.0)	137.5 (451.0)

- TB-17 and TB-18 at Pier No.2 were not drilled due to site limitations

The bedrock elevations given above are only approximate elevations determined at the exact structure boring locations and should be used only as a guide. It should be noted that two different drilling rigs were used to complete the borings. A more powerful rig completed borings TB-19, TB-20, and RW-4 while a smaller, less powerful rig completed TB-15, TB-16, and RW-3. The smaller rig was used to access the borings in the swampy conditions where the larger rig became stuck on two attempts. The final tip elevation should be determined by dynamic pile load testing using the methods outlined in Section 701.06 (c) of the INDOT Standard Specifications. The piles shall be monitored by a pile driving analyzer (PDA) during installation. The table below lists pile-driving parameters.

Table 2: Parameters for Pile Driving

Bent	No. 1	No. 2	No. 3
Design Load (Tons)	55/70/90	55/70/90	55/70/90
Factor of Safety	2.0	2.0	2.0
Factored Design Load (Tons)	110/140/180	110/140/180	110/140/180
Friction in Scour Zone (Tons)	N/A	N/A	N/A
Down Drag Friction	36x2	N/A	32.5x2
Ultimate Load (Tons)	182/212/252	110/140/180	175/205/245
Testing Method	Std. Spec. 701.06 (c)		

Piles will penetrate into the weathered shale and or to competent shale bedrock. Pile capacity through field monitoring (PDA) may be achieved within the weathered shale. Our analysis is based upon a steel H-pile section with F_y=36ksi. HP 12x53's were assumed for the 55 and 70 ton piles while HP 12x74's were assumed for the 90 ton piles. Higher capacity may be achieved through the use of F_y=50ksi steel, if desired.

Piles that are driven to the shale bedrock should be restruck. The restrike should be completed after a minimum of 7 days after initial drive. Additionally, to minimize the effects of the disturbed end-bearing stratum, a minimum spacing of the piles should be 6 feet (1.8m). This will ensure that end bearing capacities are not jeopardized by disturbance of the bedrock during driving of adjacent piles.

MSE Wall Recommendations

As indicated by the design plans, MSE Retaining Walls are proposed at the end bents of the bridge structures. These MSE Walls run parallel to CSX Rail Road and are approximately two hundred thirty (230) to two hundred sixty (260) feet (70-80m) in length. Borings RW-3 and RW-4 were conducted to analyze the soil in areas furthest away from structure borings.

External stability analysis of the proposed retaining walls was performed at the most critical section, which also corresponds to the highest section of the walls, 41 feet (12.6m) at the south wall (Abutment 1). A traffic surcharge load of 250 psf was used in the design calculations. Since the highest section of the wall is beneath the bridge abutment, the soil load above the top of the wall was also factored into the design analysis. According to the design plans, the bridge abutment extends approximately five (5) feet (1.5m) above the top of the MSE Wall at all these locations. However, it is assumed the lateral earth pressure on the abutment itself will be resisted by either tiebacks or lateral pile resistance.

When MSE plans are finalized, it is recommended that the Geotechnical Consultant be provided with a set of plans to verify the recommendations made in this report. To meet required factors of safety for sliding and bearing capacity of the walls, it is recommended that the soft soils beneath the MSE wall pad be undercut ten (10) feet (3m) and replaced with compacted B-Borrow.

Alternatively, four (4) feet (1.2 m) may be undercut beneath the proposed leveling pad elevations of the wall and replaced with "B" Borrow and three layers of uniaxial geogrid Type-II as shown in the figure in the Appendix. The first layer of geogrid should be placed 150 mm above the bottom of the excavation. Three (3) layers of geogrid should be placed perpendicular to the face of the wall and 300 mm apart vertically as indicated. The MSE Walls at both abutments should have adequate factors of safety against overturning, sliding, bearing capacity, and global stability if minimum strip lengths of **0.70H** are utilized. The letter H refers to the height of the MSE Wall. For the design of the foundation pad, a net allowable bearing pressure of 4000 psf can be used if placed upon compacted B-Borrow or reinforced soils. The calculations of our analysis are presented in the Appendix of the report. The four (4) foot undercut with geogrid is recommended due to the high water table at this location.

Based on the recommendations given in this report and the slope stability analysis performed at the critical wall section, we feel that the MSE retaining walls will have adequate global stability. Sliding block and rotational analyses were performed on the MSE Wall at Abutment 1, which yielded a critical factor of safety of 1.87. The graphical and numerical results of our analysis can be found in the Appendix of our report.

Prior to construction of the walls, all topsoil and wet or soft surface soils should be stripped from the site within construction limits. Proofrolling of the exposed subsurface should be performed in accordance with Section 203.26 in the area where new fill for the walls will be placed. Any soft, loose or unstable soils encountered during proofrolling operations, which will not readily compact, should be removed and replaced in accordance with Section 203.09. It is recommended that the base of the wall/backfill area be compacted to a minimum density of 95 percent of maximum dry density as determined by AASHTO T-99.

The design engineer should address evaluation of the internal stability of the walls against three standard modes of failure. These include pullout of the strips, tensile overstress for the strip and wall/strip connection, and corrosion of the steel reinforcement strip. The backfill for these structures is to be of structure backfill as outlined in INDOT Standard Specifications. Soil parameters used for the backfill in the internal stability analysis are assumed to be $\phi = 34°$, $c = 0$, and unit weight (γ) = 125pcf. Behind the reinforced soil mass, additional "B" Borrow backfill should be placed. This material should rise from the heel of the MSE wall on a 1:1 slope.

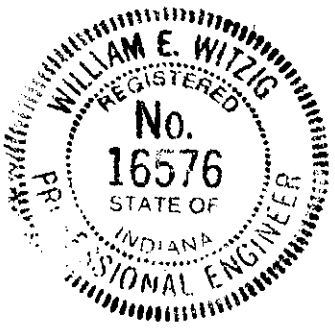
Careful consideration when compacting and placing the backfill should be given in order to minimize the increase in lateral earth pressure. Furthermore, tracked construction equipment should not be operated directly on the strips. A minimum backfill thickness of six (6) inches (150mm) is required prior to operation of tracked vehicles over the strips. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the backfill and damaging the strips. Rubber-tired equipment may pass over the reinforcement at slow speed, less than 5mph. Sudden braking and sharp turning should be avoided.

Where high water tables are indicated on the boring logs, sump pumps or other means of dewatering will be necessary to maintain a dry excavation. It should be noted the above design values are assuming proper drainage is occurring. Therefore, during construction of the retaining walls, it is recommended that a permanent subsurface drainage system be installed at or near the base of the retaining wall. It is important that the drainage system be protected by some form of filter to prevent fines from clogging the pipe. ← (?)

Benching

Benching will be necessary for areas where existing slopes are steeper than 4:1. Benches shall be a minimum of ten (10) feet wide. Benching of natural slopes and existing embankment slopes steeper than 4:1 shall be performed in accordance with Section 203.21 and 22 of the INDOT Standard Specifications.

Often, because of design and construction details that occur on a project, questions arise concerning the soil conditions. If we can give further service in these matters, please contact us at your convenience.



Very truly yours,

ALT & WITZIG ENGINEERING, INC.

William E. Witzig/bka

William E. Witzig, P.E.

Appendix

Boring Location Plan

Logs of Test Borings

Undercutting Below Bottom of MSE Wall

MSE Wall Analysis (Abutment 1)

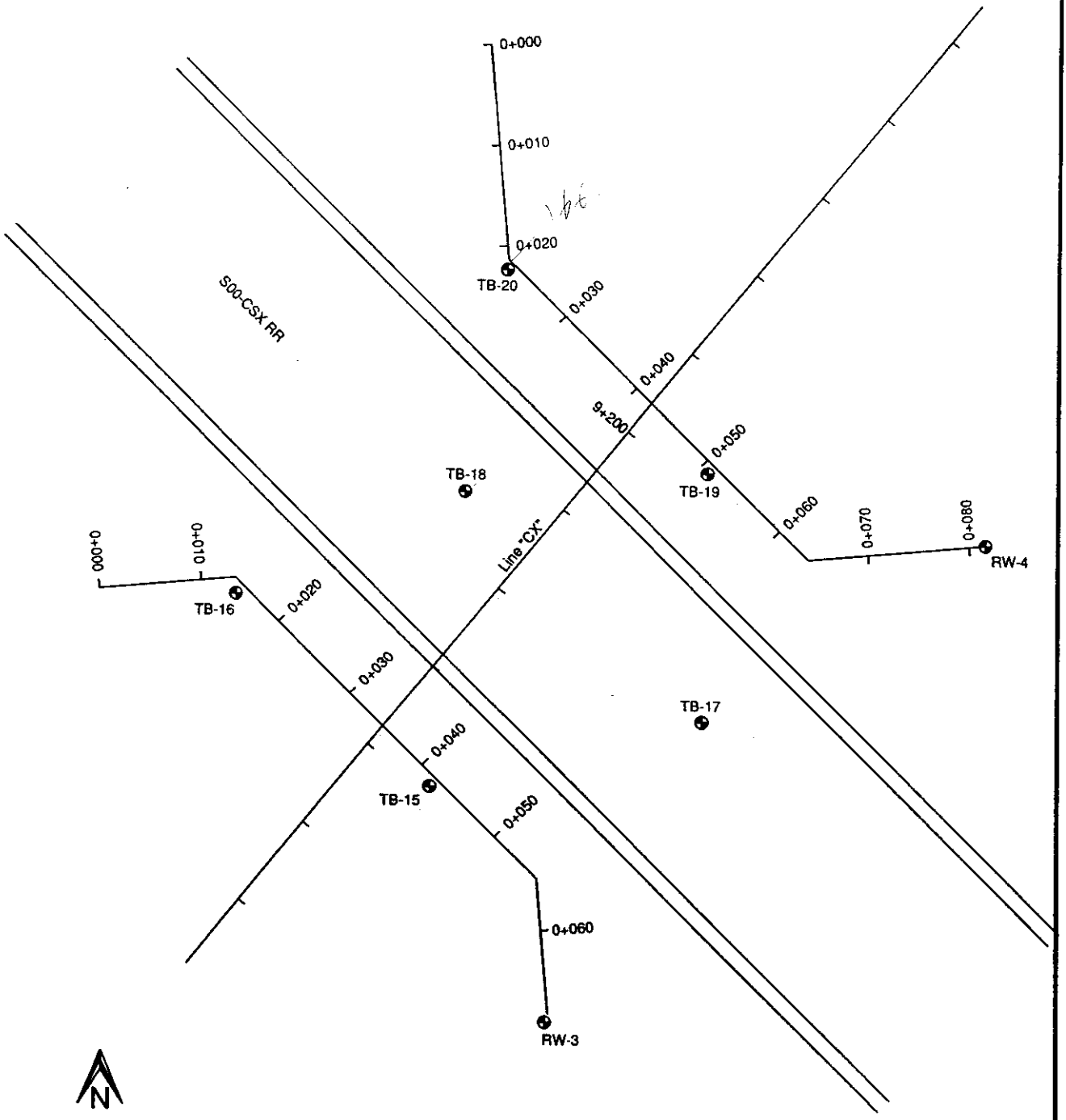
SPILE Printouts for Downdrag Force

Unconfined Compressive Strength Test Results

Summary of Unit Weight

Soil Classification Summary Sheet

BORING LOCATION PLAN



Note:
TB-17 and TB-18 were not drilled due to access constraints.

Prepared For: SR 641 in Vigo Co.		Prepared By: Alt & Witzig Engineering, Inc.	
Project Name: INDOT - Geotechnical Division		Project No: 02IN1012	Date: 12/03

STATE GENERAL NOTES

SAMPLE IDENTIFICATION

The AASHTO M-145 Soil Classification System is used to identify the soils unless otherwise noted.

SOIL PROPERTY SYMBOLS

N:	Standard "N" penetration: Blows per foot of a 140-pound hammer falling 30 inches on a 2 inch O.D. split-spoon
Qu:	Unconfined Compressive Strength, TSF
γ:	Natural Dry Density, PCF
W:	Water content, %
LL:	Liquid Limit, %
PL:	Plastic Limit, %
PI:	Plasticity Index, %
▽:	Apparent groundwater level at time noted while drilling
▼:	Apparent groundwater level at time noted upon completion of drilling
▽:	Apparent groundwater level at time noted 24 hours after completion of drilling

DRILLING AND SAMPLING SYMBOLS

SS: Split-spoon - 1 3/8" I.D., 2" O.D., except where noted
ST: Shelby-tube - 3" O.D., except where noted
RC: Rock Core, 2" O.D., Except Where Noted
AU: Auger sample
DB: Diamond bit
CB: Carbide bit
WS: Washed Sample

RELATIVE DENSITY AND CONSISTENCY CLASSIFICATION

TERM (NON-COHESIVE SOILS)	BLOWS PER FOOT
Very loose	0 - 5
Loose	6 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very dense	51 or more

TERM (COHESIVE SOILS	BLOWS PER FOOT
Very soft	0 - 3
Soft	4 - 5
Medium	6 - 10
Stiff	11 -15
Very stiff	16 - 30
Hard	31 or more

LOG OF TEST BORING

Project: DES No. 9738290 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-15
Surface Elevation 153.8m (504.5f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8400	Station	9+158	Offset	7 m Rt.	Line	CX
Datum	USGS	Weather	Sunny	Temperature	50 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	δ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	100	1-2-3		Brown Mottled Gray, Moist, Soft, Silty Clay A-6						
					Test 08						
2SS	X	100	2-1-3		Gray, Moist, Soft, Silty Loam A-4						
				5							
3SS	X	100	2-2-3		Test 01						
4SS	X	100	4-6-6	10							
5SS	X	100	4-4-5		Medium Stiff at 13.5 to 15.0 feet (Sample 5SS)						
				15	Gray, Moist, Stiff, Silty Loam A-4 Test 01						
6SS	X	100	9-9-12		Very Stiff at 18.5 to 20.0 feet (Sample 6SS)						
				20							
7SS	X	100	4-4-9								
				25							
8SS	X	100	3-2-2								
				30							
9SS	X	100	3-2-3		Gray, Moist, Soft, Silty Loam A-4 Test 01						
				35							
10SS	X	100	4-6-6								
				40							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling 0.0 (Surface) Upon Completion of Drilling
Time After Drilling 24 hrs.
Depth to Water 0.0 (Surface)
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 11/21/03 End 11/21/03 Rig ATV
Driller Mike/Craig Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738290 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-15
Surface Elevation 153.8m (504.5f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8400	Station	9+158	Offset	7 m Rt.	Line	CX
Datum	USGS	Weather	Sunny	Temperature	50 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	δ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
				45	Brownish-Blue, Moist, Stiff to Very Stiff, Silty Clay Loam A-4 Test 03						
11SS	X	100	5-8-10								
12SS	X		18-50/3	50	Gray, Moist, Weathered, Shale (Visual)						
~~13SS~~ 1RC		100	~~50/3~~	55	Auger Refusal at 54.0 feet Rock Core Initiated at 54.0 feet Dark Gray, Moist, Weathered, Shale (Visual) RQD. = 100%						
				60	Rock Core Terminated at 59.0 feet						
				65							
				70							
				75							
				80							
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738290 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-16
Surface Elevation 153.6m (503.8f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8400	Station	9+163	Offset	19 m Lt.	Line	CX
Datum	USGS	Weather	Sunny	Temperature	55 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	75	2-2-3		Brown, Wet, Soft, Silty Clay A-6 Test 08						
2SS	X	50	2-1-2	5							
3SS	X	100	5-10-10		Brown Mottled Gray, Moist, Very Soft, Silty Clay A-6 Test 08						
4SS	X	100	6-11-13	10	Gray, Moist, Very Stiff to Medium Stiff, Silty Loam A-4 Test 01						
5SS	X	50	3-4-4	15							
6SS	X	100	2-4-10	20							
7SS	X	100	3-3-5	25	Gray, Moist, Stiff to Medium Stiff, Silty Clay A-6 Test 08						
8SS	X	100	3-4-10	30	Gray, Moist, Stiff, Silty Clay Loam A-4 Test 03						
9SS	X	100	2-6-8	35	Bluish-Green, Moist, Stiff, Clay A-7-5 Test 05						
10SS	X	100	5-8-12	40							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling 0.0 (Surface) Upon Completion of Drilling 2.0
Time After Drilling 24 hrs.
Depth to Water 0.0 (Surface)
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 11/21/03 End 11/21/03 Rig ATV
Driller Mike/Craig Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738290 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-16
Surface Elevation 153.6m (503.8f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8400	Station	9+163	Offset	19 m Lt.	Line	CX
Datum	USGS	Weather	Sunny	Temperature	55 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Brown Mottled Gray, Moist, Stiff to Hard, Clay						
11SS	X	100	5-16-30	45	A-7-5						
					Test 05						
					Brown, Slightly Moist, Hard, Silty Clay Loam						
12SS	X	50	50/6	50	A-4						
					Test 03						
					Gray, Hard, Weathered, Shale (Visual)						
					Auger Refusal at 51.0 feet						
				55							
				60							
				65							
				70							
				75							
				80							
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738290 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section
4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-19
Surface Elevation 155.1m (508.7f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8400	Station	9+202	Offset	7 m Rt.	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	37 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	50	0-1-1		Brown, Very Moist, Very Soft, Silty Loam A-1						
2SS	X	80	1-2-2	▽	Test 01	1.53	89.8	28.1			
				5							
3SS	X	100	2-3-4		Medium Stiff at 6.0 to 7.5 feet (Sample 3SS)						
4SS	X	100	1-2-3			1.19	86.6	26.8			
				10	Gray, Moist, Soft, Clay A-7-5 Test 05						
5SS	X	100	3-2-3								
				15							
6SS	X	100	7-7-10								
				20	Gray, Wet, Medium Dense, Sandy Loam A-4 Test 07						
7SS	X	60	2-5-7								
				25							
8SS	X	100	4-8-13			3.78	102.0	22.7			
				30	Brown Mottled Gray, Slightly Moist, Stiff to Very Stiff, Clay A-7-5 Test 05						
9SS	X	100	5-11-17			8.84	114.2	14.9			
				35							
10SS	X	100	16-31 50/4								
				40	Gray, Dry, Hard, Weathered Shale (Visual)						

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ♀ 8.0 Upon Completion of Drilling ♀
Time After Drilling 24 hrs.
Depth to Water ▽ 4.0 ▽ ▽ ▽
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 3/5/03 End 3/5/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738290 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-19
Surface Elevation 155.1m (508.7f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8400	Station	9+202	Offset	7 m Rt.	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	37 F	Inspector	Tom Coffey

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES					
No.	Typ	Rec (%)	Blow Count	Depth		qu (qp) (tsf)	δ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
11SS	X	100	25-50/3	45							
12SS	X	100	22-50/4	50							
13SS	X	100	19-50/4	55	Gray, Dry, Hard, Weathered Shale (Visual)						
14SS	X	100	20-50/4	60							
15SS	X	100	50/5	65							
					Auger Refusal at 65.5 feet						
				70							
				75							
				80							
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738290 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section
4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-20
Surface Elevation 156.4m (513.0f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8400	Station	9+207	Offset	19 m Lt.	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	35 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	δ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
1SS	X	50	2-1-2								
2SS	X	70	1-1-3	5							
3SS	X	100	6-10-11		Very Stiff at 6.0 to 7.5 feet (Sample 3SS) Brown, Moist, Very Soft to Stiff, Silty Clay Loam A-4 Test 03						
4SS	X	100	3-5-6	10							
5SS	X	90	11-6-8	15	Gray, Slightly Moist, Stiff, Silty Loam A-1 Test 01						
6SS	X	100	2-3-3	20							
7SS	X	90	5-15-36	25	Gray, Slightly Moist, Medium Stiff to Hard, Clay A-7-5 Test 05						
8SS	X	20	26-50/4	30							
9SS	X	30	11-37 50/4	35	Gray, Dry, Hard, Weathered Shale (Visual)						
10SS	X	40	40-50/4	40							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 10.0 Upon Completion of Drilling ▼ 3.0
Time After Drilling 24 hrs.
Depth to Water ▽ 2.0 ▼ ▼ ▼
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 3/4/03 End 3/4/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738290 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-20
Surface Elevation 156.4m (513.0f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8400	Station	9+207	Offset	19 m Lt.	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	35 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
11SS	X	40	21-50/4	45							
12SS	X	20	35-50/3	50	Gray, Dry, Hard, Weathered Shale (Visual)						
13SS	X	20	50/4	55							
14SS	X	10	50/4	60							
					Auger Refusal at 62.0 feet						
				65							
				70							
				75							
				80							
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738290 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RW-3
Surface Elevation 153.2m (502.5f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	641-84-8400	Station	9+145	Offset	30 m Rt.	Line	CX
Datum	USGS	Weather	Sunny	Temperature	55 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	25	1-1-1		Brown Mottled Gray, Wet, Very Soft to Medium Stiff, Silty Clay						
2SS	X	60	2-4-4		A-6	0.59	94.9	28.7			
				5	Test 08						
3SS	X	60	1-1-0		Shelby Tube Pushed from 4.0 to 6.0 feet (1ST - 50% Recovery)						
					Gray, Wet, Very Soft, Silty Clay						
4SS	X	50	1-1-1		A-6	0.75	89.1	28.9			
				10	Test 08						
					Shelby Tube Pushed from 10.0 to 12.0 feet (2ST - 100% Recovery)						
5SS	X	90	3-2-6	15							
6SS	X	80	5-5-5	20							
7SS	X	70	5-3-3		Gray, Moist, Medium Stiff to Stiff, Silty Loam						
				25	A-4						
					Test 01						
8SS	X	80	2-3-5	30							
9SS	X	80	4-5-7	35							
					Boring Terminated at 35.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling ▽ 0 (Surface) Upon Completion of Drilling ▽ 3.0
Time After Drilling 24 hrs.
Depth to Water ▽ 0 (Surface) ▽ ▽ ▽
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 11/20/03 End 11/20/03 Rig ATV
Driller Mike/Khris Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738290 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section
4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RW-4
Surface Elevation 154.3m (506.1f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	641-84-8400	Station	9+210	Offset	35 m Rt.	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	34 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	100	1-2-1		Brown Mottled Gray, Very Moist, Very Soft, Silty Loam A-1 Test 01						
2SS	X	100	2-2-4	5	Gray, Moist, Medium Stiff, Clay A-7-6 Test 06						
3SS	X	100	3-6-4		Brown Mottled Gray, Moist, Medium Stiff, Clay A-7-5 Test 05						
4SS	X	100	2-2-3	10	Gray, Moist, Soft, Silty Clay Loam A-4 Test 03						
5SS	X	100	3-2-2	15	Gray, Moist, Soft, Clay A-7-5 Test 05						
6SS	X	100	10-7-8	20	Gray, Wet, Medium Dense, Sandy Loam A-2-4 Test 04						
7SS	X	100	7-6-6	25							
8SS	X	100	2-3-8	30	Gray, Moist, Stiff, Clay A-7-5 Test 05						
9SS	X	100	5-9-16	35	Brown Mottled Gray, Slightly Moist, Very Stiff, Silty Loam A-1 Test 01						
10SS	X	100	10-18 50/5		Gray, Dry, Hard, Weathered, Shale (Visual)						
				40	Boring Terminated at 39.9 feet						

WATER LEVEL OBSERVATIONS

While Drilling ▽ 18.0 Upon Completion of Drilling ▼ 2.0
Time After Drilling 24 hrs.
Depth to Water ▽ 1.0 ▼ ▼ ▼
Depth to Cave in

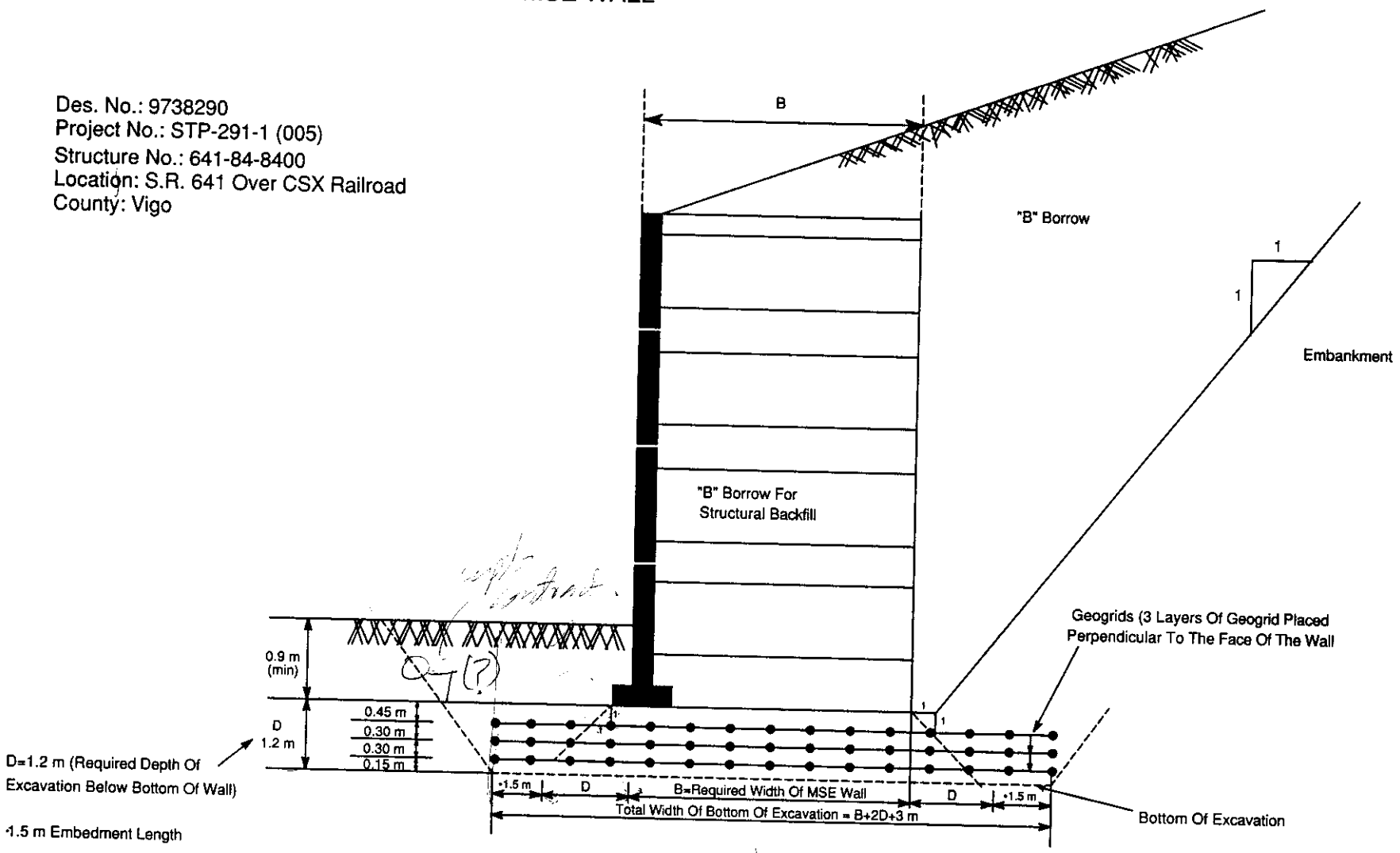
The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 3/5/03 End 3/5/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

UNDERCUTTING BELOW BOTTOM OF MSE WALL

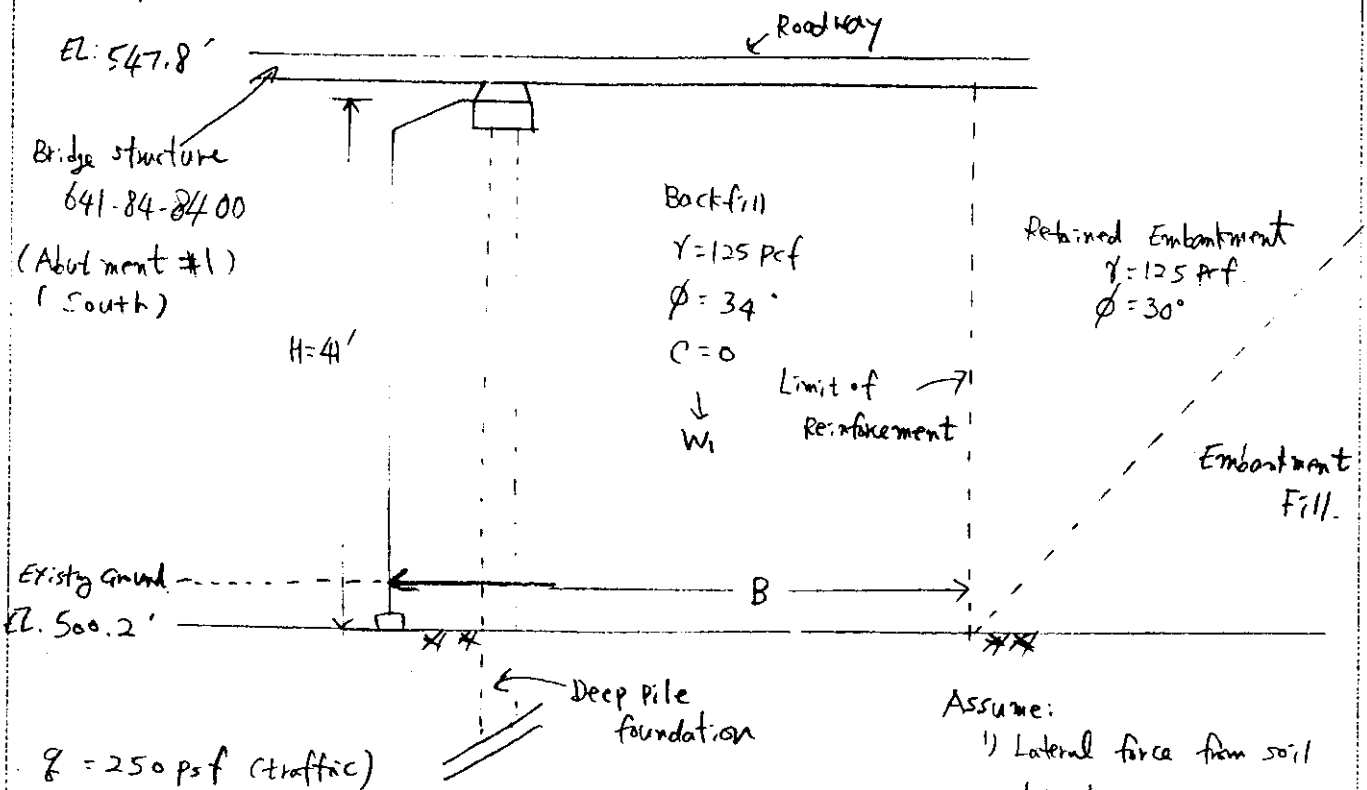
Des. No.: 9738290
Project No.: STP-291-1 (005)
Structure No.: 641-84-8400
Location: S.R. 641 Over CSX Railroad
County: Vigo



Prepared For: SR 641 in Vigo Co.		Prepared By: Alt & Witzig Engineering, Inc.	
Project Name: INDOT - Geote[redacted] Division		Project No: 02IN1012	Date: 12/03

(Abutment #1)

Soil Parameters from TB-15



Assume:

1) Lateral force from soil above top of the wall is resisted by either tie-backs into the abutments or lateral pile resistance.

q = 250 psf (traffic)

Foundation Soil : Soft, Silty Loam (Test a1)
Undercut and backfilled with "B" Borrow
(γ = 125 pcf, ϕ = 30, C = 0)

P_1 = Retained soil pressure

P_2 = Surcharge Pressure

Find K_a ⇒ $K_a = \tan^2\left(45 - \frac{\phi}{2}\right) = \tan^2\left(45 - \frac{30}{2}\right) = 0.33$

Find P_a ⇒ $P_a = P_1 + P_2 = \frac{1}{2} K_a \gamma H^2 + K_a \cdot q \cdot H$

$= \frac{1}{2}(0.33)(125)(41)^2 + (0.33)\cdot(250)(41)$

$= 34,670.625 + 3,382.5$

$= 38,053.125$ lb/ft

Find Resultant, $\bar{z}$ ⇒ $\bar{z} = \frac{P_2\left(\frac{H}{2}\right) + P_1\left(\frac{H}{3}\right)}{P_a} = \frac{3,382.5\left(\frac{41}{2}\right) + 34,670.625\left(\frac{41}{3}\right)}{38,053.125}$

$= 14.27$ ft.

02IN1012 MSE Wall Analysis

$P_a = 38,053.125$ lb/ft

$z = 14.27$ ft

* Determine Factor of Safety Against Sliding

$$F.S_{sliding} = \frac{\Sigma P_{resisting}}{\Sigma P_{driving}} = \frac{W_1 \tan\phi + CB}{P_o} \quad ; P_o = P_a$$

Without undercut, $C = 750$ psf, F.S. < 1 for sliding. Therefore assume undercut w/ B-Borrow $\phi = 30°$

Try reinforcement strip $0.7H = 0.7(41) = 28.7$ ft, use 29 ft $= B$

$\Sigma P_{resisting} = W_1 \tan\phi + CB = 148,625 \tan 30 = 85,808.7$ lb/ft

$\Sigma P_{driving} = P_a = 38,053.125$ lb/ft

$$\therefore F.S = \frac{85,808.7 \text{ lb/ft}}{38,053.125 \text{ lb/ft}} = 2.25 \geq 1.5 \quad \text{So. O.K.}$$

* Determine Factor of Safety Against Bearing Capacity Failure

Foundation soil ; $C = 2000$ $\phi = 0°$

See sheet 4

$q_{all} = 4560$ psf

Find eccentricity : $e = \frac{B}{2} - \frac{\Sigma M_R - \Sigma M_D}{\Sigma V}$

$$e = \frac{29}{2} - \left(\frac{(125)(41)(29)\left(\frac{29}{2}\right) - (38,053.125)(14.27)}{(125)(41)(29)} \right)$$

$$= 14.5 - \frac{2,155,062.5 - 543,018.09}{148,625.0} = 14.5 - 10.85 = 3.65$$

$\therefore (e = 3.65) < \left(\frac{B}{2} = 4.83\right)$

$$\sigma_v = \frac{125(41)(29) + 250(29)}{29 - (2)(3.65)} = \frac{155,875.0}{21.7} = 7183.2 \text{ psf}$$

$$F.S = \frac{Q_{ult}}{\sigma_v} = \frac{11400}{4250} = 2.7 > 2.0, \text{ so. O.K}$$

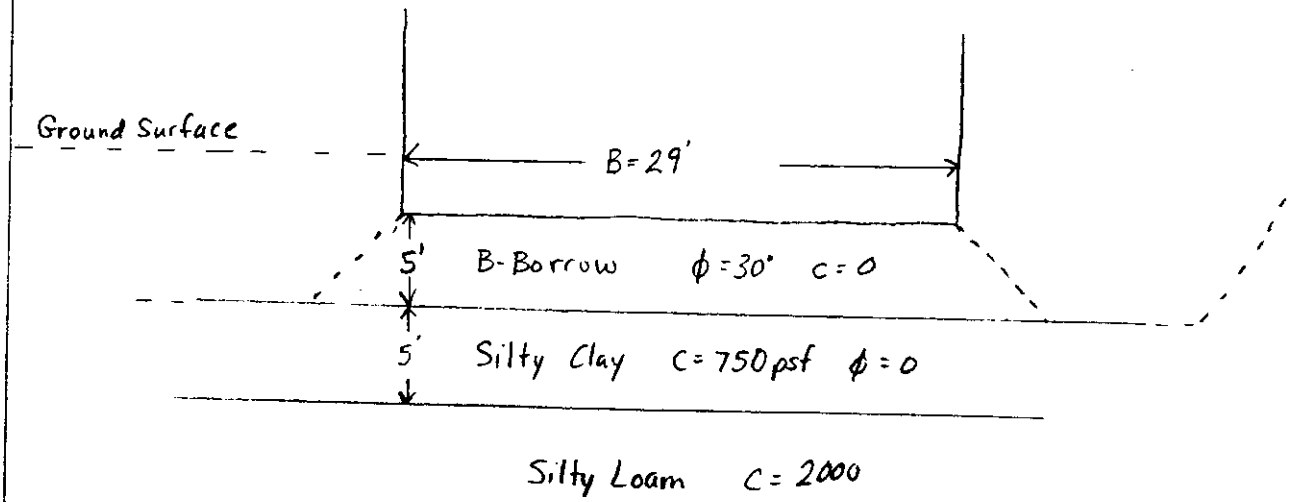
(see sheet 4)

* Determine Factor of Safety against Overturning.

$$F.S = \frac{\Sigma M_R}{\Sigma M_O} = \frac{2155,062.5}{543,018.09} = 3.97 > 1.5$$

So, O.K.

Assume: depth of undercut, $D_u = 5$ feet
replace with B-Borrow



Q_{ult} (Silty Clay) = $cN_c + \gamma D_f N_q + \frac{1}{2}\gamma B N_\gamma = (750)(5.7) = 4275$

$q_{all} = \frac{4275}{2.5} = 1{,}710$ psf

From sheets 2 & 3, $\sigma_v = 7183$ psf at base of MSE Wall

Determine load on Silty Clay = $\frac{B\sigma_v}{B+2D_u} = 5341 > 1{,}710$ not ok

Try $D_u = 10'$

Now foundation material is Silty Loam, $c = 2000$
and we have 10' of B-Borrow beneath the base

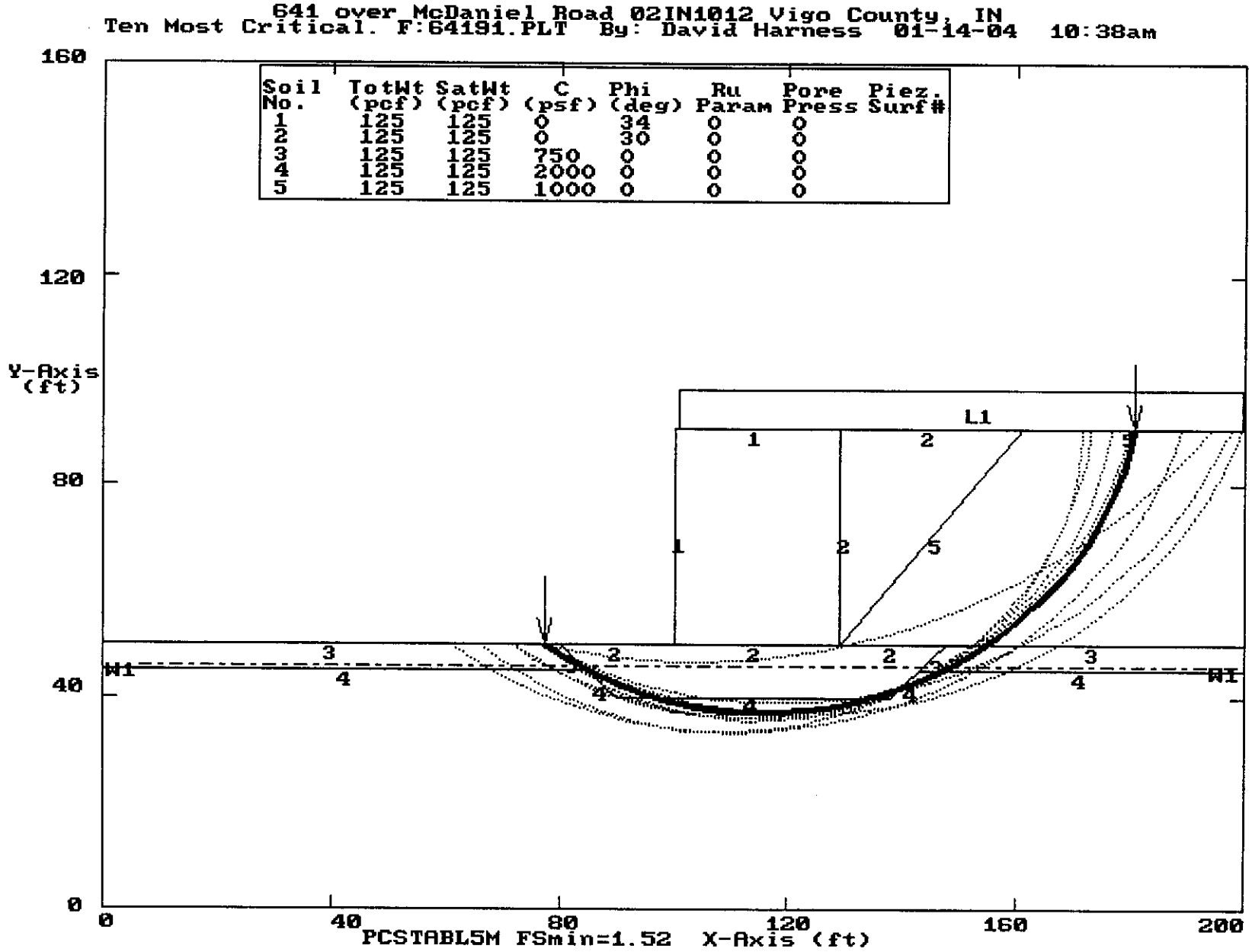
Q_{ult} (Silty Loam) = $cN_c = (2000)(5.7) = 11400$ psf $\quad q_{all} = \frac{11400}{2.5} = 4560$

Determine load on Silty Loam = $\frac{(29)(7183)}{(29+2(10))} = 4250$

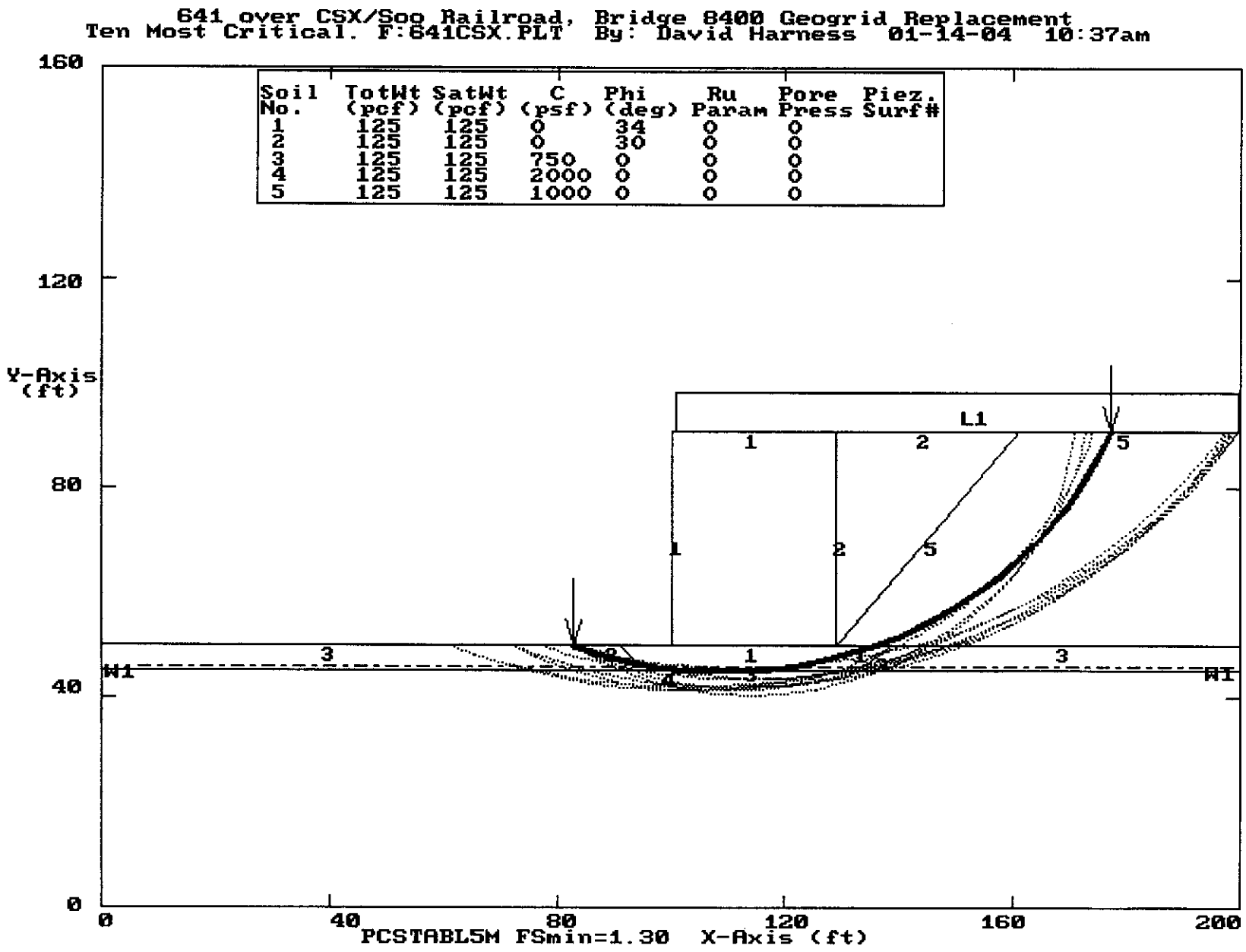
Check
q_{all} > actual load $\Rightarrow$ $4560 > 4250$ so ok ✓

So: use 10' undercut replaced with compacted B-Borrow
or
use alternate of four (4) foot undercut replaced with B-Borrow and 3 layers of uniaxial geogrid as shown

10' Undercut and Replacement with B-Borrow
Global Stability Factor of Safety = 1.5



4' Undercut and Replacement with B-Borrow and 3 Layers of Uniaxial Geogrid
Global Stability Factor of Safety = 1.3



Downdrag Force at Bent No. 1

-------- ULTIMATE STATIC PILE CAPACITY/Federal Highway Administration --------+
Nordlund (1963, 1979) and Tomlinson (1979, 1980) methods

Project Name	: SR641/CSX	Client	: INDOT
File Name	: 641b1	Project Manager	: DCH
Date	: 12/ 4/10	Computed by	: KHC

Depth of Top of Pile = 0.00 ft. Pile length = 20.00 ft.
Depth to Water Table = 0.00 ft.
Type of Pile = H Pile
HP 12x53

SKIN FRICTION CONTRIBUTION

Layer	Soil Type	Thickness (ft)	Effective Stress (psf)	Internal Friction Angle	N-SPT	Pile Perimeter (ft)
1	Cohesive	7.50	178.50	---	--	3.97
2	Cohesive	12.50	654.50	---	--	3.97

Layer	Soil Type	Undrained Shear Strength (psf)	Adhesion	Pile Taper	Sliding Friction Angle	Skin Resistance (Kips)
1	Cohesive	750.00	622.50	----	-----	18.53
2	Cohesive	1500.00	1060.00	----	-----	52.60

Total Side Friction : 71.14

POINT RESISTANCE CONTRIBUTION

Effective Stress at pile Tip (psf)	Undrained Shear Strength (psf)	SPT Value	Pile End Area (ft*ft)	Bearing Capacity Factor Nq	End Bearing Resistance (Kips)
952.00	1500.00	----	0.99	----	13.30

Ultimate Static Pile Capacity : 84.44

----- Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu -----+

Downdrag Force at Bent No. 3

ULTIMATE STATIC PILE CAPACITY/Federal Highway Administration
Nordlund (1963, 1979) and Tomlinson (1979, 1980) methods

Project Name	: SR641/CSX	Client	: INDOT
File Name	: 641b3	Project Manager	: DCH
Date	: 12/ 4/10	Computed by	: KHC

Depth of Top of Pile = 0.00 ft. Pile length = 20.00 ft.
Depth to Water Table = 0.00 ft.
Type of Pile = H Pile
HP 12x53

SKIN FRICTION CONTRIBUTION

Layer	Soil Type	Thickness (ft)	Effective Stress (psf)	Internal Friction Angle	N-SPT	Pile Perimeter (ft)
1	Cohesive	17.50	416.50	---	--	3.97
2	Cohesionless	2.50	892.50	26.00	--	3.97

Layer	Soil Type	Undrained Shear Strength (psf)	Adhesion	Pile Taper	Sliding Friction Angle	Skin Resistance (Kips)
1	Cohesive	1200.00	904.00	----	-----	62.82
2	Cohesionless	--	--------	----	19.58	2.02

Total Side Friction : 64.84

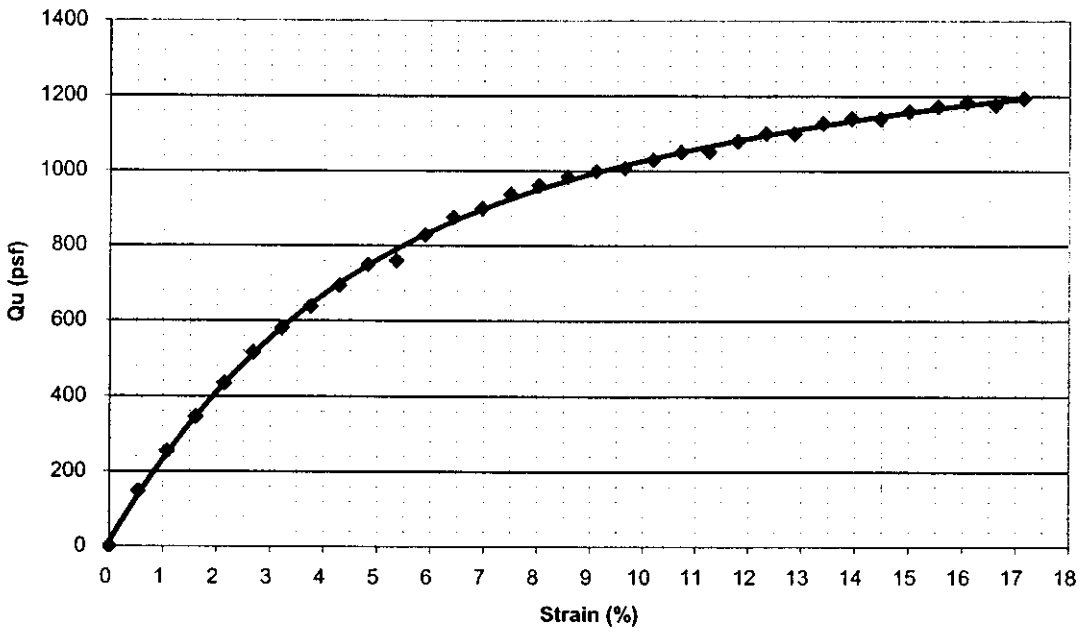
POINT RESISTANCE CONTRIBUTION

Effective Stress at pile Tip (psf)	Internal Friction Angle	SPT Value	Pile End Area (ft*ft)	Bearing Capacity Factor Nq	End Bearing Resistance (Kips)
952.00	26.00	-----	0.99	17.40	7.95

Limiting End Bearing Resistance : 13.13

Ultimate Static Pile Capacity : 72.79

Unconfined Compression Test

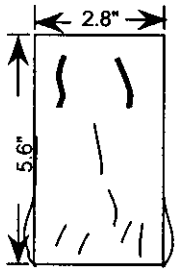


Sample Location RW-3, 1ST

Depth 4.0 - 6.0 ft Moisture Content: 28.7 (%)

Strain Rate 2% min. Dry Unit Weight: 94.9 (pcf)

FAILURE SKETCH



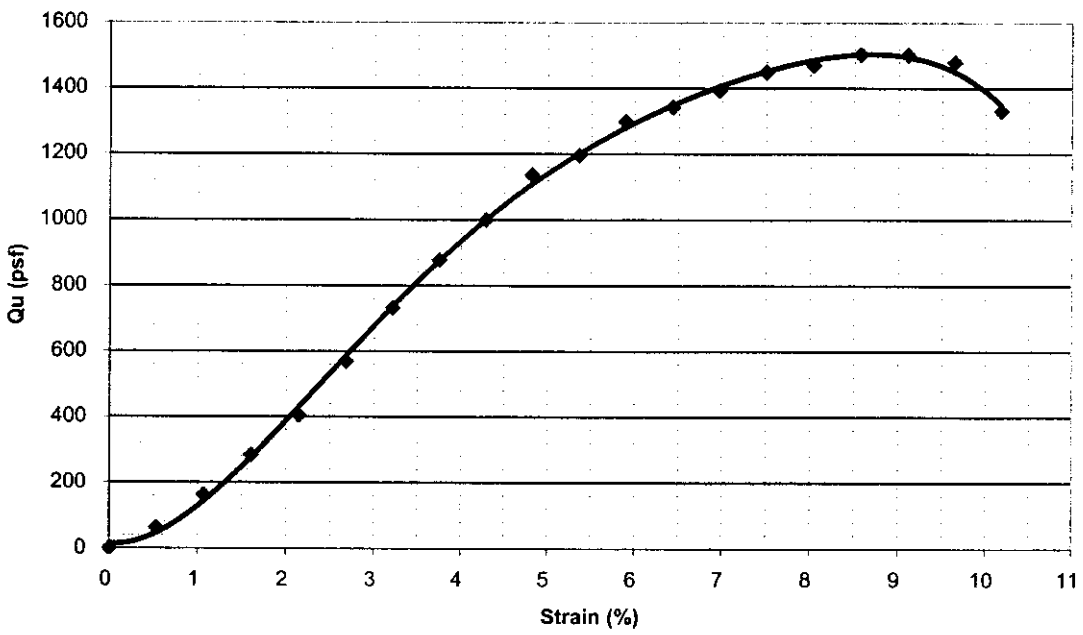
Soil Description Silty Clay, A-6, Test 08

Unconfined Compressive Strength (psf) 1,170

Failure Strain (%) 15.0

PREPARED FOR: INDOT-Geotechnical Division Indianapolis, Indiana	A&W	PREPARED BY: Alt & Witzig Engineering, Inc. Carmel, Indiana	
PROJECT NAME: S.R. 641 in Vigo County		PROJECT NO.: 02IN1012	DATE: 12/03

Unconfined Compression Test

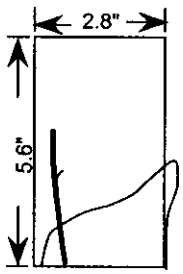


Sample Location RW-3, 2ST

Depth 10.0 - 12.0 ft Moisture Content: 28.9 (%)

Strain Rate 2% min. Dry Unit Weight: 89.1 (pcf)

FAILURE SKETCH



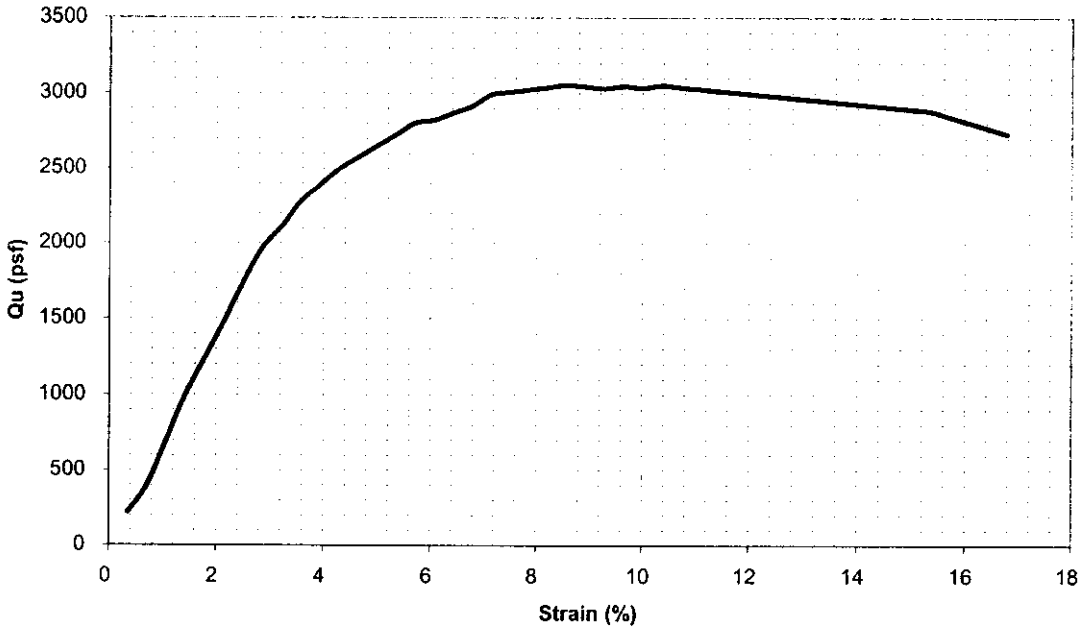
Soil Description Silty Loam, A-4, Test 01

Unconfined Compressive Strength (psf) 1,500

Failure Strain (%) 8.6

PREPARED FOR: INDOT-Geotechnical Division Indianapolis, Indiana	A&W	PREPARED BY: Alt & Witzig Engineering, Inc. Carmel, Indiana	
PROJECT NAME: S.R. 641 in Vigo County		PROJECT NO.: 02IN1012	DATE: 12/03

Unconfined Compression Test
(Split Spoon Sample)

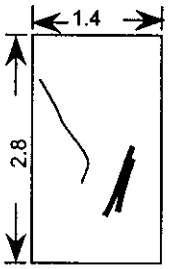


Sample Location TB-19

Depth 5.0' Moisture Content: 28.1 (%)

Strain Rate 2% min. Dry Unit Weight: 89.8 (pcf)

FAILURE SKETCH



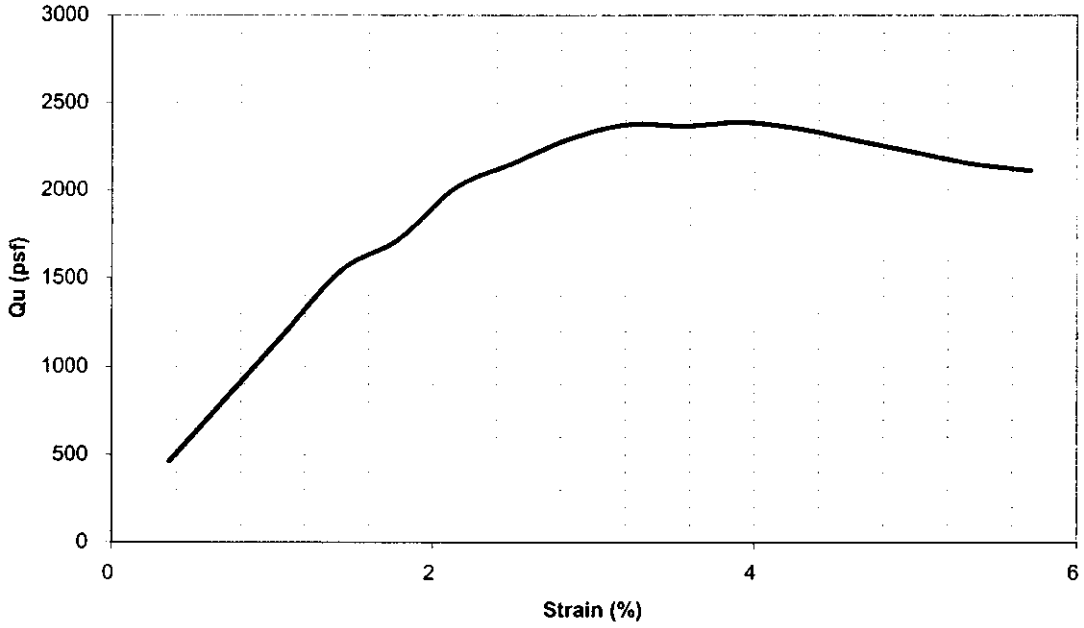
Soil Description Clay, A-7-5, Test 05

Unconfined Compressive Strength (psf) 3050

Failure Strain (%) 10.4

PREPARED FOR: INDOT - Geotechnical Division, Indianapolis, Indiana	A&W	PREPARED BY: Alt & Witzig Engineering, Inc., Carmel, Indiana	
PROJECT NAME: SR 641 in Vigo County		PROJECT NO.: 02IN1012	DATE: 11/03

Unconfined Compression Test
(Split Spoon Sample)

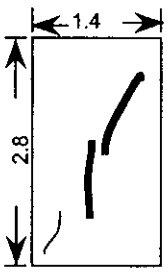


Sample Location TB-19

Depth 10.0' Moisture Content: 26.8 (%)

Strain Rate 2% min. Dry Unit Weight: 86.6 (pcf)

FAILURE SKETCH



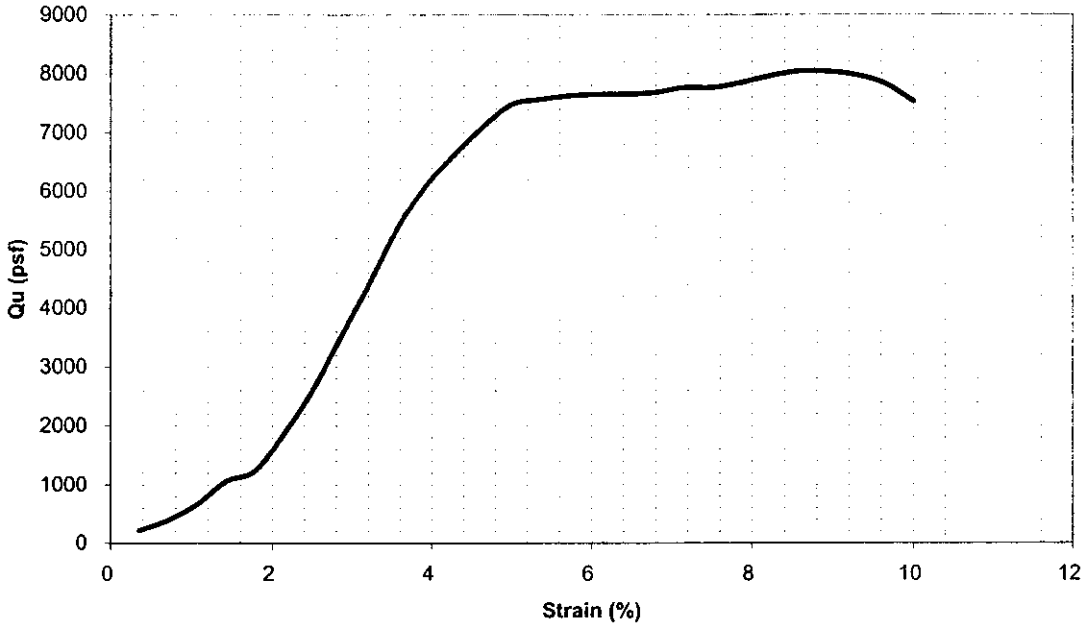
Soil Description Clay, A-7-5, Test 05

Unconfined Compressive Strength (psf) 2380

Failure Strain (%) 3.8

PREPARED FOR: INDOT - Geotechnical Division Indianapolis, Indiana	A&W	PREPARED BY: Alt & Witzig Engineering, Inc. Carmel, Indiana	
PROJECT NAME: SR 641 in Vigo County		PROJECT NO.: 02IN1012	DATE: 11/03

Unconfined Compression Test
(Split Spoon Sample)

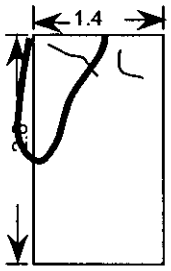


Sample Location TB-19

Depth 30.0' Moisture Content: 22.7 (%)

Strain Rate 2% min. Dry Unit Weight: 102 (pcf)

FAILURE SKETCH



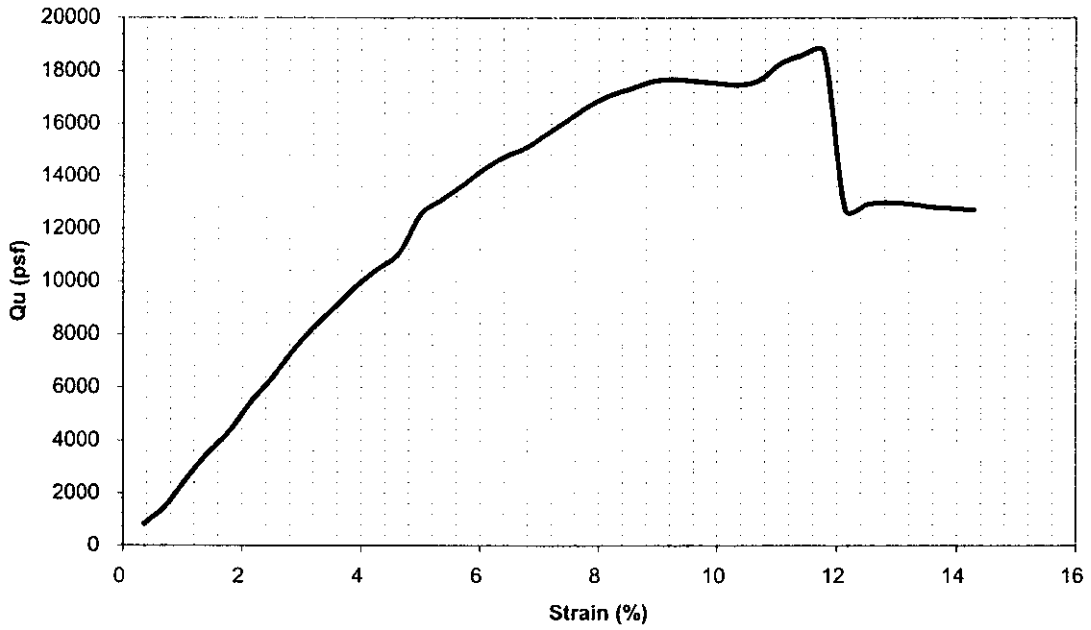
Soil Description Clay, A-7-5, Test 05

Unconfined Compressive Strength (psf) 7560

Failure Strain (%) 5.4

PREPARED FOR: INDOT - Geotechnical Division Indianapolis, Indiana	A&W	PREPARED BY: Alt & Witzig Engineering, Inc. Carmel, Indiana	
PROJECT NAME: SR 641 in Vigo County		PROJECT NO.: 02IN1012	DATE: 11/03

Unconfined Compression Test
(Split Spoon Sample)

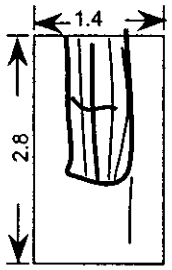


Sample Location TB-19

Depth 35.0' Moisture Content: 14.9 (%)

Strain Rate 2% min. Dry Unit Weight: 114.2 (pcf)

FAILURE SKETCH



Soil Description Clay, A-7-5, Test 05

Unconfined Compressive Strength (psf) 17670

Failure Strain (%) 9.3

PREPARED FOR: INDOT - Geotechnical Division, Indianapolis, Indiana		PREPARED BY: Alt & Witzig Engineering, Inc., Carmel, Indiana	
PROJECT NAME: SR 641 in Vigo County		PROJECT NO.: 02IN1012	DATE: 11/03

Summary of Unit Weights

Project Name: SR-641 over CSX Rail Road

Project Number: 02IN1012 Date Completed: 11/2003

Boring #	Sample Depth	Moisture Content	Wet Density	Dry Density
RW-3	4-6'	30.7	118.6	91
	10-12'	22.9	118.6	97

Project No.: STP-291-1 (005)
Des No.: 9738220
S.R. 641, Vigo County, Indiana
Alt & Witzig File: 02IN1012

SOIL CLASSIFICATION SUMMARY														
Test No.	Boring Number	Sample & Depth	Description	Passing #10	Passing #40	> #10 % Gravel	#10-#200 % Sand	#200-.002mm % Silt	% <0.002mm (%) Clay	% <0.001mm Colloids	LL	PL	PI	AASHTO Classification
01	TB-26[1]	1ST 16 to 18 ft	Silty Loam	100	100	0	6	77	17	14	26	24	2	A-4 (1)
02	TB-26[1]	3SS 5.0 to 7.5 ft	Silty Loam	100	99	0	22	61	17	17	24	18	6	A-4 (3)
03	TB-23[2]	8SS 28.5 to 30 ft	Silty Clay Loam	99	97	1	15	64	20	19	26	20	6	A-4 (4)
04	TB-28[1]	7SS 23.5 to 25 ft	Sandy Loam	100	98	0	66	18	16	14	NP	NP	--	A-2-4 (0)
05	TB-26[1]	2ST 46 to 48 ft	Clay	100	100	0	0	40	60	55	50	36	14	A-7-5 (20)
06	TB-2[3]	9SS 33.5 to 35 ft	Clay	100	100	0	1	25	74	72	54	19	35	A-7-6 (38)
07	TB-4[3]	14SS 58.5 to 60 ft	Sandy Loam	89	71	11	53	22	14	12	23	21	2	A-4 (0)
08	TB-13[4]	1ST 38 to 40 ft	Silty Clay	100	99	0	10	58	32	30	25	13	12	A-6 (8)
09	TB-10[4]	1ST 10-12 ft	Clay	100	100	0	4	40	56	49	37	28	9	A-4 (10)

Notes:
1: Soils from Des No.: 9738330, Structure 641-84-8401
2: Soils from Des No.: 9738410, Structure 641-84-8404
3: Soils from Des No.: 9738270, Structure 641-84-8398
4: Soils from Des No.: 9738280, Structure 641-84-8399

DES NO: 9738270
PROJECT NO: STP-291- 1 (005)
STATE ROAD 641 OVER HONEY CREEK
BRIDGE NO. 641-84-8398
VIGO COUNTY, INDIANA
A & W PROJECT NO: 02IN1012

PREPARED FOR
INDIANA DEPARTMENT OF TRANSPORTATION
INDIANAPOLIS, INDIANA

SEPTEMBER 26, 2003

Alt & Witzig Engineering, Inc.
4105 West 99th Street • Carmel, Indiana 46032
(317) 875-7000 • Fax (317) 876-3705

September 26, 2003

Indiana Department of Transportation
120 South Shortridge Road
Indianapolis, Indiana 46219
ATTN: Mr. Mir Zaheer, P.E.

RE: Subsurface Investigation
and Recommendations
Des No: 9738270
Project No: STP-291- 1 (005)
Structure No.: 6
Bridge No. 641-84-8398
State Road 641 over Honey Creek
Vigo County, Indiana
Alt & Witzig File: 02IN1012

Gentlemen:

In compliance with your request, we have completed a subsurface investigation and evaluation for the above referenced bridge structure.

The results of our test borings and laboratory tests are presented in the following report. It is our pleasure to transmit herewith ten copies of our report. If you have any questions, or if we can be of further service, please contact us at your convenience.

Very truly yours,

Alt & Witzig Engineering, Inc.

David C. Harness

David C. Harness, P.E.

SUMMARY OF RECOMMENDATIONS

DES NO: 9738270

PROJECT NO: STP-291-1 (005)

STRUCTURE NO: 6

BRIDGE NO. 641-84-8398– STATE ROAD 641 OVER HONEY CREEK

VIGO COUNTY, INDIANA

A foundation investigation has been performed for the proposed State Road 641 over Honey Creek in Vigo County, Indiana. Design plans indicate that a three span bridge structure is to be constructed with this project. The following approximate table illustrates the approximate bedrock elevations and estimated pile tip elevations for 55, 70, and 90 ton piles:

Table 1: Summary of Approximate Bedrock and Pile Tip Elevations

Bent/Pier No.	Boring Number	Station	Offset Line "CX"	Ground Surface Elevation, m (ft)	Approximate Bedrock Elevation, m (ft)
Bent No.1	TB-1	8+060	19mLT	152.1 (498.9)	134.1 (439.9)
	TB-2	8+060	6.6mRT	152.5 (500.2)	134.3 (440.7)
Pier No.2	TB-3	8+086	6.6mLT	151.7 (497.6)	132.8 (435.6)
	TB-4	8+086	19mRT	151.2 (495.9)	132.6 (434.9)
Pier No.3	TB-5	8+113	19mLT	150.9 (495.0)	130.5 (428.0)
	TB-6	8+113	6.6mRT	150.3 (493.0)	131.7 (432.0)
Bent No.4	TB-7	8+138	6.6mLT	152.4 (499.9)	131.6 (431.9)
	TB-8	8+138	19mRT	152.6 (500.5)	132.3 (434.0)

The bents for this new bridge may be founded on steel H-piles driven to the shale bedrock at approximate elevations as shown in Table 1. Protective tips should be used on the piles for this project. The final tip elevation should be determined by dynamic pile load testing using the methods outlined in Section 701.06 (c) of the INDOT Standard Specifications.

Due to the soft soil conditions, a minimum three (3) feet wide by three (3) feet deep riprap key should be provided below the toe of both rip rapped slopes. A permeable filter fabric should be used in conjunction with the riprap and should extend beneath the riprap key.

The shallow, natural soils encountered in our eight (8) borings were predominantly Silty Loam, A-4. The shallow soils are of medium stiff to stiff consistency. Specific subgrade recommendations for roadway construction will be provided under separate cover to this report.

September 26, 2003

Indiana Department of Transportation
120 South Shortridge Road
P.O. Box 19389
Indianapolis, Indiana 46219-0389
ATTN: Mr. Athar A. Kahn

RE: Subsurface Investigation
and Recommendations
Des No: 9738270
Project No: STP-291- 1 (005)
Structure No.: 6
Bridge No. 641-84-8398
State Road 641 over Honey Creek
Vigo County, Indiana
Alt & Witzig File: 02IN1012

Gentlemen:

In compliance with your request, we have completed eight (8) soil borings at the above referenced site. It is our pleasure to transmit herewith a copy of the report.

Purpose and Procedures

This report presents the results of a geotechnical investigation for the new State Road 641 bridge in Vigo County, Indiana for Phase II of the SR 641 Project. The site of the proposed project is southeast of Terre Haute, Indiana. The bridge is one of several structures proposed for the S.R. 641 Project. This investigation was conducted for the Indiana Department of Transportation.

The purpose of this foundation investigation was to determine the various soils profile components, the engineering characteristics of the foundation materials and to provide criteria for use by the design engineers in preparing roadway and bridge design.

The field investigations to determine the engineering characteristics of the foundation materials included a reconnaissance of the project site, drilling borings as shown on the soil profile drawings, performing standard penetration tests, and obtaining soil samples retained in the standard split-spoon sampler. The apparent groundwater level and the ground surface elevation at the boring locations were also determined. The field investigation was started on July 7, 2003, and completed on August 12, 2003.

The soil borings were performed with a drilling rig equipped with a rotary head. Conventional hollow-stem augers were used to advance the holes. Representative samples were obtained employing split-spoon sampling procedures in accordance with ASTM Procedure D-1586.

During the sampling procedure, standard penetration tests were performed at regular intervals to obtain the standard penetration value of the soil. The standard penetration value is defined as the number of blows a 140 lb hammer, falling 30 inches, required to advance the split-spoon sampler 12 inches into the soil. The results of the standard penetration tests indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

In addition to the field investigations, a supplemental laboratory investigation was conducted to ascertain additional pertinent engineering characteristics of the subsurface materials necessary in analyzing the behavior of the proposed bridge structure. All phases of the laboratory investigation were conducted in general accordance with applicable AASHTO Specifications and INDOT Exhibit "C". The laboratory testing program included supplementary visual classification on all samples. Atterberg limit tests, unit weight tests, moisture content tests, LOI tests, and grain size analyses were performed on selected soil samples.

Proposed Bridge Structure

Design plans indicate that a three span bridge structure is to be constructed at this location. The bridge is to be constructed of continuous reinforced concrete slabs with spans of 25.3 m, 27.2 m, and 25.3 m. The borings drilled for this new structure indicated the presence of shale/sandstone beneath approximately fifty-nine (59) to seventy-one and one-half (71½) feet of very soft to very stiff, Silty Loam, Silty Clay Loam, and Clay soils with layers of Sandy Loam. The bents for this new bridge may be founded on steel H-pile driven to the shale/sandstone bedrock. Hardened pile tip protectors should be used for the piles installed at this project. The approximate bedrock elevations are shown in Table 1.

Table 1: Summary of Approximate Bedrock and Pile Tip Elevations

Bent/Pier No.	Boring Number	Station	Offset Line "CX"	Ground Surface Elevation, m (ft)	Approximate Bedrock Elevation, m (ft)
Bent No.1	TB-1	8+060	19mLT	152.1 (498.9)	134.1 (439.9)
	TB-2	8+060	6.6mRT	152.5 (500.2)	134.3 (440.7)
Pier No.2	TB-3	8+086	6.6mLT	151.7 (497.6)	132.8 (435.6)
	TB-4	8+086	19mRT	151.2 (495.9)	132.6 (434.9)
Pier No.3	TB-5	8+113	19mLT	150.9 (495.0)	130.5 (428.0)
	TB-6	8+113	6.6mRT	150.3 (493.0)	131.7 (432.0)
Bent No.4	TB-7	8+138	6.6mLT	152.4 (499.9)	131.6 (431.9)
	TB-8	8+138	19mRT	152.6 (500.5)	132.3 (434.0)

The bedrock elevations given above are only approximate elevations determined at the exact structure boring locations and should be used only as a guide. The final tip elevation should be determined by dynamic pile load testing using the methods outlined in Section 701.06 (c) of the INDOT Standard Specifications. The piles shall be monitored by a pile driving analyzer (PDA) during installation. The table below lists pile-driving parameters.

Table 2: Parameters for Pile Driving

Bent/Pier	No. 1	No. 2	No. 3	No. 4
Design Load (Tons)	55/70/90	55/70/90	55/70/90	55/70/90
Factor of Safety	2.0	2.0	2.0	2.0
Factored Design Load (Tons)	110/140/180	110/140/180	110/140/180	110/140/180
Friction in Scour Zone (Tons)	N/A	22	25	N/A
Down Drag Friction (Tons)	22x2	N/A	19x2	22x2
Ultimate Load (Tons)	154/184/224	132/162/202	173/203/243	154/184/224
Testing Method	Std. Spec. 701.06 (c)			

Scour information was provided by INDOT for this location. The report indicates a Q_{500} low scour elevation of 146.12 m. The ultimate friction capacity within the scour zone was calculated to be approximately 22 tons in Pier No.2 and 25 tons in Pier No.3. Also, a maximum of two to four meters of fill will be required at bent No.1, pier No.3, and bent No.4 for Honey Creek. Therefore, down drag force analysis on bent No.1, pier No.3, and bent No.4 were conducted. Our analysis is based upon a steel H-pile section with F_y=36ksi. Higher capacity may be achieved through the use of F_y=50ksi steel, if desired. HP 12x53's were assumed for the 55 and 70 ton piles while HP 12x74's were assumed for the 90 ton piles.

Piles that are driven to the shale bedrock should be restruck. The restrike should be completed after a minimum of 7 days after initial drive. Additionally, to minimize the effects of the disturbed end-bearing stratum, a minimum spacing of the piles should be 1.8m (6 feet). This will ensure that end bearing capacities are not jeopardized by disturbance of the bedrock during driving of adjacent piles.

Slopes

Elevation data indicates that the banks of the creek are to be realigned and flattened, by excavation, to a 2:1 slope. It is recommended that riprap be placed at spill-through slopes of both outer bents and inner piers. It is recommended that the proposed riprap be a minimum of twenty-four (24) inches thick. Due to the soft soil conditions, a minimum three (3) feet wide by three (3) feet deep riprap key should be provided below the toe of both rip rapped slopes. A permeable filter fabric should be used in conjunction with the riprap and should extend beneath the riprap key.

Proposed spill-through slopes are 2:1. The existing slopes are 2:1 or gentler. Therefore, a slope stability analysis was not performed. Slope stability is not anticipated to be a problem if proper construction techniques are followed.

Benching

Benching will be necessary for areas where existing slopes are steeper than 4:1. Benches shall be a minimum of ten (10) feet wide. Benching of natural slopes and existing embankment slopes steeper than 4:1 shall be performed in accordance with Section 203.21 of the INDOT Standard Specifications.

Often, because of design and construction details that occur on a project, questions arise concerning the soil conditions. If we can give further service in these matters, please contact us at your convenience.

Very truly yours,

ALT & WITZIG ENGINEERING, INC.

William E. Witzig

William E. Witzig, P.E.

Appendix

Boring Location Plan

Logs of Test Borings

SPILE Printout for Scour Friction Determination

Settlement and Downdrag Determination

Unconfined Compressive Strength Test Results

Grain Size Distribution Curves

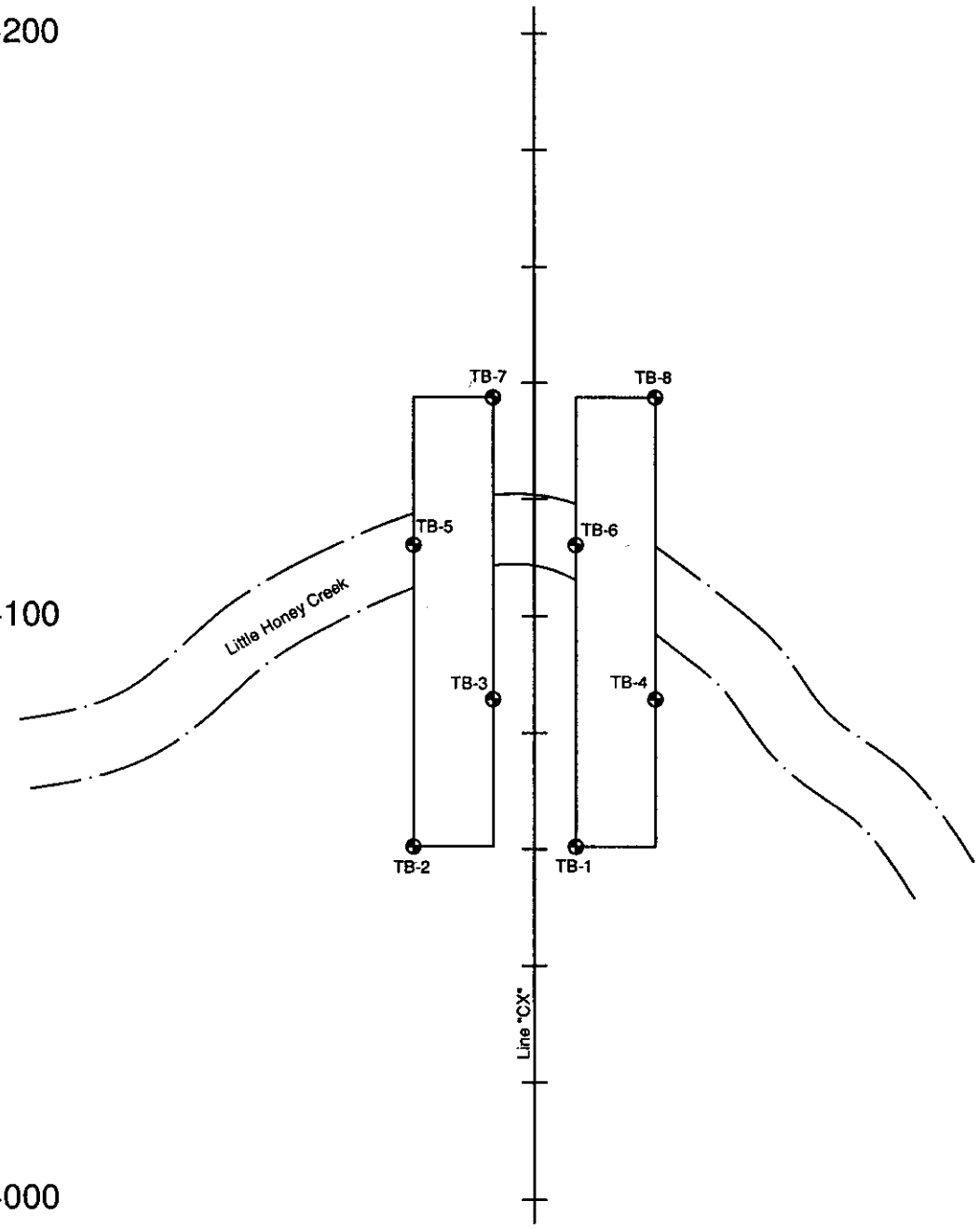
Soil Classification Summary Sheet

Summary of Atterberg Limits

Summary of Unit Weights

Summary of L.O.I.

BORING LOCATION PLAN



AW Project #: 02IN1012
SR 641 Over Honey Creek
Bridge 641-84-8398
Des No: 9738270

N

Scale: 1" = 100'
0 100

LOG OF TEST BORING

Project: DES No. 9738270 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-1
Surface Elevation 152.1 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8398	Station	8+060	Offset	19 m Lt	Line	CX
Datum	USGS	Weather	Sunny	Temperature	75 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	50	4-4-4								
2SS	X	60	2-4-2	5	Brown, Moist, Medium Stiff, Silty Loam A-4 Test 01						
3SS	X	100	2-4-3								
4SS	X	100	3-3-3	10	Brown, Moist, Loose, Sandy Loam A-2-4 Test 04						
					Brown, Wet, Loose, Sandy Loam A-2-4 Test 04 L.O.I. = 0.9%						
5SS	X	100	3-5-6	15							
6SS		100	3-6-7	20							
					Gray, Moist, Stiff, Clay A-7-5 Test 05						
7SS	X	100	5-8-7	25							
8SS	X	100	4-7-5	30							
9SS	X	100	1-2-1	35	Gray, Moist, Very Soft, Clay A-7-5 Test 05						
10SS	X	100	1-1-1	40							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 9.0 Upon Completion of Drilling ● Dry
Time After Drilling 24 hrs.
Depth to Water ▽ Dry ▽ ▽ ▽
Depth to Cave in 9.0

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 7/16/03 End 7/16/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738270 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-1
Surface Elevation 152.1 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8398	Station	8+060	Offset	19 m Lt	Line	CX
Datum	USGS	Weather	Sunny	Temperature	75 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Gray, Moist, Very Soft, Clay A-7-5 Test 05						
11SS	X	100	4-3-4	45	Gray, Moist, Medium Stiff, Silty Loam A-4 Test 02						
12SS	X	100	0-2-3	50	Gray, Wet, Very Loose, Sandy Loam A-2-4 Test 04						
13SS	X	100	2-3-5	55	Gray, Moist, Medium Stiff, Silty Clay Loam A-4 Test 03						
14SS	X	100	6-14-22	60	Gray, Slightly Moist, Hard, Weathered Shale (Visual)						
15SS	X	80	50/4	65							
16SS	X	63	50/2	70	Auger Refusal at 68.9 feet						
				75							
				80							
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738270 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section
4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-2
Surface Elevation 152.5 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8398	Station	8+060	Offset	6.6 m Rt	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	80 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	80	7-7-5								
2SS	X	100	3-3-4	5	Brown, Moist, Stiff to Medium Stiff, Silty Loam A-4 Test 01		100.0	21.4			
3SS	X	100	3-4-3								
4SS	X	100	2-4-2	10	Gray, Wet, Medium Stiff to Stiff, Silty Loam with Wet Sand Seams A-4 Test 02						
5SS	X	100	3-6-6	15	Black Mottled Gray, Moist, Clay A-7-5 Test 05		101.8	25.1			
6SS	X	100	3-4-6	20							
7SS	X	100	2-5-5	25	Gray, Moist, Medium Stiff, Clay with Wet Sand Seams A-7-5 Test 05						
8SS	X	100	3-4-5	30							
9SS	X	100	1-1-2	35	Gray, Moist, Very Soft, Clay A-7-6 (38) Test 06				54	19	35
10SS	X	100	1-2-1	40							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 18.0 Upon Completion of Drilling ▼ 11.0
Time After Drilling 24 hrs
Depth to Water ▽ 8.0 ▼ ▼ ▼
Depth to Cave in 45.0

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 7/7/03 End 7/7/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738270 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-2
Surface Elevation 152.5 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8398	Station	8+060	Offset	6.6 m Rt	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	80 F	Inspector	Tom Coffey

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES					
No.	Type	Rec (%)	Blow Count	Depth		qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Gray, Moist, Very Soft, Clay A-7-6 (38) Test 06						
11SS	X	100	2-4-6	45							
12SS	X	100	2-3-4	50	Gray, Moist, Medium Stiff, Silty Clay Loam A-4 Test 03						
13SS	X	100	2-3-3	55							
14SS	X	100	5-9-35	60							
15SS	X	100	50/4	65	Gray, Slightly Moist, Hard, Weathered Shale (Visual)						
16SS	X	100	50/4	70	Auger Refusal at 68.9 feet						
				75							
				80							
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738270 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-3
Surface Elevation 151.7 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8398	Station	8+086	Offset	6.6 m Lt	Line	CX
Datum	USGS	Weather	Sunny	Temperature	80 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	60	3-5-4		Brown, Moist, Medium Stiff, Silty Loam A-4						
					Test 01						
2SS	X	100	2-3-3	5							
3SS	X	100	3-3-2		Brown, Moist, Loose to Very Loose, Sandy Loam with Clay Seams A-2-4 Test 04						
4SS	X	50	4-2-2	10							
5SS	X	80	7-5-6	15							
6SS	X	100	6-5-6	20							
7SS	X	100	2-3-5	25	Gray, Very Moist, Stiff to Medium Stiff, Clay with Wet Sand Seams A-7-5 Test 05				48	19	29
8SS	X	100	3-5-5	30							
9SS	X	100	2-3-4	35							
10SS	X	100	1-2-1	40							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 13.5 Upon Completion of Drilling ▽ Dry
Time After Drilling 24 hrs.
Depth to Water ▽ Dry
Depth to Cave in 12.0

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 7/14/03 End 7/14/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738270 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-3
Surface Elevation 151.7 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8398	Station	8+086	Offset	6.6 m Lt	Line	CX
Datum	USGS	Weather	Sunny	Temperature	80 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Gray, Moist, Very Soft to Soft, Clay A-7-5 Test 05						
11SS	X	80	1-2-2	45							
12SS	X	100	3-9-11	50	Gray, Moist, Very Stiff, Silty Loam A-4 Test 01						
13SS	X	100	2-4-4	55	Gray, Moist, Medium Stiff to Very Stiff, Silty Clay Loam A-4 Test 03						
14SS	X	100	3-10-13	60							
15SS	X	80	50/4	65	Gray, Slightly Moist, Hard, Weathered Shale (Visual)						
16SS	X	100	50/5	70							
					Auger Refusal at 71.5 feet						
				75							
				80							
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738270 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-4
Surface Elevation 151.2 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8398	Station	8+086	Offset	19 m Rt	Line	CX
Datum	USGS	Weather	Sunny	Temperature		Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	40	3-3-7		Brown, Moist, Medium Stiff, Silty Clay Loam A-4						
2SS	X	100	2-3-3		Test 03						
				5							
3SS	X	60	2-2-3		Brown Mottled Gray, Wet, Medium Stiff to Soft, Silty Loam A-4 Test 01						
4SS	X	100	1-2-2								
				10	Gray, Moist, Soft, Silty Loam with Sand Seams A-4 Test 01						
5SS	X	100	3-5-6								
				15							
6SS	X	100	5-6-7								
				20							
7SS	X	100	4-5-7								
				25	Gray, Moist, Stiff to Very Soft, Clay A-7-5 Test 05						
8SS	X	100	4-5-5								
				30							
9SS	X	100	2-3-4								
				35							
10SS	X	100	1-1-2								
				40							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 9.0 Upon Completion of Drilling ▼ 10.5
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 7/16/03 End 7/16/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738270 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-4
Surface Elevation 151.2 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8398	Station	8+086	Offset	19 m Rt	Line	CX
Datum	USGS	Weather	Sunny	Temperature		Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Gray, Moist, Stiff to Very Soft, Clay A-7-5 Test 05						
11SS	X	100	1-1-2	45							
12SS	X	80	3-6-6	50	Gray, Moist, Stiff to Medium Stiff, Clay A-4 Test 01						
13SS	X	100	1-3-3	55							
14SS	X	80	2-5-12	60	Gray Mottled Brown, Wet, Medium Dense, Sandy Loam A-4 (0) Test 07				23	21	2
15SS	X	0	50/3		Gray, Slightly Moist, Hard, Weathered Shale (Visual)						
1RC		82	RQD = 18%	65	Auger Refusal at 65.0 feet Rock Core Initiated at 65.0 feet Black, Dry, Fissill Shale Thinly Bedded Limestone (Visual) at 68.0 feet 6 inch Coal Seam (Visual) at 69.0 feet						
				70	Rock Core Terminated at 70.0 feet						
				75							
				80							
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738270 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section
4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-5
Surface Elevation 150.9 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8398	Station	8+113	Offset	19 m Lt	Line	CX
Datum	USGS	Weather	Sunny	Temperature	85 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	5	2-5-6								
2SS	X	100	2-4-5	5	Gray Mottled Brown, Very Moist, Stiff to Medium Stiff, Silty Loam A-4 Test 01						
3SS	X	100	2-4-4								
4SS	X	100	2-3-2	10	Gray Mottled Brown, Moist, Soft, Silty Loam A-4 Test 02				31	22	9
5SS	X	100	4-6-7	15							
6SS	X	100	3-5-7	20							
7SS	X	100	4-6-8	25	Gray, Moist, Stiff to Medium Stiff, Clay A-7-5 Test 05						
8SS	X	100	2-3-3	30							
9SS	X	100	2-3-4	35							
10SS	X	100	2-3-2	40							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 25.0 Upon Completion of Drilling ▼ 14.0
Time After Drilling 24 hrs.
Depth to Water ▽ 8.0 ▼ ▽ ▽
Depth to Cave in 30.0

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 8/7/03 End 8/7/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738270 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-5
Surface Elevation 150.9 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8398	Station	8+113	Offset	19 m Lt	Line	CX
Datum	USGS	Weather	Sunny	Temperature	85 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Gray, Moist, Soft, Clay A-7-5 Test 05						
11SS	X	100	2-2-2	45							
12SS	X	100	1-2-5	50							
13SS	X	100	2-4-5	55	Gray, Moist, Medium Stiff, Silty Loam with Wet Sand Seams A-4 Test 01 Soft at 58.5 feet (Sample 14SS)						
14SS	X	80	0-1-3	60							
15SS	X	100	2-4-5	65							
16SS	X	0	50/3	70	Gray, Slightly Moist, Hard, Weathered Shale with Sandstone Fragments (Visual)						
					Auger Refusal at 71.0 feet						
				75							
				80							
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738270 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-6
Surface Elevation 150.3 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8398	Station	8+113	Offset	6.6 m Rt	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	80 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	60	2-3-4								
					Brown, Moist, Medium Stiff, Silty Loam						
2SS	X	100	3-3-3	5	A-4						
					Test 01						
3SS	X	100	2-3-3								
4SS	X	100	1-1-2								
				10	Brown Mottled Gray, Wet, Very Loose, Sandy Loam						
					A-2-4						
					Test 04						
5SS	X	100	4-6-8	15							
6SS	X	100	3-4-5		Medium Stiff at 18.5 feet (Sample 6SS)						
				20							
					Gray, Moist, Stiff, Clay with Silty Sand Seams						
7SS	X	100	2-5-7		A-7-5						
				25	Test 05						
8SS	X	100	3-4-5		Medium Stiff at 28.5 feet (Sample 8SS)						
				30							
9SS	X	100	3-5-5								
				35							
10SS	X	100	2-2-2								
				40							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 9.0 Upon Completion of Drilling ▼ 9.5
Time After Drilling 24 hrs.
Depth to Water ▽ 10.0 ▼ ▼ ▼
Depth to Cave in 51.0

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 8/8/03 End 8/8/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738270 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-6
Surface Elevation 150.3 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8398	Station	8+113	Offset	6.6 m Rt	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	80 F	Inspector	Tom Coffey

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES					
No.	Type	Rec (%)	Blow Count	Depth		qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Gray, Moist, Soft, Clay A-7-5 Test 05						
11SS	X	100	2-2-2	45							
12SS	X	100	1-2-3	50							
13SS	X	100	2-2-4	55	Gray, Moist, Medium Stiff, Silty Loam A-4 Test 01						
14SS	X	100	2-5-5	60							
					Gray, Slightly Moist, Hard, Weathered Shale (Visual) Auger Refusal at 63.0 feet						
				65							
				70							
				75							
				80							
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738270 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section
4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-7
Surface Elevation 152.4 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8398	Station	8+138	Offset	6.6 m Lt	Line	CX
Datum	USGS	Weather	Partly Sunny	Temperature	80 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	100	2-4-4								
2SS	X	100	3-4-4	5	Brown, Moist, Medium Stiff, Silty Loam A-4 Test 01						
3SS	X	100	3-3-4								
4SS	X	100	2-2-3	10	Gray, Wet, Soft, Silty Clay Loam with Wet Sand Seams A-4 Test 03						
5SS	X	60	4-5-11	15							
6SS	X	100	6-6-5	20							
7SS	X	60	4-6-5	25	Gray, Moist, Very Stiff to Medium Stiff, Clay A-7-5 Test 05						
8SS	X	100	5-5-5	30							
9SS	X	100	2-3-3	35							
10SS	X	100	3-2-3	40	Soft at 38.5 feet (Sample 10SS)						

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 19.0 Upon Completion of Drilling ▼ 14.0
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 8/12/03 End 8/12/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738270 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-7
Surface Elevation 152.4 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8398	Station	8+138	Offset	6.6 m Lt	Line	CX
Datum	USGS	Weather	Partly Sunny	Temperature	80 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
11SS	SS	100	4-3-3	45							
12SS	SS	100	3-4-4	50	Gray, Very Moist, Very Stiff to Medium Stiff, Clay A-7-5 Test 05						
13SS	SS	60	3-3-4	55							
14SS	SS	100	4-5-6	60							
15SS	SS	80	4-6-10	65	Gray Mottled Brown, Moist, Stiff to Very Stiff, Silty Loam A-4 Test 01						
16SS	SS	0	50/3	70	Gray, Slightly Moist, Hard, Weathered Sandstone (Visual)						
				75	Auger Refusal at 72.0 feet						
				80							
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738270 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-8
Surface Elevation 152.6 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8398	Station	8+138	Offset	19 m Rt	Line	CX
Datum	USGS	Weather	Sunny	Temperature	80 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	60	5-5-5		Brown, Moist, Medium Stiff, Silty Loam A-4 Test 01						
2SS	X	80	3-4-5								
3SS	X	100	3-3-5	5	Brown, Moist, Loose, Sandy Loam A-2-4 Test 04						
4SS	X	100	2-3-5								
				10	Gray, Wet, Loose, Sandy Loam A-2-4 Test 04						
5SS	X	100	4-8-12								
				15							
6SS	X	100	3-6-7								
				20							
1ST	■	80			Shelby Tube Pushed from 21.0 to 23.0 feet	1.4	116	15.8	34	20	14
7SS	X	100	2-4-6								
				25	Gray, Very Moist, Very Stiff to Medium Stiff, Clay A-7-5 Test 05						
8SS	X	100	2-3-5								
				30							
2ST	■	80			Shelby Tube Pushed from 31.0 to 33.0 feet	0.18	102.2	24.6	39	24	15
9SS	X	100	2-2-1								
				35	Gray, Wet, Very Soft to Soft, Clay A-7-5 Test 05						
10SS	X	100	2-3-3								
				40	Medium Stiff at 38.5 feet (Sample 10SS)						

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 15.0 Upon Completion of Drilling ● Dry
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 8/11/03 End 8/11/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738270 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-8
Surface Elevation 152.6 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8398	Station	8+138	Offset	19 m Rt	Line	CX
Datum	USGS	Weather	Sunny	Temperature	80 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
11SS	X	100	2-2-2	45	Gray, Wet, Very Soft to Soft, Clay A-7-5 Test 05						
12SS	X	100	0-1-1	50							
13SS	X	100	3-7-3	55	Gray, Wet, Medium Stiff, Clay with Wet Sand Seams A-7-5 Test 05						
14SS	X	100	3-6-3	60	Gray, Wet, Medium Stiff, Silty Loam with Sand Seams A-4 (1) Test 01						
15SS	X	60	3-8-11	65	Gray Mottled Black, Wet, Medium Dense, Sandy Loam A-4 Test 07						
16SS	X	0	50/3	70	Gray, Slightly Moist, Hard, Weathered Shale (Visual) Auger Refusal at 70.0 feet						
				75							
				80							
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

Scour Friction Determination for Pier No.2

-------- ULTIMATE STATIC PILE CAPACITY/Federal Highway Administration --------+
Nordlund (1963, 1979) and Tomlinson (1979, 1980) methods

Project Name : SR641 over Honey Cr Client : INDOT
File Name : hcp2 Project Manager : Dave harness
Date : 9/23/10 Computed by : KHC

Depth of Top of Pile = 0.00 ft. Pile length = 18.00 ft.
Depth to Water Table = 14.00 ft.
Type of Pile = H Pile
HP 12x53

SKIN FRICTION CONTRIBUTION

Layer	Soil Type	Thickness (ft)	Effective Stress (psf)	Internal Friction Angle	N-SPT	Pile Perimeter (ft)
1	Cohesive	3.00	160.50	---	--	3.97
2	Cohesionless	10.00	796.00	28.00	--	3.97
3	Cohesive	5.00	1452.40	---	--	3.97

Layer	Soil Type	Undrained Shear Strength (psf)	Adhesion	Pile Taper	Sliding Friction Angle	Skin Resistance (Kips)
1	Cohesive	1080.00	970.00	----	-----	11.56
2	Cohesionless	--	--------	----	21.09	8.34
3	Cohesive	1300.00	1170.00	----	-----	23.23

Total Side Friction : 43.12

POINT RESISTANCE CONTRIBUTION

Effective Stress at pile Tip (psf)	Undrained Shear Strength (psf)	SPT Value	Pile End Area (ft*ft)	Bearing Capacity Factor Nq	End Bearing Resistance (Kips)
1571.40	110.00	----	0.11	----	0.11

Ultimate Static Pile Capacity : 43.23

+----- Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu -----+

Scour Friction Determination for Pier No.3

-------- ULTIMATE STATIC PILE CAPACITY/Federal Highway Administration --------+
Nordlund (1963, 1979) and Tomlinson (1979, 1980) methods

Project Name : SR641 over Honey Cr Client : INDOT
File Name : hcp3 Project Manager : Dave harness
Date : 9/23/10 Computed by : KHC

Depth of Top of Pile = 0.00 ft. Pile length = 15.00 ft.
Depth to Water Table = 14.00 ft.
Type of Pile = H Pile
HP 12x53

SKIN FRICTION CONTRIBUTION

Layer	Soil Type	Thickness (ft)	Effective Stress (psf)	Internal Friction Angle	N-SPT	Pile Perimeter (ft)
1	Cohesive	8.00	428.00	---	--	3.97
2	Cohesionless	5.00	1093.50	28.00	--	3.97
3	Cohesive	2.00	1441.00	---	--	3.97

Layer	Soil Type	Undrained Shear Strength (psf)	Adhesion	Pile Taper	Sliding Friction Angle	Skin Resistance (Kips)
1	Cohesive	1100.00	990.00	----	-----	31.44
2	Cohesionless	--	--------	----	21.14	5.76
3	Cohesive	1560.00	1400.00	----	-----	11.12

Total Side Friction : 48.32

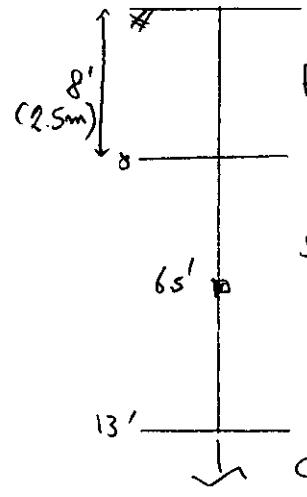
POINT RESISTANCE CONTRIBUTION

Effective Stress at pile Tip (psf)	Undrained Shear Strength (psf)	SPT Value	Pile End Area (ft*ft)	Bearing Capacity Factor Nq	End Bearing Resistance (Kips)
1488.60	110.00	----	0.11	----	0.11

Ultimate Static Pile Capacity : 48.43

+----- Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu -----+

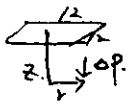
Pier No. 3 (TB-5)



∴ Assumption: fill area = 12'x12' based on the bridge cross-section provided

(1) Assume that the settlement will occur at Silty Loam layer.

Surcharge (Fill) = 130 pcf x 8 ft = 1040 psf.



$\Delta p = N_B \cdot \frac{P}{z^2}$ (Boussinesq Formula). $N_B = 0.12 \Leftarrow \frac{r}{z} = \frac{6}{6.5} = 0.92$

$= 0.12 \times \frac{1040 \times 12^2}{6.5^2} = 425$ psf

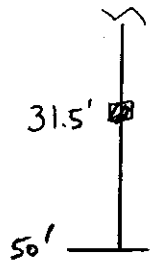
P_o at midpoint (6.5') = 121 pcf x 6.5' = 787 psf. ∴ dry condition.

$\therefore \Delta H = \frac{H}{1+e_o} C_s \cdot \log\left(1 + \frac{\Delta p}{P_o}\right) = \frac{13'}{1+0.7} \times 0.189 \times \log\left(1 + \frac{425}{787}\right)$

$= 0.27' = \underline{\underline{3.25 \text{ inches.}}}$ settled.

∴ Therefore, the settlement (3.25 inches) is greater than 0.6" (NAVFAC DM7-0: Full mobilization of negative skin Friction will be considered.

(2) Assume that the settlement will occur at the clay Layer below the Silty Loam



γ = 127 pcf. w = 25. LL = 39, Cc = 0.009(39-10) = 0.261
e = 0.7

$\Delta p = N_B \cdot \frac{P}{z^2} = 0.19 \times \frac{1040 \times 12^2}{31.5^2}$ $\qquad \frac{r}{z} = \frac{6}{31.5} = 0.19$

$= 28.7$ psf.

P_o at $31.5' = 13' \times 121^{pcf} + 18.5 \times 127 = 3923$ psf.

$\therefore \Delta H = \frac{37'}{1+0.7} \times 0.261 \times 10^{-3} \left(1 + \frac{28.7}{3923}\right) = 0.018' = 0.22$ inches Settled.

For Pier No. 3

☐ Downdrag Force (f_n)

$f_n = \beta \cdot P_o$ $\qquad \beta = 0.35$ for silty loam.

$\beta = 0.5$ for sand (fill)

P_o = effective stress

- Fill ; ($P_o = 130^{pcf} \times 4' = 520$ psf at mid point of the fill section)
  - $f_n = 0.5 \times 520 = 260$ psf.
  - Total $f_n = 260^{psf} \times \underbrace{3.97'}_{\text{Perimeter of H-Pile}} \times \underbrace{8'}_{\text{thickness of fill}} = 8258\,lb \simeq \underline{\underline{4\ ton}}$

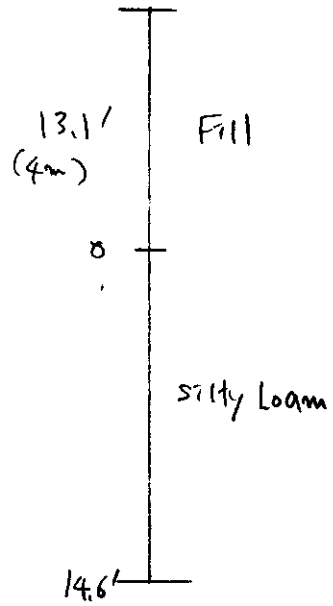
- Silty Loam
  ($P_o = 130^{pcf} \times 8' + 100^{pcf} \times 6.5 = 1690$ psf.)
  - $f_n = 0.35 \times 1690 = 592$ psf.
  - Total $f_n = 592^{psf} \times 3.97' \times 13' = 30,553\,lb \simeq 15$ ton.

Therefore, Total Downdrag force $= 4 + 15 = 19$ tons.

- Multiply by factor of safety (2) $= \underline{\underline{38\ tons}}$ O.K

For Bent No. 1 & Pier No. 4

(TB-8)



- Fill
  - $f_n = \beta \cdot p_o = 0.5 \times (130^{pcf} \times 6.6')$
    $= 429$ psf.
  - Total $f_n = 429^{psf} \times 3.97' \times 13.1'$
    $= 22311\ 16 \simeq \underline{11 \text{ tons}}$

- Silty Loam
  - $f_n = \beta \cdot p_o = 0.35 \times (13.1' \times 130^{pcf} + 7.3' \times 100^{pcf})$
    $= 851.6$ psf.
  - Total $f_n = 851.6 \times 3.97 \times 14.6$
    $= 49\ 360\ 16 \simeq \underline{25 \text{ tons}}$

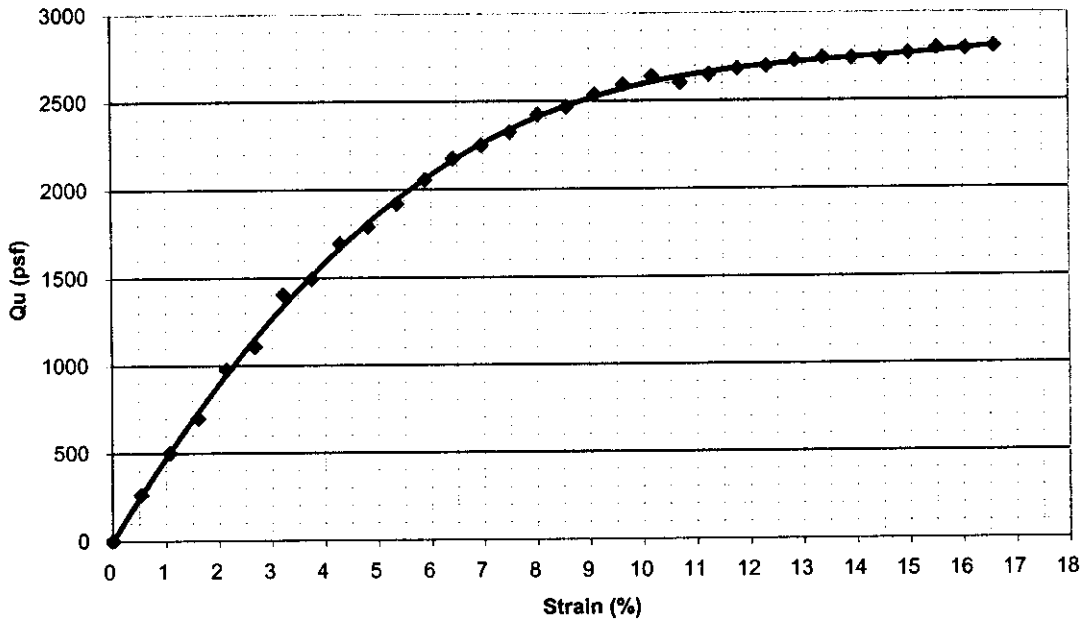
∴ Therefore total downdrag force = 11 + 25 = 36 tons
Multiply by factor of safety (2) = 72 tons

- However, positive skin friction of the silty Loam (22 tons) is smaller than total downdrag force (72 tons)

∴ Therefore, 22 tons will be applied as the downdrag force. at bent no. 1 and pier no. 4
Multiply by factor of safety (2) = 44 tons

- The End -

Unconfined Compression Test

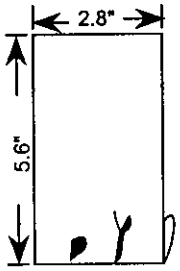


Sample Location TB-8

Depth 21.0 - 23.0 ft Moisture Content: 22.1 (%)

Strain Rate 2% min. Dry Unit Weight: 116.0 (pcf)

FAILURE SKETCH



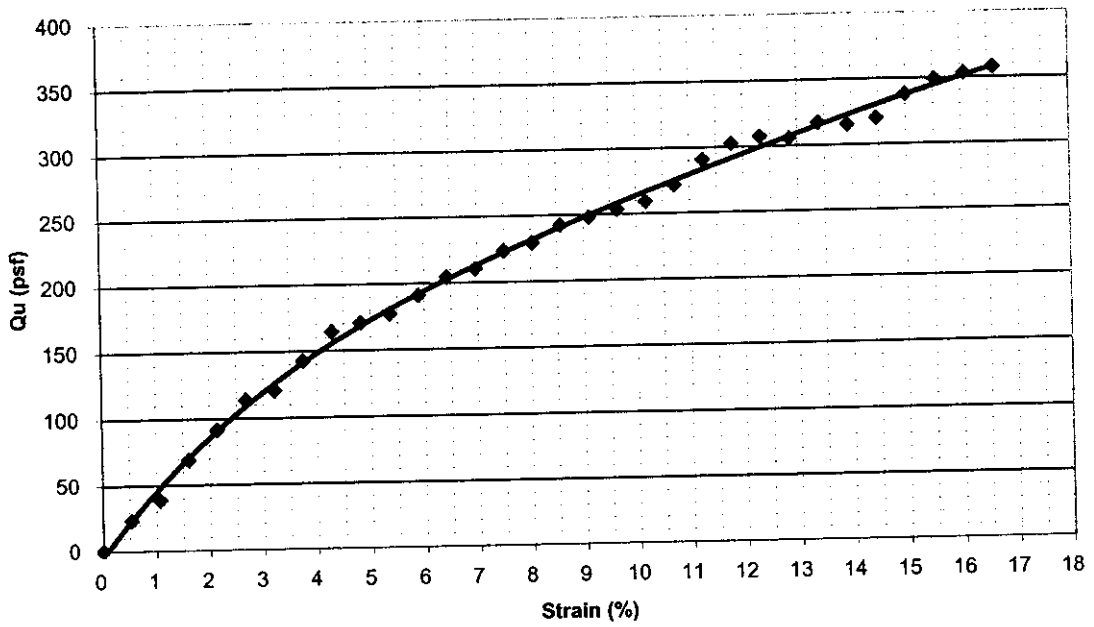
Soil Description Gray Clay, A-7-6

Unconfined Compressive Strength (psf) 2,800

Failure Strain (%) 15.0

PREPARED FOR: INDOT-Geotechnical Division Indianapolis, Indiana	A&W	PREPARED BY: Alt & Witzig Engineering, Inc. Carmel, Indiana	
PROJECT NAME: S.R. 641 in Vigo County		PROJECT NO.: 02IN1012	DATE: 9/03

Unconfined Compression Test



Sample Location TB-8

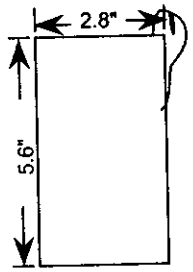
Depth 31.0 - 33.0 ft

Moisture Content 27.0 (%)

Strain Rate 2% min.

Dry Unit Weight 102.2 (pcf)

FAILURE SKETCH



Soil Description Gray Clay, A-7-6

Unconfined Compressive Strength (psf) 360

Failure Strain (%) 15.0

PREPARED FOR: INDOT-Geotechnical Division Indianapolis, Indiana	A&W	PREPARED BY: Alt & Witzig Engineering, Inc. Carmel, Indiana	
PROJECT NAME: S.R. 641 in Vigo County		PROJECT NO.: 02IN1012	DATE: 9/03

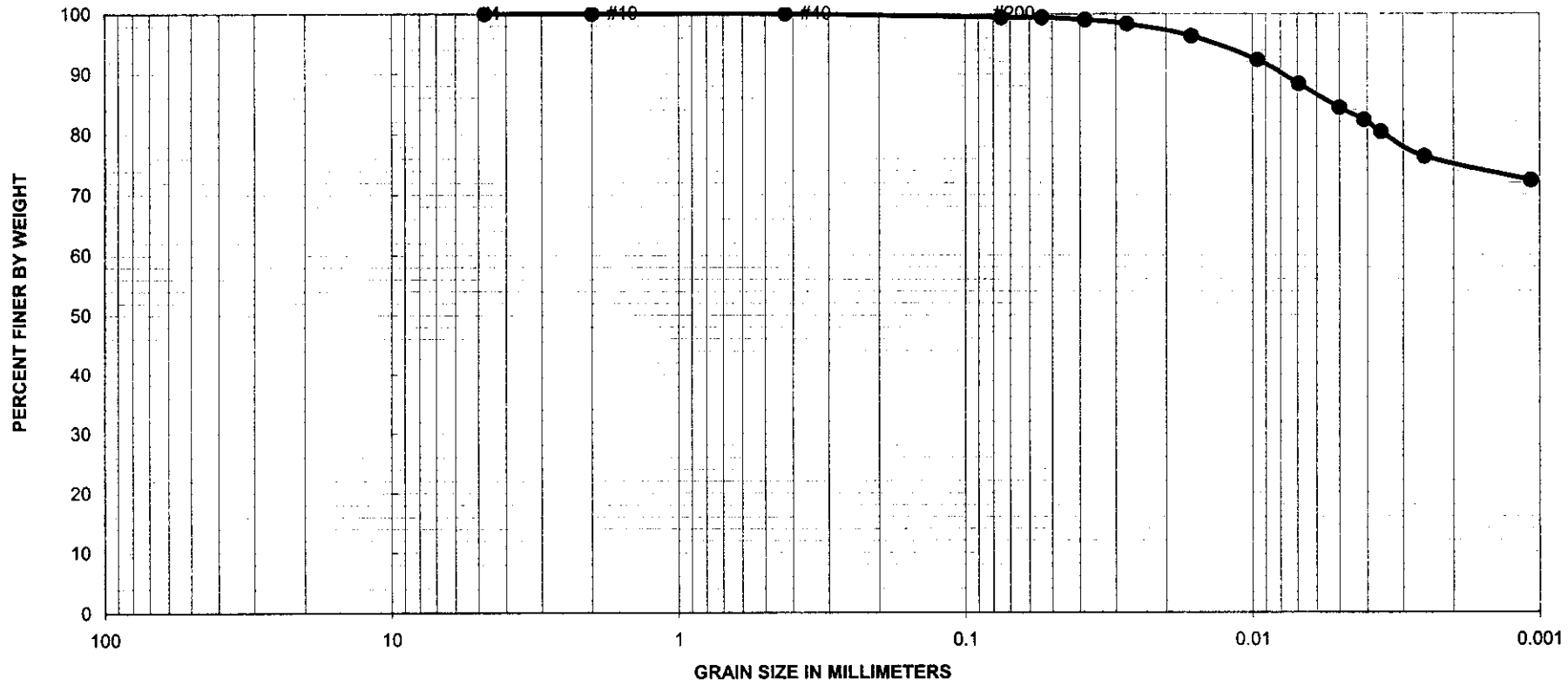
Summay of Unconfined Compressive Strength on Split Spoon Samples

Project Name: SR-641

Project Number: 02IN1012 Date Completed: 9/03

Boring #	Sample Depth	Unconfined Compresssive Strength (psf)	Failure Strain (%)
TB-2	20'	3,740	10.7
TB-2	25'	2,820	17.4
TB-2	40'	510	9.6
TB-2	55'	2,170	6.4
TB-5	7.5'	2,400	8.2
TB-5	10'	1,830	10.7
TB-5	20'	6,810	10.7
TB-5	25'	8,240	8.9
TB-5	30'	3,280	26.3
TB-5	45'	390	13.9

Grain Size Distribution Curve



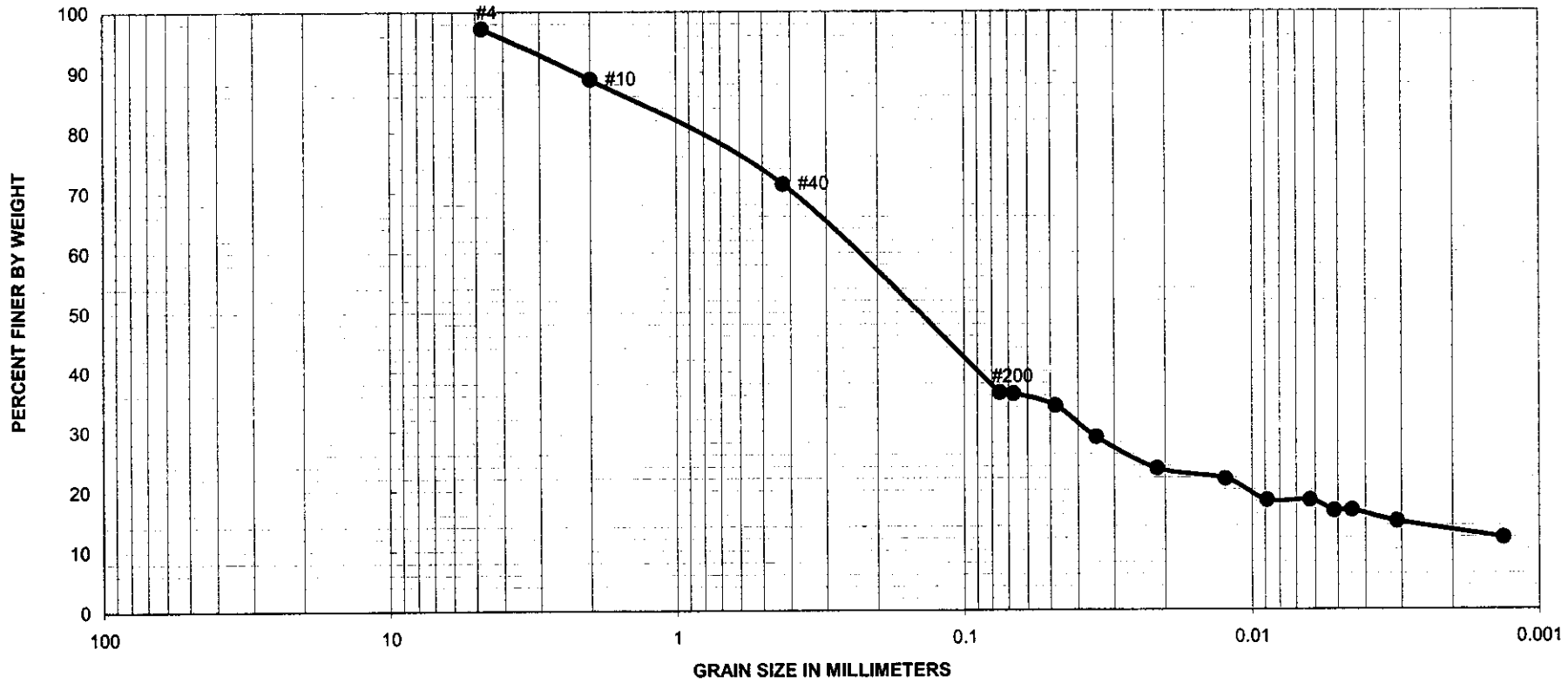
GRAVEL	SAND	SILT OR CLAY
	#10	#200

Boring No.	Sample No.	Elev or Depth	Nat w%	LL	PL	PI	Classification
TB-2	9SS	33.5-35.0 ft	-	54	19	35	Clay, A-7-6 (38)

Project: 02IN1012
Project No.: SR-641 , 01IN1012
Vigo County, Indiana
STP-291-1 (005)
Date: 09/03

A&W

Grain Size Distribution Curve



GRAVEL	SAND	SILT OR CLAY
	#10	#200

Boring No.	Sample No.	Elev or Depth	Nat w%	LL	PL	PI	Classification
TB-4	14 SS	58.5-60.0 ft	-	23	21	2	Sandy Loam, A-4(0)

Project: 02IN1012
Project No.: SR-641 , 01IN1012
Vigo County, Indiana
STP-291-1 (005)
Date: 09/03

A&W

Des No: Several
Project No.: STP-291-1 ( )
Des No.: 9738270
S.R. 641, Vigo County, Indiana
Alt & Witzig File: 02IN1012

SOIL CLASSIFICATION SUMMARY														
Test No.	Boring Number	Sample & Depth	Description	Passing #10	Passing #40	> #10 % Gravel	#10-#200 % Sand	#200-.002mm % Silt	% <0.002mm (%) Clay	% <0.001mm Colloids	LL	PL	PI	AASHTO Classification
01	TB-26[1]	1ST 16 to 18 ft	Silty Loam	100	100	0	6	77	17	14	26	24	2	A-4 (1)
02	TB-26[1]	3SS 5.0 to 7.5 ft	Silty Loam	100	99	0	22	61	17	17	24	18	6	A-4 (3)
03	TB-23[2]	8SS 28.5 to 30 ft	Silty Clay Loam	99	97	1	15	64	20	19	26	20	6	A-4 (4)
04	TB-28[1]	7SS 23.5 to 25 ft	Sandy Loam	100	98	0	66	18	16	14	NP	NP	--	A-2-4 (0)
05	TB-26[1]	2ST 46 to 48 ft	Clay	100	100	0	0	40	60	55	50	36	14	A-7-5 (20)
06	TB-2[3]	9SS 33.5 to 35 ft	Clay	100	100	0	1	25	74	72	54	19	35	A-7-6 (38)
07	TB-4[3]	14SS 58.5 to 60 ft	Sandy Loam	89	71	11	53	22	14	12	23	21	2	A-4 (0)
08	TB-13[4]	1ST 38 to 40 ft	Silty Clay	100	99	0	10	58	32	30	25	13	12	A-6 (8)

Notes:
1: Soils from Des No.: 9738330, Structure 641-84-8401
2: Soils from Des No.: 9738410, Structure 641-84-8404
3: Soils from Des No.: 9738270, Structure 641-84-8398
4: Soils from Des No.: 9738280, Structure 641-84-8399

Summary of Atterberg Limits

Project Name: SR-641

Project Number: 02IN1012 Date Completed: 9/2003

Boring #	Sample Depth	Liquid Limit	Plastic Limit	Plasticity Index
TB-2	35'	54	19	35
TB-3	25'	48	19	29
TB-4	60'	23	21	2
TB-5	10'	31	22	9
TB-8	21'-23'	34	20	14
TB-8	31'-33'	39	24	15

Summary of Unit Weights

Project Name: SR-641

Project Number: 02IN1012 Date Completed: 9/2003

Boring #	Sample Depth	Moisture Content	Wet Density	Dry Density
TB-2	5.0'	21.4	121.4	100.0
TB-2	15.0'	25.1	127.4	101.8
TB-8	21'-23'	15.8	134.3	116.0
TB-8	31-33	24.6	127.3	102.2

Summary of L.O.I.

Project Name: SR-641

Project Number: 02IN1012 Date Completed: 9/2003

Boring #	Sample Depth	L.O.I (%)
TB-1	15'	0.9

Indiana Department of Transportation

Materials and Tests Division

120 South Shortridge Road P. O. Box 19389
Indianapolis, Indiana 46219-0389
Phone: (317) 610-7251 Fax: (317) 356-9351

April 27, 2004

Mr. Gary Mroczka, Chief
Division of Design
Room N642 - IGCN

Attention: Ms. Hollie Pratt

Subject: Des No's: 9738230 & 0001350
Geotechnical Investigation – In House **ADDENDUM - 1**
MSE Walls & Ramps Construction for Proposed SR 641 over U.S. 41
Project No: STP – 291 - 1 (005)
Proposed Ramps connecting U.S. 41 to SR 641 NB & SB
in Vigo County

Gentlemen:

The subject project involves construction of SR 641 and US 41 Interchange with connector ramps on Lines "J", "K", "L" & "N" at US 41, and construction of Mechanically Stabilized Earth Walls (MSE) along east and west of US 41 for the SR 641 Northbound and Southbound Ramp bridges over U.S. 41.

Ten retaining wall borings and six roadway borings with split spoon sampling were done during the field investigation. Data from four of the six bridge structure borings drilled during earlier investigations is also used. A boring log was prepared for each boring which shows soil classifications and stratification as well as other pertinent data. Copies of the boring logs, laboratory test results, Generalized Subsurface Profiles and Boring Location Plan are transmitted with the report. Two additional roadway borings performed in the adjacent Phase are also included. The following are the recommendations of the INDOT Geotechnical Section.

ROADWAY & PAVEMENT DESIGN

Ramps at SR 641 and US 41 interchange will be constructed during this phase. The limits of the construction are as follows:

LINE	FROM STATION	TO STATION	Max. Fill	Max. Cut
CX	5+000	5+100	7.4 m	-
J	1+360	1+432	3.0 m	-
K	1+100	1+289	2.6 m	2.0 m
L	1+150	1+606	8.2 m	3.0 m
N	1+850	2+566	9.0 m	2.0 m

The predominant soil types encountered are A-4 Silt, A-4 Silty Loam, A-6 Silty Clay Loam and A- 6 Clay. The consistencies of these soils vary from soft to medium stiff to hard and they are underlain by Siltstone/Sandstone/Shale. The 24 hour water table readings were recorded in sixteen soil borings. The water table depth below the surface and the elevation readings taken after 24 hours are as follows:

Soil Boring	24 Hr water table depth (m)	24 Hr water table elevation
RB-43	0.64	177.66
RB-44	0.76	176.84
RB-45	2.28	171.72
RB-46	1.89	168.91
RB-49	0.12	177.88
RB-51	1.43	174.27
RWN-2	2.14	174.21
RWL-2	1.83	174.22
RWL-3	1.59	175.36
ARW-1	0.97	175.68
ARW-2	0.97	175.38
ARW-3	0.76	176.59
ARW-4	0.73	176.22
TBN-1	1.62	174.33
TBL-1	1.86	175.70
TBL-3	1.68	175.27

This project includes ramps and roadway embankments with fills up to 9.0 m high. The maximum fills are near the proposed ramp bridges over US 41. This embankment will be built on silty foundation soils that are soft to medium stiff, and often wet.

Wherever the fill is placed in Phase II, the foundation soils can be handled inexpensively using the following recommendations.

1. All topsoil should be removed before any new fill is placed. Proofrolling should be done in accordance with the Section 203.26 of Standard Specifications.
2. During proofrolling of the foundation subgrade, if soft soils or soils with organic matter are encountered, then these soils should be modified as per Section 203.09 of Standard Specifications.
4. Some settlements are anticipated in areas where the fill is 6.0 m (20 ft) or more. In our opinion, the estimated settlements are not detrimental to the stability of the embankments. Since there is negligible settlement with the proposed fill on Lines "J, K, L & N", the embankment fill and the pavement can be constructed in Phase –II.

5. This project involves cuts and fills. After reviewing the elevations of the 24 hour water table readings, in our opinion, the cut soils coming out of these areas might be wet. If these soils are to be used on this project as fill, soils might need aeration, disking or other means of reducing the moisture.

6. In order to reduce the build up of moisture in the existing subgrade soils, we recommend that the contract should require that the proposed ditches should be constructed before placing any fill.

7. In general, the existing surface soils below the proposed embankment fill have moisture contents higher than the optimum moistures for these soils. Most of the soils on this project have high silt contents. It may be difficult to achieve the required compaction due to pumping in silty soils. Where pumping is a problem, we recommend undercutting 300 mm (12") and replacement with compacted "B" Borrow.

   If undercutting and replacement with "B Borrow" does not seem to provide a suitable construction platform, these wet soils may be modified as per Section 203.09 of Standard Specifications This modification should be done only for the construction platform and not for the entire fill in the embankment.

8. Where existing ditches will be covered by embankment construction, all soft soils should be stripped and replaced with "B" Borrow to an elevation 0.6 m (2') above the ground water level. If the groundwater is not encountered during the removal operations, the backfill shall be in accordance with Section 203.09 of the Standard Specifications.

9. It is very important that during the construction phase of this project special consideration should be given in providing sufficient drainage for surface runoffs. Any collected water or trapped water should be diverted outside the limits of the construction zone. Lateral drains at the interface of cut and fill areas might help in alleviating this problem.

PAVEMENT RECOMMENDATIONS

Since the project has major fills, the fill soils have to come from nearby borrow pits. Therefore, an estimated "CBR" value is used from the most critical and similar soils encountered on other nearby projects.

For cut and at-grade conditions, we recommended a Type "A" Subgrade Treatment beneath the pavement, including shoulders, and an estimated Resilient Modulus (M_R) of 5250 psi should be used for the pavement design.

For fill sections, Subgrade treatment shall be in accordance with Section 207.05(a) and a Resilient Modulus (M_R) of 5250 psi shall be used for the pavement design.

1. Subsurface drains with screened outlets are recommended for this project. Filter fabric should be used in conjunction with the underdrains.

2. In fill sections, high silt content soils (greater than 50 percent silt) should not be used in the upper two feet under the pavement.

3. In at grade areas and in cut areas the natural moisture content of most of the subgrade soils may exceed their optimum moisture content.

4. The contractor should plan appropriate site drainage prior to commencing any excavation. Proper site drainage of surface runoff water will help alleviate unwanted intrusion into the excavation during the construction process.

5. Where pumping is a problem, we recommend undercutting 300 mm (12") and replacement with compacted "B" Borrow. If this is not feasible, in situ soil could be modified with chemicals in accordance with Section 215.

MSE WALLS

A-4 Silt and Silty Loam, A-6 Silty Clay Loam and A-7-6 Silty Clay were encountered within the foundation subgrade for these walls. The consistency of these soils ranges from soft to medium stiff underlain by very dense weathered Shale Sandstone and Siltstone.

The recorded elevations for 24 Hour groundwater in the soil borings, at the locations of the proposed MSE walls for the East abutment ranges from 174.33 to 175.68 from north to the south. For the West abutment, groundwater elevation was recorded in soil borings ranging from elevation 174.21 to 176.59.

US 41 West MSE wall borings

Information from soil borings RWL-1, TBL-1, ARW-3, ARW-4, TBN-3, RWN-3 and RWN-2 is used for the subject retaining wall.

US 41 East MSE wall borings

Information from soil borings RWL-2, RWL-3, TBL-3, ARW-1, ARW-2, TBN-1 and RWN-1 is used for the subject retaining wall.

The table below provides the elevation of the bedrock (Weathered Shale or Sandstone/Siltstone) encountered in soil borings along the east and west MSE walls:

WEST MSE WALL				EAST MSE WALL			
Soil Boring	Finished Grade	Bottom of Footing	Bedrock Elevation	Soil Boring	Finished Grade	Bottom of Footing	Bedrock Elevation
	(m)	(m)	(m)		(m)	(m)	(m)
RWN-2	175.50	174.59	171.93	RWN-1	175.77	174.86	170.75
RWN-3	175.69	174.78	172.45	TBN-1	176.06	175.17	171.75
TBN-3	175.69	174.78	172.64	ARW-2	176.28	175.37	173.31
ARW-4	176.00	175.09	173.91	ARW-1	176.51	175.60	173.61
ARW-3	176.22	175.31	174.31	TBL-3	176.74	175.85	172.38
TBL-1	176.66	175.75	174.51	RWL-3	176.74	177.85	172.93
RWL-1	176.50	175.59	173.99	RWL-2	176.67	175.76	171.94

For locations, offsets and for more detailed information please refer to the specific boring logs.

The finished grade elevations were taken from the roadway cross-sections and cross-sections along the MSE wall abutments provided by Mr. Mike Hoy of INDOT Design.

Wall Heights Considered in the Design:

a) It is our understanding, that these bridge abutments will be integral bents on piles. The maximum height considered in the design of the MSE wall is 9.30 m (30.50 ft), about 0.5 m below the profile grade elevation. A 2.0 feet traffic surcharge was also used. The maximum wall height is approximately equal on both the east and west walls. The profile grade elevations on Line "L" and Line "N" are 184.84 and 184.73 respectively. The top of wall elevation is taken as the high elevation at the top of the wall and the leveling pad elevation is taken as 0.91 m (3.0 ft) below the finished grade elevations as shown at the wall line in the cross-sections.

The recommendations for the MSE walls are as follows:

1. Soft Silty Loam, Silty Clay Loam and Silt were encountered in borings RWN-1, ARW-2, ARW-1, ARW-4, beneath the foundations of the MSE walls. Foundation soils where no undercutting is required should be proofrolled before construction of the wall. Soils that do not pass proofroll should be removed and replaced with compacted B Borrow.

2. Some of the foundation soils for both the east and west abutment walls that have fills of more than 6.0 m (20.0 feet), will encounter some settlement. The maximum settlement expected within the maximum fill areas (i.e. around MSE abutments) is a maximum of 1.5 inches. The total estimated time for 90 percent consolidation to occur is calculated to be 30 days.

   These settlements will not be detrimental to the MSE structures nor will they induce any additional loadings on the abutment piles. After the installation of the foundation piles, the dead and live load will not be transferred immediately to the foundation. The loads will be placed only after construction of the bridge superstructure is complete and the bridge is open to traffic, after negative skin friction has dissipated.

3. There may be some differential settlement along the length of the wall. Rectangular facing panels with continuous vertical joints should be used to accommodate this settlement.

4. The net allowable bearing pressure for the wall without any modification is calculated as 187 kPa (3900 psf). This allowable bearing pressure is not adequate for walls greater than 6.1 m (20 ft) high. Therefore, to achieve the required factor of safety for bearing capacity, walls greater than 6.1 m high will require the following modification as per recommendation # 5 and a net allowable bearing pressure of 263 kPa (5500 psf) be used.

5. In areas, where the wall exceeds 6.10 m (20.0 ft) in height the following correction to the subgrade soil is necessary to achieve the required bearing capacity:

   a. Undercut the subgrade soils down to a depth of 0.6 m (2.0 ft) beneath the pad elevation of the proposed wall. The width of the excavation at a depth of 0.6 m below the leveling pad shall be the required width of MSE wall plus 2.1 m on each side (i.e. B+2*D+2*1.5) m. Where "B" is the width of the reinforced fill and "D" is the depth of undercut in meter below the pad.

   b. Replace with compacted "B borrow" and place two uniaxial geogrids Type-II as per the INDOT's Specifications. The first layer of geogrid should be placed at the bottom of excavation. These layers of geogrid should be placed perpendicular to the face of the wall and 300 mm apart vertically. The geogrid shall be embedded at least 1.5 m on either side beyond the width (B+2*D).

6. Use of slag as a reinforced fill will reduce the contact pressure and hence, the net allowable bearing capacity required. Approved # 8 Slag generally weighs approximately 75 pcf to 90 pcf compared to the virgin material which weighs approximately 120 pcf. ***However, for wall heights greater than 7.5 m with slag, the length of reinforcement has to be increased to 0.75 times from 0.70 times "H" (the height of the wall).***

7. Some of these excavations are at or below the groundwater elevations as mentioned earlier. Where groundwater is encountered during construction, water levels should be maintained below the bottom of excavation. Where sand or silt is encountered, it may be impossible to de-water with a sump pump. It may be necessary to use well points. Any dewatering program should consider the potential for damage to the existing structures in the vicinity. The water table may be higher at the time of construction.

8. In evaluating the design for a "gravity type" MSE retaining wall, the external and internal stability should be analyzed. For external stability, the following four standard modes of failure are typically addressed:

   a) Sliding [minimum factor of safety FS 1.5].

   b) Overturning (FS 2.0)

   c) Bearing capacity, FS 2.5

   d) Global stability

   An analysis was performed for each of the external stability issues outlined above.

9. To evaluate the internal stability, three standard modes of failure are typically addressed. These include, pull out of the strips; tensile overstress of the strip and wall/strip connection; and Corrosion of the steel reinforcement strip

   We understand that the MSE Wall manufacturer will address the internal stability considerations for this project.

10. The minimum length of reinforcing strips should be 70% of the height of the wall and it should not be less than 2.44 m (8.0 ft).

11. The internal stability design will be based on an angle of internal friction of 34°□ for wall backfill material. Therefore, this backfill material must be tested to insure compliance with this design criterion and any additional design criteria as per INDOT's Specifications.

GENERAL

1. Where new embankment fill will be placed on or adjacent to existing natural slopes of existing embankments of 4:1 or steeper, benches a minimum of 3.1 m (10') wide should be cut into the existing natural slope prior to the placement of new fill. These benches should be cut in accordance with Section 203.21 of the Standard Specifications.

2. Proofrolling of the natural ground surface should be specified in accordance with Standard Specifications, Section 203.26, within all areas where new fill will be placed. Any soft soils encountered during the proofrolling operations, which will not readily compact, should be removed and replaced with "B" Borrow to an elevation 0.6 m (2') above the ground water level, if the ground water is encountered. Otherwise, backfilling should be accomplished in accordance with Section 203.09.

3. Cohesionless, granular material should not be used in ditches or with 300 mm (12") of the required finished surface of fill slopes. The material required to encase the embankment should be non-erodible material free from clods, debris, and stones and should be suitable for sustaining vegetation.

General soil strata descriptions and indicated boundaries are based on an engineering interpretation of all available subsurface information by the Geotechnical Section of the INDOT and may not necessarily reflect the actual variation in subsurface conditions between borings and samples. Detailed data and field interpretations of conditions encountered in individual borings are shown on the boring logs.

The observed water levels and/or conditions indicated on the boring logs are as recorded at the time of exploration. These water levels and/or conditions may vary considerably with time, according to the prevailing climate, rainfall or other factors and are otherwise dependent on the duration of, and methods used, in the exploration program.

If you have any questions concerning this matter, please contact us.

Very truly yours,

Athar Khan, P.E.
Chief Geotechnical Engineer

Mir Zaheer, P.E.
Senior Geotechnical Engineer

Reviewer: Steve Morris, P.E.

MZ/
cc: Mrs. Anne Rearick - Attn: Mr. Tom Caplinger – Attachments
Mrs. Anne Rearick – Attn: Ms. Lisa Casler – Attachments
Mr. Kumar Dave - Attachments
Mr. Elmo Gonzalez - Attn: Mr. Bruce Conrad - Attachments (2)
Ms. B. Thacker - Attachments
Mr. D. Cohen – Attachments
File
Attachments
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4/19/04

SUMMARY OF CLASSIFICATION TEST RESULTS

DES. NO. 9138220
PROJECT NO. STP-291-1 (2)
STRUCTURE NO. NA
COUNTY VIGO

LABORATORY NUMBER	PART	BORING NUMBER	STATION	OFFSET LINE	SAMPLE NUMBER	SAMPLE DEPTH	TEXTURAL/ UNIFIED	AASHTO	NO. 10	NO. 40	NO. 200	GRAVEL 76.2 - 2.00 mm	SAND 2.00- 0.074 mm	SILT 0.074- 0.002 mm	CLAY BELOW 0.002 mm	BELOW 0.001 mm	LL	PL	PI
)27079209305		RB-45	1+725	LINE N	SS 2 T	3.5-5.0	SILTY CLAY LOAM	A-6(12)	100.0	99.9	98.8	0.0	1.2	76.7	22.1	19.6	34.1	22.4	11.7
)27079209325		RB-46	1+575	LINE N	SS 5 T	13.5-15.0	CLAY	A-6(11)	99.3	93.6	61.9	0.7	37.4	30.6	31.3	28.3	38.5	15.7	22.
27079109508		RWL-2	8+958	20m RT	SS 2 T	3.5-5.0	SILTY CLAY LOAM	A-6(11)	100.0	99.9	99.1	0.0	0.9	78.4	20.7	18.9	33.0	22.5	10.5
27079109521		RWL-3	8+974	21m Rt of E	SS 3 T	6.0-7.5'	SILTY LOAM	A-4(6)	99.9	99.7	94.3	0.1	5.6	78.2	16.1	13.2	29.2	22.1	7.1
27079109534		TBL-3	8+989	29m Rt of E	SS 3 T	6.0-7.5'	SILTY LOAM	A-4(7)	100.0	99.9	95.8	0.0	4.2	79.2	16.6	14.7	29.5	22.0	7.5
27079109604		RWL-1	8+940	34m Lt of E	SS 2 T	3.5-5.0'	SILT	A-4(8)	100.0	99.9	98.2	0.0	1.8	81.2	17.0	14.1	30.8	23.2	7.6
)27079109562		RWN-2	9+043	27m Lt of E	SS 2 T	3.5-5.0'	SILT	A-4(6)	100.0	100.0	99.4	0.0	0.6	83.4	16.0	13.1	29.6	23.6	6.0
)27079109577		RWN-3	9+023	27m Lt of E	SS 3 T	6.0-7.5'	SILTY LOAM	A-4(5)	99.9	98.5	88.3	0.1	11.6	72.3	16.0	13.1	28.4	21.5	6.9
)37079200118		RWN-1	9+050	29m RT LINE E	SS 4 T	8.5-10.0	SILTY LOAM	A-4(6)	99.9	99.1	91.4	0.1	8.5	73.9	17.5	15.1	29.0	21.2	7.8

4/19/04

DES NO. 9138220

SUMMARY OF SPECIAL LABORATORY TEST RESULTS

DES. NO. 9138220
PROJECT NO. STP-291-1 (2)
STRUCTURE NO. NA
COUNTY VIGO

LABORATORY NUMBER	PART	BORING NUMBER	SAMPLE NUMBER	DEPTH	NATURAL WATER CONTENT (%)	pH VALUE	LOI (%)	CA & MG (%)	NATURAL WET DENSITY (pcf)	NATURAL DRY DENSITY (pcf)	MAX DRY DENSITY (pcf)	OPT. MOIST (%)	CBR @93%	CBR @97%	COHESION (Qu/2) (psf)
027079209303		RB-45	SS 1 T	1.0-2.5	22.5										
027079209305		RB-45	SS 2 T	3.5-5.0	26.3	6.3									
027079209317		RB-46	SS 1 T	1.0-2.5	19.3										
027079209325		RB-46	SS 5 T	13.5-15.0	20.4	6.1									
027079109506		RWL-2	SS 1 T	1.0-2.4	20.4										
027079109508		RWL-2	SS 2 T	3.5-5.0	23.0	6.7									
027079109521		RWL-3	SS 3 T	6.0-7.5'	22.4	6.6									
027079109534		TBL-3	SS 3 T	6.0-7.5'	23.8	6.5									
027079109539		TBL-3	SS 5 B	13.5-15.0'	31.1				119.4	91.1					899
027079109604		RWL-1	SS 2 T	3.5-5.0'	25.9	6.8									
037079200769		TB-2	SS 1 T	1.0-2.5	24.7				124.1	99.5					2142
037079200774		TB-2	SS 3 B	6.0-7.5	19.2				130.2	109.2					906
037079200777		TB-2	SS 5 T	13.5-15.0	19.2	7.2									

4/19/04

DES NO. 0001350

SUMMARY OF SPECIAL LABORATORY TEST RESULTS

DES. NO. 0001350
PROJECT NO. STP-291-1(005)
STRUCTURE NO. 641-84-8395
COUNTY VIGO

LABORATORY NUMBER	PART	BORING NUMBER	SAMPLE NUMBER	DEPTH	NATURAL WATER CONTENT (%)	pH VALUE	LOI (%)	CA & MG (%)	NATURAL WET DENSITY (pcf)	NATURAL DRY DENSITY (pcf)	MAX DRY DENSITY (pcf)	OPT. MOIST (%)	CBR @93%	CBR @97%	COHESION (Qu/2) (psf)
027079109552		TBN-1	SS 3 T	6.0-7.5'	24.5										
027079109562		RWN-2	SS 2 T	3.5-5.0'	25.7	7.1									
027079109577		RWN-3	SS 3 T	6.0-7.5'	20.3	6.7									
027079109588		TBN-3	SS 2 T	3.5-5.0'	23.9										
037079200118		RWN-1	SS 4 T	8.5-10.0	21.8	7.1									

SUMMARY OF CLASSIFICATION TESTS DATA

DES. NO. 9138220
SR 641 OVER US 41
VIGO COUNTY

Lab #	Boring	Station	Sample #	Depth (ft)	Description	AASHTO Classification	Percent Passing #10	#40	#200	Percentage of Gravel	Sand	Silt	Clay	Colloids	W %	LL	PL	PI	Natural Wet Density (pcf)	Natural Dry Density (pcf)	Max. Dry Density (pcf)	Optimum Moisture Content (%)	Qu psf
LINE "E"																							
304	ARW-1	9+004	SS-2	3.5 - 5.0	Silty Clay	A - 7 - 6 (20)	100.0	99.0	96.5	0.0	3.5	62.5	34.0	32	23.4	44	26	18		111.5			2700
305	ARW-1	9+004	SS-2	3.5 - 5.0											27.0					100.1			4900
309	ARW-1	9+004	SS-4B	9.5 - 10.0											16.3	22	16	6		128.4			3200
316	ARW-2	9+019	SS-3	6.0 - 7.5	Silty Clay Loam	A-6 (11)	100.0	99.6	98.4	0.0	1.6	75.0	23.4	22	20.6	33	22	11					
325	ARW-3	8+977	SS-2	3.5 - 5.0	Silty Loam	A-4 (9)	100.0	99.4	98.2	0.0	1.8	79.0	19.2	18	25.5	30	20	10		99.2			1500
336	ARW-4	8+994	SS-3	6.0 - 7.5	Silt	A-4 (9)	100.0	99.8	97.6	0.0	2.4	81.0	16.6	16	27.2	30	21	9					
LINE "N"																							
357	RB-43	2+300	SS-3	6.0'-7.5'	Silty Loam	A-4 (1)	99.4	94.1	73.5	0.6	25.9	57.0	16.5	14	17.7	22	18	4					
367	RB-44	2+115	SS-2	3.5 - 5.0	Silt	A-4 (8)	100.0	99.6	98.8	0.0	1.2	82.0	16.8	16	23.5	29	20	9					
369	RB-44	2+115	SS-3T	7.0 - 7.5											16.0					121.8			3900
LINE "L"																							
345	RB-49	1+290	SS-2	3.5 - 5.0	Silt	A-4 (9)	100.0	99.8	99.0	0.0	1.0	82.0	17.0	16	23.8	30	21	9					
304	ARW-1		SS-2T	4.0 - 4.5											23.4								
305	ARW-1		SS-2B	4.5 - 5.0											26.9								
316	ARW-2		SS-3T	6.5 - 7.0											20.6								
317	ARW-2		SS-3B	7.0 - 7.5											15.5								
326	ARW-3		SS-2B	4.5 - 5.0											25.4								
336	ARW-4		SS-3T	6.5 - 7.0											27.2								
337	ARW-4		SS-3B	7.0 - 7.5											25.9								
343	RB-49		SS-1T	1.5 - 2.0											28.0								
344	RB-49		SS-1B	2.0 - 2.5											26.5								
345	RB-49		SS-2T	4.0 - 4.5											22.7								
346	RB-49		SS-2B	4.5 - 5.0											23.8								
353	RB-43		SS-1T	1.5 - 2.0											26.0								
354	RB-43		SS-1B	2.0 - 2.5											27.2								
357	RB-43		SS-3T	6.5 - 7.0											17.7								
358	RB-43		SS-3B	7.0 - 7.5											17.6								
367	RB-44		SS-2T	4.0 - 4.5											22.9								
368	RB-44		SS-2B	4.5 - 5.0											23.5								

INDOT BORING LOG

BORING NO.: ARW-1
SHEET 1 OF 1

PROJECT : SB RAMP, VIGO COUNTY
LOCATION : SR 641 SB RAMP BRIDGES & MSE WALLS OVER US 41
DES NO. : 9738230, 9138220, 0001350
PROJECT NO.: STP-291-1(005)
DATE STARTED : 03-11-03
DATE COMPLETED : 03-11-03

BORING ELEVATION : 176.65
STATION : 9+004
OFFSET : 27.0 m RT
LINE : 'E'
DEPTH : 5.73 m

BORING METHOD : HSA
RIG TYPE : TRUCK MOBILE
CASING DIA. :
STRU.# :

HAMMER : Automatic
DRILLER/INSP : DT/JP
TEMPERATURE : 8.9 °C
WEATHER : SUNNY

Ground water ____ ▽ During Drilling ____ ▼ At completion 4.30 m ▼ After 24 Hrs: 0.97 m 🖼 Caved in at 4.69 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
176.35		ASPHALT 0.30									
	0.5	DARK BROWN, MOIST, MEDIUM STIFF SILTY CLAY A-7-6 (20) LAB # 304	SS 1	3 3 3	100						
	1.0 ▼										
175.13	1.5	1.52	SS 2	3	100	23	258.7	44	26	18	SS-2B, Qu = 9.8 Kips, w% = 27
		BROWN, MOIST, SOFT SILTY CLAY LOAM A-6 LAB # 316		2 3							
	2.0		SS 3	2	100						
	2.5			2							
173.61	3.0	3.05	SS 4	2	100	16	306.6	22	16	6	
		BROWN WEATHERED SANDSTONE (VISUAL)		1 2 3							
	3.5										
	4.0										
	4.5 ▼ 🖼		SS 5	6 13 33	100						
	5.0										
	5.5										
170.92		5.73									
	6.0	Bottom of Boring at 5.73 m	SS 6	50/0.3"	25						
	6.5										
	7.0										
	7.5										
	8.0										
	8.5										
	9.0										
	9.5										
	10.0										

INDOT BORING LOG 9738230.GPJ IN DOT.GDT 4/8/04

INDOT BORING LOG

BORING NO.: ARW-2

PROJECT : SB RAMP, VIGO COUNTY

SHEET 1 OF 1

LOCATION : SR 641 SB RAMP BRIDGES & MSE WALLS OVER US 41

DATE STARTED : 03-11-03

DES NO. : 9738230, 9138220, 0001350

PROJECT NO.: STP-291-1(005)

DATE COMPLETED : 03-11-03

BORING					
ELEVATION	: 176.35	BORING METHOD	: HSA	HAMMER	: Automatic
STATION	: 9+019	RIG TYPE	: TRUCK MOBILE	DRILLER/INSP	: DT/JP
OFFSET	: 27.0 m RT	CASING DIA.	:	TEMPERATURE	: 8.9 °C
LINE	: 'E'	STRU.#	:	WEATHER	: SUNNY
DEPTH	: 5.79 m				

Ground water ____ ▽ During Drilling ____ ▼ At completion 4.24 m ▼ After 24 Hrs: 0.97 m ⊠ Caved in at 4.75 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
176.05		TOPSOIL 0.30									
	0.5	BROWN, MOIST, MEDIUM STIFF, SILTY LOAM A-4 LAB # 02-9577	SS 1	2 3 3	40						
	1.0 ▼		SS 2	3 3 3	100						
174.83	1.5	1.52									
	2.0	GRAY TO BROWN, MOIST, SOFT SILTY CLAY LOAM A-6 (11) LAB # 316	SS 3	2 2 2	100	21		33	22	11	
	2.5										
173.31	3.0	3.05	SS 4		100						
	3.5	BROWN, DRY HARD WEATHERED SANDSTONE (VISUAL)		3 2 3							
	4.0 ▼										
	4.5		SS 5	8 30 50/0.4'	100						
	5.0 ⊠										
	5.5										
170.62		5.73	SS 6	50/0.2'							
	6.0	Bottom of Boring at 5.79 m									
	6.5										
	7.0										
	7.5										
	8.0										
	8.5										
	9.0										
	9.5										
	10.0										

INDOT BORING LOG 9738230.GPJ IN DOT.GDT 4/8/04

INDOT BORING LOG

BORING NO.: ARW-3

PROJECT : SB RAMP, VIGO COUNTY
SHEET 1 OF 1

LOCATION : SR 641 SB RAMP BRIDGES & MSE WALLS OVER US 41
DATE STARTED : 03-11-03

DES NO. : 9738230, 9138220, 0001350
PROJECT NO.: STP-291-1(005)
DATE COMPLETED : 03-11-03

BORING ELEVATION	: 177.35	BORING METHOD	: HSA	HAMMER	: Automatic
STATION	: 8+977	RIG TYPE	: TRUCK MOBILE	DRILLER/INSP	: DT/JP
OFFSET	: 27.0 m L	CASING DIA.	:	TEMPERATURE	: 5.6 °C
LINE	: 'E'	STRU.#	:	WEATHER	: CLOUDY
DEPTH	: 5.73 m				

Ground water ____ ▽ During Drilling ____ ▼ At completion DRY ▽ After 24 Hrs: 0.76 m 🖂 Caved in at 5.00 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
177.05		TOPSOIL 0.30									
	0.5	BROWN, MOIST, MEDIUM STIFF, SILTY LOAM A-4 (9) LAB # 325	SS 1	3 4 5	100						
	1.0										
	1.5		SS 2	3 2 2	100	25	143.7	30	10	20	SOFT IN SS-2
	2.0										
	2.5		SS 3	2 3	100						
174.31	3.0	3.05	SS 4	4	100						
	3.5	BROWN, DRY, HARD WEATHERED SANDSTONE (VISUAL)		3 4 4							
	4.0										
	4.5		SS 5	43 50/0.2"							
	5.0	🖂									
	5.5										
171.62		5.73									
	6.0	Bottom of Boring at 5.73 m	SS 6	50/0.2"	30						
	6.5										
	7.0										
	7.5										
	8.0										
	8.5										
	9.0										
	9.5										
	10.0										

INDOT BORING LOG 9738230.GPJ IN DOT.GDT 4/8/04

INDOT BORING LOG

BORING NO.: ARW-4
SHEET 1 OF 1

PROJECT : SB RAMP, VIGO COUNTY
LOCATION : SR 641 SB RAMP BRIDGES & MSE WALLS OVER US 41
DES NO. : 9738230, 9138220, 0001350
PROJECT NO.: STP-291-1(005)
DATE STARTED : 03-12-03
DATE COMPLETED : 03-12-03

BORING ELEVATION : 176.95
STATION : 8+994
OFFSET : 27.0 m L
LINE : 'E'
DEPTH : 5.73 m

BORING METHOD : HSA
RIG TYPE : TRUCK MOBILE
CASING DIA. :
STRU.# :

HAMMER : Automatic
DRILLER/INSP : DT/JP
TEMPERATURE : 6.7 °C
WEATHER : CLOUDY

Ground water ____ ▽ During Drilling ____ ▼ At completion 4.21 m ▼ After 24 Hrs: 0.73 m ⊠ Caved in at 4.72 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	REMARKS
176.65		TOPSOIL 0.30									
	0.5	BROWN, MOIST, MEDIUM STIFF TO STIFF, SILTY LOAM A-4 LAB # 325	SS 1	3 3 3	60						
	1.0										
175.43	1.5	1.52	SS 2	4 2 3	35						
	2.0	BROWN, MOIST, SOFT, SILT A-4 (9) LAB # 336									
	2.5		SS 3	1 2 3	60	27		30	21	9	
173.91	3.0	3.05	SS 4		100						SS-3B, w% = 26
	3.5	BROWN & GRAY SLIGHTLY MOIST, HARD, WEATHERED SANDSTONE (VISUAL)		1 2 2							
	4.0										
	4.5		SS 5	15 43 50/0.2'	100						
	5.0										
	5.5										
171.22		5.73									
	6.0	Bottom of Boring at 5.73 m	SS 6	50/0.2'	25						
	6.5										
	7.0										
	7.5										
	8.0										
	8.5										
	9.0										
	9.5										
	10.0										

INDOT BORING LOG

BORING NO.: RWL-1

PROJECT : SB RAMP, VIGO COUNTY
SHEET 1 OF 1

LOCATION : SR 641 SB RAMP BRIDGES & MSE WALLS OVER US 41
DATE STARTED : 09-12-02

DES NO. : 9738230, 9138220, 0001350
PROJECT NO.: STP-291-1(005)
DATE COMPLETED : 09-12-02

BORING				
ELEVATION	: 177.95	BORING METHOD	: HSA	HAMMER : Automatic
STATION	: 8+940	RIG TYPE	: TRUCK MOBILE	DRILLER/INSP : BS/JP
OFFSET	: 34.0 m L	CASING DIA.	:	TEMPERATURE : 23.9 °C
LINE	: 'E'	STRU.#	:	WEATHER : SUNNY
DEPTH	: 8.78 m			

Ground water ____ ▽ During Drilling ____ ▼ At completion DRY ▼ After 24 Hrs: N/A ____ Caved in at 7.65 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
177.65		TOPSOIL (visual) 0.30									
	0.5	BROWN, SLIGHTLY MOIST, MEDIUM STIFF, SILTY LOAM (visual)	SS 1	4 4 5	100						
177.04	1.0	0.91									
	1.5	BROWN, MOIST, STIFF TO VERY STIFF, SILT A-4(8) LAB # 02-9604	SS 2	4 5 6	100	26		31	23	8	
	2.0		SS 3	3 5 7	85						
	2.5										
	3.0		SS 4	8 12 11	100						
	3.5										
173.99	4.0	3.96									
	4.5	BROWN, DRY, MOIST, WEATHERED, SANDSTONE (VISUAL)	SS 5	30/.6 50/.4	55						SANDSTONE AT 4.11m
	5.0										
	5.5										
	6.0		SS 6	50/.3	15						
	6.5										
	7.0										
170.79		7.16									
	7.5	GRAY, DRY, FISSILE, SHALE (VISUAL)	SS 7	50/03	15						
	8.0										
	8.5										
169.18		8.77									
	9.0	Bottom of Boring at 8.78 m	SS 8	50/.3	10						
	9.5										
	10.0										

INDOT BORING LOG 9738230.GPJ IN DOT.GDT 4/8/04

INDOT BORING LOG

BORING NO.: RWL-2
SHEET 1 OF 1
DATE STARTED : 09-10-02
DATE COMPLETED : 09-10-02

PROJECT : SB RAMP, VIGO COUNTY
LOCATION : SR 641 SB RAMP BRIDGES & MSE WALLS OVER US 41
DES NO. : 9738230, 9138220, 0001350
PROJECT NO.: STP-291-1(005)

BORING ELEVATION	: 176.05	BORING METHOD : HSA	HAMMER : Automatic
STATION	: 8+958	RIG TYPE : TRUCK MOBILE	DRILLER/INSP : BS/JP
OFFSET	: 20.0 m RT	CASING DIA. :	TEMPERATURE : 32.2 °C
LINE	: 'E'	STRU.# :	WEATHER : SUNNY
DEPTH	: 9.14 m		

Ground water ____ ▽ During Drilling ____ ▼ At completion DRY ▼ After 24 Hrs: 1.83 m ⊠ Caved in at 7.13 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
175.75	0.5	TOPSOIL (visual) 0.30									
		BROWN, SLIGHTLY MOIST, STIFF,SILTY LOAM A-4 LAB# 02-9521	SS 1	5 6 6	65	20					
175.14	1.0	0.91									
	1.5	BROWN, MOIST, STIFF TO MEDIUM STIFF ,SILT A-4 LAB# 02-9604	SS 2	4 6 6	100	23		33	23	10	
	2.0		SS 3	4 4 6	100						
	2.5										
	3.0		SS 4	5 6 6	100						
	3.5										
171.94	4.0	4.11									
	4.5	BROWN TO GRAY, SLIGHTLY MOIST, HIGHLY WEATHERED, SILTSTONE (visual)	SS 5	11 16 42	100						
	5.0										
	5.5										
	6.0		SS 6	50/.3	20						
	6.5										
168.95	7.0	7.10									
	7.5	GRAY, DRY, FISSILE, SHALE (VISUAL)	SS 7	50/.3	25						
	8.0										
	8.5										
166.92	9.0	9.14	SS 8	50/.1	10						
	9.5	Bottom of Boring at 9.14 m									
	10.0										

INDOT BORING LOG 9738230.GPJ IN DOT.GDT 4/8/04

INDOT BORING LOG

BORING NO.: RWL-3

PROJECT : SB RAMP, VIGO COUNTY
SHEET 1 OF 1

LOCATION : SR 641 SB RAMP BRIDGES & MSE WALLS OVER US 41
DATE STARTED : 09-11-02

DES NO. : 9738230, 9138220, 0001350
PROJECT NO.: STP-291-1(005)
DATE COMPLETED : 09-11-02

BORING ELEVATION	: 176.95	BORING METHOD	: HSA	HAMMER	: Automatic
STATION	: 8+914	RIG TYPE	: TRUCK MOBILE	DRILLER/INSP	: BS/JP
OFFSET	: 20.0 m RT	CASING DIA.	:	TEMPERATURE	: 15.6 °C
LINE	: 'E'	STRU.#	:	WEATHER	: SUNNY
DEPTH	: 8.72 m				

Ground water ____ ▽ During Drilling ____ ▼ At completion 6.34 m ▼ After 24 Hrs: 1.59 m ▣ Caved in at 8.72 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
176.65		TOPSOIL (visual) 0.30									
	0.5	BROWN, DRY TO SLIGHTLY MOIST, MEDIUM STIFF, SILTY CLAY LOAM A-6 LAB # 02-9502	SS 1	5 6 3	20						
	1.0										
	1.5		SS 2	4 4 4	30						
174.97	2.0	1.98									
		BROWN, MOIST MEDIUM STIFF TO STIFF, SILT LOAM A-4(6) LAB # 02-9521	SS 3	4 4 5	100	22		29	22	7	
	2.5										
	3.0		SS 4	5 6 8	100						
	3.5										
172.93	4.0	4.02									
		BROWN, DENSE, WEATHERED SANDSTONE (VISUAL)	SS 5	22 30 .50	100						
	4.5										
	5.0										
	5.5										
171.16	6.0	5.79									
		GRAY, DRY, FISSILE, VERY DENSE, SHALE (VISUAL)	SS 6	50/.1	10						
	6.5										
	7.0										
	7.5		SS 7	50/.1	10						
	8.0										
	8.5										
168.36		8.60									
	9.0	Bottom of Boring at 8.72 m	SS 8	50/.1	10						
	9.5										
	10.0										

INDOT BORING LOG 9738230.GPJ IN DOT.GDT 4/8/04

INDOT BORING LOG

BORING NO.: RWN-1

PROJECT : SB RAMP, VIGO COUNTY
SHEET 1 OF 1

LOCATION : SR 641 SB RAMP BRIDGES & MSE WALLS OVER US 41
DATE STARTED : 01-09-03

DES NO. : 9738230, 9138220, 0001350
PROJECT NO.: STP-291-1(005)
DATE COMPLETED : 01-09-03

BORING ELEVATION	: 176.35	BORING METHOD	: HSA	HAMMER	: Automatic
STATION	: 9+050	RIG TYPE	: TRUCK MOBILE	DRILLER/INSP	: BS/JP
OFFSET	: 29.0 m L	CASING DIA.	:	TEMPERATURE	: 7.2 °C
LINE	: 'E'	STRU.#	:	WEATHER	: SUNNY
DEPTH	: 8.75 m				

Ground water ____ ▽ During Drilling ____ ▼ At completion 4.36 m ▼ After 24 Hrs: BF ____ Caved in at 7.80 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
176.05	0.0	ASPHALT (visual) 0.30									
	0.5	BROWN, SLIGHTLY MOIST, MEDIUM STIFF, SILTY LOAM A-4 LAB # 02-9577	SS 1	15 7 3	20						
	1.0										PETROLEOM ODOR IN SS-1
	1.5		SS 2	4 3 4	50						
174.53	2.0	1.83 GRAY TO BROWN, MOIST, SOFT TO MEDIUM STIFF, SILTY LOAM A-4(6) LAB # 03-0118	SS 3	3 2 3	80						
	2.5										
	3.0		SS 4	3 2 3	90						
	3.5										
	4.0										
	4.5		SS 5	4 2 4	20						
	5.0										
170.75	5.5	5.61 BROWN, DRY, HARD, SILTSTONE (VISUAL)	SS 6	50/.3	20						
	6.0										
	6.5										
	7.0										
169.16	7.5	7.19 GRAY, DRY, HARD, SHALE(VISUAL)	SS 7	44/6 50/.1	30						WATER ON RODS AT 7.16m
	8.0										
	8.5										
167.61	9.0	8.75 Bottom of Boring at 8.75 m	SS 8	50/.2	20						
	9.5										
	10.0										

INDOT BORING LOG

BORING NO.: RWN-2

PROJECT : SB RAMP, VIGO COUNTY
SHEET 1 OF 1

LOCATION : SR 641 SB RAMP BRIDGES & MSE WALLS OVER US 41
DATE STARTED : 09-11-02

DES NO. : 9738230, 9138220, 0001350
PROJECT NO.: STP-291-1(005)
DATE COMPLETED : 09-11-02

BORING					
ELEVATION	: 176.35	BORING METHOD	: HSA	HAMMER	: Automatic
STATION	: 9+043	RIG TYPE	: TRUCK MOBILE	DRILLER/INSP	: BS/JP
OFFSET	: 27.0 m L	CASING DIA.	:	TEMPERATURE	: 25.6 °C
LINE	: 'E'	STRU.#	:	WEATHER	: SUNNY
DEPTH	: 8.81 m				

Ground water ____ ▽ During Drilling ____ ▼ At completion 7.68 m ▼ After 24 Hrs: 2.14 m 🖂 Caved in at 7.96 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
176.05	0.5	TOPSOIL (visual) 0.30 BROWN, MOIST, STIFF, SILTY LOAM A-4 LAB # 02-9577	SS 1	5 5 6	40						
175.17	1.5	1.19 BROWN, MOIST, MEDIUM STIFF, SILT A-4(6) LAB # 02-9562	SS 2	3 4 5	80						
	2.5		SS 3	4 4 5	100						
	3.5		SS 4	4 4 5	100						
171.94	4.5	4.42 BROWN, DRY, WEATHERED SANDSTONE (VISUAL)	SS 5	6 21 50/.3	85						
	6.0		SS 6	50/.2	20						
	7.5		SS 7	50/.2	20						
167.55	9.0	8.81 Bottom of Boring at 8.81 m	SS 8	50/.4	30						
	10.0										

INDOT BORING LOG 9738230.GPJ IN DOT.GDT 4/8/04

INDOT BORING LOG

BORING NO.: RWN-3

PROJECT : SB RAMP, VIGO COUNTY
SHEET 1 OF 1

LOCATION : SR 641 SB RAMP BRIDGES & MSE WALLS OVER US 41
DATE STARTED : 09-11-02

DES NO. : 9738230, 9138220, 0001350
PROJECT NO.: STP-291-1(005)
DATE COMPLETED : 09-11-02

BORING	ELEVATION : 176.65	BORING METHOD : HSA		HAMMER : Automatic	
	STATION : 9+023	RIG TYPE : TRUCK MOBILE		DRILLER/INSP : BS/JP	
	OFFSET : 27.0 m L	CASING DIA. :		TEMPERATURE : 18.3 °C	
	LINE : 'E'	STRU.# :		WEATHER : SUNNY	
	DEPTH : 8.72 m				

Ground water ____ ▽ During Drilling ____ ▼ At completion 7.86 m ▼ After 24 Hrs: BF ⊠ Caved in at 7.96 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
176.35		TOPSOIL (visual) 0.30									
	0.5	BROWN, MOIST, STIFF, SILTY LOAM A-4(5) LAB # 02-9577	SS 1	4 5 6	60						
	1.0										
	1.5		SS 2	9 16 13	100						
	2.0		SS 3	7 10 9	100						
	2.5										
	3.0		SS 4	3 6 6	100						
	3.5										
	4.0										
172.45		4.20									
	4.5	BROWN, SLIGHT MOIST, HIGHLY WEATHERED, SANDSTONE (VISUAL)	SS 5	7 16 20	90						SANDSTONE AT 4.27m
	5.0										
	5.5										
	6.0		SS 6	10/6 50/.2	80						
	6.5										
	7.0										
	7.5		SS 7	50/.1	10						
	8.0										
	8.5										
167.94		8.72									
	9.0	Bottom of Boring at 8.72 m	SS 8	50/.1	10						
	9.5										
	10.0										

INDOT BORING LOG 9738230.GPJ IN DOT.GDT 4/8/04

INDOT BORING LOG

BORING NO.: TBL-1

PROJECT : SB RAMP, VIGO COUNTY
SHEET 1 OF 1

LOCATION : SR 641 SB RAMP BRIDGES & MSE WALLS OVER US 41
DATE STARTED : 09-19-02

DES NO. : 9738230, 9138220, 0001350
PROJECT NO.: STP-291-1(005)
DATE COMPLETED : 09-19-02

BORING ELEVATION	: 177.56	BORING METHOD	: HSA	HAMMER	: Automatic
STATION	: 8+961	RIG TYPE	: TRUCK MOBILE	DRILLER/INSP	: BS/JP
OFFSET	: 27.0 m RT	CASING DIA.	:	TEMPERATURE	: 26.7 °C
LINE	: 'E'	STRU.#	:	WEATHER	: CLOUDY
DEPTH	: 8.75 m				

Ground water ____ ▽ During Drilling ____ ▼ At completion DRY ▼ After 24 Hrs: 1.86 m 🖂 Caved in at 8.08 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
177.25	0.5	TOPSOIL (visual) 0.30									
		BROWN, DRY, MEDIUM STIFF, SILTY LOAM A-4 LAB # 02-9534	SS 1	4 4 4	30						
176.64	1.0	0.91									
	1.5	BROWN, MOIST, MEDIUM STIFF, SILT A-4 LAB # 02-9534	SS 2	5 3 5	80						
	2.0		SS 3	4 5 4	25						
175.12	2.5	2.44									
		BROWN, MOIST, MEDIUM STIFF SILTY LOAM A-4 LAB # 02-9534	SS 4	3 3 6	60						
174.51	3.0	3.05									
	3.5	BROWN TO GRAY, SLIGHTLY MOIST, WEATHERED, SANDSTONE (VISUAL)									
	4.0										
	4.5		SS 5	7 17 30	100						
	5.0										
	5.5										
171.76		5.79									
	6.0	GRAY, DRY, FISSILE, SHALE (VISUAL)	SS 6	50/.4	30						
	6.5										
	7.0										
	7.5		SS 7	56 50/.2	30						
	8.0										
	8.5										
168.81		8.75									
	9.0	Bottom of Boring at 8.75 m	SS 8	50/.2	20						
	9.5										
	10.0										

INDOT BORING LOG 9738230.GPJ IN DOT.GDT 4/8/04

INDOT BORING LOG

BORING NO.: TBL-3
SHEET 1 OF 2

PROJECT : SB RAMP, VIGO COUNTY
LOCATION : SR 641 SB RAMP BRIDGES & MSE WALLS OVER US 41
DES NO. : 9738230, 9138220, 0001350 PROJECT NO.: STP-291-1(005)

DATE STARTED : 09-11-02
DATE COMPLETED : 09-11-02

BORING ELEVATION : 176.95
STATION : 8+989
OFFSET : 29.0 m RT
LINE : 'E'
DEPTH : 14.78 m

BORING METHOD : HSA
RIG TYPE : TRUCK MOBILE
CASING DIA. :
STRU.# :

HAMMER : Automatic
DRILLER/INSP : BS/JP
TEMPERATURE : 21.1 °C
WEATHER : SUNNY

Ground water ____ ▽ During Drilling ____ ▼ At completion 4.60 m ▼ After 24 Hrs: 1.68 m 🖼 Caved in at 12.50 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
176.86		CONCRETE 0.09									
176.65		SAND (visual) 0.30									
	0.5	GRAY, SLIGHTLY MOIST, MEDIUM STIFF, SILTY CLAY LOAM A-6 LAB # 02-9508	SS 1	3 4 4	65						
	1.0										
175.43	1.5	1.52	SS 2	3 2 4	100						
	2.0	BROWN, SLIGHTLY MOIST, MEDIUM STIFF, SILTY LOAM A-4 (7) LAB # 02-9534	SS 3	2 2 4	80						
	2.5										
	3.0		SS 4	3 4 5	70	24		30	22	8	
	3.5										
	4.0										
172.38	4.5	4.57	SS 5	3 4 5	70	31	86.2				
	5.0	BROWN, DRY, DENSE, WEATHERED, SANDSTONE (VISUAL)									
	5.5										
	6.0		SS 6	50/.2	20						
	6.5										
	7.0										
	7.5		SS 7	50/.1	10						
	8.0										
	8.5										
168.24		8.72									
	9.0	GRAY, DRY, VERY DENSE, WEATHERED SILTSTONE (VISUAL)	SS 8	50/.1	10						
	9.5										
	10.0										

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INDOT BORING LOG

BORING NO.: TBL-3

PROJECT : SB RAMP, VIGO COUNTY

SHEET 2 OF 2

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	REMARKS
	10.5	GRAY, DRY, VERY DENSE, WEATHERED SILTSTONE (VISUAL)	SS 9	50/.1	10						WATER ON TUBE
	11.0										
	11.5										
165.13		11.83									
	12.0	BROWN, DRY, DENSE, WEATHERED, SANDSTONE (VISUAL)	SS 10	100/.4	30						
	12.5										
	13.0										
163.70		13.26									
	13.5	GRAY, DRY, VERY DENSE, SHALE (VISUALI)	SS 11	43 50/.2	50						
	14.0										
	14.5										
162.11		14.84									
	15.0	Bottom of Boring at 14.78 m	SS 12	50/.2	20						
	15.5										
	16.0										
	16.5										
	17.0										
	17.5										
	18.0										
	18.5										
	19.0										
	19.5										
	20.0										
	20.5										
	21.0										
	21.5										
	22.0										

INDOT BORING LOG

BORING NO.: TBN-1

PROJECT : SB RAMP, VIGO COUNTY
SHEET 1 OF 1

LOCATION : SR 641 SB RAMP BRIDGES & MSE WALLS OVER US 41
DATE STARTED : 09-12-02

DES NO. : 9738230, 9138220, 0001350
PROJECT NO.: STP-291-1(005)
DATE COMPLETED : 09-12-02

BORING ELEVATION	: 175.95	BORING METHOD	: HSA	HAMMER	: Automatic
STATION	: 9+033	RIG TYPE	: TRUCK MOBILE	DRILLER/INSP	: BS/JP
OFFSET	: 28.0 m RT	CASING DIA.	:	TEMPERATURE	: 23.9 °C
LINE	: 'E'	STRU.#	:	WEATHER	: SUNNY
DEPTH	: 8.75 m				

Ground water ____ ▽ During Drilling ____ ▼ At completion 6.49 m ▼ After 24 Hrs: 1.62 m ⊠ Caved in at 8.11 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
175.65		TOPSOIL (visual) 0.30									
	0.5	GRAY, MOSIT, MEDIUM STIFF, SILTY LOAM A-4 LAB # 02-9577	SS 1	2 3 3	60						
	1.0										
	1.5		SS 2	4 3 4	50						
	2.0		SS 3	3 4 4	100						
173.46	2.5	2.50									
	3.0	BROWN, MOIST, MEDIUM STIFF, SILT A-4 LAB # 02-9502	SS 4	4 4 5	100						
	3.5										
	4.0										
171.75		4.21									
	4.5	BROWN, DRY, WEATHERED, SANDSTONE (VISUAL)	SS 5	7 12 45	100						
	5.0										
	5.5										
	6.0		SS 6	50/.2	20						
	6.5										
168.94	7.0	7.01									
	7.5	GRAY, DRY, HARD, FISSILE, SHALE (VISUAL)	SS 7	50/.2	20						
	8.0										
	8.5										
167.21		8.75									
	9.0	Bottom of Boring at 8.75 m	SS 8	50/.2	20						
	9.5										
	10.0										

INDOT BORING LOG 9738230.GPJ IN DOT.GDT 4/8/04

INDOT BORING LOG

BORING NO.: TBN-3
SHEET 1 OF 2

PROJECT : SB RAMP, VIGO COUNTY
LOCATION : SR 641 SB RAMP BRIDGES & MSE WALLS OVER US 41
DES NO. : 9738230, 9138220, 0001350 PROJECT NO.: STP-291-1(005)

DATE STARTED : 09-12-02
DATE COMPLETED : 09-12-02

BORING ELEVATION	: 176.75	BORING METHOD	: HSA	HAMMER	: Automatic
STATION	: 9+010	RIG TYPE	: TRUCK MOBILE	DRILLER/INSP	: BS/JP
OFFSET	: 28.0 m L	CASING DIA.	:	TEMPERATURE	: 22.2 °C
LINE	: 'E'	STRU.#	:	WEATHER	: SUNNY
DEPTH	: 13.50 m				

Ground water ___ ▽ During Drilling ___ ▼ At completion 7.80 m ▼ After 24 Hrs: BF 🖳 Caved in at 12.34 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
176.45		TOPSOIL (visual) 0.30									
	0.5	BROWN, SLIGHTLY MOIST, MEDIUM STIFF, SILTY LOAM A-4 LAB # 02-9577	SS 1	4 4 5	75						
175.69	1.0	1.07									
	1.5	BROWN, MOIST, MEDIUM STIFF, SILT A-4 LAB # 02-9562	SS 2	3 4 5	100						
	2.0		SS 3	6 5 6	100						
174.26	2.5	2.50									
	3.0	BROWN, MOIST, STIFF, SILTY LOAM A-4 LAB # 02-9577	SS 4	5 5 7	100						
	3.5										
172.64	4.0	4.11									
	4.5	MOTTLED BROWN AND GRAY, SLIGHTLY MOIST, WEATHERED, SANDSTONE (VISUAL)	SS 5	12 27 50	100						
	5.0										
	5.5										
	6.0		SS 6	50/.2	20						
	6.5										
	7.0										
	7.5		SS 7	50/.2	20						
	8.0										
	8.5										
	9.0		SS 8	50/.1	10						
	9.5										
	10.0										

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INDOT BORING LOG

BORING NO.: TBN-3

PROJECT : SB RAMP, VIGO COUNTY

SHEET 2 OF 2

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	REMARKS
	10.5	MOTTLED BROWN AND GRAY, SLIGHTLY MOIST, WEATHERED, SANDSTONE (VISUAL)	SS 9	50/.1	10						
	11.0										
	11.5										
165.05		11.70									
	12.0	GRAY, DRY, HARD, SHALE (VISUAL)	SS 10	50/.3	25						
	12.5										
	13.0										
163.25	13.5	13.50	SS 11	30/6 50/.3	30						
		Bottom of Boring at 13.50 m									
	14.0										
	14.5										
	15.0										
	15.5										
	16.0										
	16.5										
	17.0										
	17.5										
	18.0										
	18.5										
	19.0										
	19.5										
	20.0										
	20.5										
	21.0										
	21.5										
	22.0										

INDOT BORING LOG

BORING NO.: RB-43
SHEET 1 OF 1
DATE STARTED : 03-12-03
DATE COMPLETED : 03-12-03

PROJECT : SR 641 PHASE 2
LOCATION : SR 641 & US 41 INTERCHANGE
DES NO. : 9138220
PROJECT NO.: STP-291-1(005)

BORING ELEVATION	: 178.30	BORING METHOD	: HSA	HAMMER	: AUTOMATIC
STATION	: 2+300	RIG TYPE	: TRUCK MOBILE	DRILLER/INSP	: DT/JP
OFFSET	: 0.00 m	CASING DIA.	: 8"	TEMPERATURE	: 6.7 °C
LINE	: 'N'	STRU.#	: N/A	WEATHER	: CLOUDY
DEPTH	: 7.22 m				

Ground water ___ ▽ During Drilling ___ ▼ At completion DRY ▼ After 24 Hrs: 0.64 Caved in at 5.27 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
177.99	0.5	TOPSOIL (VISUAL) 0.30 BROWN, MOIST,MEDIUM STIFF, SILT A-4 LAB # 367	SS 1	3 4 4	100						
176.78	1.5	1.52	SS 2	3 3 3	100						
	2.0	BROWN, MOIST, MEDIUM STIFF, SILTY LOAM A-4 (1) LAB # 357	SS 3	2 3 3	100						
175.25	3.0	3.05	SS 4	2 3 4	100						
	3.5	BROWN, MOIST, STIFF, SANDY CLAY LOAM (VISUAL)									
	4.0										
	4.5		SS 5	3 4 10	100						
	5.0										
172.66	5.5	5.64									
	6.0	BROWN, DRY, HARD, SILTSTONE (VISUAL)	SS 6	50/.3	30						
	6.5										
171.14	7.0	7.16									
171.08	7.5	GRAY, DRY, HARD, SHALE (VISUAL) 7.22 Bottom of Boring at 7.22 m	SS 7	50/.2	20						
	8.0										
	8.5										
	9.0										
	9.5										
	10.0										

INDOT BORING LOG 9138220.GPJ IN DOT.GDT 4/15/04

INDOT BORING LOG

BORING NO.: RB-44
SHEET 1 OF 1
DATE STARTED : 03-12-03
DATE COMPLETED : 03-12-03

PROJECT : SR 641 PHASE 2
LOCATION : SR 641 & US 41 INTERCHANGE
DES NO. : 9138220
PROJECT NO.: STP-291-1(005)

BORING ELEVATION : 177.60
STATION : 2+115
OFFSET : 0.00 m
LINE : 'N'
DEPTH : 7.28 m

BORING METHOD : HSA
RIG TYPE : TRUCK MOBILE
CASING DIA. : 8"
STRU.# : N/A

HAMMER : AUTOMATIC
DRILLER/INSP : DT/JP
TEMPERATURE : 12.8 °C
WEATHER : SUNNY

Ground water ____ ▽ During Drilling ____ ▼ At completion DRY ▼ After 24 Hrs: 0.76 ▣ Caved in at 5.24 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
177.30		TOPSOIL (VISUAL) 0.30									
	0.5	MOTTLED BROWN TO GRAY, MOIST, MEDIUM STIFF , SILT A-4 (8) Lab # 367	SS 1	4 4 4	75						
	1.0										
176.08	1.5	1.52	SS 2	4 7 7	100						
		BROWN, MOIST, STIFF, SILTY LOAM A-4 LAB # 357									
	2.0		SS 3	3 8 10	100						
	2.5										
	3.0		SS 4	3 9 10	100						
	3.5										
173.49	4.0	4.11									
	4.5	LIGHT BROWN, SLIGHTLY MOIST, HARD, WEATHERED SANDSTONE (VISUAL)	SS 5	18 52 50/.2	100						
	5.0										
	5.5										
171.87		5.73									
	6.0	GRAY, DRY, HARD, SHALE (VISUAL)	SS 6	50/.3	25						
	6.5										
	7.0										
170.32		7.28	SS 7	50/.4	30						
	7.5	Bottom of Boring at 7.28 m									
	8.0										
	8.5										
	9.0										
	9.5										
	10.0										

INDOT BORING LOG 9138220.GPJ IN DOT.GDT 4/15/04

INDOT BORING LOG

BORING NO.: RB-45
SHEET 1 OF 1
DATE STARTED : 09-05-02
DATE COMPLETED : 09-05-02

PROJECT : SR 641 PHASE 2
LOCATION : SR 641 & US 41 INTERCHANGE
DES NO. : 9138220
PROJECT NO.: STP-291-1(005)

BORING ELEVATION : 174.00
STATION : 1+725
OFFSET : 0.00 m
LINE : 'N'
DEPTH : 7.62 m

BORING METHOD : HSA
RIG TYPE : TRUCK MOBILE
CASING DIA. : 8"
STRU.# : N/A

HAMMER : AUTOMATIC
DRILLER/INSP : DT/JL
TEMPERATURE : 31.1 °C
WEATHER : SUNNY

Ground water ____ ▽ During Drilling ____ ▼ At completion DRY ▼ After 24 Hrs: 2.28 Caved in at 6.13 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
173.69		TOPSOIL 0.30									
	0.5	BROWN, SLIGHTLY MOIST, MEDIUM STIFF, SILTY CLAY LOAM A-6 (12) LAB # 02-9305	SS 1	5 5 6	70	23					
	1.0										
	1.5		SS 2	4 3 4	80	26		34	22	12	
172.17		1.83									
	2.0	BROWN MOTTLED GRAY, SLIGHTLY MOIST, MEDIUM STIFF, CLAY A-6 LAB # 02-9325	SS 3	3 3 3	80						
	2.5										
	3.0		SS 4	2 4 5	100						
	3.5										
	4.0										
169.73		4.27									
	4.5	GRAY, SLIGHTLY MOIST, MEDIUM DENSE SAND (VISUAL)	SS 5	5 9 17	100						
	5.0										
	5.5										
168.36		5.64									
	6.0	GRAY, DRY, VERY DENSE, WEATHERED SILTSTONE (VISUAL)	SS 6	12 27 70	100						
	6.5										
166.99	7.0	7.01									
		GRAY, DRY, VERY DENSE SHALE (VISUAL)	SS 7	19 37 50	80						
166.38	7.5	7.62									
		Bottom of Boring at 7.62 m									
	8.0										
	8.5										
	9.0										
	9.5										
	10.0										

INDOT BORING LOG 9138220.GPJ IN DOT.GDT 4/14/04

INDOT BORING LOG

BORING NO.: RB-46
SHEET 1 OF 1
DATE STARTED : 09-06-02
DATE COMPLETED : 09-06-02

PROJECT : SR 641 PHASE 2
LOCATION : SR 641 & US 41 INTERCHANGE
DES NO. : 9138220
PROJECT NO.: STP-291-1(005)

BORING ELEVATION	: 170.80	BORING METHOD	: HSA	HAMMER	: AUTOMATIC
STATION	: 1+575	RIG TYPE	: TRUCK MOBILE	DRILLER/INSP	: DT/JL
OFFSET	: 0.00 m	CASING DIA.	: 8"	TEMPERATURE	: 22.2 °C
LINE	: 'N'	STRU.#	: N/A	WEATHER	: SUNNY
DEPTH	: 10.67 m				

Ground water ____ ▽ During Drilling ____ ▼ At completion 9.02 m ▼ After 24 Hrs: 1.89 ⊠ Caved in at 9.33 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
170.49		TOPSOIL (VISUAL) 0.30									
	1	BROWN, SLIGHTLY MOIST, MEDIUM STIFF, SILTY CLAY LOAM A-6 LAB # 02-9305	SS 1	3 5 6	65	19					
			SS 2	5 4 5	80						
	2		SS 3	5 5 8	90						
168.21		2.59									
	3	BROWN TO GRAY, SLIGHTLY MOIST, STIFF CLAY A-6 (11) LAB # 02-9325	SS 4	14 3 7	90						
	4		SS 5	12 8 12 19	100	20		38	16	22	
	5										
165.16		5.64									
	6	BLACK, MOIST, DENSE, VERY WEATHERED COAL (VISUAL)	SS 6	14 22 28	100						
	7		SS 7	8 13 20	100						
	8										
	9		SS 8	30 50/.2	50						
	10										
160.59		10.21									
160.13		GRAY, DRY, DENSE, SHALE (VISUAL) 10.67	SS 9	27 40 65	100						
	11	Bottom of Boring at 10.67 m									
	12										

INDOT BORING LOG 9138220.GPJ IN DOT.GDT 4/14/04

INDOT BORING LOG

BORING NO.: **RB-47**

PROJECT : SR 641 PHASE 2
SHEET 1 OF 1
LOCATION : SR 641 & US 41 INTERCHANGE
DATE STARTED : 03-18-03
DES NO. : 9138220
PROJECT NO.: STP-291-1(005)
DATE COMPLETED : 03-18-03

BORING					
ELEVATION	: 172.90	BORING METHOD	: HSA	HAMMER	: AUTOMATIC
STATION	: 1+260	RIG TYPE	: TRUCK MOBILE	DRILLER/INSP	: DT/JP
OFFSET	: 0.00 m	CASING DIA.	: 8"	TEMPERATURE	: 18.3 °C
LINE	: 'J'	STRU.#	: N/A	WEATHER	: PARTLY CLOUDY
DEPTH	: 4.57 m				

Ground water ____ ▽ During Drilling ____ ▼ At completion 1.04 m ▼ After 24 Hrs: N/A Caved in at 1.49 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
172.59		TOPSOIL (VISUAL) 0.30									
	0.5	BROWN, MOIST, SOFT, SILTY CLAY LOAM A-6 LAB # 02-9305	SS 1	3 2 3	100						
	1.0 ▼										
	1.5 ▣		SS 2	2 3 2	40						
171.07		1.83									
	2.0	MOTTLED BROWN TO GRAY, MOIST, SOFT TO MEDIUM STIFF, CLAY A-6 LAB # 02-9325	SS 3	1 2 3	100						
	2.5										
	3.0		SS 4	1 3 2	100						
	3.5										
	4.0										
168.33	4.5	4.57	SS 5	3 4 5	90						
		Bottom of Boring at 4.57 m									
	5.0										
	5.5										
	6.0										
	6.5										
	7.0										
	7.5										
	8.0										
	8.5										
	9.0										
	9.5										
	10.0										

INDOT BORING LOG 9138220.GPJ IN DOT.GDT 4/14/04

INDOT BORING LOG

BORING NO.: RB-48
SHEET 1 OF 2

PROJECT : SR 641 PHASE 2
LOCATION : SR 641 & US 41 INTERCHANGE
DES NO. : 9138220
PROJECT NO.: STP-291-1(005)
DATE STARTED : 03-18-03
DATE COMPLETED : 03-18-03

BORING ELEVATION : 172.41
STATION : 1+100
OFFSET : 0.00 m
LINE : 'J'
DEPTH : 10.67 m

BORING METHOD : HSA
RIG TYPE : TRUCK MOBILE
CASING DIA. : 8"
STRU.# : N/A

HAMMER : AUTOMATIC
DRILLER/INSP : DT/JP
TEMPERATURE : 17.8 °C
WEATHER : PARTLY CLOUDY

Ground water ____ ▽ During Drilling ____ ▼ At completion 4.21 m ▼ After 24 Hrs: N/A ⊠ Caved in at 4.72 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
172.11	0.0	TOPSOIL (VISUAL)									
		0.30									
	0.5	MOTTLED BROWN , MOIST, MEDIUM STIFF, SILTY CLAY LOAM A-6 LAB # 9305	SS 1	3 3 4	100						
	1.0										
	1.5		SS 2	2 2 3	85						
	2.0		SS 3	4 3 5	100						
	2.5										
	3.0		SS 4	2 3 3	100						
	3.5										
	4.0										
168.30		4.11									
	4.5	BROWN, MOIST, MEDIUM STIFF, CLAY A-6 LAB # 02-9325	SS 5	4 5 4	100						
	5.0										
	5.5										
166.62		5.79									
	6.0	BROWN, DRY, HARD, SILTSTONE (VISUAL)	SS 6	14 30 50	100						
	6.5										
	7.0										
164.88	7.5	7.53									
		BLACK, DRY, HARD, COAL (VISUAL)	SS 7	20 32 33	70						
	8.0										
	8.5										
	9.0		SS 8	28 50/.3	40						
162.96	9.5	9.45									
		GRAY, DRY, HARD SHALE (VISUAL)									
	10.0										

Continued on next page

INDOT BORING LOG

BORING NO.: RB-48

PROJECT : SR 641 PHASE 2

SHEET 2 OF 2

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	REMARKS
	10.5	GRAY, DRY, HARD SHALE (VISUAL)	SS 9	12 21 32	40						
161.74		10.67									
	11.0	Bottom of Boring at 10.67 m									
	11.5										
	12.0										
	12.5										
	13.0										
	13.5										
	14.0										
	14.5										
	15.0										
	15.5										
	16.0										
	16.5										
	17.0										
	17.5										
	18.0										
	18.5										
	19.0										
	19.5										
	20.0										
	20.5										
	21.0										
	21.5										
	22.0										

INDOT BORING LOG

BORING NO.: RB-49

PROJECT : SR 641 PHASE 2
SHEET 1 OF 1

LOCATION : SR 641 & US 41 INTERCHANGE
DATE STARTED : 03-12-03

DES NO. : 9138220
PROJECT NO.: STP-291-1(005)
DATE COMPLETED : 03-12-03

BORING ELEVATION	: 178.00	BORING METHOD	: HSA	HAMMER	: AUTOMATIC
STATION	: 1+290	RIG TYPE	: TRUCK MOBILE	DRILLER/INSP	: DT/JP
OFFSET	: 0.00 m	CASING DIA.	: 8"	TEMPERATURE	: 7.2 °C
LINE	: 'L'	STRU.#	: N/A	WEATHER	: CLOUDY
DEPTH	: 4.57 m				

Ground water ____ ▽ During Drilling ____ ▼ At completion DRY ▼ After 24 Hrs: 0.12 Caved in at 3.17 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
177.70		TOPSOIL (VISUAL) 0.30									
	0.5	MOTTLED BROWN, MOIST, MEDIUM STIFF, SILTY LOAM A-4 LAB # 357	SS 1	3 3 3	100						
	1.0										
	1.5		SS 2	1 3 4	100						
	2.0										
175.71		2.29	SS 3	3 5 5	100						
	2.5	TAN,MOIST,MEDIUM STIFF,SILTY LOAM (VISUAL)									
174.95	3.0	3.05	SS 4	1 3 3	100						
	3.5	BROWN, MOIST,HARD,COARSE GRAINED SANDY LOAM (VISUAL)									
	4.0										
173.43	4.5	4.57	SS 5	15 20 18	100						
		Bottom of Boring at 4.57 m									
	5.0										
	5.5										
	6.0										
	6.5										
	7.0										
	7.5										
	8.0										
	8.5										
	9.0										
	9.5										
	10.0										

INDOT BORING LOG

BORING NO.: RB-51
SHEET 1 OF 1
DATE STARTED : 09-24-02
DATE COMPLETED : 09-24-02

PROJECT : SR 641 PHASE 2
LOCATION : SR 641 & US 41 INTERCHANGE
DES NO. : 9138220
PROJECT NO.: STP-291-1(005)

BORING ELEVATION : 175.70
STATION : 1+260
OFFSET : 0.00 m
LINE : 'K'
DEPTH : 7.32 m

BORING METHOD : HSA
RIG TYPE : TRUCK MOBILE
CASING DIA. : 8"
STRU.# : N/A

HAMMER : AUTOMATIC
DRILLER/INSP : BS/JP
TEMPERATURE : 17.8 °C
WEATHER : SUNNY

Ground water ___ ▽ During Drilling ___ ▼ At completion DRY ▼ After 24 Hrs: 1.43 Caved in at 6.49 m

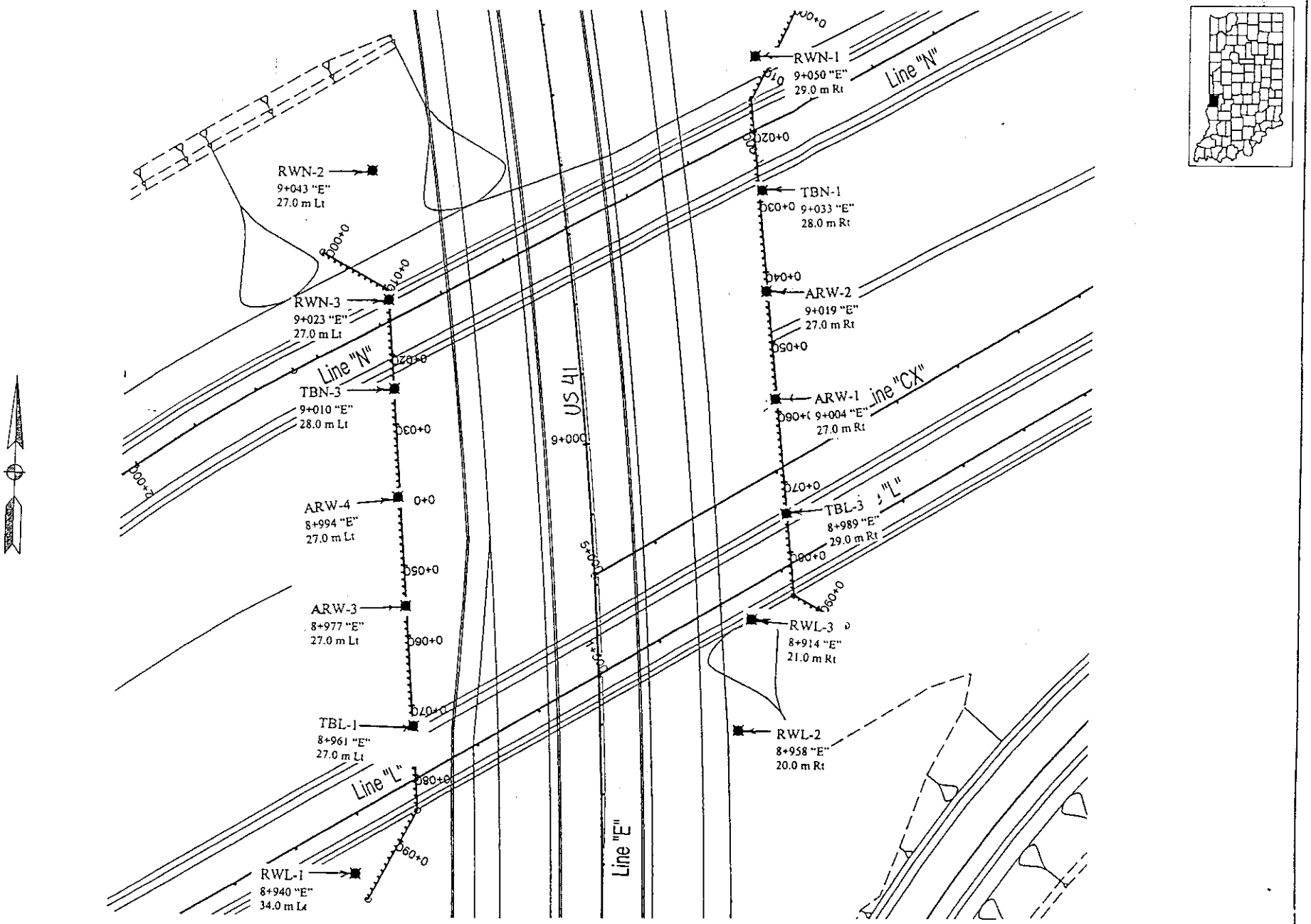
STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
175.39		ASPHALT 0.30									
	0.5	BROWN, MOIST, MEDIUM STIFF, SILTY CLAY LOAM A-6 LAB # 02-9305	SS 1	5 4 4	50						
	1.0										
	1.5 ▽		SS 2	3 3 3	60						
	2.0		SS 3	3 4 3	75						
	2.5										
	3.0		SS 4	4 4 5	75						
	3.5										
	4.0										
171.49		4.21									
	4.5	BROWN, SLIGHTLY MOIST, MODERATELY INDURATED WEATHERED SANDSTONE (VISUAL)	SS 5	17 37 50	100						
	5.0										
	5.5										
	6.0		SS 6		15						
169.60		6.10									
	6.5 ⊠	GRAY, DRY, FISSILE, SHALE (VISUAL)		50/.3							
	7.0										
168.41		7.28	SS 7		15						
	7.5	Bottom of Boring at 7.32 m		50/.4							
	8.0										
	8.5										
	9.0										
	9.5										
	10.0										

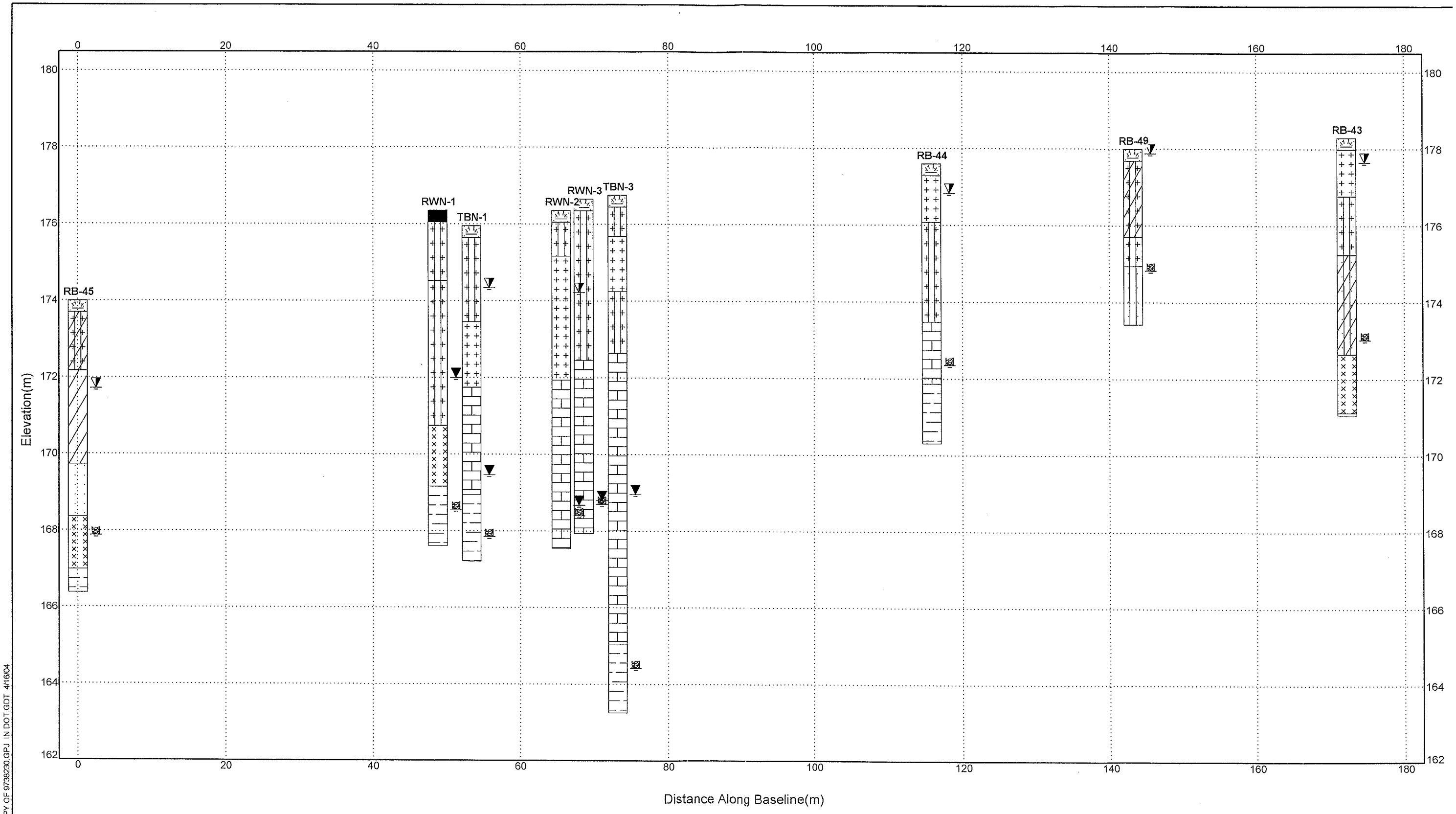
INDOT BORING LOG 9138220.GPJ IN DOT.GDT 4/14/04

BORING LOCATION PLAN FOR MSE WALLS

Designation No's: 9138220, 9738230 & 0001350

S. R. 641 NB Ramp Over US 41 & SR 641 SB Ramp Over US 41 in Vigo County





INDOT - GEOTECHNICAL SECTION

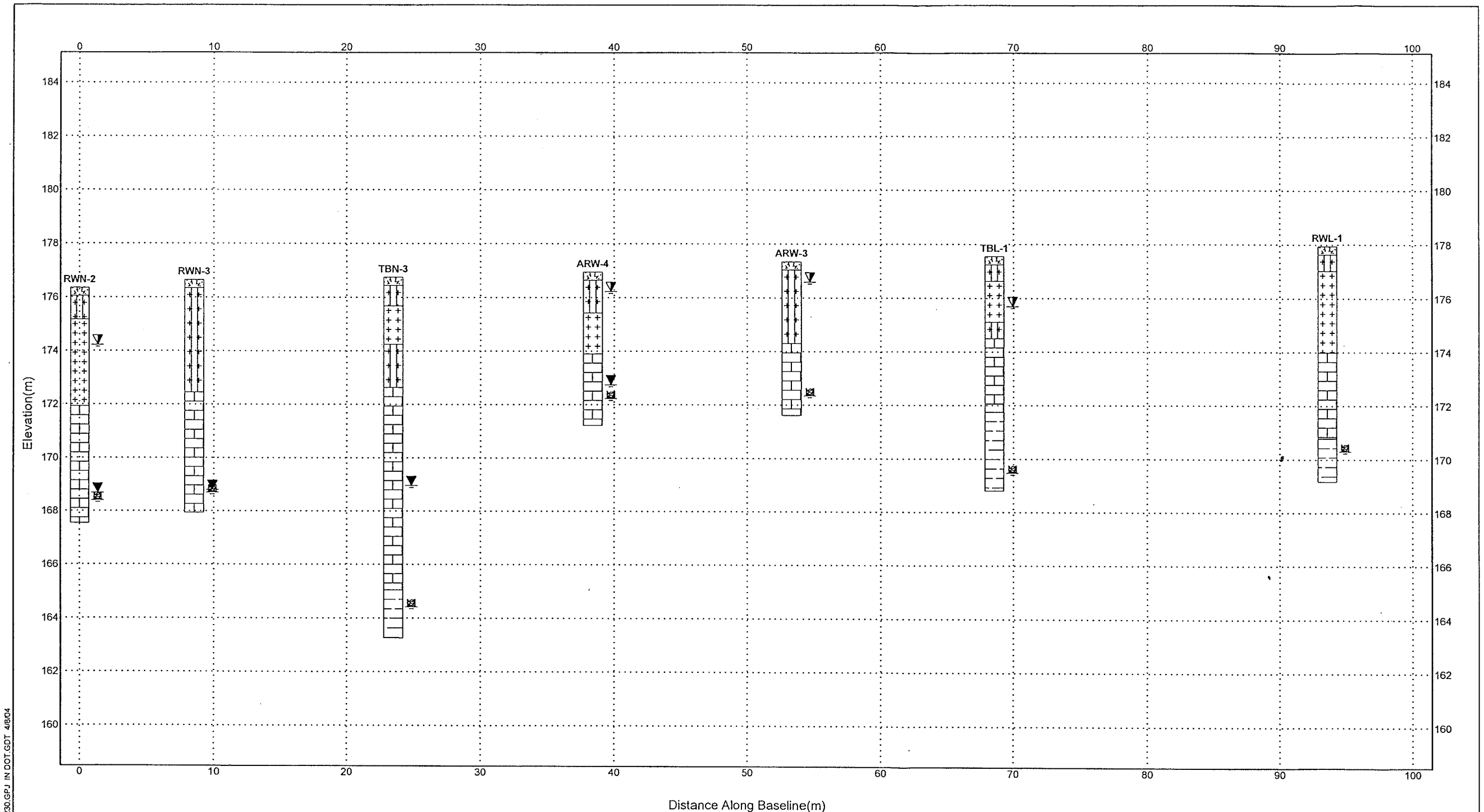
Telephone: (317) 610-7251 EXT 224
Fax: (317) 356 9351

LITHOLOGY GRAPHICS

- Topsoil
- Indiana DOT: Silt
- Indiana DOT: Silty Loam
- Indiana DOT: Sandy Clay Loam
- Siltstone
- Indiana DOT: Shale
- Indiana DOT: Sandstone
- Indiana DOT: Silty Clay Loam
- Indiana DOT: Clay
- Indiana DOT: Sand
- Indiana DOT: Sandy Loam
- Asphalt

GENERALIZED SOIL PROFILE
PHASE II SR641
SR 641 RAMPS, BRIDGES & MSE WALLS
OVER US 41, IN VIGO COUNTY

Project Number: STP-291-1(0C



STRATIGRAPHY & GW - B SIZE 9738230.GPJ IN DOT.GDT 4/8/04

INDOT - Geo Tech Section

Telephone: (3170 610 7251 XTN 224
Fax: (317) 356 9351

LITHOLOGY GRAPHICS

Topsoil

Indiana DOT: Silty Loam

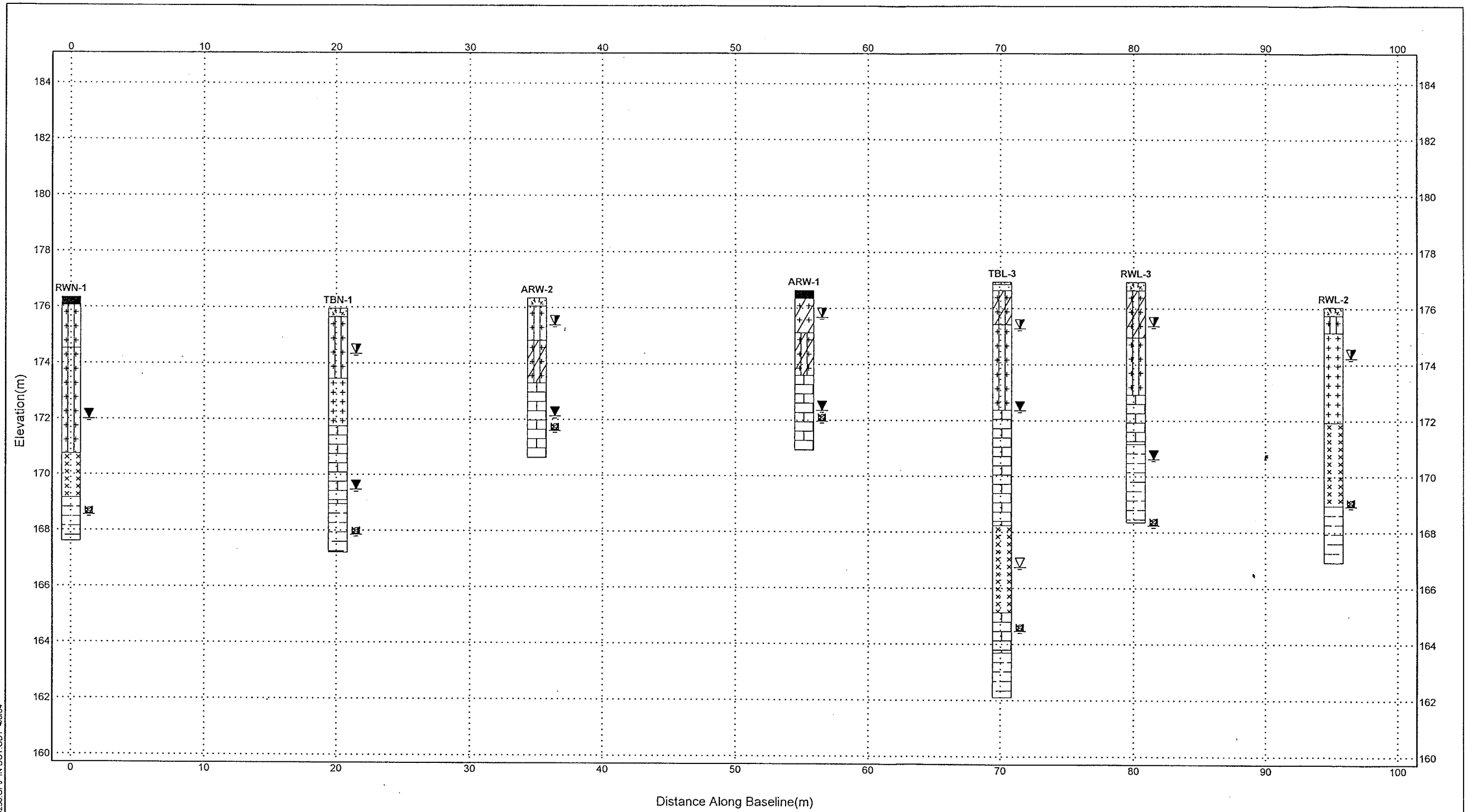
Indiana DOT: Sandstone

Indiana DOT: Silt

Indiana DOT: Shale

SU 41 WEST MSE WALL
SR 641 RAMPS - OVER US 41
VIFO COUNTY

Project Number: STP-291-1(005)



INDOT - Geo Tech Section

Telephone: (317) 610 7251 XTN 224
Fax: (317) 656 9351

LITHOLOGY GRAPHICS

- Asphalt
- Indiana DOT: Silty Clay
- Indiana DOT: Silty Clay Loam
- Indiana DOT: Sandstone
- Topsoil
- Indiana DOT: Silty Loam
- Indiana DOT: Silt
- Siltstone
- Indiana DOT: Shale
- Concrete
- Indiana DOT: Sand

US 41 EAST MSE WALL
SR 641 RAMPS- OVER US 41
VIGO COUNTY

Project Number: STP-291-1(005)

STRATIGRAPHY & GW - B SIZE 9738230.GPJ IN DOT.GDT 4/8/04

Indiana Department of Transportation

Materials and Tests Division
120 South Shortridge Road P.O. Box 19389
Indianapolis, Indiana 46219-0389
Phone: (317) 232-5280 Fax: (317) 356-9351

May 8, 2003

Mr. Phelps Klika, Chief
Division of Design
Room N642 - IGCN

Attention: Ms. Hollie Pratt

Subject: Des No's: 9738230 & 0001350
Geotechnical Investigation – In House **(Bridge Structures only)**
New Bridge Construction for Proposed SR 641 over U.S. 41
Structure No's: 641-84-8394 & 641-84-8395
Project No: STP – 291 - 1 (005)
Proposed SR 641 NB and SR 641 SB Ramps over U.S. 41
in Vigo County

Gentlemen:

The subject project involves construction of a two 2-Span bridges for the SR 641 Northbound Ramp over U.S. 41 and for the SR 641 Southbound Ramp over U.S. 41. Mechanically Stabilized Earth Walls (MSE) will be built along the abutments. The proposed bridges are located on Line "L" at Station 1+500 and on Line "N" at Station 1+930 respectively.

Six structure borings, three for each bridge structure, with split spoon sampling were done during the field investigation. A boring log was prepared for each boring which shows soil classifications and stratification as well as other pertinent data. Copies of the boring logs, laboratory results and Boring Location Plan are transmitted with the report.

The laboratory test results for some retaining wall borings are still not complete. Therefore, the Geotechnical recommendations for the retaining walls will be published later as an addendum to this report. The Geotechnical recommendations for roadway and the pavement design will be published later under Designation Number 0001250.

The results from the laboratory tests and further analyses for retaining walls and embankments may add some additional loads to compensate for the negative skin friction on the piles. Further, depending on the findings and analyses for the roadway and embankment portion, there may be a need for waiting period, or for stage construction of embankments.

The following are the recommendations of the INDOT Geotechnical Section.

BRIDGE STRUCTURE

1. Based on the soil conditions encountered in soil borings TBL-1, TBL-2, TBL-3, TBN-1, TBN-2 & TBN-3, we recommend that the new bridge structures should be supported on HP steel piles at all the bents driven into sound bedrock. We estimate that Steel HP piles could develop design loads of 356 kN, 490 kN & 622 kN with ultimate loads of 890 kN, 1225 kN & 1555 kN at refusal into shale, siltstone, or sandstone bedrock. The following are the sound bedrock elevations were piles may achieve the required ultimate capacity. The piles may not penetrate this deep because it would require driving through approximately three meters of weathered sandstone or siltstone.

APPROXIMATE BEDROCK ELEVATIONS

	Northbound Ramp Bridge Line "L"			Southbound Ramp Bridge Line "N"		
Location	Bent 1	Pier 2	Bent 3	Bent 1	Pier 2	Bent 3
Soil boring	TBL-1	TBL-2	TBL-3	TBN-1	TBN-2	TBN-3
Approximate Bedrock/ Pile Tip Elevations	169.80	170.30	168.50	168.80	170.80	169.80

For locations, offsets and for more detailed information please refer to the specific boring logs.

2. The selection of the size of steel HP piles should be based on the allowable combined axial and bending stresses. In addition, the minimum pile lengths should be 3.0 m (10.0 ft) into the existing natural ground.

3. Pile tips will be required for the piles driven into weathered rock.

4. Piles driven into shales should be spaced a minimum of 1.8 m center to center. This is necessary because shale may fracture with every subsequent pile driven into the shale, and the fracturing of the shale will relax the pile tip of the previously driven piles in that group. This is needed to avoid achieving lower pile capacities during restrike, and further driving down each pile may create the similar situation as explained earlier.

5. If piles are used with design loads greater than 623 kN (70 Tons), then dynamic pile testing (PDA) should be specified, and the Geotechnical Section should be contacted for the number and location of dynamic pile tests.

6. We recommend that the construction project engineer should restrike all piles in every group a minimum of 72 hours after the adjacent piles have been driven, to check for relaxation that may occur in shales due to fracturing of shale. If necessary, redrive the pile to the required ultimate capacity.

7. The following pile load tables may be used:

Pile Loading for 356 kN/490 kN/622 kN/800 kN

BENT	#1 & #3	#2
	Loading (kN)	
DESIGN LOAD	356/490/622*	356/490/622*
FACTOR OF SAFETY*	2.5/2.5/2.5*	2.5/2.5/2.5*
FACTORED DESIGN LOAD	890/1225/1555	890/1225/1555
FRICTION IN SCOUR ZONE	N/A	N/A
DOWN DRAG FRICTION	N/A**	N/A**
ULTIMATE LOAD**	890/1225/1555**	890/1225/1555**
TESTING METHOD*	Standard Specification Section. 701.a or 701.c*	

* ***If piles are driven higher than 622 kN design load, "Dynamic Pile Testing" (PDA) will be required and the factor of safety and ultimate capacities will reduce based on a factor of safety of 2.0 instead of 2.5.***

** ***Additional downdrag friction may be added once the MSE wall and the roadway borings are completed.***

DRILLED SHAFT

As an alternate to the pile foundations, drilled shafts can be used to support the bridge structures. These shafts can be designed for a net allowable end bearing pressure of 30,000 psf. In order to attain this design capacity, the piers should not be spaced closer than three pier diameters center to center. The drilled shafts should be socketed a minimum of 1.5 m (5.0 ft) down below the bottom of the coal seam which was encountered at elevation 163.80 in boring TBL-3. We estimate that this coal seam will be encountered all over the project at approximately the same elevation.

Upon our request, Mr. Randy Strain of INDOT Design provided the individual loadings for these bents and interior piers and they are as follows:

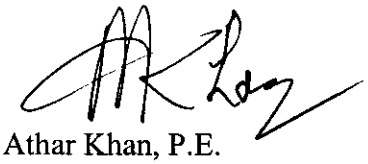
Structure No.	641-84-8394(NB Ramp)	641-84-8395 (SB Ramp)
	Load (Kips)	Load (Kips)
Bent # 1	740	709
Pier # 2	1777	1993
Bent # 3	778	708

We ran lateral analyses COM624P for an axial load of 780 Kips for a 72 inch diameter shaft and the results are given in the following table. Also, other diameter drilled shafts can be checked and a set of two or more shafts can be used at each pier or bent location.

Lateral Load (Kips)	Axial Load (Kips)	Pile Head Deflection (inches)	Maximum Moment (inch-Kips)	Maximum Total Stress (psi)	Depth Below Ground of Max. Moment (ft)
5.0	780	0.05	1660	237	14.20
10.0	780	0.10	3330	284	14.2
15.0	780	0.15	5000	330	14.2
20.0	780	0.20	6690	377	14.2

If you have any questions concerning this matter, please contact us.

Very truly yours,



Athar Khan, P.E.
Chief Geotechnical Engineer

Mir Zaheer, P.E.
Senior Geotechnical Engineer

Reviewer: Steve Morris, P.E.

MZ/ MZN

cc: Mrs. Mary Jo Hamman - Attn: Mr. Greg Klevitsky - Attachments
Mr. Elmo Gonzalez - Attn: Mr. Mike Wink - Attachments (2)
Ms. B. Thacker - Attachments
Mr. D. Cohen – Attachments
File

Attachments

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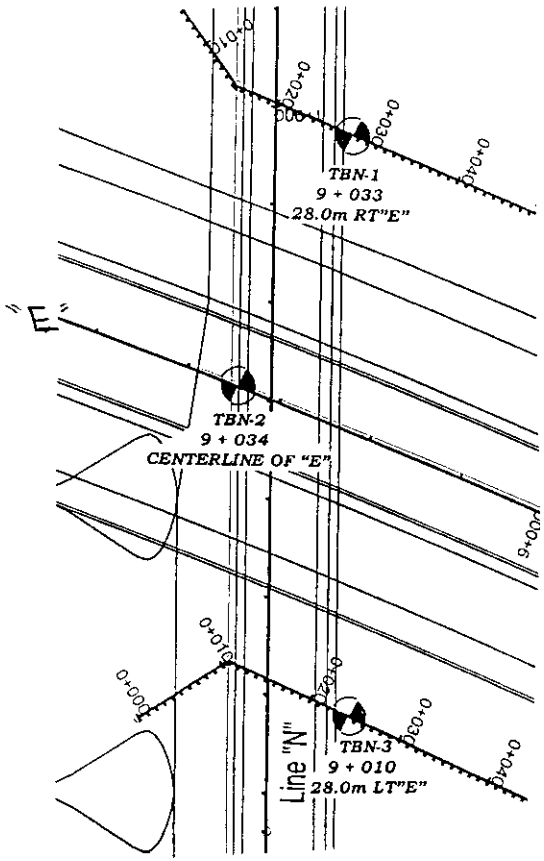
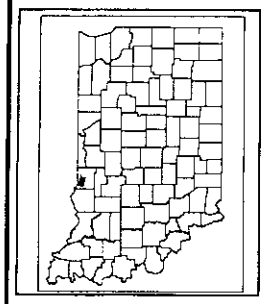
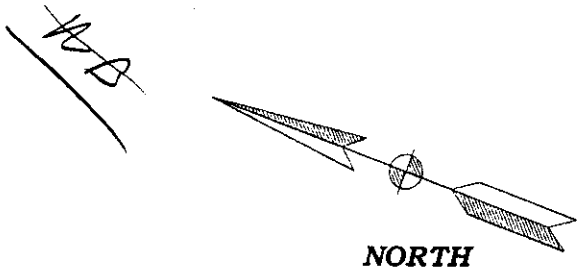
BORING LOCATION PLAN







NOT TO SCALE

INDIANA DEPARTMENT OF TRANSPORTATION INDOT

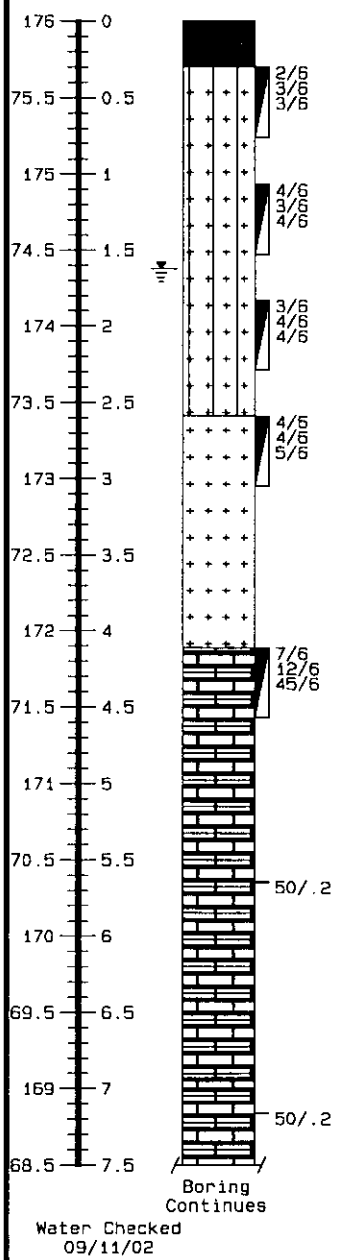
GEOTECHNICAL ENGINEERING SECTION

DES NO: 0001350
PROJECT NO: STP-291-1(005)
STRUCTURE NO: 641-84-8395
LOCATION: U.S.641 N.B.RAMP OVER U.S.41.
COUNTY: VIGO

PREPARED BY: R.C.W.
CHECKED BY: M.Z.
DATE: 04/15/2003

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 0001350 BORING No: TBN-1
STRUCTURE NO: 641-84-8395 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: NORTH BOUND RAMP OVER U.S.41. ELEV: 176.m
STATION/OFFSET/LINE 9 + 033 28.0m RT OF LINE "E" START 09/11/02
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 09/11/02
WATER DEPTH @ COMP.6.49m : AFTER 24 HRS: 1.62m CAVED: 8.11m



Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
DARK GRAY, MOIST, MEDIUM STIFF, SILTY LOAM A-4 # 02-9577		SS-1	60	
		SS-2	50	
	STRONG FUEL ODOR IN SS-3	SS-3	100	
TAN, MOIST, MEDIUM STIFF, SILT A-4 # 02-9502	STRONG FUEL ODOR IN SS-4	SS-4	100	
TAN, DRY, WEATHERED, SANDSTONE (VISUAL)		SS-5	100	
		SS-6	20	
GRAY, DRY, HARD, FISSILE, SHALE (VISUAL)		SS-7	20	

DRILLER: DT INSPECTER: JP DATUM: USC & GS
WEATHER: SUNNY TEMP: 75 F PAGE: 1 OF 1

DIVISION OF MATERIALS AND TESTS

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 0001350 BORING No: TBN-1
STRUCTURE NO: 641-84-8395 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: NORTH BOUND RAMP OVER U.S.41. ELEV: 176.m
STATION/OFFSET/LINE 9 + 033 28.0m RT OF LINE "E" START 09/11/02
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 09/11/02
WATER DEPTH @ COMP.6.49m : AFTER 24 HRS: 1.62m CAVED: 8.11m

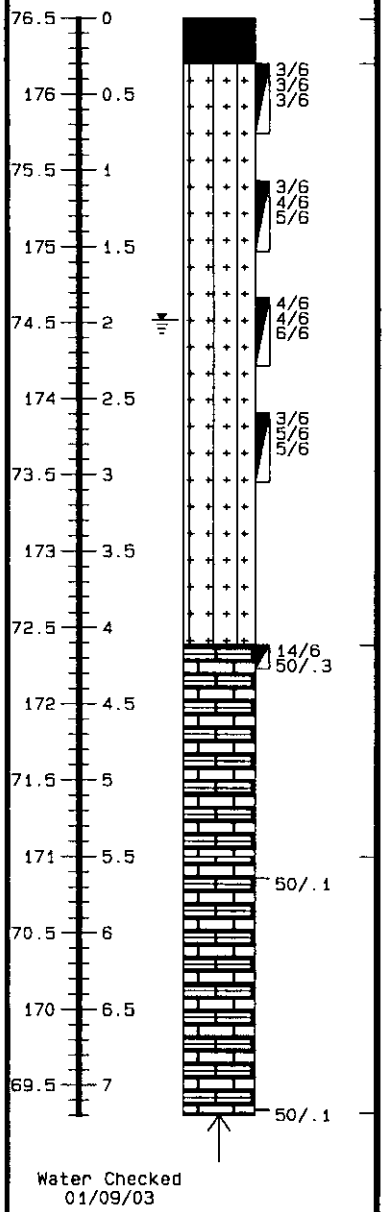
ELEV. / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
168.5 — 7.5 168 — 8 167.5 — 8.5	50/.2	BTH 8.75m (28.7')		SS-8	20	

DRILLER: DT INSPECTER: JP DATUM: USC & GS
WEATHER: SUNNY TEMP: 75 F PAGE: 1 OF 1

DIVISION OF MATERIALS AND TESTS

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 0001350 BORING No: TBN-2
STRUCTURE NO: 641-84-8395 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: NORTH BOUND RAMP OVER U.S.41. ELEV: 176.5m
STATION/OFFSET/LINE 9 + 034 CENTERLINE OF LINE E" START 01/09/03
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 01/09/03
WATER DEPTH @ COMP.5.58m : AFTER 24 HRS: 1.98m CAVED: 7.04m



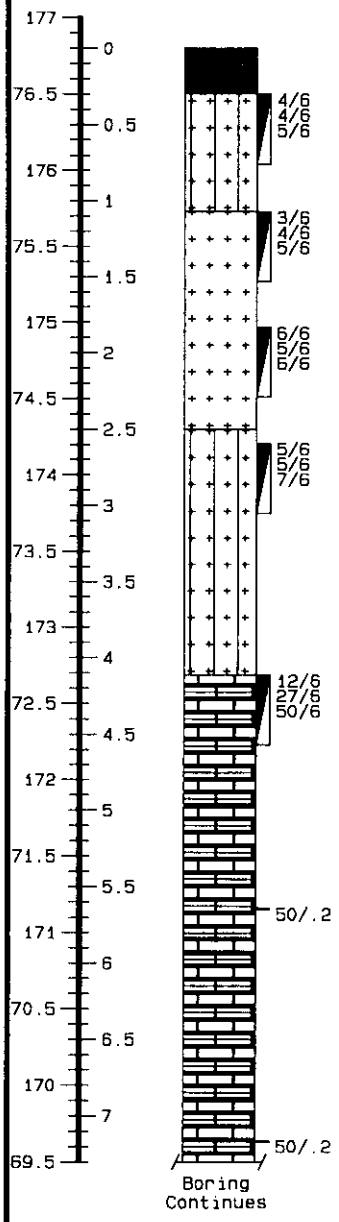
Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
BROWN TO TAN, SLIGHTLY MOIST, MEDIUM STIFF, SILTY LOAM A-4 #03-0118		SS-1	20	
		SS-2	65	
		SS-3	100	
		SS-4	100	
DRY, HARD, HIGHLY WEATHERED SILTSTONE (VISUAL)		SS-5	50	
TAN, DRY, HARD, SILTSTONE (VISUAL)	WATER ON RODS AT 5.79m	SS-6	10	
BTH 7.19m		SS-7	10	

DRILLER: BS INSPECTER: JL DATUM: USC & GS
WEATHER: M.SUNNY TEMP: 42 F PAGE: OF

DIVISION OF MATERIALS AND TESTS

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 0001350 BORING No: TBN-3
STRUCTURE NO: 641-84-8395 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: NORTH BOUND RAMP OVER U.S.41. ELEV: 176.8m
STATION/OFFSET/LINE 9 + 010 28.0m LT OF LINE "E" START 09/12/02
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 09/12/02
WATER DEPTH @ COMP.7.80m : AFTER 24 HRS: BACKFILLED CAVED: 12.34m



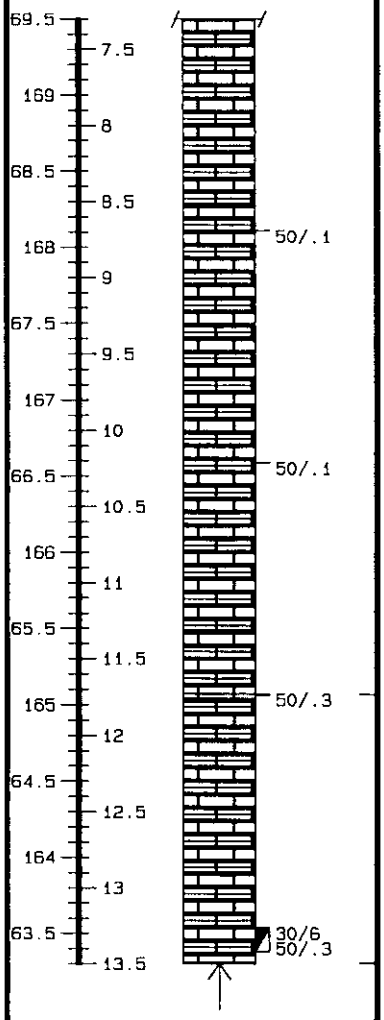
Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
BROWN, SLIGHTLY MOIST, MEDIUM STIFF, SILTY LOAM A-4 # 02-9577		SS-1	75	
TAN, MOIST, MEDIUM STIFF, SILT A-4#02-9562		SS-2	100	
		SS-3	100	
TAN, MOIST, STIFF, SILTY LOAM A-4 # 02-9577		SS-4	100	
MOTTLED TAN & GRAY, SLIGHTLY MOIST, WEATHERED, SANDSTONE (VISUAL)	HIGHLY WEATHERED AT 4.32m	SS-5	100	
		SS-6	20	
		SS-7	20	

DRILLER: DT INSPECTER: JP DATUM: USC & GS
WEATHER: SUNNY TEMP: 72 F PAGE: 1 OF 1

DIVISION OF MATERIALS AND TESTS

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 0001350 BORING No: TBN-3
STRUCTURE NO: 641-84-8395 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: NORTH BOUND RAMP OVER U.S.41. ELEV: 176.8m
STATION/OFFSET/LINE 9 + 010 28.0m LT OF LINE "E" START 09/12/02
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 09/12/02
WATER DEPTH @ COMP.7.80m : AFTER 24 HRS: BACKFILLED CAVED: 12.34m



Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
		SS-8	10	
		SS-9	10	
GRAY, DRY, HARD, SHALE (VISUAL)		SS-10	25	
BTH 13.50m (44.3')		SS-11	30	

DRILLER: DT INSPECTER: JP DATUM: USC & GS
WEATHER: SUNNY TEMP: 72 F PAGE: 1 OF 1

DIVISION OF MATERIALS AND TESTS

4/11/03

SUMMARY OF CLASSIFICATION TEST RESULTS

DES. NO. 0001350
PROJECT NO. STP-291-1(005)
STRUCTURE NO. 641-84-8395
COUNTY VIGO

LABORATORY NUMBER	PART	BORING NUMBER	STATION	OFFSET LINE	SAMPLE NUMBER	SAMPLE DEPTH	TEXTURAL/ UNIFIED	AASHTO	NO. 10	NO. 40	NO. 200	GRAVEL 76.2 - 2.00 mm	SAND 2.00- 0.074 mm	SILT 0.074- 0.002 mm	CLAY BELOW 0.002 mm	BELOW 0.001 mm	LL	PL	PI
027079109562		RWN-2	9+043	27m Lt of E	SS 2 T	3.5-5.0'	SILT	A-4(6)	100.0	100.0	99.4	0.0	0.6	83.4	16.0	13.1	29.6	23.6	6.0
027079109577		RWN-3	9+023	27m Lt of E	SS 3 T	6.0-7.5'	SILTY LOAM	A-4(5)	99.9	98.5	88.3	0.1	11.6	72.3	16.0	13.1	28.4	21.5	6.9
037079200118		RWN-1	9+050	29m RT LINE E	SS 4 T	8.5-10.0	SILTY LOAM	A-4(6)	99.9	99.1	91.4	0.1	8.5	73.9	17.5	15.1	29.0	21.2	7.8

5/08/03

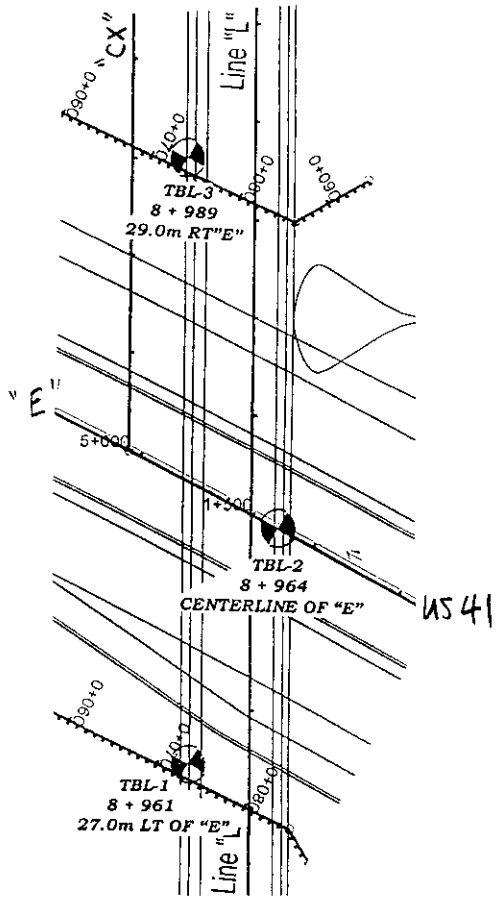
DES. NO. 0001350
PROJECT NO. STP-291-1(005)
STRUCTURE NO. 641-84-8395
COUNTY VIGO

DES NO. 0001350

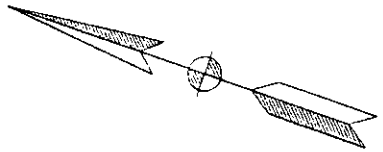
SUMMARY OF SPECIAL LABORATORY TEST RESULTS

LABORATORY NUMBER	PART	BORING NUMBER	SAMPLE NUMBER	DEPTH	NATURAL WATER CONTENT (%)	pH VALUE	LOI (%)	CA & MG (%)	NATURAL WET DENSITY (pcf)	NATURAL DRY DENSITY (pcf)	MAX DRY DENSITY (pcf)	OPT. MOIST (%)	CBR @93%	CBR @97%	COHESION (Qu/2) (psf)
027079109552		TBN-1	SS 3 T	6.0-7.5'	24.5										
027079109562		RWN-2	SS 2 T	3.5-5.0'	25.7	7.1									
027079109577		RWN-3	SS 3 T	6.0-7.5'	20.3	6.7									
027079109588		TBN-3	SS 2 T	3.5-5.0'	23.9										
037079200118		RWN-1	SS 4 T	8.5-10.0	21.8	7.1									

BORING LOCATION PLAN



NOT TO SCALE



NORTH

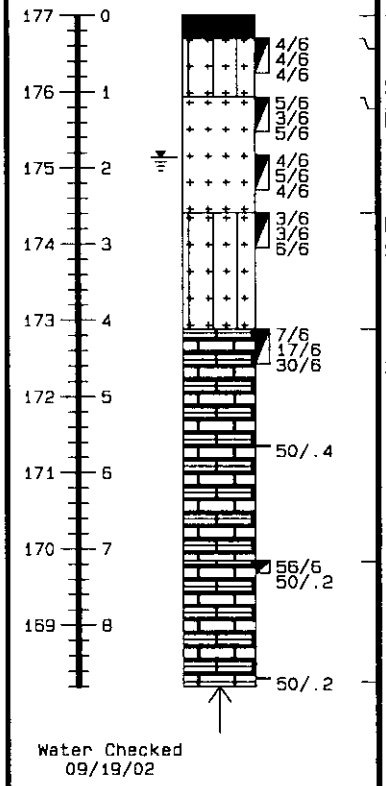
GEOTECHNICAL ENGINEERING SECTION

DES NO: 9738230
PROJECT NO: STP-291-1(005)
STRUCTURE NO: 641-84-8394
LOCATION: U.S.641 S.B.RAMP OVER U.S. 41.
COUNTY: VIGO

PREPARED BY: R.C.W.
CHECKED BY: M.Z.
DATE: 04/15/2003

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 9738230 BORING No: TBL-1
STRUCTURE NO: 641-84-8394 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: S.R.641 SB RAMP OVER U.S.41. ELEV: 177.0m
STATION/OFFSET/LINE 8 + 961 27.0m LT OF LINE "E" START 09/19/02
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 09/19/02
WATER DEPTH @ COMP.DRY : AFTER 24 HRS: 1.86m CAVED: 8.08m



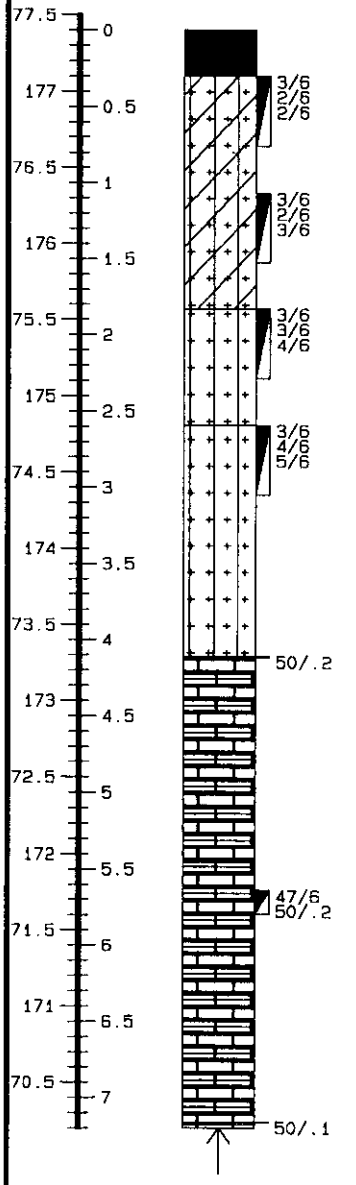
Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
BROWN, DRY, MEDIUM STIFF, SILTY LOAM A-4 # 02-9534		SS-1	30	
BROWN, MOIST, MEDIUM STIFF, SILT A-4 # 02-9604		SS-2	80	
		SS-3	25	
BROWN, MOIST, MEDIUM STIFF, SILTY LOAM A-4 # 02-9534		SS-4	60	
BROWN & GRAY, SLIGHTLY MOIST, WEATHERED, SANDSTONE (VISUAL)	SANDSTONE AT 4.33m	SS-5	100	
		SS-6	30	
GRAY, DRY, FOSSIL, SHALE (VISUAL)		SS-7	30	
BTH 8.75m(28.7')		SS-8	20	

DRILLER: DT INSPECTER: JP DATUM: USC & GS
WEATHER: CLOUDY TEMP: 80 F PAGE: 1 OF 1

DIVISION OF MATERIALS AND TESTS

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 9738230 BORING No: TBL-2
STRUCTURE NO: 641-84-8394 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: S.R.641 SB RAMP OVER U.S.41. ELEV: 177.40m
STATION/OFFSET/LINE 8 + 964 CENTERLINE OF "E" START 01/09/03
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 01/09/03
WATER DEPTH @ COMP.DRY : AFTER 24 HRS: .46m CAVED: 6.52m



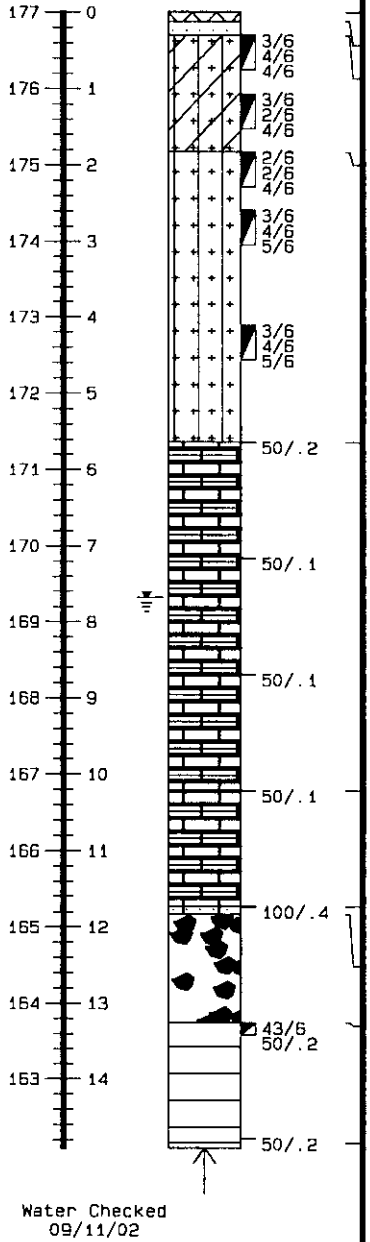
Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
BROWN, SLIGHTLY MOIST, SOFT, SILTY CLAY LOAM A-6 # 02-9508		SS-1	30	
		SS-2	100	
BROWN, SLIGHTLY MOIST, MEDIUM STIFF, SILTY LOAM A-4 # 02-9521		SS-3	100	
TAN & ORANGE MOTTLED, SLI-MOIST, MEDIUM STIFF, SILTY LOAM A-4 # 02 9521		SS-4	100	
TAN, DRY, HARD, HIGHLY WEATHERED, SILTSTONE (VISUAL)		SS-5	20	
		SS-6	45	
GRAY, DRY, HARD, SHALE (VISUAL)		SS-7	10	
BTH 7.19m				

DRILLER: BS INSPECTER: JL DATUM: USC & GS
WEATHER: M.SUNNY TEMP: 39 F PAGE: OF

DIVISION OF MATERIALS AND TESTS

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(005) DES NO: 9738230 BORING No: TBL-3
STRUCTURE NO: 641-84-8394 COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: S.R.641 SB RAMP OVER U.S.41. ELEV: 177.0m
STATION/OFFSET/LINE 8 + 989 29.0m RT OF LINE "E" START 09/11/02
BORING METHOD @ RIG TYPE: HSA/TRUCK .20m DIA.BORING. FINISH 09/11/02
WATER DEPTH @ COMP.4.60m : AFTER 24 HRS: 7.68m CAVED: 12.50m



Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
CONCRETE (VISUAL)				
SAND (VISUAL)		SS-1	65	
BROWN, SLIGHTLY MOIST, MEDIUM STIFF, SILTY CLAY LOAM A-6 # 02-9508		SS-2	100	
TAN, SLIGHTLY MOIST, MEDIUM STIFF, SILTY LOAM A-4 (7) # 02-9534		SS-3	80	
		SS-4	70	
		SS-5	70	86.0
TAN, DRY, MEDIUM DENSE, SANDSTONE (VISUAL)		SS-6	20	
		SS-7	10	
		SS-8	10	
GRAY, DRY, VERY DENSE, WEATHERED, SILTSTONE (VISUAL)		SS-9	10	
GRAY, DRY, VERY DENSE, SANDSTONE (VISUAL)		SS-10	30	
BLACK, DRY, VERY DENSE, COAL (VISUAL)				
GRAY, DRY, VERY DENSE, SHALE (VISUAL)		SS-11	50	
BTH 14.84m (48.7')		SS-12	20	

DRILLER: DT INSPECTER: JP DATUM: USC & GS
WEATHER: SUNNY TEMP: 70 F PAGE: 1 OF 1

DIVISION OF MATERIALS AND TESTS

5/08/03

SUMMARY OF CLASSIFICATION TEST RESULTS

DES. NO. 9738230
PROJECT NO. STP-291-1(001)
STRUCTURE NO. 641-84-8394
COUNTY VIGO

LABORATORY NUMBER	PART	BORING NUMBER	STATION	OFFSET LINE	SAMPLE NUMBER	SAMPLE DEPTH	TEXTURAL/ UNIFIED	AASHTO	NO. 10	NO. 40	NO. 200	GRAVEL 76.2 - 2.00 mm	SAND 2.00- 0.074 mm	SILT 0.074- 0.002 mm	CLAY BELOW 0.002 mm	BELOW 0.001 mm	LL	PL	PI
027079109508		RWL-2	8+858	20m RT	SS 2 T	3.5-5.0	SILTY CLAY LOAM	A-6(11)	100.0	99.9	99.1	0.0	0.9	78.4	20.7	18.9	33.0	22.5	10.5
027079109521		RWL-3	8+974	21m Rt of E	SS 3 T	6.0-7.5'	SILTY LOAM	A-4(6)	99.9	99.7	94.3	0.1	5.6	78.2	16.1	13.2	29.2	22.1	7.1
027079109534		TBL-3	8+989	29m Rt of E	SS 3 T	6.0-7.5'	SILTY LOAM	A-4(7)	100.0	99.9	95.8	0.0	4.2	79.2	16.6	14.7	29.5	22.0	7.5
027079109604		RWL-1	8+940	34m Lt of E	SS 2 T	3.5-5.0'	SILT	A-4(8)	100.0	99.9	98.2	0.0	1.8	81.2	17.0	14.1	30.8	23.2	7.6
037079200777		TB-2		LINE A	SS 5 T	13.5-15.0	SANDY CLAY LOAM	A-6(4)	97.9	88.9	46.3	2.1	51.6	25.1	21.2	18.9	30.7	15.0	15.7

5/08/03

DES NO. 9738230

SUMMARY OF SPECIAL LABORATORY TEST RESULTS

DES. NO. 9738230
PROJECT NO. STP-291-1(001)
STRUCTURE NO. 641-84-8394
COUNTY VIGO

LABORATORY NUMBER	PART	BORING NUMBER	SAMPLE NUMBER	DEPTH	NATURAL WATER CONTENT (%)	pH VALUE	LOI (%)	CA & MG (%)	NATURAL WET DENSITY (pcf)	NATURAL DRY DENSITY (pcf)	MAX DRY DENSITY (pcf)	OPT. MOIST (%)	CBR @93%	CBR @97%	COHESION (Qu/2) (psf)
027079109506		RWL-2	SS 1 T	1.0-2.4	20.4										
027079109508		RWL-2	SS 2 T	3.5-5.0	23.0	6.7									
027079109521		RWL-3	SS 3 T	6.0-7.5'	22.4	6.6									
027079109534		TBL-3	SS 3 T	6.0-7.5'	23.8	6.5									
027079109539		TBL-3	SS 5 B	13.5-15.0'	31.1				119.4	91.1					899
027079109604		RWL-1	SS 2 T	3.5-5.0'	25.9	6.8									
037079200769		TB-2	SS 1 T	1.0-2.5	24.7				124.1	99.5					2142
037079200774		TB-2	SS 3 B	6.0-7.5	19.2				130.2	109.2					906
037079200777		TB-2	SS 5 T	13.5-15.0	19.2	7.2									

Indiana Department of Transportation

Materials and Tests Division
120 South Shortridge Road P.O. Box 19389
Indianapolis, Indiana 46219-0389
Phone: (317) 232-5280 Fax: (317) 356-9351
Phone: (317) 610 7251 Fax: (317) 356 9351

September 08, 2003

Mr. Niranjan Shah, Acting Chief
Design Division
Indiana Department of Transportation
Room N 601 - IGCN

Attention: Mrs. Hollie Pratt

Subject: Des. No.: 9738330
Project No: STP – 291 - (2)
Structure No: 641-84-8401
McDaniel Road Over Little Honey Creek
in Vigo County

Gentlemen:

Copies of the completed Geotechnical Report are being forwarded to those listed below with the following additional comments:

1. The waiting period for the restrike of piles set in shale bedrock shall be a minimum of 7 days.

If you have any questions concerning the above matter, please call us.

Very truly yours,

Athar A. Khan, P.E.
Chief Geotechnical Engineer

Mir Zaheer, P.E.
Senior Geotechnical Engineer

MZ
cc:
Mr. Tom Caplinger – Attn: Mr. Greg Klevitsky – Attachments
Mr. E. Gonzalez – Attn: Mr. Mike Monahan – Attachments (2)
Ms. J. Somers – Attachments
Mr. D. Cohen - Attachments
File
H:\Mir\Letters\Alt & Witzig\9738330-SR641.doc

DES NO: 9738330
PROJECT NO: STP-291-(2)
MCDANIEL ROAD OVER LITTLE HONEY CREEK
BRIDGE NO. 641-84-8401
VIGO COUNTY, INDIANA
A & W PROJECT NO: 02IN1012

PREPARED FOR
INDIANA DEPARTMENT OF TRANSPORTATION
INDIANAPOLIS, INDIANA

AUGUST 28, 2003

Alt & Witzig Engineering, Inc.
4105 West 99th Street • Carmel, Indiana 46032
(317) 875-7000 • Fax (317) 876-3705

August 28, 2003

Indiana Department of Transportation
120 South Shortridge Road
P.O. Box 19389
Indianapolis, Indiana 46219-0389
ATTN: Mr. Athar A. Kahn

RE: Subsurface Investigation
and Recommendations
Des No: 9738330
Project No: STP-291-(2)
Structure 10
Bridge No. 641-84-8401
McDaniel Road over Little Honey Creek
Vigo County, Indiana
Alt & Witzig File: 02IN1012

Gentlemen:

In compliance with your request, we have completed three (3) of the four (4) proposed soil borings at the above referenced site. The fourth boring was not completed due to ownership conflict and the consistent findings of the other three borings. If required, the fourth boring will be conducted during the construction phase of this project. It is our pleasure to transmit herewith a copy of the report.

Purpose and Procedures

This report presents the results of a geotechnical investigation for the new McDaniel Road bridge in Vigo County, Indiana for Phase II of the SR 641 Project. The site of the proposed project is southeast of Terre Haute, Indiana on McDaniel Road. The bridge is one of several structures proposed for the S.R. 641 Project. This investigation was conducted for the Indiana Department of Transportation.

The purpose of this foundation investigation was to determine the various soils profile components, the engineering characteristics of the foundation materials and to provide criteria for use by the design engineers in preparing roadway and bridge design.

The field investigations to determine the engineering characteristics of the foundation materials included a reconnaissance of the project site, drilling borings as shown on the soil profile drawings, performing standard penetration tests, and obtaining soil samples retained in the standard split-spoon sampler. The apparent groundwater level and the ground surface elevation at the boring locations were also determined. The field investigation was started on June 3, 2003, and completed on June 5, 2003.

The soil borings were performed with a drilling rig equipped with a rotary head. Conventional hollow-stem augers were used to advance the holes. Representative samples were obtained employing split-spoon sampling procedures in accordance with ASTM Procedure D-1586.

During the sampling procedure, standard penetration tests were performed at regular intervals to obtain the standard penetration value of the soil. The standard penetration value is defined as the number of blows a 140 lb hammer, falling 30 inches, required to advance the split-spoon sampler 12 inches into the soil. The results of the standard penetration tests indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

In addition to the field investigations, a supplemental laboratory investigation was conducted to ascertain additional pertinent engineering characteristics of the subsurface materials necessary in analyzing the behavior of the proposed bridge structure. All phases of the laboratory investigation were conducted in general accordance with applicable AASHTO Specifications and INDOT Exhibit "C". The laboratory testing program included supplementary visual classification on all samples. Atterberg limit tests, unit weight tests, moisture content tests, pH tests, and grain size analyses were performed on selected soil samples.

Proposed Bridge Structure

Design plans indicate that a three span bridge structure is to be constructed at this location to replace the current single span bridge. The bridge is to be constructed of continuous reinforced concrete slabs with spans of 9.4 m, 12 m, and 9.4 m. The borings drilled for this new structure indicated the presence of shale beneath approximately seventy four (74) to eighty one (81) feet of very soft to medium stiff, Silty Clay Loam soils with layers of Sandy Loam. The bents for this new bridge may be founded on steel H-piles driven to the shale bedrock. Hardened pile tip protectors should be used for the piles installed at this project. The approximate shale elevations are shown in Table 1.

Table 1: Summary of Approximate Shale and Pile Tip Elevations

Bent No.	Boring Number	Station	Offset Line "C"	Ground Surface Elevation, m (ft)	Approximate Shale Elevation, m (ft)
1	TB-25	99+928	10mLT	151.9 (498.5)	129.4 (424.5)
2	TB-26	99+938	14mRT	151.8 (498.0)	128.6 (422)
3	TB-27*	99+950	N/A	N/A	N/A
4	TB-28	99+959	2mRT	155.0 (508.5)	130.3 (427.5)

*TB-27 has not been completed. If required, it will be completed during the construction phase.

The bedrock elevations given above are only approximate elevations determined at the exact structure boring locations and should be used only as a guide. The final tip elevation should be determined by dynamic pile load testing using the methods outlined in Section 701.06 (c) of the INDOT Standard Specifications. The piles shall be monitored by a pile driving analyzer (PDA) during installation. The table below lists pile-driving parameters.

Table 2: Parameters for Pile Driving

Bent	1 & 4	2 & 3
Design Load (Tons)	55/70/90	55/70/90
Factor of Safety	2.0	2.0
Factored Design Load (Tons)	110/140/180	110/140/180
Friction in Scour Zone (Tons)	N/A	60
Down Drag Friction	negligible	N/A
Ultimate Load (Tons)	110/140/180	170/200/240
Testing Method	Std. Spec. 701.06 (c)	

Scour information was provided by INDOT for this location. The report indicates a Q_{500} low scour elevation of 136.6 m. The ultimate friction capacity within the scour zone was calculated to be approximately 60 tons. Only one to two meters of fill will be required at bents #1 and #4 to establish grade at the existing roadway. Therefore, down drag force analysis on the end bent piles was not conducted. Our analysis is based upon a steel H-pile section with F_y=36ksi. Higher capacity may be achieved through the use of F_y=50ksi steel, if desired. HP 12x53's were assumed for the 55 and 70 ton piles while HP 12x74's were assumed for the 90 ton piles.

Piles that are driven to the shale bedrock should be restruck. The restrike should be completed after a minimum of 24 hours after initial drive. Additionally, to minimize the effects of the disturbed end-bearing stratum, a minimum spacing of the piles should be 1.8m (6 feet). This will ensure that end bearing capacities are not jeopardized by disturbance of the bedrock during driving of adjacent piles.

Slopes

As mentioned previously, the new three span bridge is to replace the existing one span bridge over Little Honey Creek. Elevation data indicates that the banks of the creek are to be flattened, by excavation, to a 2:1 slope. It is recommended that riprap be placed at both spill-through slopes. It is recommended that the proposed riprap be a minimum of twenty-four (24) inches thick. Due to the soft soil conditions, a minimum three (3) feet wide by three (3) feet deep riprap key should be provided below the toe of both rip rapped slopes. A permeable filter fabric should be used in conjunction with the riprap and should extend beneath the riprap key.

Proposed spill-through slopes are 2:1. The existing slopes are 1:1 or steeper. Therefore, a slope stability analysis was not performed. Slope stability is not anticipated to be a problem if proper construction techniques are followed.

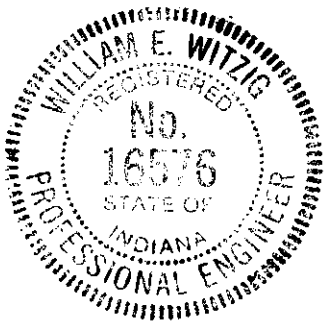
Benching

Benching will be necessary for areas where existing slopes are steeper than 4:1. Benches shall be a minimum of four (4) feet wide. Benching of natural slopes and existing embankment slopes steeper than 4:1 shall be performed in accordance with Section 203.21 and 22 of the INDOT Standard Specifications.

Removal of Existing Bridge Structure

The existing structure should be removed in accordance with Section 202.03 of the INDOT Standard Specifications.

Often, because of design and construction details that occur on a project, questions arise concerning the soil conditions. If we can give further service in these matters, please contact us at your convenience.



Very truly yours,

ALT & WITZIG ENGINEERING, INC.

William E. Witzig /DKA

William E. Witzig, P.E.

SUMMARY OF RECOMMENDATIONS

DES NO: 9738330

PROJECT NO: STP-291-(2)

STRUCTURE NO: 10

BRIDGE NO. 641-84-8401– MCDANIEL ROAD OVER LITTLE HONEY CREEK

VIGO COUNTY, INDIANA

A foundation investigation has been performed for the proposed new McDaniel Road over Little Honey Creek in Vigo County, Indiana. Design plans indicate that a three span bridge structure is to be constructed with this project. The following approximate table illustrates the approximate shale elevations and estimated pile tip elevations for 55, 70, and 90 ton piles:

Table 1: Summary of Approximate Shale and Pile Tip Elevations

Bent No.	Boring Number	Station	Offset Line "C"	Ground Surface Elevation, m (ft)	Approximate Shale Elevation, m (ft)
1	TB-25	99+928	10mLT	151.9 (498.5)	129.4 (424.5)
2	TB-26	99+938	14mRT	151.8 (498.0)	128.6 (422)
3	TB-27	99+950	N/A	N/A	N/A
4	TB-28	99+959	2mRT	155.0 (508.5)	130.3 (427.5)

The bents for this new bridge may be founded on steel H-piles driven to the shale bedrock at approximate elevations as shown in Table 1. Protective tips should be used on the piles for this project. The final tip elevation should be determined by dynamic pile load testing using the methods outlined in Section 701.06 (c) of the INDOT Standard Specifications.

Due to the soft soil conditions, a minimum three (3) feet wide by three (3) feet deep riprap key should be provided below the toe of both rip rapped slopes. A permeable filter fabric should be used in conjunction with the riprap and should extend beneath the riprap key.

The shallow, natural soils encountered in our three borings were predominantly Silty Loam, A-4. The shallow soils are of very soft to soft consistency. Specific subgrade recommendations for roadway construction will be provided under separate cover to this report.

Appendix

Boring Location Plan

Logs of Test Borings

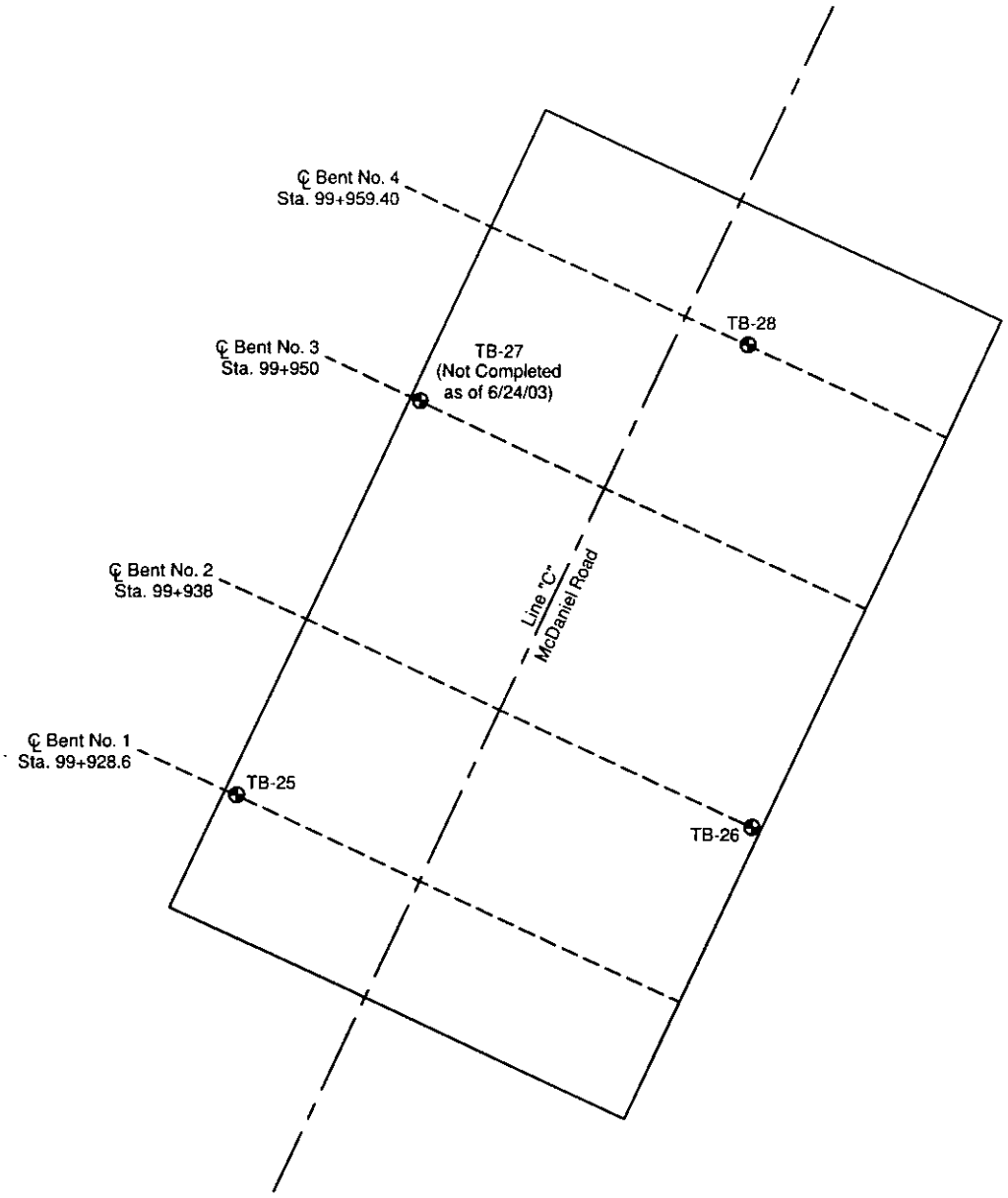
SPILE Printout for Scour Friction Determination

Unconfined Compressive Strength Test Results

Grain Size Distribution Curves

Soil Classification Summary Sheet

BORING LOCATION PLAN



AW Project #: 02IN1012
McDaniel Road over Little Honey Creek
Bridge 641-84-8401
Des No: 9738330

N

Scale: 1" = 30'

0 30

LOG OF TEST BORING

Project: DES No. 9738330 - S.R. 641
Location: Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section
4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-25
Surface Elevation 498.5 ft.
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8401	Station	99+928	Offset	10 Lt	Line	"C"
Datum	USGS	Weather	Cloudy	Temperature	60 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	ɣ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	100	1-1-1		Brown, Moist, Very Loose, Sandy Loam A-4 Test 04						
2SS	X	100	1-1-1								
3SS	X	100	1-2-2	5 ▽	Gray, Very Moist to Wet, Very Soft to Medium Stiff, Silty Loam A-4 Test 02						
4SS	X	40	1-1-2								
5SS	X	100	3-2-4	10							
6SS	X	100	7-11-10	15							
7SS	X	100	9-9-4		Brown, Wet, Medium Dense to Loose, Sandy Loam A-2-4 Test 04						
8SS	X	100	4-4-5	20							
9SS	X	100	1-1-5	25							
10SS	X	100	2-3-3	30	Gray, Wet, Medium Stiff, Silty Clay Loam A-4 Test 03						
				35							
				40							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ♀ 18.0 Upon Completion of Drilling ● 9.5
Time After Drilling 24 hrs
Depth to Water ▽ 6.0 ▼ ▼ ▼
Depth to Cave in 10.0

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 6/3/03 End 6/3/03 Rig B-59
Driller Winkler Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738330 - S.R. 641
Location: Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-25
Surface Elevation 498.5 ft.
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8401	Station	99+928	Offset	10 Lt	Line	"C"
Datum	USGS	Weather	Cloudy	Temperature	60 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	Pi (%)
					Gray, Wet, Very Soft to Medium Stiff, Silty Clay Loam A-4, Test 03						
11SS	X	100	1-1-2	45							
12SS	X	100	1-1-2	50	Wet Sand Seams 50-60 feet						
13SS	X	100	2-3-4	55	5' of heave in auger @ sample 13SS						
14SS	X	100	1-2-2	60	Brown, Wet, Dense, Sandy Loam A-2-4 Test 04						
15SS	X	50	13-19-14	65	5' of heave in auger @ sample 15SS 10' of heave in auger - could not get out to sample. Augered to refusal						
16SS	X			70							
17SS	X			75	Gray, Slightly Moist, Hard, Weathered Shale (Visual)						
18SS	X			80	Auger Refusal at 80.0 feet						
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738330 - S.R. 641
Location: Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-26
Surface Elevation 498.0 ft.
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8401	Station	99+938	Offset	14 Rt	Line	"C"
Datum	USGS	Weather	Cloudy	Temperature	60 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	100	3-4-3		Brown to Gray, Moist, Medium Stiff to Soft, Silty Loam A-4 Test 02						
2SS	X	100	1-3-3	5							
3SS	X	100	1-2-3		pH = 6.34				24	18	6
4SS	X	100	1-2-4	10	Brown to Gray, Moist, Medium Stiff, Silty Loam A-4 Test 01						
5SS	X	100	5-4-4	15							
1ST	■	75			Pushed Shelby Tube 16'-18'	0.8	106.6	21.3	26	24	2
6SS	X	100	6-13-13	20	Brown, Wet, Medium Dense to Loose, Sandy Loam A-2-4 Test 04						
7SS	X	100	5-10-7	25							
8SS	X	100	5-5-4	30	Gray, Very Moist, Soft, Silty Clay Loam A-4 Test 03						
9SS	X	100	3-2-3	35							
10SS	X	100	1-3-3	40	Gray, Wet, Medium Stiff, Clay A-7-5 Test 05						

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 11.0 Upon Completion of Drilling ● 8.5
Time After Drilling 24 hrs.
Depth to Water ▽ 6.0 ▼ ▼ ▼
Depth to Cave in 14.0

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 6/4/03 End 6/4/03 Rig B-59
Driller Winkler Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738330 - S.R. 641
Location: Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-26
Surface Elevation 498.0 ft.
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8401	Station	99+938	Offset	14 Rt	Line	"C"
Datum	USGS	Weather	Cloudy	Temperature	60 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
11SS	X	100	1-1-2	45	Gray, Wet, Very Soft, Clay A-7-5 Test 05						
2ST	■	80			Pushed Shelby Tube 46'-48'	0.48	74.4	45.4	50	36	14
12SS	X	100	1-1-2	50	pH = 7.33						
13SS	X	100	2-2-3	55	Gray, Wet, Soft, Silty Loam A-4 Test 02						
14SS	X	100	3-5-11	60	Brown and Gray, Wet, Medium Dense to Dense, Sandy Loam A-2-4 Test 04						
15SS	X	100	5-8-15	65							
16SS	X	100	7-14-18	70							
17SS	X	100	5-10-16	75							
18SS	X	100	23-50/2	80	Gray, Slightly Moist, Hard, Weathered Shale (Visual)						
				85	Auger Refusal at 80.0 feet						

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738330 - S.R. 641
Location: Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-28
Surface Elevation 508.5 ft.
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8401	Station	99+959	Offset	2 Rt	Line	"C"
Datum	USGS	Weather	Sunny	Temperature	60 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					5" Asphalt						
1SS	X	100	3-3-4		7" Brown Sand & Gravel (Visual) Dark Brown Silty Clay (Fill-Visual)						
2SS	X	100	1-1-2	5	Brown and Gray, Moist, Very Soft to Soft, Silty Loam A-4 Test 02						
3SS	X	100	1-2-3								
4SS	X	100	1-1-2	10	Brown and Gray, Moist, Very Stiff, Silty Loam A-4 Test 02						
5SS	X	100	4-8-11	15							
6SS	X	100	3-4-5	20	Gray, Wet, Loose to Medium Dense, Sandy Loam with occasional Silt Seams A-2-4 Test 04						
7SS	X	100	5-10-12	25	pH = 7.35				NP	NP	–
8SS	X	100	2-2-2	30	Gray, Wet, Very Loose to Loose, Sandy Loam A-2-4 Test 04						
9SS	X	80	1-3-5	35							
10SS	X	100	2-2-3	40							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 18.0 Upon Completion of Drilling ▽ Caved @ 7.0
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 6/5/03 End 6/5/03 Rig B-59
Driller Winkler Editor D. Harness
Remarks EZ Mud added to boring to keep heave down. Boring backfilled and patched upon completion.

LOG OF TEST BORING

Project: DES No. 9738330 - S.R. 641
Location: Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-28
Surface Elevation 508.5 ft.
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8401	Station	99+959	Offset	2 Rt	Line	"C"
Datum	USGS	Weather	Sunny	Temperature	60 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Gray, Wet, Very Loose to Loose, Sandy Loam A-2-4 Test 04						
11SS	X	100	2-2-3	45	Gray, Wet, Soft to Very Soft, Clay A-7-5 Test 05						
12SS	X	100	1-1-1	50							
13SS	X	100	1-1-1	55							
14SS	X	100	3-2-3	60							
					Gray and Brown, Wet, Medium Dense, Sandy Loam A-2-4 Test 04						
15SS	X	100	3-6-13	65							
16SS	X	100	8-26-19	70	Dense at Sample 16SS						
17SS	X	100	6-10-17	75							
18SS	X	100	8-11-14	80							
					Gray, Slightly Moist, Hard, Weathered Shale (Visual)						
19SS	X	100	50/3	85	Auger Refusal at 84.0 feet						

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

ULTIMATE STATIC PILE CAPACITY/Federal Highway Administration
Nordlund (1963, 1979) and Tomlinson (1979, 1980) methods

Project Name : McDaniel Road Bridge
File Name : 02IN1012
Date : 7/21/10
Client : INDOT
Project Manager : David Harness
Computed by : dch

Depth of Top of Pile = 0.00 ft.
Depth to Water Table = 6.00 ft.
Type of Pile = H Pile
HP 12x53

Pile length = 50.00 ft.

SKIN FRICTION CONTRIBUTION

Layer	Soil Type	Thickness (ft)	Effective Stress (psf)	Internal Friction Angle	N-SPT	Pile Perimeter (ft)
1	Cohesive	17.00	864.00	---	--	3.97
2	Cohesionless	13.00	1728.00	30.00	--	3.97
3	Cohesive	20.00	2678.40	---	--	3.97

Layer	Soil Type	Undrained Shear Strength (psf)	Adhesion	Pile Taper	Sliding Friction Angle	Skin Resistance (Kips)
1	Cohesive	600.00	586.81	----	-----	39.61
2	Cohesionless	--	--------	----	22.59	26.86
3	Cohesive	600.00	600.00	----	-----	47.65

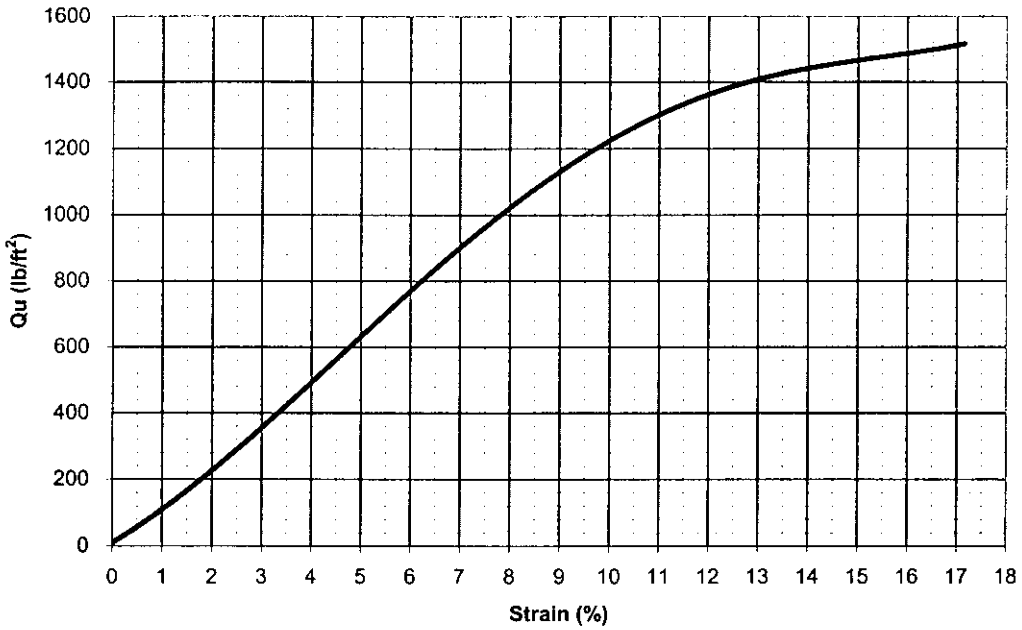
Total Side Friction : 114.12

POINT RESISTANCE CONTRIBUTION

Effective Stress at pile Tip (psf)	Undrained Shear Strength (psf)	SPT Value	Pile End Area (ft*ft)	Bearing Capacity Factor Nq	End Bearing Resistance (Kips)
3254.40	600.00	----	0.11	----	0.58

Ultimate Static Pile Capacity : 114.71

Unconfined Compression Test

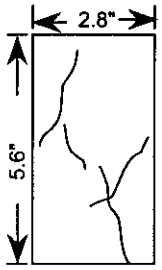


Sample Location: TB-26, 1ST

Depth: 16-18 ft Moisture Content: 21.3 (%)

Strain Rate: 2% min. Dry Unit Weight: 106.6 (lb/ft^3)

FAILURE SKETCH



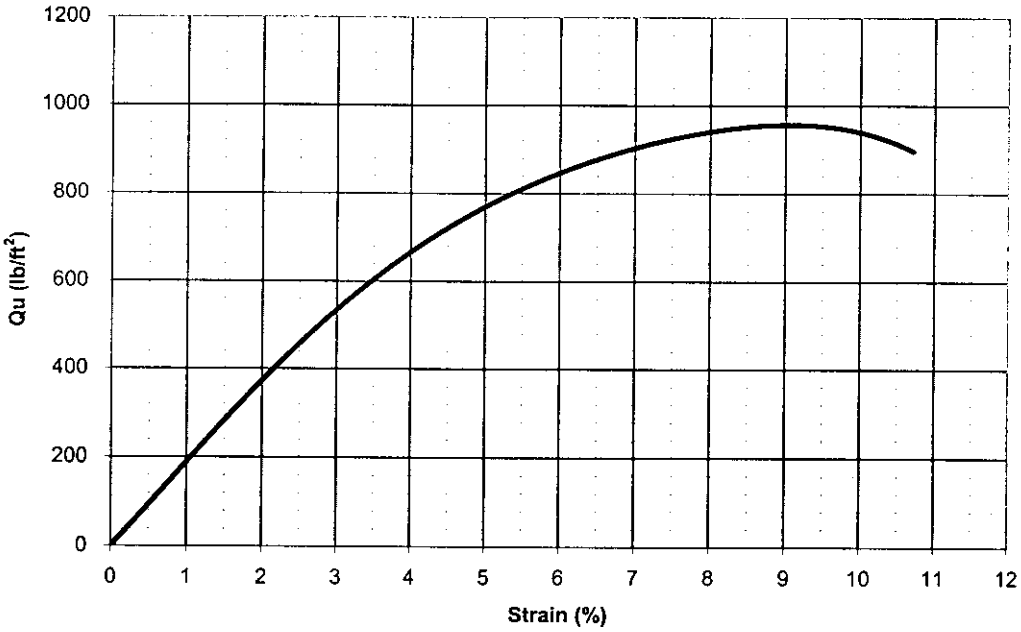
Soil Description: Gray Silty Loam, A-4

Unconfined Compressive Strength (lb/ft^2): 1,600

Failure Strain (%): 15.0

PREPARED FOR: INDOT-Geotechnical Division, Indianapolis, Indiana	A&W	PREPARED BY: Alt & Witzig Engineering, Inc., Indianapolis, Indiana	
PROJECT NAME: US-641, Terre Haute, Indiana		PROJECT NO.: 02IN1012	DATE: 6/03

Unconfined Compression Test

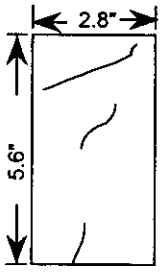


Sample Location: TB-26, 2ST

Depth: 46-48 ft Moisture Content: 45.4 (%)

Strain Rate: 2% min. Dry Unit Weight: 74.9 (lb/ft^3)

FAILURE SKETCH



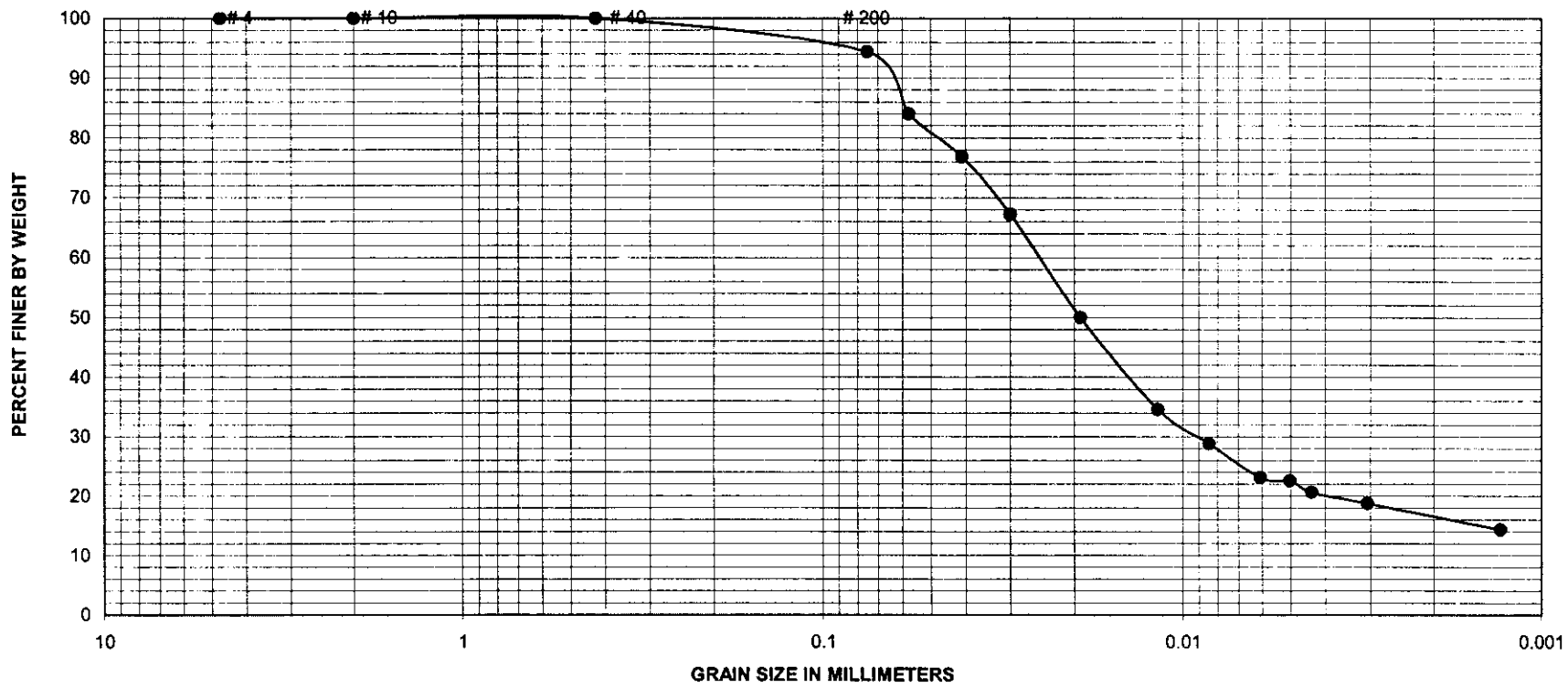
Soil Description: Gray Clay, A-7-5

Unconfined Compressive Strength (lb/ft^2): 960

Failure Strain (%): 9.0

PREPARED FOR: INDOT-Geotechnical Division, Indianapolis, Indiana	A&W	PREPARED BY: Alt & Witzig Engineering, Inc. Indianapolis, Indiana	
PROJECT NAME: US-641, Terre Haute, Indiana		PROJECT NO.: 02IN1012	DATE: 6/03

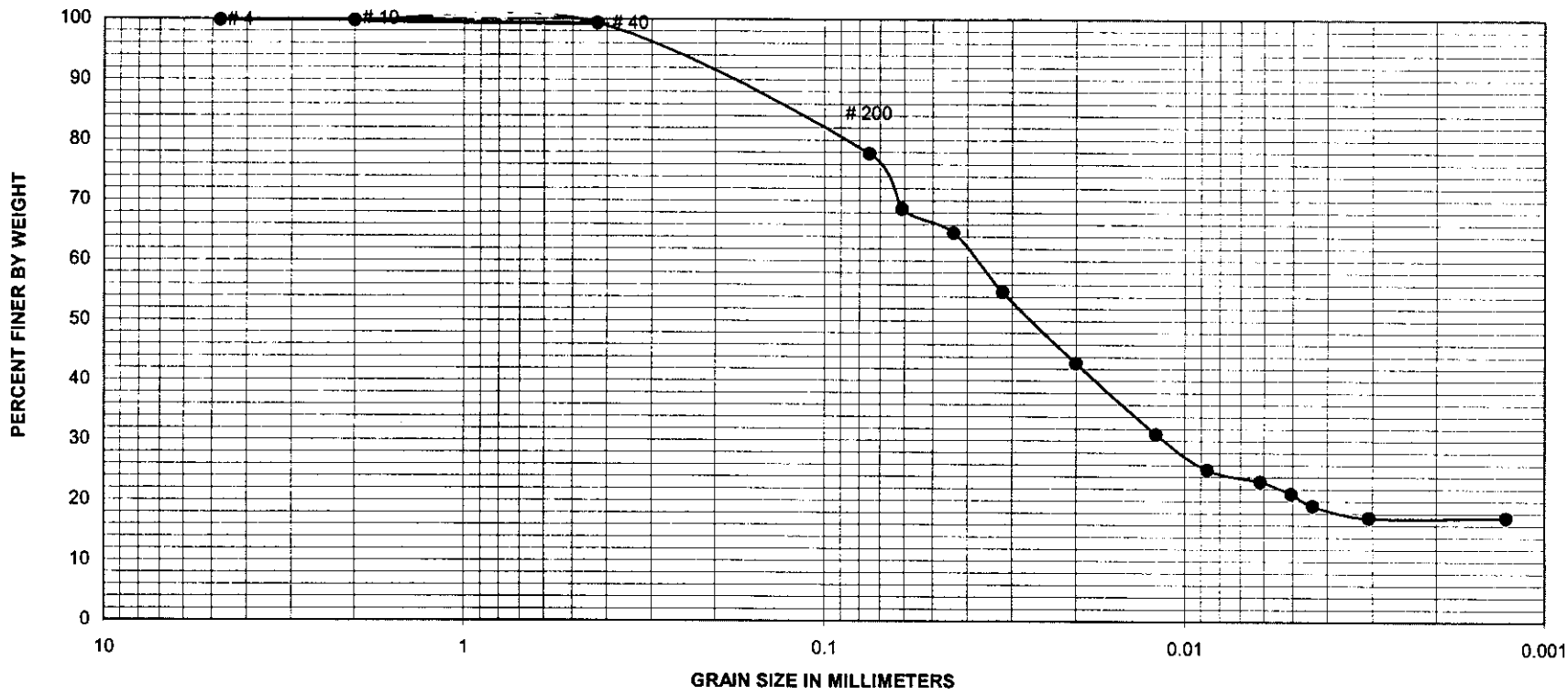
Grain Size Distribution Curve



GRAVEL	SAND	SILT OR CLAY

Boring No.	Sample No.	Elev or Depth	Nat w%	LL	PL	PI	Classification - Test 01	Project: SR 641 2IN1012
TB-26	1ST	16-18'		26	24	2	Silt Loam A-4	Vigo County, Indiana
								STP-291-1 (2)
								Date: 6/03

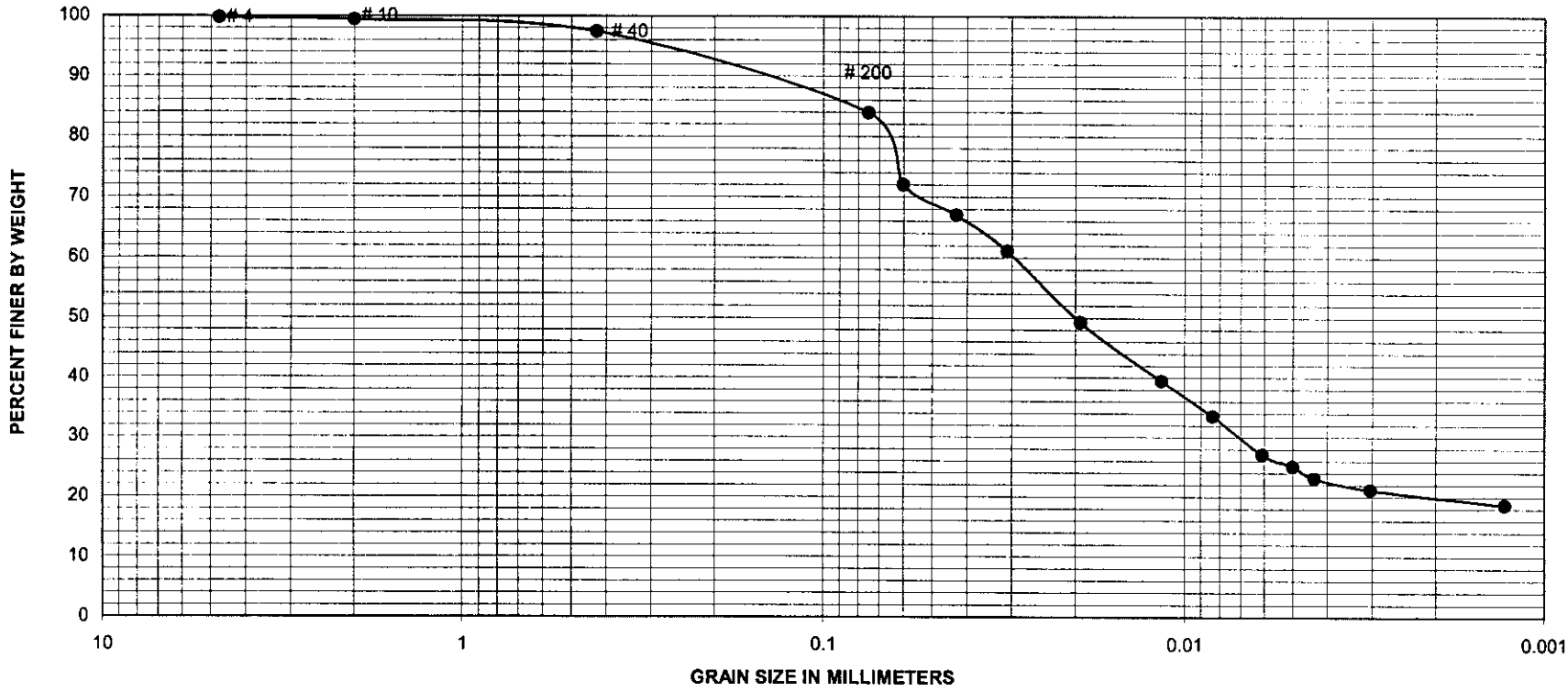
Grain Size Distribution Curve



GRAVEL	SAND	SILT OR CLAY

Boring No.	Sample No.	Elev or Depth	Nat w%	LL	PL	PI	Classification - Test 02	Project: SR-641 - 02IN1012
TB-26	3SS	5.0 & 7.5'		24	18	6	Silty Loam	Vigo County, Indiana
							A-4	STP-291-1 (2)
							pH 6.34	
								Date: 06/03

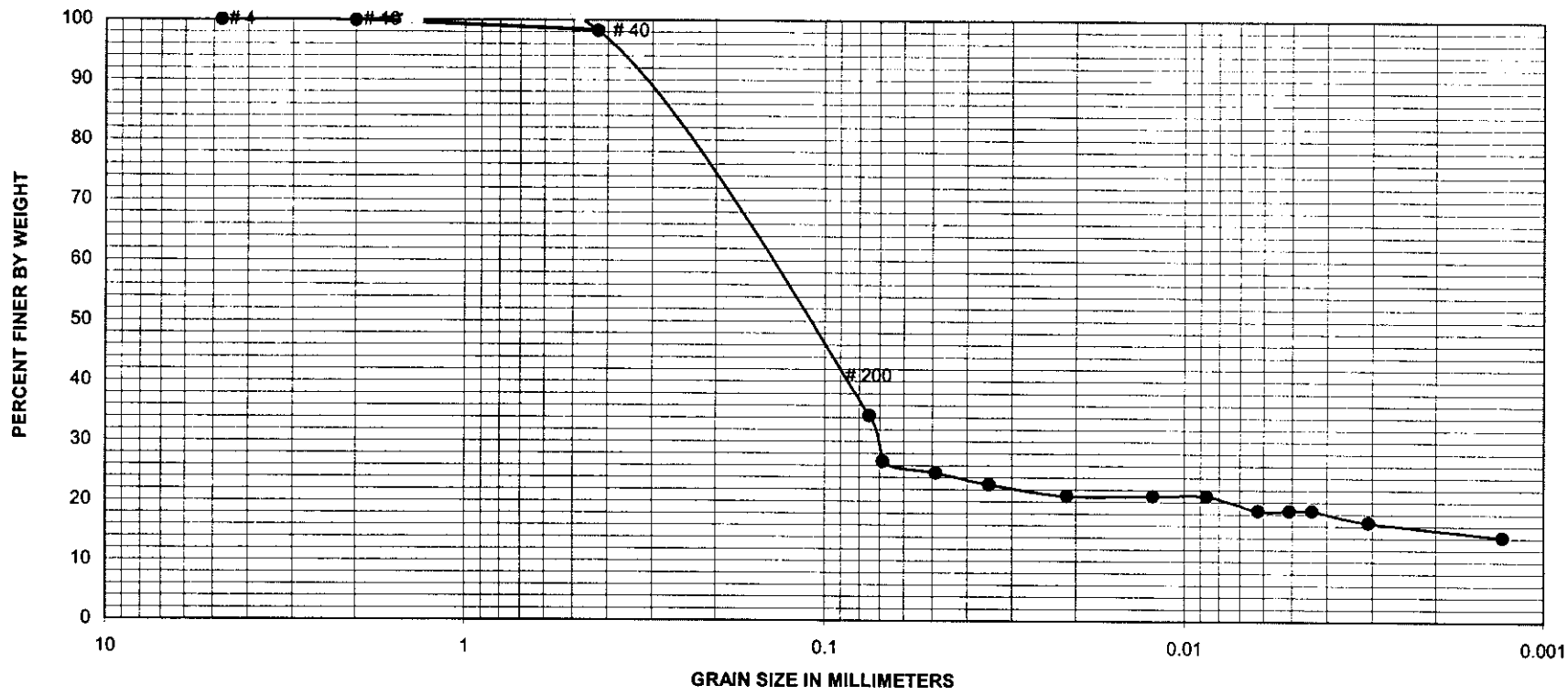
Grain Size Distribution Curve



GRAVEL	SAND	SILT OR CLAY

Boring No.	Sample No.	Elev or Depth	Nat w%	LL	PL	PI	Classification-Test 03	Project: SR-641 - 02IN1012
TB-23	8SS	28.5-30'		26	20	6	Silty Clay Loam	Vigo County, Indiana
							A-4	STP-291-1 (2)
							pH 6.65	
								Date: 06/03

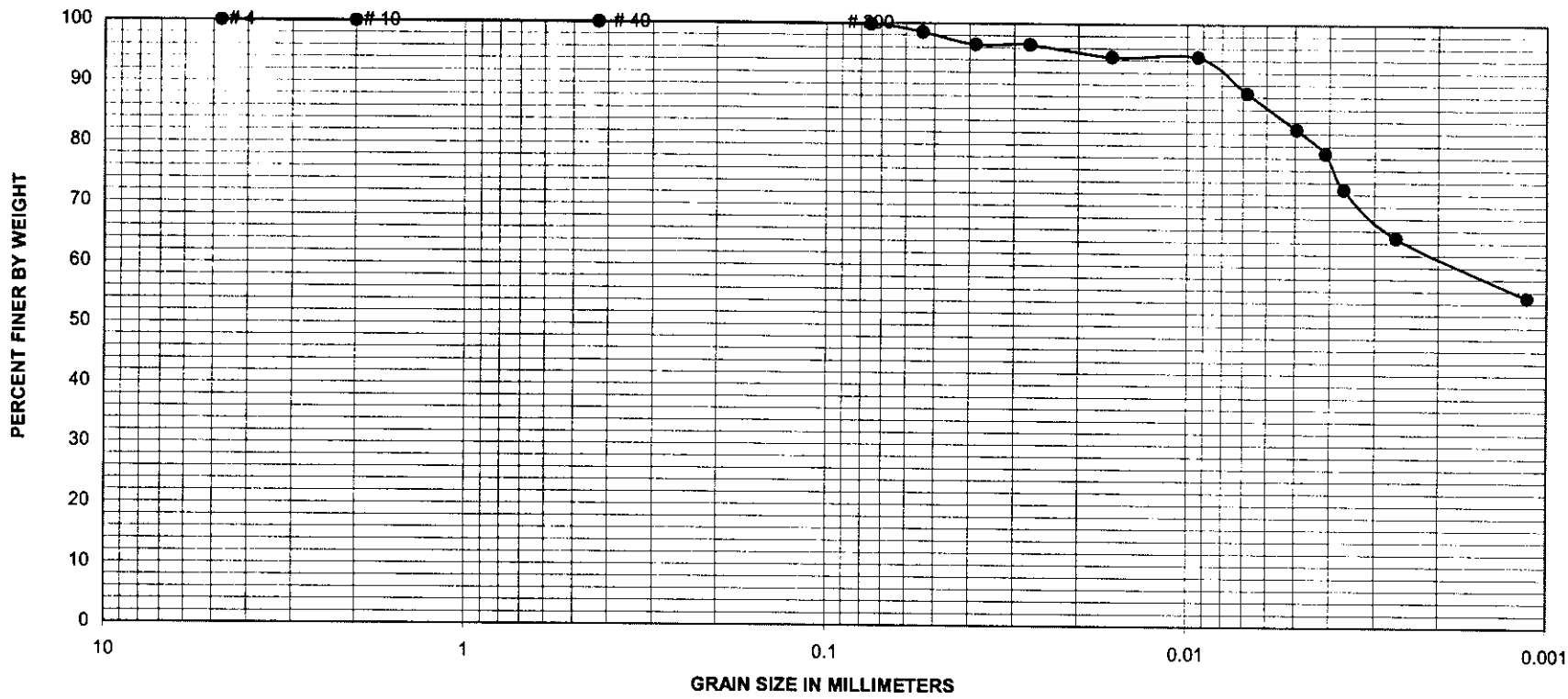
Grain Size Distribution Curve



GRAVEL	SAND	SILT OR CLAY

Boring No.	Sample No.	Elev or Depth	Nat w%	LL	PL	PI	Classification - Test 04	Project: SR-641 - 02IN1012
TB-28	7SS	25.0 T & B'			NP		Sandy Loam	Vigo County, Indiana
							A-2-4	STP-291-1 (2)
							pH 7.35	
								Date: 06/03

Grain Size Distribution Curve



GRAVEL	SAND	SILT OR CLAY

Boring No.	Sample No.	Elev or Depth	Nat w%	LL	PL	PI	Classification - Test 05
TB-26	2ST	46-48'	45.4	50	36	14	Clay
							A-7-5
							pH 7.33

Project: SR-641 - 02IN1012
Vigo County, Indiana
STP-291-1 (2)

Date: 06/03

Des No: Several
Project No:. STP-291-1 (2)
S.R. 641, Vigo County, Indiana
Alt & Witzig File: 02IN1012

SOIL CLASSIFICATION SUMMARY

Test No.	Boring Number	Sample & Depth	Description	Passing #10	Passing #40	> #10 % Gravel	#10-#200 % Sand	#200-.002mm % Silt	% <0.002mm (%) Clay	% <0.001mm Colloids	LL	PL	PI	AASHTO Classification
01	TB-26	1ST 16 to 18 ft	Silty Loam	100	100	0	6	77	17	14	26	24	2	A-4 (1)
02	TB-26	3SS 5.0 to 7.5 ft	Silty Loam	100	99	0	22	61	17	17	24	18	6	A-4 (3)
03	TB-23	8SS 28.5 to 30 ft	Silty Clay Loam	99	97	1	15	64	20	19	26	20	6	A-4 (4)
04	TB-28	7SS 23.5 to 25 ft	Sandy Loam	100	98	0	66	18	16	14	NP	NP	--	A-2-4 (0)
05	TB-26	2ST 46 to 48 ft	Clay	100	100	0	0	40	60	55	50	36	14	A-7-5 (20)

Indiana Department of Transportation

Materials and Tests Division
120 South Shortridge Road P.O. Box 19389
Indianapolis, Indiana 46219-0389
~~Phone: (317) 232-5280 Fax: (317) 356-9351~~
Phone: (317) 610 7251 Fax: (317) 356 9351

July 16, 2003

Mr. Phelps Klika, Chief
Design Division
Indiana Department of Transportation
Room N 601 - IGCN

Attention: Mrs. Hollie Pratt

Subject: Des. No.: 9738410
Project No: STP – 291 - (2)
Structure No: 641-84-8404
SR 641 over Feree Road, in Vigo County

Gentlemen:

Copies of the completed Geotechnical Report are being forwarded to those listed below with the following additional comments:

1. The waiting period for the restrike of piles set in shale bedrock shall be a minimum of 24 hours and for the piles and pile tips setting in clays the minimum waiting period for the restrike shall be 72 hours.

If you have any questions concerning the above matter, please call us.

Very truly yours,

Steve Morris
for Athar A. Khan, P.E.
Chief Geotechnical Engineer

Mir Zaheer
Mir Zaheer, P.E.
Senior Geotechnical Engineer

MZ
cc:
Ms. Mary Jo Hamman – Attn: Mr. Greg Klevitsky – Attachments
Mr. E. Gonzalez – Attn: Mr. Mike Monahan – Attachments (2)
Ms. B. Thacker – Attachments
Mr. D. Cohen - Attachments
File
H:\Mir\Letters\Alt & Witzig\9738410-SR641.doc

DES NO: 9738410

PROJECT NO: STP-291-(2)

STRUCTURE NO: 9

BRIDGE NO. 641-84-8404– S.R. 641 OVER FEREE ROAD

VIGO COUNTY, INDIANA

A & W PROJECT NO: 02IN1012

PREPARED FOR

INDIANA DEPARTMENT OF TRANSPORTATION

INDIANAPOLIS, INDIANA

JUNE 30, 2003

Alt & Witzig Engineering, Inc.
4105 West 99th Street • Carmel, Indiana 46032
(317) 875-7000 • Fax (317) 876-3705

June 30, 2003

Indiana Department of Transportation
120 South Shortridge Road
P.O. Box 19389
Indianapolis, Indiana 46219-0389
ATTN: Mr. Athar A. Kahn

RE: Subsurface Investigation
and Recommendations
Des No: 9738410
Project No: STP-291-(2)
Structure 9
Bridge No. 641-84-8404
S.R. 641 over Feree Road
Vigo County, Indiana
Alt & Witzig File: 02IN1012

Gentlemen:

In compliance with your request, we have completed six (6) soil borings at the above referenced site. It is our pleasure to transmit herewith a copy of the report.

Purpose and Procedures

This report presents the results of a geotechnical investigation for the new bridge in Vigo County, Indiana for Phase II of the SR 641 Project. The site of the proposed project is southeast of Terre Haute, Indiana on Feree Road just east of Fagin Road. The bridge is one of several structures proposed for the S.R. 641 Project. This investigation was conducted for the Indiana Department of Transportation.

The purpose of this foundation investigation was to determine the various soils profile components, the engineering characteristics of the foundation materials and to provide criteria for use by the design engineers in preparing roadway, retaining wall, and bridge design.

The field investigations to determine the engineering characteristics of the foundation materials included a reconnaissance of the project site, drilling borings as shown on the soil profile drawings, performing standard penetration tests, and obtaining soil samples retained in the standard split-spoon sampler. The bridge borings were offset slightly due to overhead obstructions. The apparent groundwater level and the ground surface elevation at the boring locations were also determined. The field investigation was started on March 3, 2003, and completed on June 10, 2003.

The soil borings were performed with a drilling rig equipped with a rotary head. Conventional hollow-stem augers were used to advance the holes. Representative samples were obtained employing split-spoon sampling procedures in accordance with ASTM Procedure D-1586.

During the sampling procedure, standard penetration tests were performed at regular intervals to obtain the standard penetration value of the soil. The standard penetration value is defined as the number of blows a 140 lb hammer, falling 30 inches, required to advance the split-spoon sampler 12 inches into the soil. The results of the standard penetration tests indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

In addition to the field investigations, a supplemental laboratory investigation was conducted to ascertain additional pertinent engineering characteristics of the subsurface materials necessary in analyzing the behavior of the proposed bridge structure. All phases of the laboratory investigation were conducted in general accordance with applicable AASHTO Specifications and INDOT Exhibit "C". The laboratory testing program included supplementary visual classification on all samples. Atterberg limit tests, unit weight tests, moisture content tests, pH tests, and grain size analyses were performed on selected soil samples.

Proposed Bridge Structure

Design plans indicate that two single span bridge structures (North and South bound) are to be constructed with this project. The bridges are to be constructed of prestressed concrete I-beams with a span of 80 feet (24.4m) at a skew of 32°18' Lt. The borings drilled for this new structure indicated the presence of shale beneath approximately thirty (30) to forty (40) feet of mostly hard, Silty Clay Loam soils. The end bents for this new bridge may be founded on steel H-piles driven into the hard cohesive soils, or to the top of the weathered shale, depending on required load capacity. Hardened pile tip protectors should be used for this project. The approximate shale elevations are shown in Table 1.

Table 1: Summary of Approximate Shale and Pile Tip Elevations

Bent	Boring Number	Station	Offset "CX"	Ground Surface Elevation, m (ft)	Approximate Shale Elevation, m	Pile Tip Elevation 40/55/70 Ton Piles, m	Depth Below Pile Cap* (m)
1SB	TB-21	9+781	8mLT	162.5 (533)	152.4 (500)	157/154.2/152.1	15.4
1NB	TB-22	9+798	19mRT	160.8 (527.5)	150.9 (495)	155.1/152.4/150.3	16.9
2SB	TB-23	9+798	19mLT	163.0 (535.0)	153.6 (504)	157.6/154.8/152.7	14.2
2NB	TB-24	9+815	8mRT	161.3 (529.0)	150.0 (492)	155.8/153/150.9	17.8

* Interpolated from bridge drawings to be approximately elevation 167.8m.

The bedrock elevations given above are only approximate elevations determined at the exact structure boring locations and should be used only as a guide. The preliminary pile tip elevations were calculated by SPILE and are also approximate. The final tip elevation should be determined by dynamic pile load testing using the methods outlined in Section 701.06 (c) of the INDOT Standard Specifications. The piles shall be monitored by a pile driving analyzer (PDA) during installation. The table below lists pile-driving parameters.

Table 2: Parameters for Pile Driving

Bent	No. 1	No. 2
Design Load (Tons)	40/55/70	40/55/70
Factor of Safety	2.0	2.0
Factored Design Load (Tons)	80/110/140	80/110/140
Friction in Scour Zone (Tons)	N/A	N/A
Down Drag Friction	N/A	N/A
Ultimate Load (Tons)	80/110/140	80/110/140
Testing Method	Std. Spec. 701.06 (c)	

High capacity piles will penetrate into the hard, Silty Clay Loam soils which overly the shale bedrock. Pile capacity through field monitoring (PDA) may be achieved prior to reaching the bedrock. However, 70 Ton piles that are driven to within five pile diameters (approximately 5 feet) of soil-bedrock interface should be driven into the bedrock. Our analysis is based upon a steel H-pile section with F_y=36ksi. Higher capacity may be achieved through the use of F_y=50ksi steel, if desired.

Piles that are driven to the weathered shale or shale bedrock should be restruck. The restrike should be completed after a minimum of 72 hours after initial drive. Additionally, to minimize the effects of the disturbed end-bearing stratum, a minimum spacing of the piles should be 1.8m (6 feet). This will ensure that end bearing capacities are not jeopardized by disturbance of the bedrock during driving of adjacent piles.

Down drag friction was not included due to the medium stiff to hard, shallow soils conditions. These soils are not anticipated to settle more than ½ inch under the load of a maximum of twenty (20) feet of fill required to construct the bridge and MSE walls.

MSE Wall Recommendations

As indicated by the design plans, MSE Retaining Walls are proposed at the end bents of the bridge structures. These MSE Walls run parallel to Feree Road and are approximately two hundred thirty (230) to two hundred sixty (260) feet (70-80m) in length. Borings RW-5 and RW-6 were conducted to analyze the soil in areas furthest away from structure borings.

External stability analyses of the proposed retaining walls were performed at the most critical sections, which also corresponds to the highest section of the walls, 24 feet (7.3m) at the north MSE wall (Abutment 2) and 23 feet (7m) at the south wall (Abutment 1). A traffic surcharge load of 250 psf was used in the design calculations. Since the highest section of the wall is beneath the bridge abutment, the soil load above the top of the wall was also factored into the design analysis. According to the design plans, the bridge abutment extends approximately five (5) feet (1.5m) above the top of the MSE Wall at all these locations. However, it is assumed the lateral earth pressure on the abutment itself will be resisted by either tiebacks or lateral pile resistance.

When MSE plans are finalized, it is recommended that the Geotechnical Consultant be provided with a set of plans to verify the recommendations made in this report. To meet required factors of safety for sliding of all the walls, it is recommended that three (3') feet (0.9m) be undercut beneath the wall and its strip foundation and replaced with "B" Borrow. The MSE Walls at both abutments should have adequate factors of safety against overturning, sliding, bearing capacity, and global stability if minimum strip lengths of **0.75H** are utilized. The letter H refers to the height of the MSE Wall. For the design of the foundation pad, a net allowable bearing pressure of 4000 psf can be used. The calculations of our analysis are presented in the Appendix of the report.

Based on the recommendations given in this report and the slope stability analysis performed at the critical wall section, we feel that the MSE retaining walls will have adequate global stability. Sliding block and rotational analyses were performed on the MSE Wall at Abutment 1, which yielded a critical factor of safety of 1.56. The graphical and numerical results of our analysis can be found in the Appendix of our report.

Prior to construction of the walls, all topsoil and wet or soft surface soils should be stripped from the site within construction limits. Proofrolling of the exposed subsurface should be performed in accordance with Section 203.26 in the area where new fill for the walls will be placed. Any soft, loose or unstable soils encountered during proofrolling operations, which will not readily compact, should be removed and replaced in accordance with Section 203.09. It is recommended that the base of the wall/backfill area be compacted to a minimum density of 95 percent of maximum dry density as determined by AASHTO T-99.

Evaluation of the internal stability of the walls against three standard modes of failure should be addressed by the design engineer. These include pullout of the strips, tensile overstress for the strip and wall/strip connection, and corrosion of the steel reinforcement strip. The backfill for these structures is to be of structural "B" Borrow as outlined in INDOT Standard Specifications. Soil parameters used for the backfill in the internal stability analysis are assumed to be $\phi = 34°$, $c = 0$, and unit weight (γ) = 125pcf. Behind the reinforced soil mass, additional "B" Borrow backfill should be placed. This material should rise from the heel of the MSE wall on a 1:1 slope. Any loose sand exposed in the foundation excavation should be compacted with a heavy vibrating roller before construction of the MSE wall. Careful consideration when compacting and placing the

backfill should be given in order to minimize the increase in lateral earth pressure. Furthermore, tracked construction equipment should not be operated directly on the strips. A minimum backfill thickness of six (6) inches (150mm) is required prior to operation of tracked vehicles over the strips. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the backfill and damaging the strips. Rubber-tired equipment may pass over the reinforcement at slow speed, less than 5mph. Sudden braking and sharp turning should be avoided.

Where high water tables are indicated on the boring logs, sump pumps or other means of dewatering will be necessary to maintain a dry excavation. It should be noted the above design values are assuming proper drainage is occurring. Therefore, during construction of the retaining walls, it is recommended that a permanent subsurface drainage system be installed at or near the base of the retaining wall. It is important that the drainage system be protected by some form of filter to prevent fines from clogging the pipe.

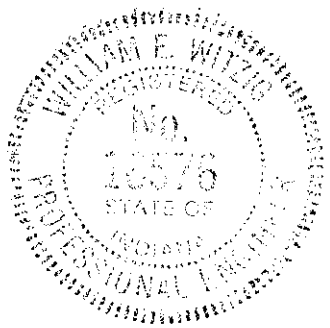
Slope Stability

A slope stability analysis was performed at the south end bent location utilizing the information from boring TB-22 at Station 9+798. The analysis found the proposed design to be adequate. The analysis is included in the Appendix of this report. A slope stability problem is not anticipated if proper construction techniques are followed.

Benching

Benching will be necessary for areas where existing slopes are steeper than 4:1. Benches shall be a minimum of four (4) feet wide. Benching of natural slopes and existing embankment slopes steeper than 4:1 shall be performed in accordance with Section 203.21 and 22 of the INDOT Standard Specifications.

Often, because of design and construction details that occur on a project, questions arise concerning the soil conditions. If we can give further service in these matters, please contact us at your convenience.



Very truly yours,

ALT & WITZIG ENGINEERING, INC.

William E. Witzig

William E. Witzig, P.E.

SUMMARY OF RECOMMENDATIONS

DES NO: 9738410

PROJECT NO: STP-291-(2)

STRUCTURE NO: 9

BRIDGE NO. 641-84-8404– S.R. 641 OVER FEREE ROAD

VIGO COUNTY, INDIANA

A foundation investigation has been performed for the proposed new S.R. 641 Bridge over Feree Road in Vigo County, Indiana. Design plans indicate that a single span bridge structure is to be constructed with this project. The following approximate table illustrates the approximate shale elevations and estimated pile tip elevations for 40, 55, and 70 ton piles:

Bent	Boring Number	Station	Offset "CX"	Ground Surface Elevation, m (ft)	Approximate Shale Elevation, m	Pile Tip Elevation 40/55/70 Ton Piles, m	Depth Below Pile Cap* (m)
1SB	TB-21	9+781	8mLT	162.5 (533)	152.4 (500)	157/154.2/152.1	15.4
1NB	TB-22	9+798	19mRT	160.8 (527.5)	150.9 (495)	155.1/152.4/150.3	16.9
2SB	TB-23	9+798	19mLT	163.0 (535.0)	153.6 (504)	157.6/154.8/152.7	14.2
2NB	TB-24	9+815	8mRT	161.3 (529.0)	150.0 (492)	155.8/153/150.9	17.8

Table 1: Summary of Approximate Shale and Pile Tip Elevations

The end bent piers for this new bridge may be founded on steel H-piles driven into the hard silty clay loam or shale bedrock at approximate elevations as shown in Table 1. If piles are driven to capacity within the overlying silty clay loam, a minimum of five pile diameters thickness of soil must be between the pile tip and the bedrock surface. Piles that are closer than five pile diameters must be driven to the shale bedrock. Protective tips should be used on the piles. The final tip elevation should be determined by dynamic pile load testing using the methods outlined in Section 701.06 (c) of the INDOT Standard Specifications.

The MSE Walls at both abutments should have adequate factors of safety against overturning, sliding, bearing capacity, and global stability if minimum strip lengths of 0.75H are utilized. To meet required factors of safety for sliding of all the walls, it is recommended that three (3') feet (0.9m) be undercut beneath the wall and its strip foundation and replaced with "B" Borrow. For the design of the foundation pad, a net allowable bearing pressure of 4000 psf can be used.

The shallow, natural soils encountered over most of the project site were predominantly Silty Loam, A-4. The shallow soils in some of the borings indicate soft to medium stiff material. Some undercutting and replacing of the shallow soft material with compacted "B" Borrow will be necessary for the construction of the MSE Wall. Specific subgrade recommendations for roadway construction will be provided under separate cover to this report.

Appendix

Boring Location Plan

Logs of Test Borings

MSE Wall Analyses (Abutments 1 & 2)

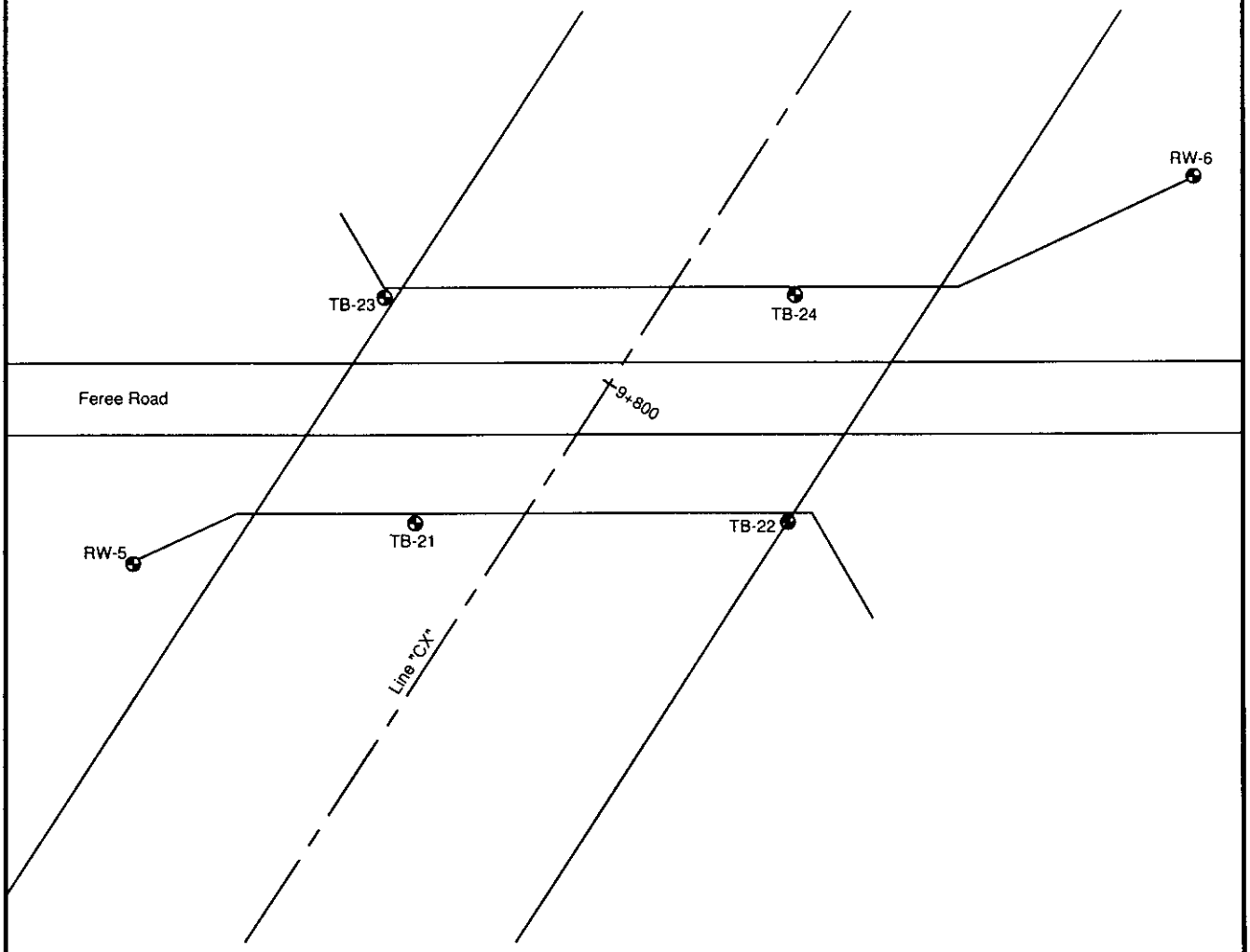
SPILE Printouts for 40/55/70 Ton Piles

Unconfined Compressive Strength Test Result

Grain Size Distribution Curves

Soil Classification Summary Sheet

BORING LOCATION PLAN



AW Project #: 02IN1012
SR 641 over Feree Road
Bridge 641-84-8404
Des No: 9738410

N

Scale: 1" = 50'
0 50

LOG OF TEST BORING

Project: S.R. 641
Location: Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section
4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RW-5
Surface Elevation 538.0
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	641-84-8404	Station	9+765	Offset	25 Lt	Line	"CX"
Datum	USGS	Weather	Cloudy	Temperature	35 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	100	2-3-4		Brown, Moist, Stiff, Silty Loam A-4 Test 01						
2SS	X	100	4-10-11	5	Brown, Wet, Medium Dense, Sandy Loam A-2-4 Test 04						
3SS	X	100	9-12-11								
4SS	X	100	4-11-21	10	Brown, Moist, Hard, Silty Loam A-4 Test 02						
5SS	X	100	21-48-50	15	Occasional wet sand seams (Visual)						
6SS	X	100	25-46-43	20							
7SS	X	100	9-22-42	25	Gray, Moist, Hard, Silty Clay Loam A-4 Test 03						
8SS	X	100	10-17-31		Brown and Gray, Moist, Hard, Silty Loam A-4 Test 02						
				30	Boring Terminated at 30.0 feet						
				35							
				40							

WATER LEVEL OBSERVATIONS

While Drilling ▽ 13.0 Upon Completion of Drilling ▼ Caved @ 8.0'
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 3/4/03 End 3/4/03 Rig B-59
Driller Winkler Editor D. Harness
Remarks

LOG OF TEST BORING

Project: S.R. 641
Location: Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RW-6
Surface Elevation 527.0
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	641-84-8404	Station	9+842	Offset	14 Rt	Line	"CX"
Datum	USGS	Weather	Sunny	Temperature	70 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	100	2-4-5		Brown, Moist, Medium Stiff, Silty Loam A-4 Test 02						
2SS	X	100	2-3-4	5	Shelby Tube Pushed from 3' to 5' (1ST)	1.1	97.6	23.4			
3SS	X	100	2-2-5								
4SS	X	100	1-2-4	10	Brown and Gray, Slightly Moist, Very Stiff to Hard, Silty Loam A-4 Test 01						
5SS	X	80	6-9-11	15							
6SS	X	100	6-15-21	20	Dry, Hard, Highly Weathered Silty Shale (Visual)						
7SS	X	100	11-36 50/5	25							
8SS	X	100	31-50/3	30							
					Auger Refusal at 33.0 feet						
				35							
				40							

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry Upon Completion of Drilling ▼ Dry
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 3/4/03 End 3/4/03 Rig B-59
Driller Winkler Editor D. Harness
Remarks

LOG OF TEST BORING

Project: S.R. 641
Location: Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-21
Surface Elevation 533.0
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8404	Station	9+781	Offset	8 Lt	Line	"CX"
Datum	USGS	Weather	Sunny	Temperature	30 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
				▽	Topsoil (Visual)						
1SS	X	80	1-4-6		Brown, Moist, Medium Stiff to Stiff, Silty Loam A-4 Test 01						
2SS	X	100	2-4-6	5							
3SS	X	100	4-7-7								
4SS	X	100	3-7-9	10	Brown, Very Moist, Medium Dense, Sandy Loam A-2-4 Test 04						
5SS	X	100	16-42 50/4	15	Gray, Slightly Moist, Hard, Silty Clay Loam A-4 Test 03						
6SS	X	100	13-40 50/4	20							
7SS	X	100	9-20-44	25							
8SS	X	100	10-20-32	30							
9SS	X	100	18-33-50	35	Gray-Tan, Slightly Moist, Hard, Highly Weathered Silty Shale (Visual)						
10SS	X	100	10-28-40	40							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 13.0 Upon Completion of Drilling ● 25.0
Time After Drilling 24 hrs
Depth to Water ▽ 0.75 ▼ ▼ ▼
Depth to Cave in 31.0

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 3/3/03 End 3/3/03 Rig B-59
Driller Winkler Editor D. Harness
Remarks

LOG OF TEST BORING

Project: S.R. 641
Location: Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-21
Surface Elevation 533.0
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8404	Station	9+781	Offset	8 Lt	Line	"CX"
Datum	USGS	Weather	Sunny	Temperature	30 F	Inspector	Tom Coffey

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES					
No.	Type	Rec (%)	Blow Count	Depth		qu (qp) (tsf)	δ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
11SS	X	100	15-32 50/3	45	Gray, Dry, Hard, Weathered Shale (Visual)						
12SS	X	100	50/3	50	Auger Refusal at 49.0 feet						
				55							
				60							
				65							
				70							
				75							
				80							
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: S.R. 641
Location: Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-22
Surface Elevation 527.5
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8404	Station	9+798	Offset	19 Rt	Line	"CX"
Datum	USGS	Weather	Sunny	Temperature	34 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	80	1-2-2		Brown, Moist, Soft to Very Stiff, Silty Loam A-4 Test 01						
2SS	X	80	1-3-3	5							
3SS	X	100	4-8-8				96.6	23.4			
4SS	X	100	6-20-30	10	Gray, Slightly Moist, Hard, Silty Clay Loam A-4 Test 03						
5SS	X	100	13-29-42	15							
6SS	X	100	9-25-41	20							
7SS	X	100	8-30-50/4	25	Gray to Tan, Dry, Hard, Highly Weathered Silty Shale (Visual)						
8SS	X	100	9-19-31	30							
9SS	X	100	29-50/3	35	Brown to Gray, Dry, Hard, Weathered Shale (Visual)						
10SS	X	100	37-50/4	40							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry Upon Completion of Drilling ▼ Dry
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 3/4/03 End 3/4/03 Rig B-59
Driller Winkler Editor D. Harness
Remarks

LOG OF TEST BORING

Project: S.R. 641
Location: Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-22
Surface Elevation 527.5
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8404	Station	9+798	Offset	19 Rt	Line	"CX"
Datum	USGS	Weather	Sunny	Temperature	34 F	Inspector	Tom Coffey

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES					
No.	Type	Rec (%)	Blow Count	Depth		qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
				45	Auger Refusal at 41.0 feet						
				50							
				55							
				60							
				65							
				70							
				75							
				80							
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: S.R. 641
Location: Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section
4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-23
Surface Elevation 535.0
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8404	Station	9+798	Offset	19 Lt	Line	"CX"
Datum	USGS	Weather	Partly Sunny	Temperature	75 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	60	3-4-5		Brown, Moist, Medium Stiff to Hard, Silty Loam A-4 Test 01		121.3	11.3			
2SS	X	100	4-5-6	5							
3SS	X	100	4-11-22								
4SS	X	100	12-22-30	10	Brown, Moist, Hard, Silty Loam A-4 Test 02						
5SS	X	100	28-50/4	15							
6SS	X	100	15-50/3	20	Gray, Slightly Moist, Hard, Silty Clay Loam A-4 Test 03						
7SS	X	100	13-28-48	25							
8SS	X	100	7-18-40	30			122.0	13.4	26	20	6
					Gray, Dry, Hard, Weathered Shale (Visual)						
9SS	X	100	9-18-50	35							
10SS	X	100	9-28-40	40							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 12.5 Upon Completion of Drilling ▼ 22.0
Time After Drilling
Depth to Water ▽ ▼ ▼ ▼
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 6/10/03 End 6/10/03 Rig B-59
Driller Winkler Editor D. Harness
Remarks

LOG OF TEST BORING

Project: S.R. 641
Location: Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-23
Surface Elevation 535.0
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8404	Station	9+798	Offset	19 Lt	Line	"CX"
Datum	USGS	Weather	Partly Sunny	Temperature	75 F	Inspector	Tom Coffey

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES					
No.	Type	Rec (%)	Blow Count	Depth		qu (qp) (tsf)	δ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
11SS	X	100	15-45-50	45							
12SS	X	100	40-50/3	50	Auger Refusal at 49.5 feet						
				55							
				60							
				65							
				70							
				75							
				80							
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project	S.R. 641
Location	Vigo County, Terre Haute, IN
Client	INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No.	TB-24
Surface Elevation	529.0
Proj. #	STP-291-1(2)
AW Proj. #	02IN1012
Sheet	1 of 2

Str. No.	641-84-8404	Station	9+815	Offset	8 Rt	Line	"CX"
Datum	USGS	Weather	Sunny	Temperature	78 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	60	2-4-6		Brown, Moist, Medium Stiff to Very Stiff, Silty Loam A-4 Test 01						
2SS	X	100	2-6-10	5							
3SS	X	100	9-28-40		Moist, Hard, Highly Weathered Clayey Sandstone (Visual)						
4SS	X	0	50/2	10							
5SS	X	100	22-31-40		Gray, Slightly Moist, Hard, Silty Clay Loam A-4 Test 03						
6SS	X	100	6-23-32	15							
7SS	X	100	10-41-45	20							
8SS	X	100	7-23-42	25							
9SS	X	100	9-22-34	30							
					Brown to Gray, Moist, Hard, Silty Loam A-4 Test 02						
10SS	X	50	36-50/3	35	Gray, Dry, Hard, Weathered Shale (Visual)						
				40	Continued Next Page						

WATER LEVEL OBSERVATIONS

While Drilling	13.0	Upon Completion of Drilling		
Time After Drilling	24 hrs			
Depth to Water	7.5			
Depth to Cave in				

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 6/8/03 End 6/8/03 Rig B-59
Driller Winkler Editor D. Harness
Remarks 4SS Driving on Rock

LOG OF TEST BORING

Project: S.R. 641
Location: Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

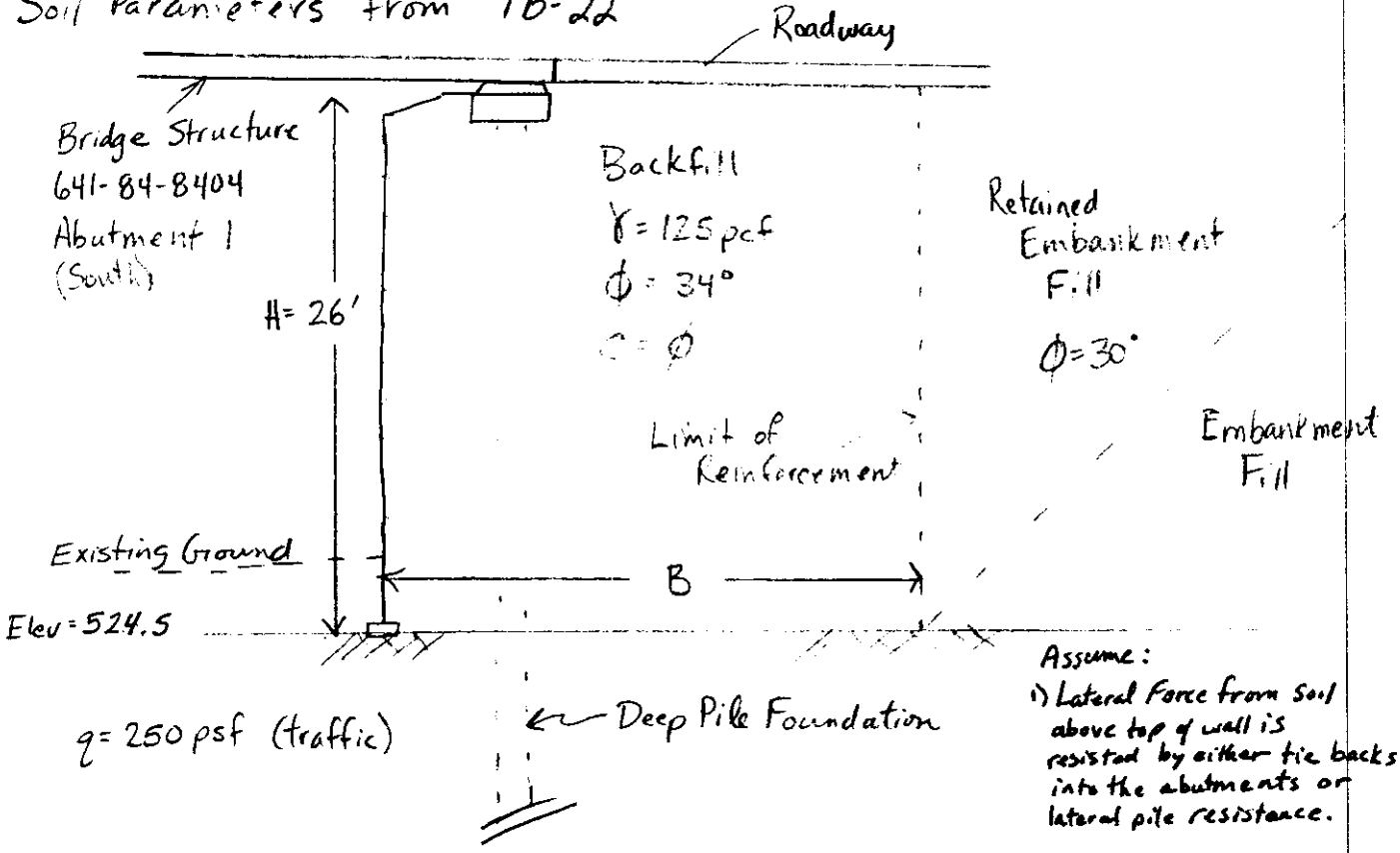
Boring No. TB-24
Surface Elevation 529.0
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8404	Station	9+815	Offset	8 Rt	Line	"CX"
Datum	USGS	Weather	Sunny	Temperature	78 F	Inspector	Tom Coffey

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES					
No.	Type	Rec (%)	Blow Count	Depth		qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
11SS	X	50	50/4	45	Auger Refusal at 43.5 feet						
				50							
				55							
				60							
				65							
				70							
				75							
				80							
				85							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

Soil Parameters from TB-22



q = 250 psf (traffic)

Assume:
1) Lateral Force from soil above top of wall is resisted by either tie backs into the abutments or lateral pile resistance.

Foundation Soil: Medium to Very Stiff, Silty Clay (Test 01)
c = 2200psf (Sample 1ST, RW-6)
γ = 120pcf

P_1 = Retained Soil Pressure

P_2 = Surcharge Pressure

Find K_a ⇒ $K_a = \tan^2(45 - \phi/2) = \tan^2(45 - 30/2) = 0.33$

Find P_a ⇒ $P_a = P_1 + P_2 = \frac{1}{2} K_a \gamma H^2 + K_a q H$

$= \frac{1}{2}(0.33)(125)(26)^2 + (0.33)(250)(26)$

$= 13,942.5 + 2145 = \boxed{16,087.5 \text{ lb/ft}}$

Find Resultant, z $\quad z = \frac{P_2(H/2) + P_1(H/3)}{P_a} = \frac{13,942.5(26/2) + 2145(26/3)}{16,087.5}$

$= \boxed{12.4 \text{ ft}}$

$P_a = 16,087.5$ lb/ft

$z = 12.4$ ft

Determine Factor of Safety Against Sliding

$$F.S._{sliding} = \frac{\Sigma P_{resisting}}{\Sigma P_{driving}} = \frac{W_1 \tan\phi + cB}{P_o}$$

$P_o = P_a = 16,087.5$ lb/ft

Try reinforcement strip $0.7H = 0.7(26) = 18.2$ ft use $19' = B$

$\phi = 0 \therefore W_1 \tan\phi = 0$ ↳ $P_{resisting} = cB = (2,200\ psf)(19\ ft)$

$= 41,800$ lbs/ft

$$F.S. = \frac{41,800\ lb/ft}{16,087.5\ lb/ft} = 2.6 > 1.5$$ so ok

Determine Factor of Safety Against Bearing Capacity Failure

Foundation Soils: $c = 2,200$ psf $N_c = 5.7$ $\gamma = 120$ pcf

$Q_{ult} = cN_c = (2,200)(5.7) = 12,540$ psf

$q_{all} = \frac{12,540\ psf}{2.5} = 5016$ psf Say 5,000

Find eccentricity: $e = \frac{B}{2} - \frac{\Sigma M_r - \Sigma M_o}{\Sigma V}$

$$e = \frac{19}{2} - \left(\frac{19(125)(26)\left(\frac{19}{2}\right) - (16,087.5)(12.4)}{19(125)(26)}\right)$$

$$= 9.5 - \left(\frac{586,625 - 199,485}{61,750}\right)$$

$= 3.23$

Check that $e < \frac{B}{6}$ $\frac{19}{6} = 3.17$ $e > \frac{B}{6}$ so try $B = 20'$

$e = 3.07$ @ $B = 20'$ Check $e < \frac{B}{6}$ $\frac{20}{6} = 3.3$

$e = 3.07 < 3.3$ so ok, use 20' strips on $0.75H$

$$\sigma_v = \frac{125(26)(20) + 250(20)}{20 - (2)(3.07)} = \frac{65,000 + 5000}{13.86} = 5050 psf$$

$$F.S. = \frac{Qult}{\sigma_v} = \frac{12,540}{5050} = 2.5 > 2 \quad \text{so ok} \checkmark$$

Determine Factor of Safety against Overturning

$$F.S. = \frac{\Sigma M_R}{\Sigma M_O} = \frac{586,625}{199,485} = 2.9 > 1.5 \quad \text{so ok} \checkmark$$

Soil Parameters from TB-24, See Worksheet for Abutment 1 for sketch

Bridge 641-84-8404
Abutment 2 (North)

Backfill: $\gamma = 125$, $\phi = 34°$ $c = 0$
Retained Fill: $\gamma = 125$, $\phi = 30°$ $c = 0$
$K_a = 0.33$ $H = 28'$

$q = 250$ psf Foundation Soil: Medium Stiff to Very Stiff Silty Clay
$c = 2200$ psf $\gamma = 120$ pcf

P_1 = Retained Soil Pressure

P_2 = Surcharge Pressure

Find P_a => $P_a = P_1 + P_2 = \frac{1}{2} K_a \gamma H^2 + K_a q H$

$= \frac{1}{2}(0.33)(125)(28)^2 + (0.33)(250)(28)$

$= 16{,}170 + 2310 = \boxed{18{,}480 \text{ lb/ft}}$

Find Resultant, Z $\quad Z = \frac{P_2(H/2) + P_1(H/3)}{P_a} = \frac{16170(28/2) + 2310(28/3)}{18480}$

$= \boxed{13.4 \text{ ft}}$

Factor of Safety Against Sliding

$F.S._{sliding} = \frac{W_1 \tan\phi + cB}{P_o}$ $\quad P_o = P_a = 18{,}480$

Try reinforcement strip $= 0.75H = 0.75(28) = 21$ ft $= B$

$\phi = 0 \therefore W\tan\phi = 0$ $\quad$ Resist $= cB = (2{,}200)(21) = 46{,}200$ lb/ft

$F.S. = \frac{46200}{18{,}480} = 2.5 > 1.5$ so ok ✓

Factor of Safety Against Bearing Capacity Failure

$c = 2200$ psf $\quad N_c = 5.7$ $\quad \gamma = 120$ pcf

$Q_{ult} = cN_c = (2200)(5.7) = 12{,}540$ psf

$q_{all} = \frac{12540}{2.5} = 5016$ say 5000 psf

Find eccentricity $e = \frac{B}{2} - \frac{\Sigma M_r - \Sigma M_o}{\Sigma V}$

$$e = \frac{21}{2} - \left(\frac{21(125)(28)\left(\frac{21}{2}\right) - (18490)(13.4)}{21(125)(28)} \right)$$

$$= 10.5 - \left(\frac{771750 - 247632}{73500} \right) = 3.37$$

check $e < \frac{B}{6}$ $\quad \frac{21}{6} = 3.5$

$e = 3.37 < \frac{B}{6} = 3.5$ So ok ✓

Use 21' long reinforcement strips, @ 0.75H

$$\sigma_v = \frac{(125)(28)(21) + 250(21)}{21 - (2)(3.07)} = \frac{73500 + 5250}{14.86} = 5300 \text{ psf}$$

$$F.S. = \frac{Q_{ult}}{\sigma_v} = \frac{12540}{5300} = 2.37 > 2 \quad \text{So ok ✓}$$

Factor of Safety Against Overturning

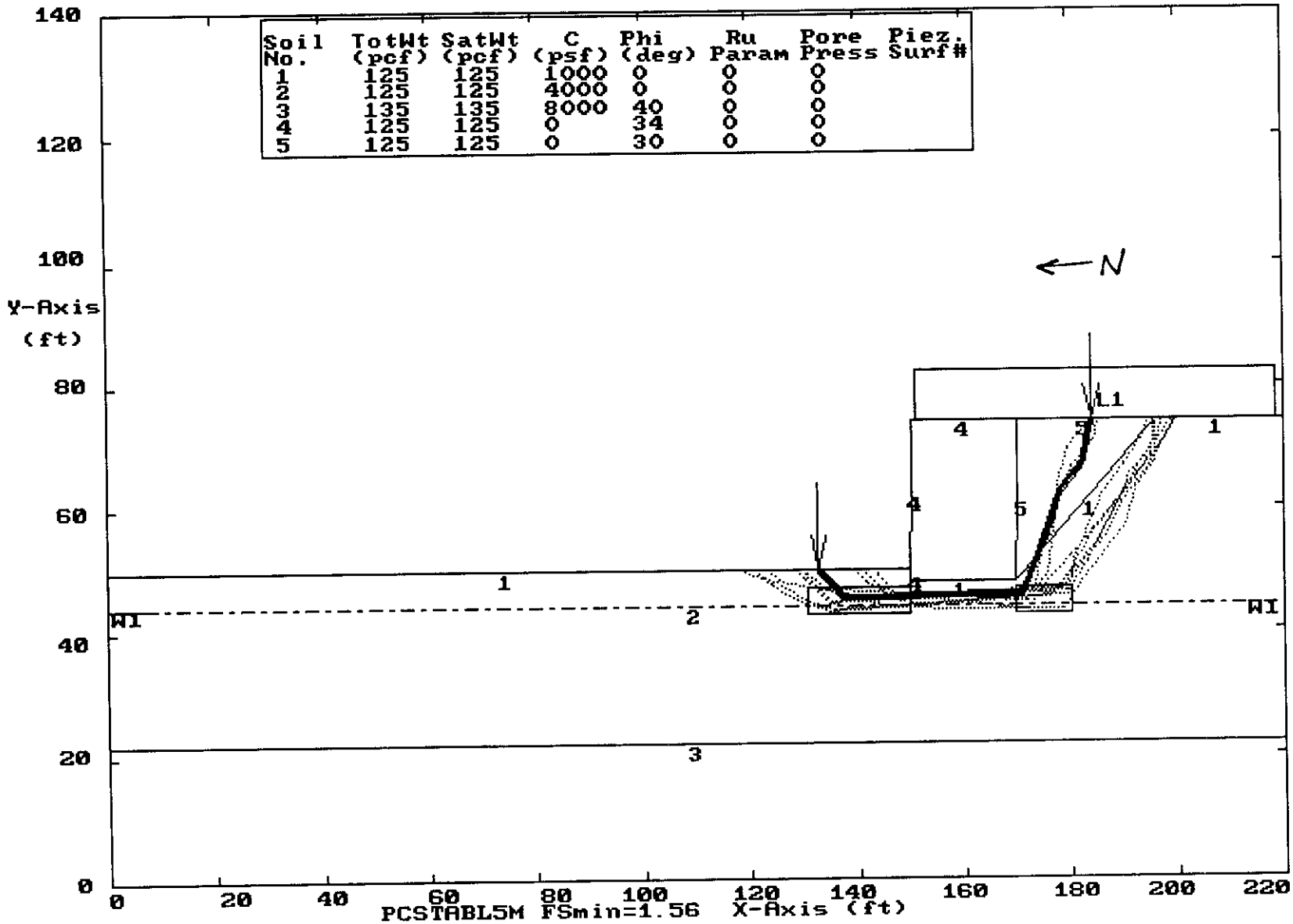
$$F.S. = \frac{\Sigma M_r}{\Sigma M_o} = \frac{771750}{247632} = 3.1 > 1.5 \quad \text{So ok ✓}$$

MSE Wall @ Abutment 1

F.S. = 1.56

641 over Feree Road, Bridge 9 02IN1012 Vigo County, IN
Ten Most Critical. F:64191.PLT By: msw 06-27-03 9:10am

Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	125	125	1000	0	0	0	
2	125	125	4000	0	0	0	
3	135	135	8000	40	0	0	
4	125	125	0	34	0	0	
5	125	125	0	30	0	0	



PCSTABL5M FSmin=1.56

40 Ton S.R 641 over Ferree Rd.

ULTIMATE STATIC PILE CAPACITY/Federal Highway Administration
Nordlund (1963, 1979) and Tomlinson (1979, 1980) methods

Project Name	: SR 641, Vigo Co.	Client	: INDOT
File Name	: 02IN1012	Project Manager	: David Harness
Date	: 6/25/10	Computed by	: dch

Depth of Top of Pile = 0.00 ft.
Depth to Water Table = 12.00 ft.
Type of Pile = H Pile
HP 12x53

Pile length = 18.00 ft.

SKIN FRICTION CONTRIBUTION

Layer	Soil Type	Thickness (ft)	Effective Stress (psf)	Internal Friction Angle	N-SPT	Pile Perimeter (ft)
1	Cohesive	10.00	605.00	---	--	3.97
2	Cohesionless	8.00	1585.20	35.00	--	3.97

Layer	Soil Type	Undrained Shear Strength (psf)	Adhesion	Pile Taper	Sliding Friction Angle	Skin Resistance (Kips)
1	Cohesive	1100.00	852.00	----	-----	33.82
2	Cohesionless	--	--------	----	26.43	23.15

Total Side Friction : 56.98

POINT RESISTANCE CONTRIBUTION

Effective Stress at pile Tip (psf)	Internal Friction Angle	SPT Value	Pile End Area (ft*ft)	Bearing Capacity Factor Nq	End Bearing Resistance (Kips)
1835.60	38.00	-----	0.99	110.40	143.37

Limiting End Bearing Resistance : 264.66

Ultimate Static Pile Capacity : 200.35

55 Ton S.R. 641 over Feree Rd.

-------- ULTIMATE STATIC PILE CAPACITY/Federal Highway Administration --------
Nordlund (1963, 1979) and Tomlinson (1979, 1980) methods

Project Name	: SR 641, Vigo Co.	Client	: INDOT
File Name	: 02IN1012	Project Manager	: David Harness
Date	: 6/25/10	Computed by	: dch

Depth of Top of Pile = 0.00 ft.
Depth to Water Table = 12.00 ft.
Type of Pile = H Pile
HP 12x53

Pile length = 27.00 ft.

SKIN FRICTION CONTRIBUTION

Layer	Soil Type	Thickness (ft)	Effective Stress (psf)	Internal Friction Angle	N-SPT	Pile Perimeter (ft)
1	Cohesive	10.00	605.00	---	--	3.97
2	Cohesionless	17.00	1866.90	35.00	--	3.97

Layer	Soil Type	Undrained Shear Strength (psf)	Adhesion	Pile Taper	Sliding Friction Angle	Skin Resistance (Kips)
1	Cohesive	1100.00	852.00	----	-----	33.82
2	Cohesionless	--	--------	----	26.43	57.94

Total Side Friction : 91.77

POINT RESISTANCE CONTRIBUTION

Effective Stress at pile Tip (psf)	Internal Friction Angle	SPT Value	Pile End Area (ft*ft)	Bearing Capacity Factor Nq	End Bearing Resistance (Kips)
2399.00	38.00	-----	0.99	110.40	187.38

Limiting End Bearing Resistance : 264.66

Ultimate Static Pile Capacity : 279.14

+------ Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu ------+

70 Ton S.R. 641 over Force Rd.

-------- ULTIMATE STATIC PILE CAPACITY/Federal Highway Administration --------
Nordlund (1963, 1979) and Tomlinson (1979, 1980) methods

Project Name	: SR 641, Vigo Co.	Client	: INDOT
File Name	: 02IN1012	Project Manager	: David Harness
Date	: 6/25/10	Computed by	: dch

Depth of Top of Pile = 0.00 ft. Pile length = 34.00 ft.
Depth to Water Table = 12.00 ft.
Type of Pile = H Pile
HP 12x53

SKIN FRICTION CONTRIBUTION

Layer	Soil Type	Thickness (ft)	Effective Stress (psf)	Internal Friction Angle	N-SPT	Pile Perimeter (ft)
1	Cohesive	10.00	605.00	---	--	3.97
2	Cohesionless	20.00	1960.80	35.00	--	3.97
3	Cohesionless	4.00	2752.00	35.00	--	3.97

Layer	Soil Type	Undrained Shear Strength (psf)	Adhesion	Pile Taper	Sliding Friction Angle	Skin Resistance (Kips)
1	Cohesive	1100.00	852.00	----	-----	33.82
2	Cohesionless	--	--------	----	26.43	71.60
3	Cohesionless	--	--------	----	26.43	20.10

Total Side Friction : 125.52

POINT RESISTANCE CONTRIBUTION

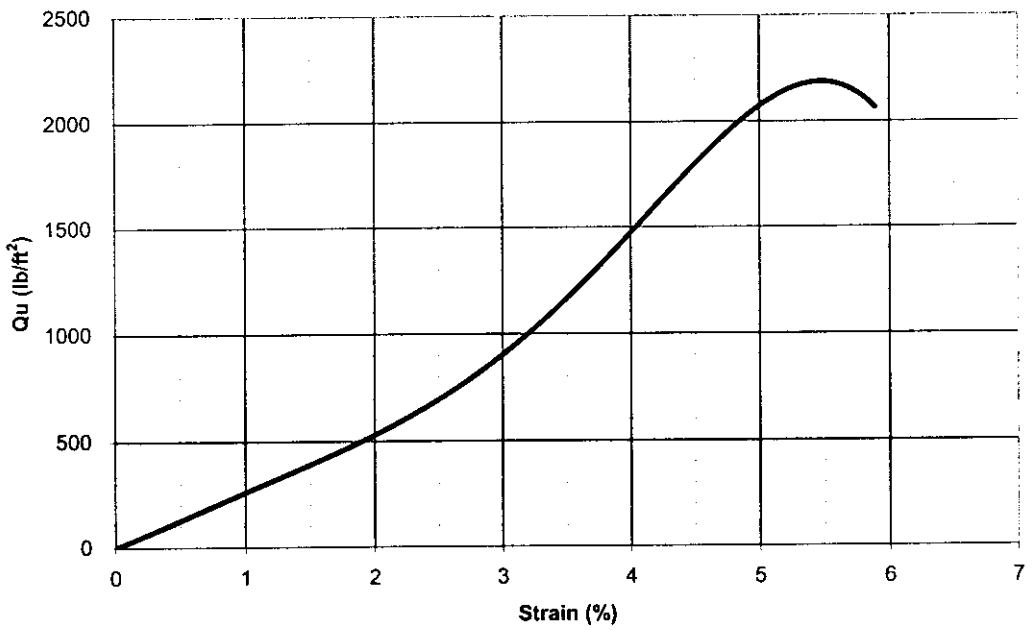
Effective Stress at pile Tip (psf)	Internal Friction Angle	SPT Value	Pile End Area (ft*ft)	Bearing Capacity Factor Nq	End Bearing Resistance (Kips)
2917.20	38.00	-----	0.99	110.40	227.85

Limiting End Bearing Resistance : 264.66

Ultimate Static Pile Capacity : 353.37

----- Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu -----

Unconfined Compression Test

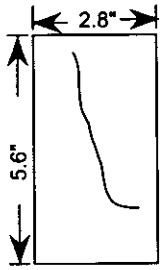


Sample Location: RW-6, 1ST

Depth: 3-5 ft Moisture Content: 23.6 (%)

Strain Rate: 2% min. Dry Unit Weight: 97.6 (lb/ft^3)

FAILURE SKETCH



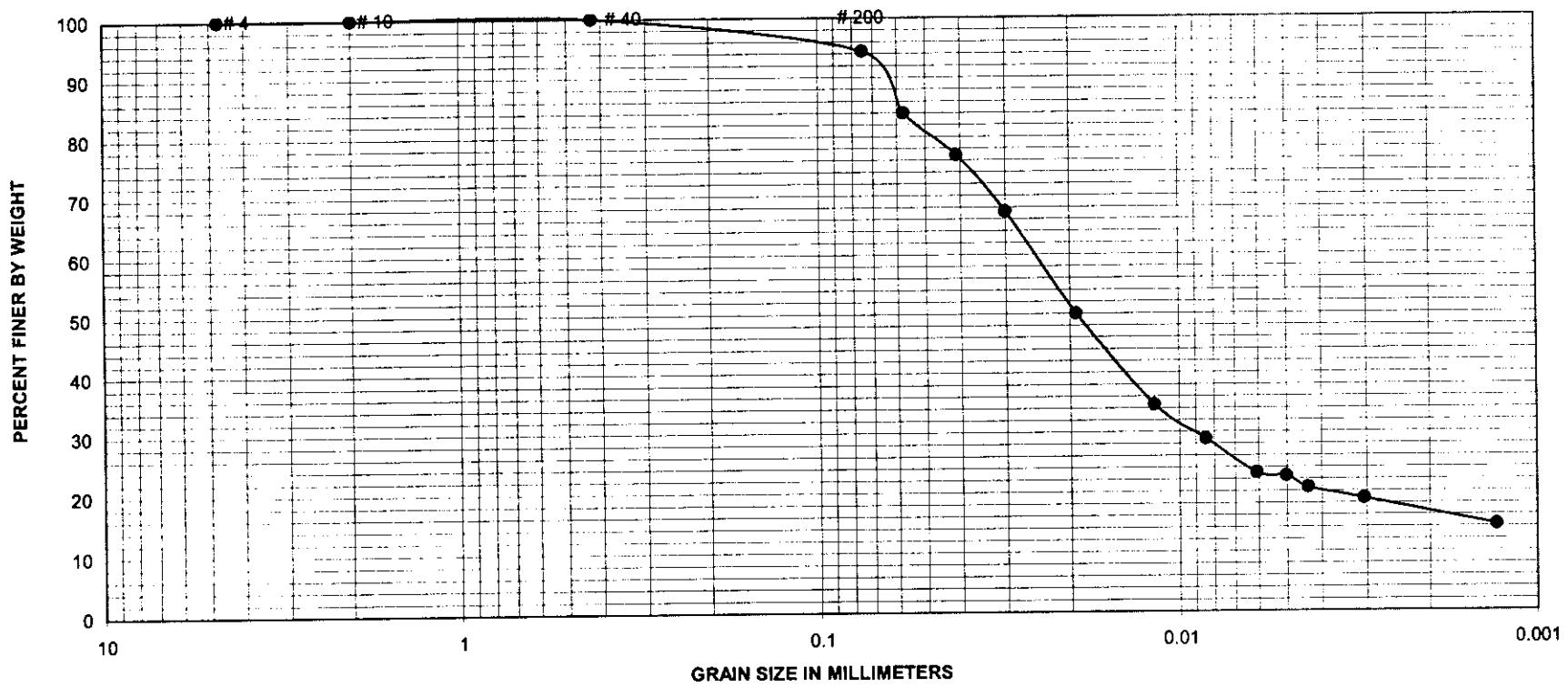
Soil Description: Brown Silty Loam, Test 02

Unconfined Compressive Strength (lb/ft^2): 2,200

Failure Strain (%): 5.5

PREPARED FOR: INDOT-Geotechnical Division, Indianapolis, Indiana	A&W	PREPARED BY: Alt & Witzig Engineering, Inc., Carmel, Indiana	
PROJECT NAME: SR-641, Vigo County, Indiana		PROJECT NO.: 02IN1012	DATE: 6/03

Grain Size Distribution Curve



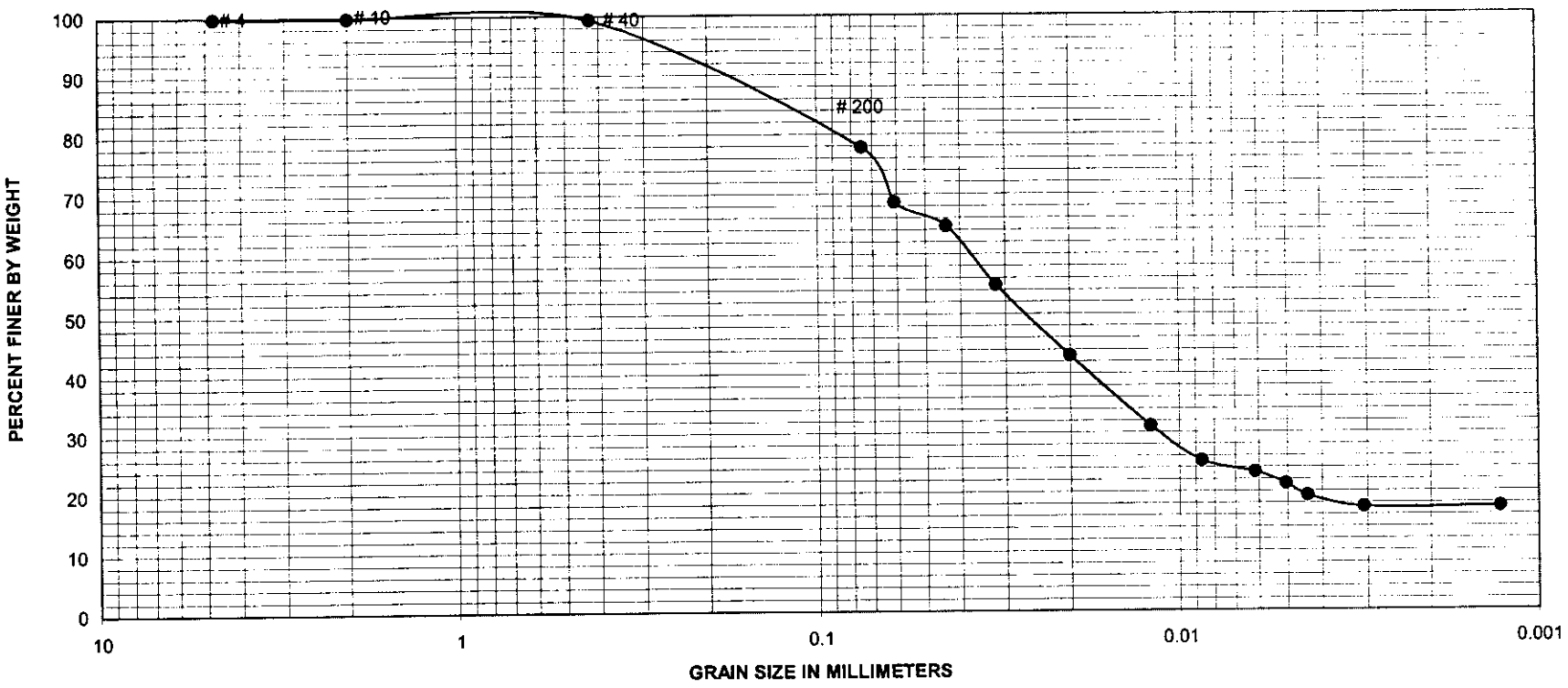
GRAVEL	SAND	SILT OR CLAY

Boring No.	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	Classification - Test 01
TB-26	1ST	16-18'		26	24	2	Silt Loam A-4

Project: SR 641 2IN1012
Vigo County, Indiana
STP-291-1 (2)

Date: 6/03

Grain Size Distribution Curve



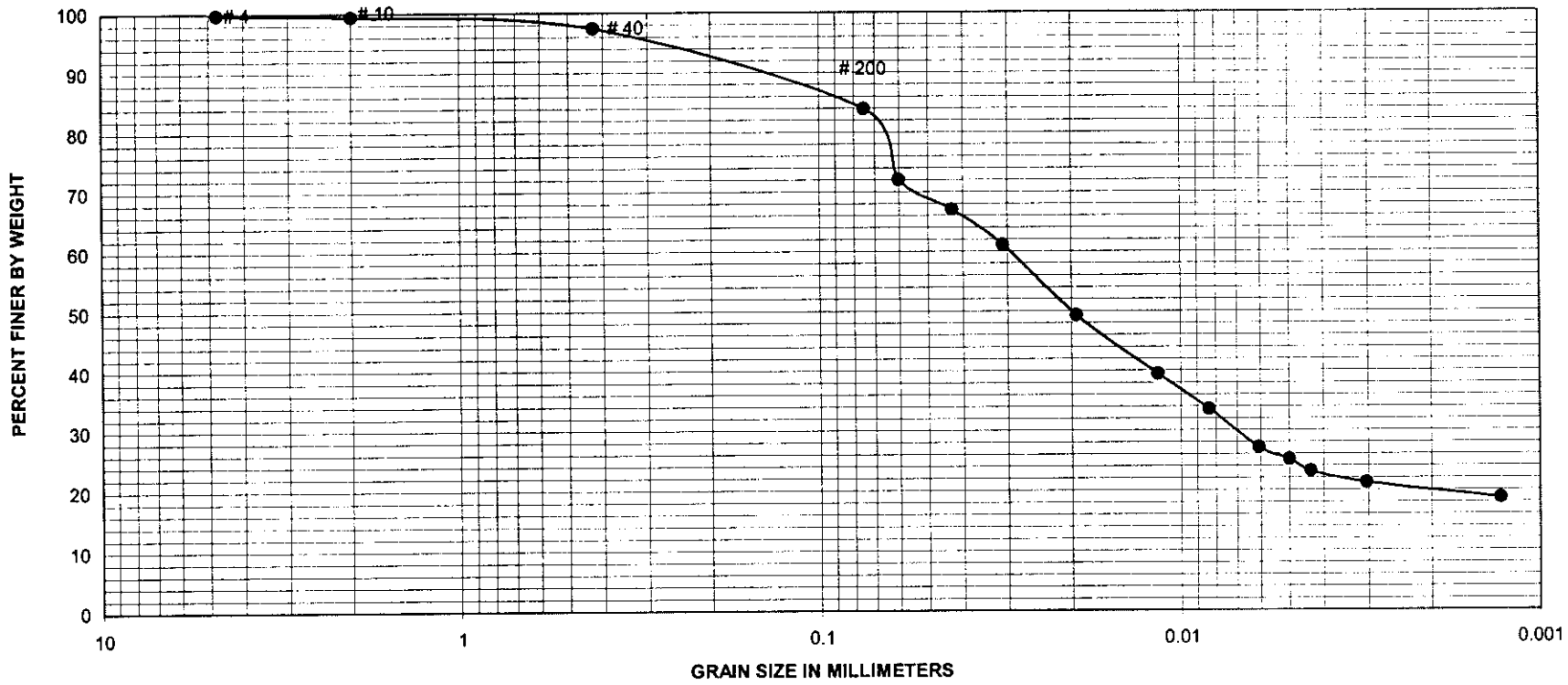
GRAVEL	SAND	SILT OR CLAY

Boring No.	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	Classification - Test 02
TB-26	3SS	5.0 & 7.5'		24	18	6	Silty Loam
							A-4
							pH 6.34

Project: SR-641 - 02IN1012
Vigo County, Indiana
STP-291-1 (2)

Date: 06/03

Grain Size Distribution Curve



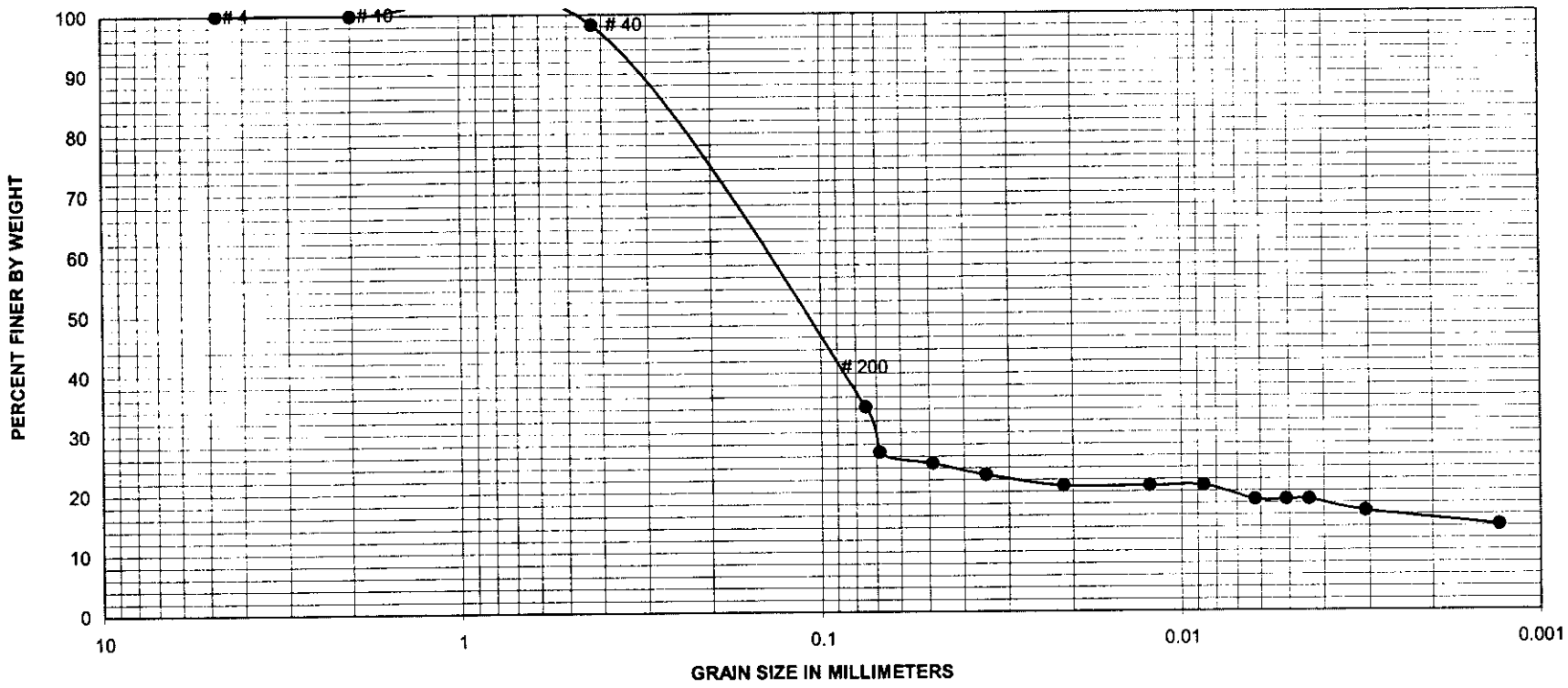
GRAVEL	SAND	SILT OR CLAY

Boring No.	Sample No.	Elev or Depth	Nat w%	LL	PL	PI	Classification-Test 03
TB-23	8SS	28.5-30'		26	20	6	Silty Clay Loam
							A-4
							pH 6.65

Project: SR-641 - 02IN1012
Vigo County, Indiana
STP-291-1 (2)

Date: 06/03

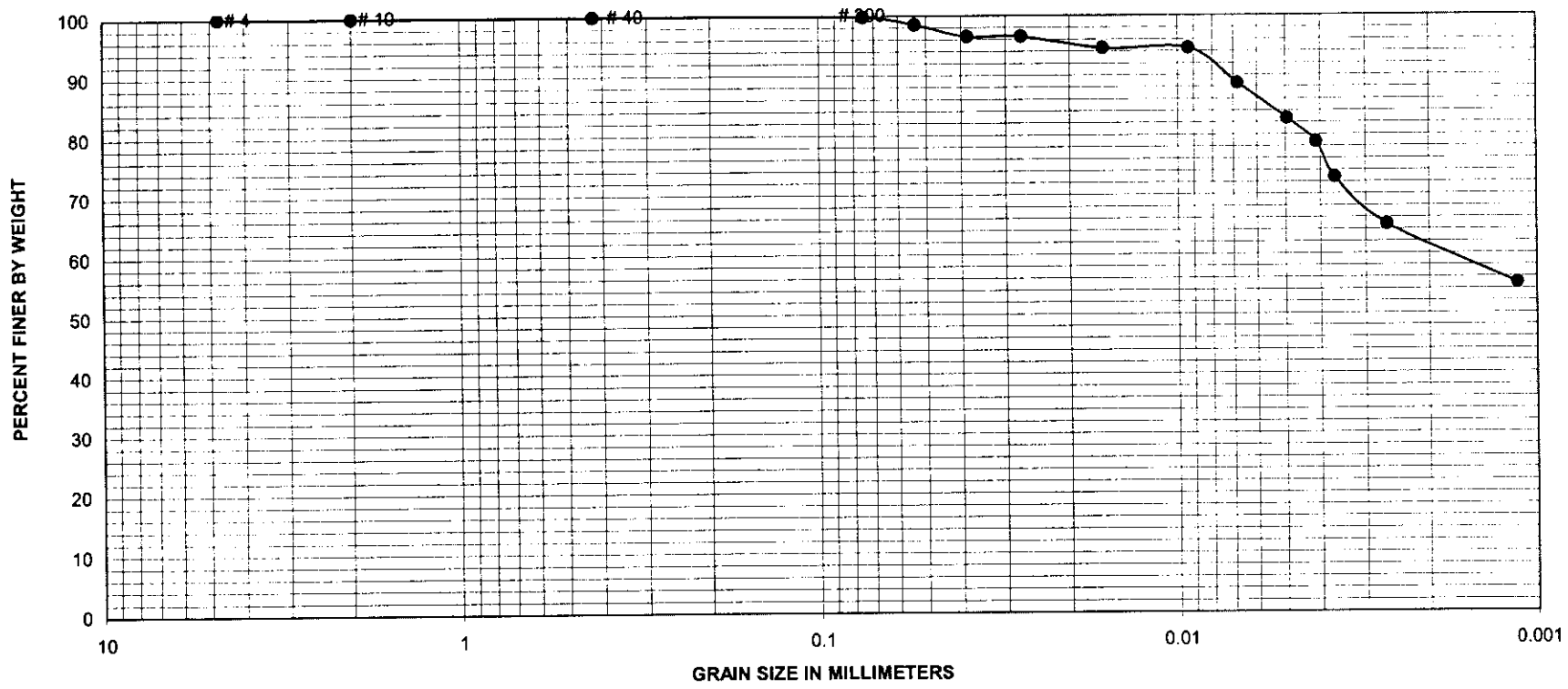
Grain Size Distribution Curve



GRAVEL	SAND	SILT OR CLAY

Boring No.	Sample No.	Elev or Depth	Nat w%	LL	PL	PI	Classification - Test 04	Project: SR-641 - 02IN1012
TB-28	7SS	25.0 T & B'			NP		Sandy Loam	Vigo County, Indiana
							A-2-4	STP-291-1 (2)
							pH 7.35	
								Date: 06/03

Grain Size Distribution Curve



GRAVEL	SAND	SILT OR CLAY

Boring No.	Sample No.	Elev or Depth	Nat w%	LL	PL	PI	Classification - Test 05
TB-26	2ST	46-48'	45.4	50	36	14	Clay
							A-7-5
							pH 7.33

Project: SR-641 - 02IN1012

Vigo County, Indiana

STP-291-1 (2)

Date: 06/03

Des No: Several
Project No:. STP-291-1 (2)
S.R. 641, Vigo County, Indiana
Alt & Witzig File: 02IN1012

SOIL CLASSIFICATION SUMMARY

Test No.	Boring Number	Sample & Depth	Description	Passing #10	Passing #40	> #10 % Gravel	#10-#200 % Sand	#200-.002mm % Silt	% <0.002mm (%) Clay	% <0.001mm Colloids	LL	PL	PI	AASHTO Classification
01	TB-26	1ST 16 to 18 ft	Silty Loam	100	100	0	6	77	17	14	26	24	2	A-4
02	TB-26	3SS 5.0 to 7.5 ft	Silty Loam	100	99	0	22	61	17	17	24	18	6	A-4
03	TB-23	8SS 28.5 to 30 ft	Silty Clay Loam	99	97	1	15	64	20	19	26	20	6	A-4
04	TB-28	7SS 23.5 to 25 ft	Sandy Loam	100	98	0	66	18	16	14	NP	NP	--	A-2-4
05	TB-26	2ST 46 to 48 ft	Clay	100	100	0	0	40	60	55	50	36	14	A-7-5

Indiana Department of Transportation

Materials and Tests Division

120 South Shortridge Road P. O. Box 19389
Indianapolis, Indiana 46219-0389
Phone: (317) 610-7251 Fax: (317) 356-9351

November 8, 2004

Mr. Gary Mroczka, Chief
Division of Design
Room N642 - IGCN

Attention: Ms. Kimberly Peters

Subject: Des No: 9138220
Geotechnical Investigation – In House **(ADDENDUM)**
New Road & Bridge Construction for Proposed SR 641
IVY Tech Access Road
Project No: STP – 291 - 1 ( )
in Vigo County

Gentlemen:

This addendum is initiated at the request of Mr. Randy Strain of INDOT Design Division. A three-sided culvert is proposed, crossing the MSE wall fill at approximate Station 1+170. As per the sketch submitted by Mr. Randy Strain, the culvert is a 16.0 ft span with a 10.0 ft rise and the bottom of footings will be placed at an elevation 169.40. Data from soil borings RY-2 and RY-3 drilled during the previous investigations is used in providing the required design parameters for the proposed construction of culvert.

Soft to medium stiff clay loam (A-7-6) and sandy loam was encountered in soil borings RY-2 and RY-3 down to weathered shale or weathered sandstone.

The foundation soils underneath the culvert will experience some consolidation. A net allowable bearing capacity of 2000 psf is recommended to be used for the subject culvert. To minimize the effect of differential settlements it is advisable to use a continuous raft footing instead of strip footings for this culvert. As an alternate, to eliminate the total settlement and differential settlements, the proposed culvert can be built on 10 x 42 HP piles or 12 x 53 HP piles with pile tips driven into shale bedrock. The allowable structural capacities of these 10 x 42 HP and 12 x 53 HP piles for Grade 36 are 55 Tons and 70 Tons and for Grade 50 steel these are 75 Tons and 95 Tons respectively.

The recorded 24 Hour groundwater elevations in the soil borings RY-2 & RY-3 near the locations of the proposed culvert ranges from 172.30 to 171.70 from east to the west. Where groundwater is encountered during construction, water levels should be maintained below the bottom of excavation. Where sand is encountered, it may be impossible to de-water with a sump pump. It may be necessary to use well points. Any dewatering program should consider the potential for damage to the existing structures in the vicinity.

All soil borings within this area were performed in the months of September and October. Depending on the time of construction, the water table at that time may vary from the ones recorded during initial investigations. For additional information please refer to the geotechnical report published on January 22, 2004 under designation number 9138220.

If you have any questions concerning this matter, please contact us.

Very truly yours,

Athar Khan, P.E.
Chief Geotechnical Engineer

Mir Zaheer, P.E.
Senior Geotechnical Engineer

MZ/
cc: Mrs. Anne Rearick - Attn: Mr. Randy Strain
Mr. Elmo Gonzalez - Attn: Mr. Mike Wink
Ms. J. Somers
Mr. D. Cohen
File

Indiana Department of Transportation

Materials and Tests Division

120 South Shortridge Road P. O. Box 19389
Indianapolis, Indiana 46219-0389
Phone: (317) 610-7251 Fax: (317) 356-9351

January 22, 2004

Mr. Gary Mroczka, Chief
Division of Design
Room N642 - IGCN

Attention: Mrs. Hollie Pratt

Subject: Des No: 9138220
Geotechnical Investigation – In House
New Road & Bridge Construction for Proposed SR 641
IVY Tech Access Road
Project No: STP – 291 - 1 ( )
in Vigo County

Gentlemen:

The subject project involves construction of a new access road to Ivy Tech Campus. The scope includes realignment of the previously proposed centerline for construction of a new 20 ft wide pavement with 2.0 ft wide shoulders, with up to 1.4 m fills and 0.8 m cuts. The proposed roadway crosses over an existing detention pond which will be partially filled with a back-to-back MSE wall structure. The proposed fill within the pond will be up to 4.0 m (13.2 ft). The project limits extend approximately from Station 0+960 to Station 1+463 Line "Y".

A geotechnical report was published on March 20, 2002 under designation number 0001250 for the old proposed alignment, and four roadway borings, RB-1, RB-2, RB-3 & RB-4, performed during the previous investigation are included with this report. Two structure borings (RY-2 & RY-3) and two roadway borings (RY-1 & RY-4) with split spoon sampling were done for the subject project during the recent field investigation. A boring log was prepared for each boring which shows soil classifications and stratification as well as other pertinent data. The soil classifications are referenced to the laboratory tests done on the original project (Designation No: 0001250). For the pavement design refer to the geotechnical report under Designation Number 0001250. Copies of the new and old boring logs and laboratory results are transmitted with this report.

The following are the recommendations of the INDOT Geotechnical Section.

MSE WALL RECOMMENDATIONS

The proposed roadway crosses over an existing detention pond which will be partially filled. Back-to-back MSE walls will be built along the north and south of the roadway to retain the fills. The maximum proposed fill within the pond will be up to 4.0 m (13.2 ft).

The soils encountered in the order of predominance within the subgrade for these walls are Clay Loam and Silt. The consistencies of these soils range from soft to medium stiff and were underlain by weathered sandstone or weathered shale overlying shale bedrock.

The recorded 24 Hour groundwater elevations in the soil borings RY-2 & RY-3 at the locations of the proposed MSE walls ranges from 172.30 to 171.70 from east to the west.

As per Ms. Lisa Casler of INDOT Design Division, these walls will be built 27 ft apart. The leveling pad elevation is assumed at 0.91 m (3.0 ft) below the deepest section of the pond bed /dredge line. The maximum height considered in the design of the MSE wall is 5.0 m (16.40 ft). The maximum wall height is taken from the roadway profile elevation of 174.20 down to a depth of 0.91 m (3.0 ft) below the deepest section within the pond bed.

The recommendations for the MSE walls are as follows:

1. The roadway will cross an existing detention pond and MSE walls will be built along the north and south edges of the roadway to retain the fill. The detention pond needs to be temporarily dewatered before any fill is placed.

2. Soft to medium stiff clay loam (A-7-6) and sandy loam was encountered in soil borings RY-2 and RY-3 down to weathered shale or weathered sandstone. The foundation soils for both the north and south walls will experience some consolidation. Slip joints will be necessary to take care of the settlement. Therefore, in our opinion, the rectangular wall panels should be stacked vertically to form continuous vertical slip joints in the face of the wall.

3. Most of the excavations are below the groundwater table as mentioned above. Where groundwater is encountered during construction, water levels should be maintained below the bottom of excavation. Where sand is encountered, it may be impossible to de-water with a sump pump. It may be necessary to use well points. Any dewatering program should consider the potential for damage to the existing structures in the vicinity. All soil borings within this area were performed in the months of September and October. Depending on the time of construction, the water table at that time may be higher.

4. In evaluating the design for a "gravity type" MSE retaining wall, the external and internal stability should be analyzed. For external stability, the following four standard modes of failure are typically addressed:

    a) Sliding [minimum factor of safety FS 1.5].
    b) Overturning (FS 2.0)
    c) Bearing capacity, FS 2.5
    d) Global stability

    Considering the width between the front face of the walls, and no overlapping of reinforcements, the active wedges at the back of wall will be mobilized. These walls are designed as independent walls with full active thrust being mobilized. An analysis was performed for each of the external stability issues outlined above. Allowable bearing capacities are given in the table below in this report.

5. The net allowable bearing or contact pressures are calculated for various heights are given in the table:

Wall Height (feet)	Net Allowable Bearing Capacity (psf)
8.0	2200
12.0	2650
16.4	3300

6. To evaluate the internal stability, three standard modes of failure are typically addressed. These include:

   a) pull out of the strips;
   b) tensile overstress of the strip and wall/strip connection; and
   c) Corrosion of the steel reinforcement strip

   We understand that the MSE Wall manufacturer will address the internal stability considerations for this project.

7. Tracked construction equipment should not be operated directly on the strips. A minimum backfill thickness of 150 mm is required prior to operation of tracked vehicles over the strips. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the backfill and damaging the strips.

8. Rubber-tired equipment may pass over the reinforcement at slow speeds, less than 10 km/hr. Sudden braking and sharp turning should be avoided.

9. The minimum length of reinforcing strips should be 70% of the height of the wall and it should not be less than 2.44 m (8.0 ft). The reinforcement should not be tied together; however, it can overlap each other.

10. The backfill should consist of a relatively clean free-draining granular backfill. ***The reinforced backfill material shall be of INDOT's No. 8 gradation stone and shall be placed from the leveling pad elevation up to the elevation of the high water table or Q_{100} elevation whichever is applicable for this detention pond. A separator fabric/filter fabric should be placed underneath the fill and the submerged portion of the No. 8 stone should be enveloped in this fabric.***

11. Behind and between the reinforced soil mass for the two retaining walls, additional structure backfill should be placed. ***The requirement for the Structure backfill to rise from the heel of the MSE wall (the tail end of the lowest reinforcing strip) on a 1:1 slope should be waived.***

12. The internal stability design will be based on an angle of internal friction of 34° for wall backfill material. Therefore, this backfill material must be tested to insure compliance with this design criterion and any additional design criteria as per INDOT's Specifications.

If you have any questions concerning this matter, please contact us.

Very truly yours,

for Athar Khan, P.E.
Chief Geotechnical Engineer

Mir Zaheer, P.E.
Senior Geotechnical Engineer

Reviewer: Steve Morris, P.E.

MZ/
cc: Mrs. Anne Rearick - Attn: Mr. Tom Caplinger – Attachments
Mrs. Lisa Casler - Attachments
Mr. Elmo Gonzalez - Attn: Mr. Mike Wink - Attachments (2)
Ms. J. Somers - Attachments
Mr. D. Cohen - Attachments
File
Attachments
H:\Mir\Reports\9138220.doc

INDOT BORING LOG

BORING NO.: RY-1

PROJECT : Roadway
SHEET 1 OF 1
LOCATION : IVY TECH ACCESS ROAD @ SR 641
DATE STARTED : 10-21-03
DES NO. : 9138220
PROJECT NO.: STP-291-1( )
DATE COMPLETED : 10-21-03

BORING					
ELEVATION	: 173.86	BORING METHOD	: HSA	HAMMER	:
STATION	: 1+027	RIG TYPE	: TRUCK MOBILE	DRILLER/INSP	: SD/DT
OFFSET	: 0.00 m	CASING DIA.	: 203 mm	TEMPERATURE	: 17.2 °C
LINE	: 'Y'	CORE SIZE	:	WEATHER	: SUNNY
DEPTH	: 3.05 m				

GROUNDWATER: ▽ During Drilling ▼ At completion DRY ▼ After 24 Hrs DRY Caved in at 1.98 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
173.55		TOPSOIL (visual) 0.30									
	0.5	Brown, moist, medium stiff, CLAY LOAM A-7-6 Lab # 01-6436	SS 1	2 3 4	80		286.1				
173.10		0.76									
	1.0	Brown to Gray, very moist, medium stiff, SILT A-4 Lab # 01-6438									SS-1B; C= 2986 psf, Dry Density= 96.3 pcf, Wet Density = 121.4 pcf
			SS 2	4 3 4	100						
172.33	1.5	1.52									
		Brown to Gray, moist, medium stiff, CLAY LOAM A-7-6 Lab # 01-6436									
	2.0		SS 3	3 2 4	100				19		SS-3B; PL = 19.4
	2.5										
			SS 4	4 3 4	80						
170.81	3.0	3.05									
		Bottom of Boring at 3.05 m									
	3.5										
	4.0										
	4.5										
	5.0										
	5.5										
	6.0										

TEST 0001250.GPJ IN DOT.GDT 1/15/04

INDOT BORING LOG

BORING NO.: RY-2

PROJECT : Roadway
SHEET 1 OF 2
LOCATION : IVY TECH ACCESS ROAD @ SR 641
DATE STARTED : 10-22-03
DES NO. : 9138220
PROJECT NO.: STP-291-1( )
DATE COMPLETED : 10-22-03

BORING	ELEVATION : 172.85	BORING METHOD : HSA		HAMMER :	
	STATION : 1+133	RIG TYPE : TRUCK MOBILE		DRILLER/INSP : SD/DT	
	OFFSET : 0.00 m	CASING DIA. : 203 mm		TEMPERATURE : 17.2 °C	
	LINE : 'Y'	CORE SIZE :		WEATHER : SUNNY	
	DEPTH : 9.08 m				

GROUNDWATER: ▽ During Drilling ▼ At completion DRY ▼ After 24 Hrs 0.30 m 🖂 Caved in at 1.22 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	REMARKS
172.55 ▽		TOPSOIL (visual) 0.30									
	0.5	Brown to Gray, moist, medium stiff to soft, CLAY LOAM A-7-6 Lab # 01-6436	SS 1	3 3 3	60						
	1.0										
	1.5		SS 2	3 2 3	100				23		SS-2B; PL = 22.8
	2.0		SS 3	3 2 4	100						
	2.5										
	3.0		SS 4	2 2 3	100						
	3.5										
	4.0										
	4.5		SS 5	3 2 3	100						
168.28		4.57									
	5.0	Gray and white, dense, weathered SANDSTONE (visual)									
	5.5										
	6.0		SS 6	5 10	100						

Continued on next page

INDOT BORING LOG

BORING NO.: RY-2

PROJECT : Roadway

SHEET 2 OF 2

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	REMARKS
166.76				23							
		Gray,weathered,SHALE (visual)									
	6.5										
	7.0										
			SS 7	25 57	100						
165.38	7.5	7.47									
		Gray,SHALE (RQD 60%)									
	8.0										
			CR 1 RQD= 60%		60						
	8.5										
163.77	9.0	9.08									
		Bottom of Boring at 9.08 m									
	9.5										
	10.0										
	10.5										
	11.0										
	11.5										
	12.0										
	12.5										
	13.0										

TEST 0001250.GPJ IN DOT.GDT 1/15/04

INDOT BORING LOG

BORING NO.: RY-3

PROJECT : Roadway

SHEET 1 OF 2

LOCATION : IVY TECH ACCESS ROAD @ SR 641

DATE STARTED : 10-22-03

DES NO. : 9138220

PROJECT NO.: STP-291-1( )

DATE COMPLETED : 10-22-03

BORING					
ELEVATION	: 172.26	BORING METHOD	: HSA	HAMMER	:
STATION	: 1+200	RIG TYPE	: TRUCK MOBILE	DRILLER/INSP	: SD/DT
OFFSET	: 0.00 m	CASING DIA.	: 203 mm	TEMPERATURE	: 17.2 °C
LINE	: 'Y'	CORE SIZE	:	WEATHER	: SUNNY
DEPTH	: 12.13 m				

GROUNDWATER: ▽ During Drilling ▼ At completion DRY ▼ After 24 Hrs 0.60 m Caved in at 1.83 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
171.95		TOPSOIL (visual) 0.30									
	0.5	Brown, moist, medium stiff, SILT A-4 Lab # 01-6438	SS 1	2 3 2	45						
171.50		0.76									
	1.0	Brown to Gray, moist, medium stiff, CLAY LOAM A-7-6 Lab # 01-6436	SS 2	5 5 6	50		138.8				SS-2B; C = 1449 psf, Dry density = 99 pcf, Wet Density = 124 pcf
	1.5										
	2.0		SS 3	4 4 5	100						
169.97		2.29									
	2.5	Brown to Gray, very moist, hard, SANDY LOAM (visual)	SS 4	4 3 4	100		189.2				SS-4T; C = 1976 psf, Dry Density = 113.33 pcf, Wet Density = 132.1 pcf
	3.0										
	3.5										
	4.0										
	4.5		SS 5	5 5 5	100						
	5.0										
	5.5										
	6.0		SS 6	39 83	100						

Continued on next page

INDOT BORING LOG

PROJECT : Roadway

BORING NO.: RY-3

SHEET 2 OF 2

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	REMARKS
166.16		6.10 Gray,weathered,SHALE(visual)									
	6.5										
	7.0										
	7.5		SS 7	11 15 23	100						
	8.0										
	8.5										
	9.0		SS 8	100/.5	100						
	9.5										
	10.0										
161.96		10.30 Gray,SHALE (RQD 86%)	SS 9	100/.3	100						
	10.5										
	11.0										
	11.5		CR 1 RQD= 99%								
	12.0										
160.13		12.13 Bottom of Boring at 12.13 m									
	12.5										
	13.0										

TEST 0001250.GPJ IN DOT.GDT 1/15/04

INDOT BORING LOG

BORING NO.: RY-4
SHEET 1 OF 1

PROJECT : Roadway
LOCATION : IVY TECH ACCESS ROAD @ SR 641
DES NO. : 9138220
PROJECT NO.: STP-291-1( )
DATE STARTED : 10-22-03
DATE COMPLETED : 10-22-03

BORING ELEVATION : 171.97
STATION : 1+445
OFFSET : 0.00 m
LINE : 'Y'
DEPTH : 4.57 m

BORING METHOD : HSA
RIG TYPE : TRUCK MOBILE
CASING DIA. : 203 mm
CORE SIZE :

HAMMER :
DRILLER/INSP : SD/DT
TEMPERATURE : 21.1 °C
WEATHER : CLOUDY

GROUNDWATER: ▽ During Drilling ▼ At completion DRY ▼ After 24 Hrs 1.2 m Caved in at 2.44 m

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 15cm	% RECOVERY	MOISTURE CONTENT	UNCONF. COMP., kPa	ATTERBERG LIMITS LL	PL	PI	REMARKS
171.66		TOPSOIL (visual) 0.30									
	0.5	Brown, moist, medium stiff, SILT A-4 Lab # 01-6438	SS 1	2 3 4	60						
171.21		0.76									
	1.0	Brown to Gray, moist, medium stiff to hard, CLAY LOAM A-7-6 Lab # 01-6436									
	1.5		SS 2	3 2 1	100						
	2.0		SS 3	1 1 2	100						
	2.5										
	3.0		SS 4	2 3 3	100						
168.92		3.05									
	3.5	Gray,very weathered,SANDSTONE(visual)									
	4.0										
	4.5		SS 5	3 3 6	100						
167.40		4.57									
		Bottom of Boring at 4.57 m									
	5.0										
	5.5										
	6.0										

TEST_0001250.GPJ_IN DOT.GDT 1/15/04

1/21/04

SUMMARY OF CLASSIFICATION TEST RESULTS

DES. NO. 9138220
PROJECT NO. STP-291-1 (2)
STRUCTURE NO. NA
COUNTY VIGO

LABORATORY NUMBER	PART	BORING NUMBER	STATION	OFFSET LINE	SAMPLE NUMBER	SAMPLE DEPTH	TEXTURAL/ UNIFIED	AASHTO	NO. 10	NO. 40	NO. 200	GRAVEL 76.2 - 2.00 mm	SAND 2.00- 0.074 mm	SILT 0.074- 0.002 mm	CLAY BELOW 0.002 mm	BELOW 0.001 mm	LL	PL	PI
037079207789		RY-1	1+027	CL	SS 3 B	6.0-7.5												19.4	
037079207812		RY-2	1+133	CL	SS 2 B	3.5-5.0												22.8	

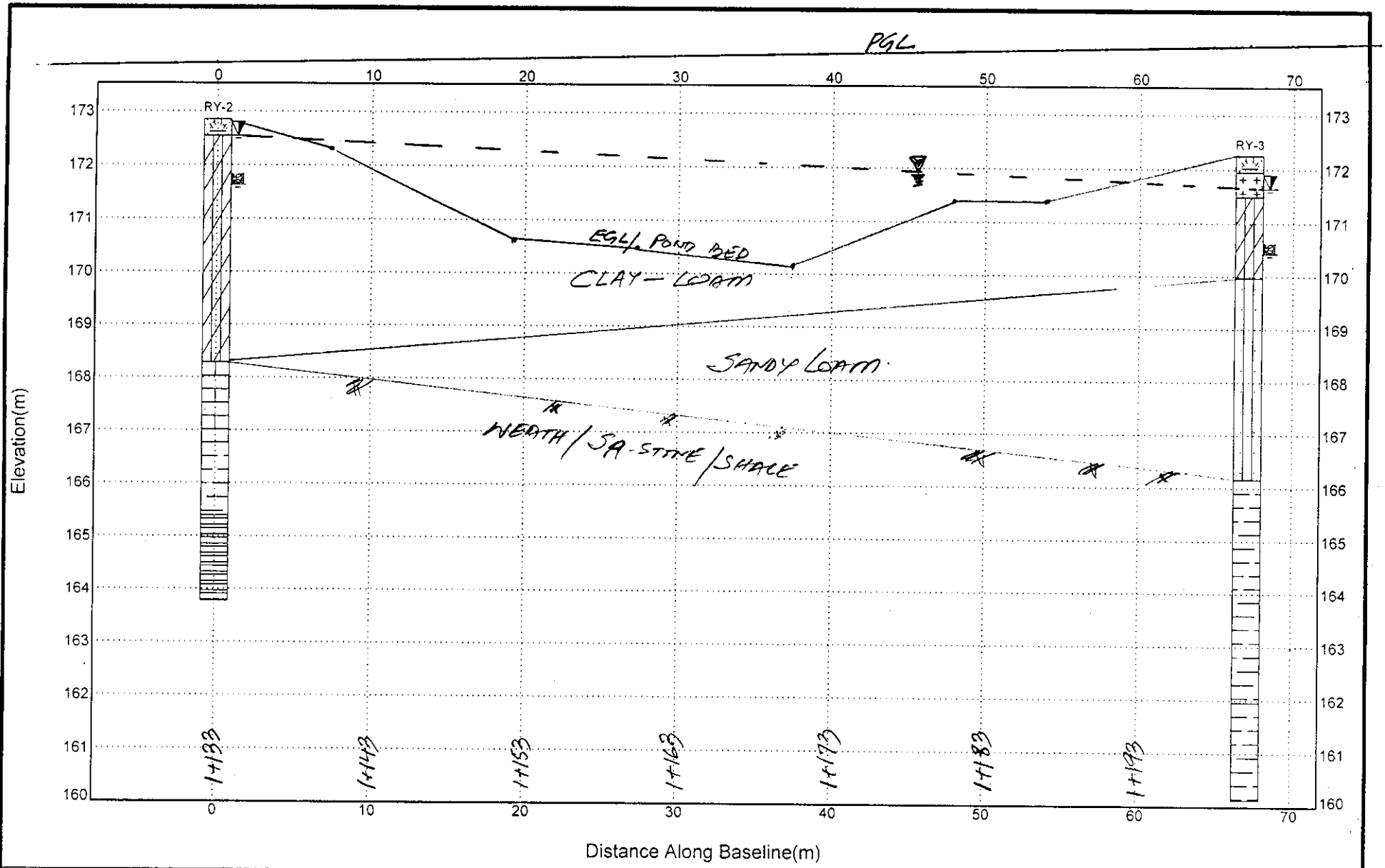
1/21/04

DES NO. 9138220

SUMMARY OF SPECIAL LABORATORY TEST RESULTS

DES. NO. 9138220
PROJECT NO. STP-291-1 (2)
STRUCTURE NO. NA
COUNTY VIGO

LABORATORY NUMBER	PART	BORING NUMBER	SAMPLE NUMBER	DEPTH	NATURAL WATER CONTENT (%)	pH VALUE	LOI (%)	CA & MG (%)	NATURAL WET DENSITY (pcf)	NATURAL DRY DENSITY (pcf)	MAX DRY DENSITY (pcf)	OPT. MOIST (%)	CBR @93%	CBR @97%	COHESION (Qu/2) (psf)
037079207785		RY-1	SS 1 B	1.0-2.5	26.1				121.4	96.3					2986
037079207795		RY-3	SS 2 B	3.5-5.0	25.3				124.0	99.0					1449
037079207798		RY-3	SS 4 T	8.5-10.0	16.6				132.1	113.3					1976

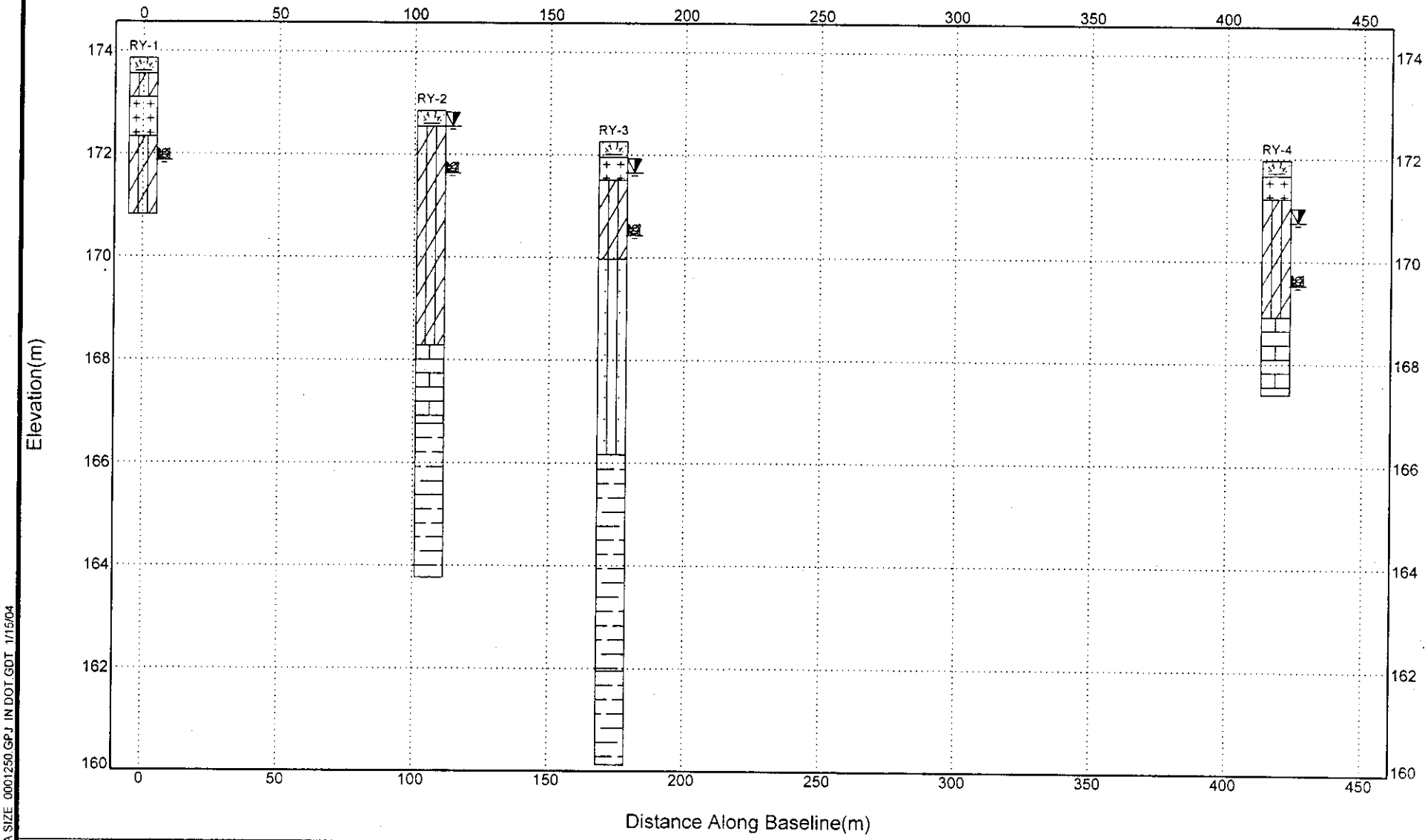


STRATIGRAPHY & GW - A SIZE 0001250.GPJ IN_DOT.GDT 1/15/04

INDOT - Geo Tech Section

Telephone:
Fax:

Project: Roadway
Location: IVY TECH ACCESS ROAD @ SR 641
Number: STP-291-1( )



STRATIGRAPHY & GW - A SIZE 0001250.GPJ IN DOT.GDT 1/15/04

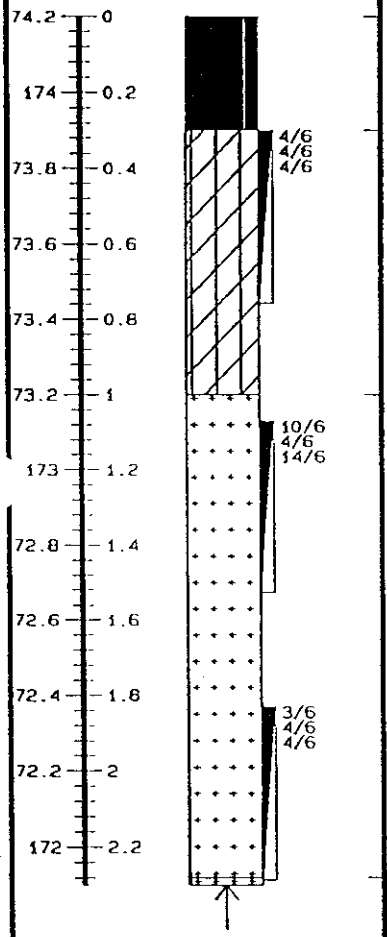
INDOT - Geo Tech Section

Telephone:
Fax:

Project: Roadway
Location: IVY TECH ACCESS ROAD @ SR 641
Number: STP-291-1( )

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(001) DES NO: 0001250 BORING No: RB-1
STRUCTURE NO: N/A COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: PROPOSED IVY TECH ACCESS ROAD. ELEV: 174.20m
STATION/OFFSET/LINE 1 + 020 C L OF LINE "Y" START 09/16/01
BORING METHOD @ RIG TYPE: HSA/TRUCK .20 m DIA. BORING. FINISH 09/16/01
WATER DEPTH @ COMP.DRY : AFTER 24 HRS: BACKFILLED CAVED: N/A



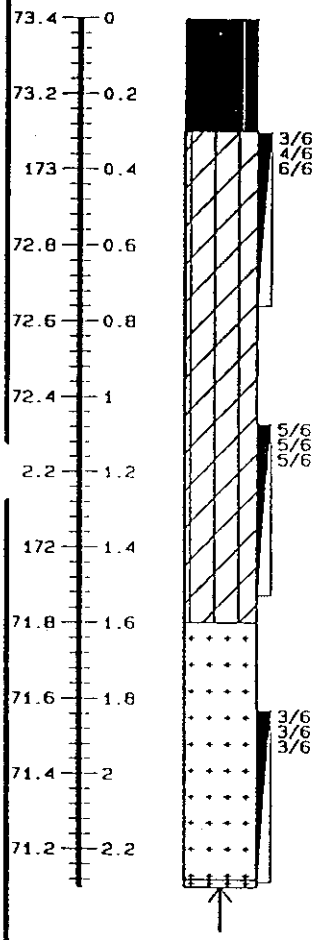
ELEV. / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
		TOPSOIL (VISUAL)				
		BROWN, SLIGHTLY MOIST, MEDIUM STIFF, CLAY LOAM A-7-6 (18) #01-6436		SS-1	90	
		BROWN, MOIST, MEDIUM DENSE TO LOOSE, SILT A-4 (4) #01-6438		S-2	100	
				SS-3	100	
		BTH 2.29m (7.50')				

DRILLER: DT INSPECTER: JP DATUM: USC & GS
WEATHER: SUNNY TEMP: 86 F PAGE: 1 OF 1

DIVISION OF MATERIALS AND TESTS

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(001) DES NO: 0001250 BORING No: RB-2
STRUCTURE NO: N/A COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: PROPOSED IVY TECH ACCESS ROAD. ELEV: 173.4 m
STATION/OFFSET/LINE 1 + 220 C L OF LINE "Y" START 07/16/01
BORING METHOD @ RIG TYPE: HSA/TRUCK .20 m DIA. BORING. FINISH 07/16/01
WATER DEPTH @ COMP.DRY : AFTER 24 HRS: BACKFILLED CAVED: .40 m



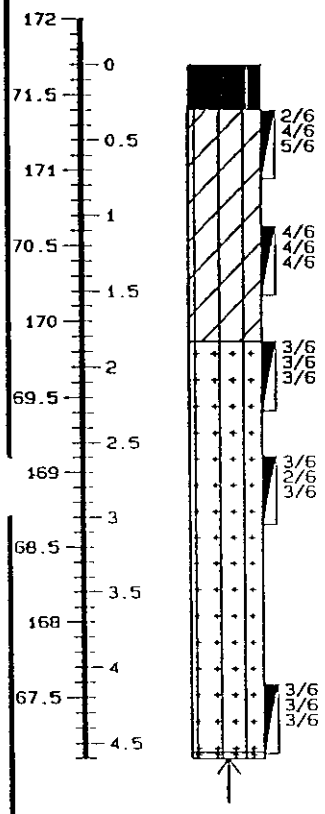
Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
BROWN MOTTLED, SLIGHTLY MOIST, MEDIUM STIFF, CLAY LOAM A-7-6 #01-6436		SS-1	100	
		SS-2	100	
MOTTLED BROWN, MOIST, LOOSE, SILT A-4 #01-6438		SS-3	100	
BTH 2.29m (7.50')				

DRILLER: DT INSPECTER: JP DATUM: USC & GS
WEATHER: SUNNY TEMP: 87 F PAGE: 1 OF 1

DIVISION OF MATERIALS AND TESTS

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(001) DES NO: 0001250 BORING No: RB-3
STRUCTURE NO: N/A COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: PROPOSED IVY TECH ACCESS ROAD. ELEV: 171.7 m
STATION/OFFSET/LINE 1 + 430 C L OF LINE "Y" START 07/16/01
BORING METHOD @ RIG TYPE: HSA/TRUCK .20 m DIA. BORING. FINISH 07/16/01
WATER DEPTH @ COMP.DRY : AFTER 24 HRS: BACKFILLED CAVED: .61 m



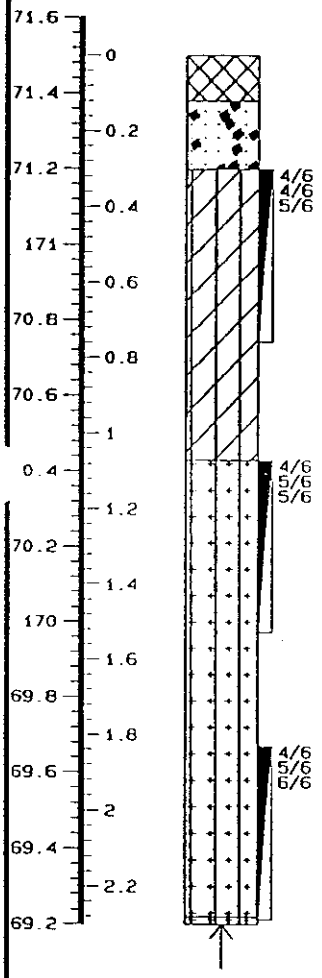
Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
TOPSOIL (VISUAL)				
BROWN, SLIGHTLY MOIST, MEDIUM STIFF, CLAY LOAM A-7-6 #01-6436		SS-1	90	
		SS-2	100	
BROWN, WET, MEDIUM STIFF, SILTY LOAM A-4 #01-6466		SS-3	100	
		SS-4	100	
		SS-5	100	
BTH 4.57m (15.0')	WATER ON THE RODS AT 4.27m			

DRILLER: DT INSPECTER: JP DATUM: USC & GS
WEATHER: SUNNY TEMP: 87 F PAGE: 1 OF 1

DIVISION OF MATERIALS AND TESTS

INDIANA DEPARTMENT OF TRANSPORTATION

PROJECT NO: STP-291-1(2) DES NO: 0001250 BORING No: RB-4
STRUCTURE NO: N/A COUNTY: VIGO ROAD NO: S.R.641
PROJECT LOCATION: PROPOSED S.R.641 PHASE 1 ELEV: 171.50m
STATION/OFFSET/LINE 4 + 600 3.0m RT OF LINE "S-2-A" START 07/17/01
BORING METHOD @ RIG TYPE: HSA/TRUCK .20 m DIA. BORING. FINISH 07/17/01
WATER DEPTH @ COMP.DRY : AFTER 24 HRS: BACKFILLED CAVED: .30 m



ELEV. / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS & FIELD TEST DATA	Description	Remarks	SAMPLE NO:	RECOV %	Qu Kpa
		ASPHALT (VISUAL)				
		SAND & GRAVEL (SUBBASE) (VISUAL)				
		GRAY, SLIGHTLY MOIST, MEDIUM STIFF, CLAY LOAM A-7-6 #01-6436		SS-1	70	
		GRAY, MOIST, MEDIUM STIFF, SILTY LOAM A-4 #01-6466		SS-2	30	
				SS-3	100	
		BTH 2.29m(7.50')				

DRILLER: DT INSPECTER: JP DATUM: USC & GS
WEATHER: SUNNY TEMP: 73 F PAGE: 1 OF 1

DIVISION OF MATERIALS AND TESTS

1/21/04

SUMMARY OF CLASSIFICATION TEST RESULTS

DES. NO. 0001250
PROJECT NO. STP-291-1(001)
STRUCTURE NO.
COUNTY Vigo

LABORATORY NUMBER	PART	BORING NUMBER	STATION	OFFSET LINE	SAMPLE NUMBER	SAMPLE DEPTH	TEXTURAL/ UNIFIED	AASHTO	NO. 10	NO. 40	NO. 200	GRAVEL 76.2 - 2.00 mm	SAND 2.00- 0.074 mm	SILT 0.074- 0.002 mm	CLAY BELOW 0.002 mm	BELOW 0.001 mm	LL	PL	PI
017079106436		RB-1	1+020	CL	SS 1 T	1.0-2.5'	CLAY LOAM	A-7-6(18)	94.1	91.3	77.0	5.9	17.1	48.2	28.8	26.4	45.5	22.4	23.1
017079106438		RB-1	1+020	CL	SS 2 T	3.5-5.0'	SILT	A-4(4)	99.1	98.9	97.9	0.9	1.2	83.0	14.9	12.8	27.5	23.0	4.5

1/21/04

DES NO. 0001250

SUMMARY OF SPECIAL LABORATORY TEST RESULTS

DES. NO. 0001250
PROJECT NO. STP-291-1(001)
STRUCTURE NO.
COUNTY Vigo

LABORATORY NUMBER	PART	BORING NUMBER	SAMPLE NUMBER	DEPTH	NATURAL WATER CONTENT (%)	pH VALUE	LOI (%)	CA & MG (%)	NATURAL WET DENSITY (pcf)	NATURAL DRY DENSITY (pcf)	MAX DRY DENSITY (pcf)	OPT. MOIST (%)	CBR @93%	CBR @97%	COHESION (Qu/2) (psf)
017079106436		RB-1	SS 1 T	1.0-2.5'	25.6	7.1									
017079106438		RB-1	SS 2 T	3.5-5.0'	24.8	7.6									
017079106442		RB-2	SS 1 T	1.0-2.5'	25.6										

Indiana Department of Transportation

Materials and Tests Division

120 South Shortridge Road P. O. Box 19389
Indianapolis, Indiana 46219-0389
Phone: (317) 610-7251 Fax: (317) 356-9351

January 23, 2004

Mr. Gary Moraczka, Chief
Design Division
Indiana Department of Transportation
Room N 601 - IGCN

Attention: Mrs. Hollie Pratt

Subject: Des. No's.: 9138220
Project No: STP – 291 - 1 ( ) & Various
SR 641 – Phase II New Roadway Construction
Vigo County

Gentlemen:

The Geotechnical Investigation for the subject project has been completed and copies of the Geotechnical Report are being forwarded to those listed below.

If you have any questions concerning the above matter, please call us.

Very truly yours,

for Athar A. Khan, P.E.
Chief Geotechnical Engineer

Mir Zaheer, P.E.
Senior Geotechnical Engineer

MZ
cc:
Mrs. Anne Rearick - Attn: Mr. Tom Caplinger– Attachments
Mrs. Lisa Casler - Attachment
Mr. E. Gonzalez – Attn: Mr. Bruce Conrad – Attachments (2)
Ms. J. Somers – Attachments
Mr. D. Cohen - Attachments
File
H:\Mir\Letters\Alt & Witzig\9138220.doc

SUBSURFACE INVESTIGATION & RECOMMENDATIONS

DES NO: 9138220
PROJECT NO: STP-291-1 (2)
S.R. 641 ROADWAY
VIGO COUNTY, INDIANA

PREPARED BY:
ALT & WITZIG ENGINEERING, INC.
GEOTECHNICAL DIVISION
PROJECT NO: 02IN1012

PREPARED FOR
INDIANA DEPARTMENT OF TRANSPORTATION
INDIANAPOLIS, INDIANA

DECEMBER 5, 2003

Alt & Witzig Engineering, Inc.
4105 West 99th Street • Carmel, Indiana 46032
(317) 875-7000 • Fax (317) 876-3705

December 5, 2003

Indiana Department of Transportation
120 South Shortridge Road
Indianapolis, Indiana 46219
ATTN: Mr. Mir Zaheer, P.E.

RE: Subsurface Investigation & Recommendations
Project No: STP-291-1 (2)
Des No.: 9138220
S.R. 641 Roadway
Vigo County, Indiana
Alt & Witzig Project No: 02IN1012

Gentlemen:

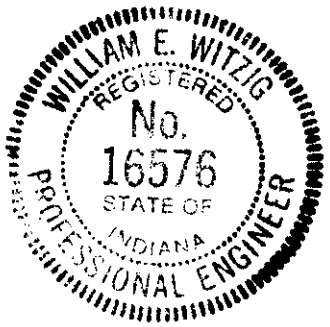
In compliance with your request, we have completed a subsurface investigation and evaluation for the above referenced project. It is our pleasure to transmit herewith 10 copies of the report.

The results of our test borings and laboratory tests are presented in the appendix of the report. Our recommendations for the project are presented in the "Discussion and Recommendations" section of the report.

If you have any questions or comments regarding this matter, please contact us at your convenience.

Sincerely,

ALT & WITZIG ENGINEERING, INC.



David C. Harness, P.E.

William E. Witzig, P.E.

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EXECUTIVE SUMMARY

A subsurface investigation has been performed for the proposed S.R. 641 Roadway in Vigo County, Indiana. Specially, the project begins near Woodsmall Road in Section 23, T11N, R9W in Honey Creek Township (STA. 6+400 on Line CX) and ends in Section 12, T11N, R9W in Honey Creek Township (STA. 10+200 on Line CX). The proposed road intersects with Honey Creek, McDaniel Road, CSX railroad, and Feree Road where grade separation structures will be constructed. The soil conditions and geotechnical recommendations for these structures are provided under separate covers. This project also includes roadway construction along line "W" near Woodsmall Road.

Beneath the topsoil layer, the natural shallow soil encountered over most of the project site was Silty Loam (AASHTO A-4) and Silty Clay Loam (AASHTO A-4). Groundwater levels encountered during drilling and up to 24-hours after completion of the drilling ranged from water at the surface to a depth of twenty-seven (27) feet below existing grade.

With the exception of topsoil, soils at and below grade appear suitable to support the anticipated traffic design data and the proposed drainage structures. A Type "A" subgrade treatment is recommended. A design Resilient Modulus value of 6500 psi is recommended for the pavement design based upon the predominant soil type at this site.

Cuts on the order of fifteen (15) meters and fills of up to fourteen (14) meters are proposed along Line "CX". Analysis indicates that the cut areas will be stable at their proposed 3:1 slopes. However, certain fill areas will require ground modification (wick drains) prior to embankment construction. The proposed drainage structures should have adequate foundation support from the existing soils. However, some consideration must be given to differential settlement under drainage pipes in areas of thick fills where wick drains are proposed.

SUBSURFACE INVESTIGATION AND RECOMMENDATIONS

INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed S.R. 641 Roadway southeast of Terre Haute, Indiana. The project begins near Woodsmall Road (STA.6+400 Line CX) southeast of Allendale and ends at the north side of Feree Road (STA. 10+200 Line CX) northeast of Allendale. The geotechnical recommendations for the bridge structures associated with this project have been issued under separate cover to this report. This investigation was conducted for Indiana Department of Transportation (INDOT).

Authorization to perform this investigation was in the form of a notice to proceed from Athar Khan of INDOT to Alt & Witzig Engineering, Inc.

The scope of this investigation included a review of geological maps of the area, review of geologic and related literature, a reconnaissance of the immediate site, subsurface exploration, field and laboratory testing, and engineering analysis and evaluation of the materials.

The purpose of this subsurface investigation was to determine the engineering characteristics of the subsurface materials and to provide criteria and recommendations for use during design and construction of the cut sections, embankments, pavement sections, and drainage structures.

DESCRIPTION OF SITE

Site Location

The project begins at Station 6+400 Line "CX" and ends at Station 10+200 Line "CX". The project area can be located in Site Location Map of the appendix. A short non-mainline roadway, Line "W", is proposed just east of Line "CX" near the start of the project.

Site Topography and Drainage

The land at the location of the proposed road consists mostly of open agricultural fields, pastures, and trees. Elevation along Line "CX" ranges from 152.4m at Station 8+305 to 169.4m at 7+872. Drainage patterns flow off the open fields into low-lying areas, existing ponds, and into Honey Creek.

General Geology

The site of this project lies in the Wabash Lowland of the State of Indiana. The Soil Survey Map of Vigo County indicated that the shallow soils over the project area consist mostly of Ayrshire Fine Sandy Loam. Bartle Silt Loam, Reesville Silty Loam, and Wakeland Silt Loam.

Bedrock in the project area lies in carbonate rocks of Pennsylvanian geologic age. The bedrock in the project area was encountered at depths ranging from four (4) to ninety (90) feet, based upon borings conducted for the bridge structures associated with this project.

The project begins atop a ridge and continues north along a gently rolling topography (elevations generally 163 to 168 m). Then the project mainline drops sharply as it crosses Honey Creek and continues across an ancient stream valley (elevations 150 to 154 m) until north of the CSX/SOO rail road lines. At that point, the ground surface rises to an average elevation of 161 m.

The bedrock was found to be between 18.3 to 27.4 m deep in the valley portion of the project. The upland portions of the project encountered bedrock between 1.2 and 11.3 meters. Additionally, the wide, low, valley contains a layer of soft clay that varies in depth from 10.7 to 17.7 meters below existing grade.

FIELD INVESTIGATIONS

Scope

Field investigations to determine the engineering characteristics of the subgrade and foundation materials included a reconnaissance of the project site, drilling borings, performing standard penetration tests, obtaining soil samples retained in the standard split-spoon and Shelby tube samplers, and obtaining bag samples for the purposes of classification, moisture-density relationship, CBR, and subgrade resilient modulus tests. The apparent groundwater level at the boring locations was also determined. The field investigation began on March 4, 2003, and was completed on November 21, 2003.

Proposed test borings RB-2, RB-7, and RB-16 were not performed due to site access limitations. However, information from these locations is not considered critical based upon the borings performed in the vicinity and the proposed grading plan. Boring RB-1A was added to the project after finding very shallow rock in RB-1. Shelby tubes were also advanced at RB-1A (referred to as RB-1a).

Drilling and Sampling Procedures

The soil borings were performed with a drilling rig equipped with a rotary head. Conventional hollow-stem augers were used to advance the holes. Representative samples were obtained employing split-spoon and Shelby-tube samples in accordance with ASTM Procedures D-1586 and D-1587, respectively.

Field Tests and Measurements

Penetration tests. During the sampling procedure, standard penetration tests were performed at regular intervals to obtain the standard penetration value of the soil. The standard penetration value is defined as the number of blows a 140 lb (76 kg) hammer, falling 30 inches (76 cm), required to advance the split-spoon sampler 12 inches (30 cm) into the soil. The results of the standard penetration tests indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

Water level measurements. Groundwater levels measured during drilling and upon completion of the drilling ranged from four (4) to twenty-seven (27) feet below existing grade. The twenty-four (24) hour groundwater readings ranged from surface in RB-19 to three and one-half (3½) feet of groundwater level in SL-6. The exact location of the water table should be anticipated to fluctuate somewhat depending upon normal seasonal variations in precipitation and surface runoff. The USDA Soil Survey Book of Vigo County indicates that the soils along line CX have seasonal high water ranging from one (1) to three (3) feet below grade.

Ground surface elevation. The elevations of the ground surface shown on the boring logs were determined using the road plans provide by INDOT. Borings were field staked for this investigation using the provided prints and elevations are assumed accurate to the nearest one (1) foot. The ground surfaces reported on the individual logs are referenced from existing ground surface.

LABORATORY INVESTIGATIONS

In addition to the field investigations, a supplemental laboratory investigation was conducted to ascertain additional pertinent engineering characteristics of the subsurface materials necessary in analyzing the behavior of the proposed roadway construction.

All phases of the laboratory investigation were conducted in general accordance with applicable AASHTO Specifications and INDOT Exhibit "C".

The laboratory-testing program included supplementary visual classification on all samples. Atterberg limit tests, moisture content tests, pHs, unit weights and grain size analyses were performed on representative soil samples. In addition, unconfined compression tests were performed on Shelby tube samples from RB-1A. The results of our testing are located in the appendix of the report. A moisture-density relationship, CBR, and subgrade resilient modulus tests were performed on a Clay (A-6) sample collected from auger cuttings of boring RB-12.

DISCUSSION AND RECOMMENDATIONS

Project Description

The project will consist of constructing a new state road approximately two and four-tenth (2.4) miles (3.8km) southeast of Terre Haute in Vigo County, Indiana. Specially, the project begins near Woodsmall Road in Section 23, T11N, R9W in Honey Creek Township (STA. 6+400) and ends in Section 12, T11N, R9W in Honey Creek Township (STA. 10+200) along Line CX.

In addition to Line CX, other minor project lines exist to connect existing streets into proposed S.R. 641. These are Line W, that begins at Woodsmall Road at an offset of approximately 170m to the east of Line CX, and Line 3, Line 4, Line 5, and Line 6 connecting a re-aligned McDaniel Road (Line C) to proposed S.R. 641 Line CX via on and off ramps. The discussion of Lines 3, 4, 5, 6, and C have been submitted with the bridge structure report "S.R. 641 over McDaniel Road".

Design plans indicate that physical cross-section of typical Line CX will be 32.4 meters wide. A 10.5-meter wide clear zone at each side will add twenty-one (21) meters to the overall width. An eighteen (18)-meter wide median will be constructed along the centerline. Maximum fills up to fourteen (14) meters and cuts up to fifteen (15) meters are expected on this project.

Drainage Structures

Several drainage structures are proposed along this project. Preliminary invert or footing elevations for these structures are indicated on the plans. Based on the anticipated depths of the future structures, the foundation soils encountered should provide adequate bearing capacity.

The borings (RB-1, RB-4, RB-5, RB-8, RB-17 through RB-19, and SL-5) drilled at the proposed structure sites mostly encountered soft to stiff Silt Loam or Silty Clay Loam at the invert elevation of drainage structures. Highly weathered shale was encountered within one (1) foot (0.3m) of the invert elevation of structure No. 21 in boring RB-1. However, sandstone and siltstones may also be encountered in this area. Some rock excavation may be required for this structure. Furthermore, the subgrades, although suitable for support of the proposed drainage structures, may require modification prior to placement of embankment fills. The construction of the embankments is discussed later in this report.

Groundwater levels measured during drilling and upon completion of the drilling ranged from four (4) feet (1.2m) to twenty-seven (27) feet (8m) below existing grade. Additionally, groundwater level measurements performed twenty-four (24) hours after the completion of the boring indicated that the groundwater levels ranged from surface at RB-19 to three and one-half (3½) feet at SL-6 below existing grade. Therefore, soft subgrade can be expected during the wet months. However, major groundwater difficulties are not expected in cut areas (RB-8, RB-9). Conventional dewatering systems such as sump pumps should suffice for excavation into the Silty Loam or Silty Clay Loam. However, well points may be necessary in the deeper Sandy Loam.

Any loose or soft soils encountered along the drainage pipes should be undercut a maximum of two (2) feet (0.6m) and replaced with Structure Backfill.

All of the soils surrounding the structures should be compacted to a minimum of 95% of the maximum dry density as determined in accordance with Section 203.24 of INDOT Standard Specifications. The soil in the bottom of the excavation, any bedding material, and the Structure Backfill, should be tested to insure compliance with this density criterion. Where water is

encountered, the Structure Backfill should be placed in accordance with Section 211.03 of the Standard Specifications to an elevation at least two (2) feet (0.6m) above the ground water level.

It is important to protect the drainage structure during construction because maximum strength does not develop until the fill consolidates. It is necessary to avoid imposing concentrated loads far in excess of those the drainage structure would normally carry. Heavy vehicles moving too close to the walls of the drainage structure can create an eccentric loading with harmful results.

The recommendations for drainage structures 24, 25, and 32 have been provided in the geotechnical report for Structure #7, SR 641 over McDaniel Road.

Roadway Construction Recommendations-General

Stripping

The ground surface of two and four-tenth (2.4) miles (3.8km) along the proposed S.R. 641 roadway varies from relatively flat and gentle rolling agricultural fields to wooded areas with large hills and ravines. With portions of the terrain being wooded, clearing and grubbing will be necessary. This procedure should be performed in accordance with Section 211.03 of the INDOT Standard Specifications.

Any topsoil or loose soils encountered during earthwork construction is not considered to be suitable subgrade material and should be removed. Additionally, some existing natural drainage ways, creeks, and man-made ponds are to be covered by embankment construction. Several ponds are to be drained to construct embankments. Any soft soils encountered should be stripped from the site and replaced with "B" Borrow to an elevation of two (2) feet (0.6m) above any ground water level. If groundwater is not encountered, backfill shall be in accordance with Section 203.09 of the INDOT Standard Specifications.

Benching

Benching of natural slopes and existing embankment slopes of 4:1 or steeper should be performed in accordance with Section 203.21 of the INDOT Standard Specifications. Benches should be of sufficient width to accommodate the required compaction equipment.

Erosion Control

Cohesionless, granular material should not be used in ditches, or within twelve (12) inches (305mm) of the required finished surfaces of fill-slopes. Sandy Loam was encountered in borings RB-9, RB-10, RB-17 and RB-18. The Sandy Loam from RB-9 will be used as fill for embankments, as the cut at this location is on the order of thirty (30) to fifty (50) feet. The material required to encase embankments should be non-erodable material free from clods, debris, and stones, and suitable for sustaining vegetation. Seeding and/or sodding of the finished earth slopes should be performed as soon as possible after the construction is completed to minimize erosion.

Corrosion

Tests performed at varying depths throughout the project indicate pHs of 6.33 to 7.76. Thus, it appears that corrosion protection for underground facilities, such as concrete structures, will not be necessary.

Organic Materials

LOI tests were not performed for the roadway borings. Organic soils (topsoil, as indicated by the boring logs, and others discovered during construction) should be undercut and removed and replaced with suitable materials. Only RB-13 contained a significant thickness of topsoil (approximately 0.3 to 0.36 m (12 to 14 inches)). Most roadway borings encountered 0.15 to 0.2 m (6 to 8 inches) of topsoil.

Embankment Construction

Fills up to fourteen (14) meters (45 feet) are expected for this project. Before any fill is placed, any topsoil or loose soils encountered during earthwork construction not considered to be suitable subgrade material shall be removed. If groundwater is not encountered, backfill shall be in accordance with Section 203.09 of the INDOT Standard Specifications. If groundwater is encountered, backfilling shall be accomplished utilizing "B" borrow in accordance with 211.02 to an elevation at least two (2) feet (0.6m) above the ground water level. After the topsoil or loose materials have been removed, proofrolling of the natural ground surface may be performed in accordance with Section 203.26 within proposed fill areas.

It is recommended that all soil embankments be compacted to at least ninety-five (95) percent of their maximum dry density. The moisture content shall be within –2 and +1 percentage points of optimum moisture content. Maximum density and optimum moisture content shall be determined in accordance with AASHTO T 99. If the embankment material is too wet or dry, the material should be aerated to remove any excess moisture or watered and disked until the moisture content is within the specified range. The placement of embankment material shall be in accordance with Section 203.23 of INDOT Standard Specifications

Due to the 77% silt content of Test 01 and 64% silt content of Test 03, these soils are susceptible to pumping when saturated. It is our recommendation that if these soils cannot pass proofroll, they should be undercut and replaced with compacted "B" Borrow or chemically modified. Due to the large fills on this project, some settlement of newly constructed embankments is expected. Estimated settlements of the in-situ soils have been evaluated, and the results are in this report.

On a majority of the proposed embankments, the design plans indicate sideslopes of 3:1. Based on the soils encountered in this area, we feel that these slopes are adequate provided construction of the fill is accomplished per Section 203 of INDOT Standard Specifications and the recommendations throughout this report.

Fill Areas and Geotechnical Recommendations

According to the cross sections provided and the results of our test borings, the major fill sections and existing subgrade conditions are summarized as follows:

Table 1: Subgrade soils in fill areas

Station to Station	Boring No.	Height of Fill	Shallow Subgrade Characteristics
6+400 to 6+700 (Line CX)	RB-1A	17-35 ft (5.2-10.7 m)	Very soft to soft, Silty Loam (Test 02)
6+700 to 7+100 (Line CX)	RB-3	0-17 ft (0-5.2 m)	Medium stiff, Silty Clay Loam (Test 03)
8+150 to 8+640 (Line CX)	RB-11, RB-12	12-26 ft (3.6-8 m)	Medium stiff to stiff, Silty Clay Loam (Test 03)
8+950 to 9+500 (Line CX)	RB-13, RB-14	22-44 ft (6.8-13.3 m)	Very soft to Medium stiff, Silty Clay Loam (Test 03)
9+500 to 10+200 (Line CX)	RB-15, RB-17 RB-18, RB-19	4-30 ft (0.8-9 m)	Stiff, Silty Clay Loam (Test 03)
10+030 to 10+250 (Line W)	SL-5	0-13 ft (0-4 m)	Very Soft, Silty Loam (Test 01)

As indicated in above table, the natural soils near test borings RB-1A and RB-14 will likely require undercutting prior to placement of embankment fills of thirty-five (35) feet (10.7m) and twenty-nine (29) feet (8.8m), respectively.

Station 6+400 to Station 6+700, Line CX

Boring RB-1A drilled at station 6+600 encountered soft to very soft, Silty Loam to a depth of six and one-half (6½) feet below existing grade. The Silty Loam was then underlain by weathered shale. Two Shelby tube samples were pushed from 1.0 to 3.0 feet and 3.0 to 5.0 feet, and unconfined compression tests were performed, resulting in unconfined compressive strengths of 800 and 1500 psf. RB-1A hole was caved in at one (1) foot at the time of 24-hours groundwater reading. The readings during drilling and upon completion of the boring indicated depths of five and one-half (5½) feet and ten (10) feet below existing grade, respectively. Therefore, to allow construction of the embankment, it is recommended that the very soft Silty Loam at stations 6+400 to 6+700 be modified or undercut prior to fill placement. If the undercutting is required, the shallow soft soils should be undercut and replaced with compacted "B" Borrow to an elevation two (2) feet (0.6m) above the groundwater level. Otherwise, backfilling should be per Section 203.09. During undercutting, dewatering will be necessary because of the high water table.

Station 6+700 to Station 7+100, Line CX

Boring RB-3 drilled at station 6+800 encountered medium stiff, Silty Clay Loam to a depth of three (3) feet below existing grade. The Silty Clay Loam was then underlain by medium stiff to soft, Silty Loam to a depth of twelve (12) feet. Beneath the Silty Loam, medium stiff, Silty Clay Loam was encountered to the termination depth of the boring. The groundwater-level reading twenty-four (24) hours after the boring indicated water at three and one-half (3½) feet below existing grade. Due to the nature of medium stiff, Silty Clay at shallow depth, no settlement or stability problems are expected. However, during the construction, dewatering may be necessary because of the high water table.

Station 8+150 to Station 8+640, Line CX

Borings RB-11 and RB-12 were drilled at stations 8+350 and 8+600, respectively in this section. Boring RB-11 encountered medium stiff to stiff, Silty Clay Loam to the termination depth of the boring. The groundwater-level reading at RB-12 twenty-four (24) hours after the boring indicated water at four and one-half (4½) feet below existing grade. Boring RB-12 encountered medium stiff to very stiff, Clay to a depth of fourteen and one-half (14½) feet. Beneath the Clay, medium dense, Sandy Loam was encountered to the termination depth of the boring. The groundwater-level readings during and upon completion of the boring indicated the groundwater levels to be two and one-half (2½) feet and three and one-half (3½) feet, respectively, below existing grade.

Due to the nature of medium stiff to very stiff, Silty Clay Loam or Clay at shallow depth, no settlement or stability problems are expected. However, during the construction, dewatering will be necessary because of the high water table.

A CBR and a subgrade resilient modulus tests were performed on bag samples obtained from RB-12. The tested soils are Clay (A-6, Type 10). The results of those tests are presented in the appendix of this report.

Station 8+950 to Station 9+500, Line CX

Borings RB-13 and RB-14 were drilled at stations 9+060 and 9+380, respectively in these areas. The land between RB-13 and RB-14 can be best described as a low land area, with a wetland present just north of RB-13. Water was standing at the surface near RB-13 to the CSX rail road tracks (Station 9+060) throughout the entire year. RB-14 is actually located at the end of the lowland on a small ridge.

Boring RB-13 encountered medium stiff, Silty Clay Loam to a depth of five (5) feet below existing grade. Beneath the Silty Clay, medium stiff, Silty Loam was encountered to a depth of eight and one-half (8½) feet, which is then underlain by very stiff to medium stiff, Clay to the termination depth of the boring. However, boring RB-14 encountered very soft, Silty Clay Loam to a depth of three and one-half (3½) feet below existing grade. RB-14 was dry at the time of groundwater-level measurements during and upon completion of the drilling. The Silty Clay Loam was then underlain by medium stiff to stiff, Silty Loam. The very soft, Silty Clay Loam may not pass proofroll inspection. Therefore, it is recommended that the upper three and one-half (3½) feet be modified or undercut prior to the placement of the fill. However, from Stations 8+950 to 9+060 along Line "CX", wick drains will be installed to speed consolidation of the natural soils under the weight of the proposed embankment. These recommendations are provided later in this report. Specific recommendations are provided regarding subgrade treatment prior to fill placement in these areas.

Station 9+500 to Station 10+200, Line CX

Boring RB-15 drilled at station 9+550 encountered stiff, Silty Clay Loam to a depth of three and one-half (3½) feet below existing grade. The Silty Clay Loam was then underlain by very stiff to hard, Silty Loam. RB-15 was dry at the time of groundwater-level measurements during and upon completion of the drilling. Some drainage swales are present in the vicinity of RB-15 that may contain soft surfacial soils. If the undercutting is required for these areas, any shallow soft soils should be undercut and replaced with compacted "B" Borrow to an elevation two (2) feet (0.6m) above the groundwater level. Otherwise, backfilling should be per Section 203.09. Boring RB-17, RB-18, and RB-19 also encountered soft to medium stiff, Silty Loam and Silty Clay Loam.

However, the fill height diminishes to less than fifteen (15) feet beyond station 10+080. Therefore, only minor undercutting is anticipated toward the end of the project (north of Feree Road).

It should be noted that there is a small pond present at Station 9+900. This pond will need to be drained and soft soils removed prior to construction of embankment fills. The depth of this pond was gauged to be approximately five (5) feet. Soft soils within the pond were measured to be less than one (1) foot.

Station 10+030 to Station 10+200, Line W

Boring SL-5 drilled at station 10+085 Line W encountered very soft to soft, Silty Loam to a depth of six and one-half (6½) feet below existing grade. The Silty Loam was then underlain by medium stiff to stiff, Silty Clay Loam. The groundwater-level readings upon completion of the boring indicated the groundwater level to be five (5) feet below existing grade. The SL-5 was caved in at a depth of six (6) feet at the time of twenty-four (24) hour groundwater level measurement. It is recommended that subgrade at stations from 10+030 to 10+200 along Line W be modified or undercut to the depth of soft layer prior to the placement of the fill. If the undercutting is required, the shallow soft soils should be undercut and replaced with compacted "B" Borrow to an elevation two (2) feet (0.6m) above the groundwater level. Otherwise, backfilling should be per Section 203.09. During undercutting, dewatering will be necessary because of the high water table.

Station 100+380 to Station 100+680, Line C

Embankment construction on Line C was covered in the geotechnical report for Structure #7, SR 641 over McDaniel Road. In that report, wick drains were recommended along Line C in areas of thick embankment fills. The summary wick drain discussion information is provided in this report. It should also be noted that the proposed embankment should be terminated at Station

100+580 and tapered to existing grade at Station 100+680. The embankment and bent construction for the McDaniel Road bridge over CSX railroad will be investigated during future phases of this project. The need to extend the wick drains beyond those Stations listed in Table3 for Line C should be determined at that time.

Moisture Contents of Subgrade Soils in Fill Areas

The following table summarizes the moisture content of the shallow soils in areas of embankment fill:

Table 2: Moisture Content Ranges of Subgrade Soils in Fill Areas

Station to Station	Boring No.	Height of Fill	Moisture Content Range
6+400 to 6+700 (Line CX)	RB-1A	17-35 ft (5.2-10.7 m)	26.3-29.0%
6+700 to 7+100 (Line CX)	RB-3	0-17 ft (0-5.2 m)	14.4-20.1%
8+150 to 8+640 (Line CX)	RB-11, RB-12	12-26 ft (3.6-8 m)	15.6-24.1%
8+950 to 9+500 (Line CX)	RB-13, RB-14	22-44 ft (6.8-13.3 m)	13.5-21.7%
9+500 to 10+200 (Line CX)	RB-15, RB-17 RB-18, RB-19	4-30 ft (0.8-9 m)	12.7-25.6%
10+030 to 10+250 (Line W)	SL-5	0-13 ft (0-4 m)	19-23.5%

The optimum moisture content of the shallow subgrade soils for this project can be expected to range between 14 and 17 percent. The table above further illustrates that the subgrade soils are above optimum and will require either undercutting and replacement or modification prior to construction of embankments.

Wick Drain Recommendations

The wick drain recommendations provided herein are from the geotechnical report "S.R. 641 over McDaniel Road, S.R 641 Ramps, and McDaniel Road". That report should be referenced for further subsurface information regarding the wick drains.

Based upon a residual settlement of one (1) inch and a one-month time of consolidation from completion of the embankment fills, it is recommended that the spacing for wick drains be as follows:

Table 3: Design parameters for wick drain installation

Station to Station	Line	Offset, m	Wick Drain Spacing (ft)	Elevation of Wick Drain Tip, m (ft)
8+640 to 8+910	CX	25 Lt to 25 Rt	6	136.2 (447)
1+240 to 1+270	4	5 Lt to 20 Rt	6	136.2 (447)
1+000 to 1+130	5	See Note 2	6	136.2 (447)
8+950 to 9+060	CX	35 Lt to 35 Rt	6	136.2 (447)
1+270 to 1+302	4	27 Lt to 8 Rt	6	136.2 (447)
1+000 to 1+140	6	See Note 1	6	136.2 (447)
100+520 to 100+662* Near 100+520	C	25 Lt to 25 Rt See Note 3	6	136.2 (447)

Note 1: Line 6, near proposed line "CX" embankment, offsets not clear on plans
Note 2: Line 5, near proposed line "C" embankment, offsets not clear on plans
Note 3: Line C, near the intersection of lines "5" and "6", offsets not clear on plans
* Proposed embankment height for Line C should terminate at Station 100+580 and taper to existing grade at Station 100+680. Embankment and bent construction for the McDaniel Road Bridge over CSX will be determined in future phase of project.

In general, the wick drains are proposed in the low-lying valley between Honey Creek and the CSX/SOO railroads where embankment fills exceed twenty (20) feet (6m). Other fill heights will also impart settlements, but are not expected to exceed the pre-consolidation pressure of the underlying soft clays. Therefore, the settlements in other embankment areas should be expected to be on the order of two to three inches.

Prior to installation of the wick drains, a two (2) foot (0.6m) drainage blanket should be constructed on the exposed subgrade. The drainage blanket should be comprised of "B" Borrow. The exposed subgrade should be graded to allow gravity drainage. All topsoil and wet or soft surface soils should be stripped from the site within construction limits. Proofrolling of the exposed subsurface should be performed in accordance with Section 203.26 in the area where new fill for the walls will be placed. Any soft, loose or unstable soils encountered during proofrolling operations, which will not readily compact, should be removed and replaced with "B" Borrow.

Our analysis assumes that the wick drains will be installed in an equilateral triangle pattern. The rate of consolidation should be monitored by settlement plates and toe stakes that are constructed, installed, and monitored in accordance with section 204.03 of the Standard Specifications. Because of the short time frame of consolidation, piezometers are not recommended at this location.

Cut Excavation

According to the design plans, cuts up to fifteen and two-tenth (15.2) meter (50 feet) are expected from Station 7+100 to 7+950 along Line CX at the side ditches. At the proposed subgrade elevations are medium stiff, Silty Clay Loam (RB-6) and very dense, Sandy Loam (RB-9). The slope stability analysis was performed at the maximum cut at station 7+880 Line CX. The results were discussed later in this report.

Cut Areas and Geotechnical Recommendations

According to the cross sections and the results of our test borings, the major cut sections, their conditions and corresponding subgrade are summarized as follows:

Table 4: Subgrade soils in cut areas

Station to Station	Boring No.	Height of Cut	Subgrade Soils at Proposed Grade
7+100 to 7+400 (Line CX)	RB-6	0-10 ft (0-3 m)	Medium stiff, Silty Clay Loam (Test 03)
7+400 to 7+650 (Line CX)	RB-8	4-24 ft (1.3-7.2 m)	Very stiff, Silty Loam (Test 01)
7+650 to 7+90 (Line CX)	RB-9	0-39 ft (0-12m)	Very dense, Sandy Loam (Test 07)

The cuts along Line CX centerline vary in depth with the largest being thirty-nine (39) feet (12m) at Station 7+870.

Station 7+100 to Station 7+400

Boring RB-6 drilled at Station 7+260 on Line CX encountered very stiff, Silty Clay Loam to a depth of three and one-half (3½) feet below existing grade. Beneath the Silty Clay Loam, medium stiff, Silty Clay Loam was encountered to a depth of thirteen (13) feet. The proposed grade line is located within the medium stiff soils at this location. Stiff, Silty Loam was then encountered to the termination depth of the drilling. RB-6 was dry at the time of groundwater-level measurements during and upon completion of the drilling. Therefore, it is anticipated that the subsurface soil encountered at the proposed grade depth support the anticipated pavement and traffic loads if it is constructed in accordance with Section 203 of Indiana Specification.

Station 7+400 to Station 7+650

Boring RB-8 drilled at Station 7+480, 30m LT on Line CX encountered stiff, Silty Clay Loam to a depth of three (3) feet below existing grade. Beneath the Silty Clay Loam, very stiff to medium stiff, Silty Loam was encountered to the termination depth of the boring. Boring RB-8 was dry at the time of groundwater-level readings during and upon completion of the boring. It is anticipated that proposed grade depth would be located at a depth of six (6) feet below existing grade. Therefore, it is anticipated that the subsurface soil encountered at the proposed grade depth support the anticipated pavement and traffic loads if it is constructed in accordance with Section 203 of Indiana Specification.

Additionally, two ponds are located within the proposed roadway embankment. Design plans indicate that these man-made ponds (dammed valleys) will be drained prior to embankment construction. Although the centerline of S.R. 641 requires cutting to achieve grade between Station 7+450 and 7+650, the ponds will require some filling. It is recommended that after the ponds are drained, the saturated, shallow, pond soils be removed to stable soils. The embankment may then be constructed in accordance with Section 203 of INDOT Standard Specifications.

Station 7+650 to Station 7+940

Boring RB-9 drilled at Station 7+760 on Line CX encountered stiff to medium stiff, Silty Loam to a depth of thirteen (13) feet below existing grade. Beneath the Silty Loam, very stiff, Silty Clay Loam was encountered to a depth of sixteen (16) feet, which is underlain by loose, Sandy Loam to a depth of twenty and one-half (20½) feet. Beneath the Sandy Loam, hard, Silty Loam was encountered to a depth of twenty-eight and one-half (28½) feet. Beneath the Silty Loam, wet, very dense, Sandy Loam was encountered to the termination depth of the boring. The

RB-9 hole was caved in at a depth of twenty-eight (28) feet at the time of twenty-four (24) hour groundwater reading. The groundwater-level readings during and upon completion of the boring were indicated twenty-seven (27) feet and twenty-three and one-half (23½) feet of groundwater levels below existing grade, respectively. It is anticipated that proposed grade depth would be located at a depth of twenty-five (25) feet below existing grade. Therefore, some water may be encountered during construction.

Based on design slope of 3:1 at the maximum cut location (Station 7+880 Line CX), slope stability analysis was performed using PC-STABL 5M. As a result, the proposed cut slope carries 3.30 of factor of safety (FS). Therefore, no stability problem was anticipated at the cut slope. The slope stability data are included at the appendix of this report.

Table 5: Moisture Content Ranges of Subgrade Soils in Cut Areas

Station to Station	**Boring No.**	**Height of Cut**	**Moisture Content Range**
7+100 to 7+400 (Line CX)	RB-6	0-10 ft (0-3 m)	13.3-22.3%
7+400 to 7+650 (Line CX)	RB-8	4-24 ft (1.3-7.2 m)	12.9-13.6%
7+650 to 7+90 (Line CX)	RB-9	0-39 ft (0-12m)	9.9-18.3% (from –1 to –15 ft)

The optimum moisture content of the shallow subgrade soils for this project can be expected to range between 14 and 17 percent. The table above illustrates that the majority of the subgrade soils in the cut areas are close to the acceptable moisture content range. However, seasonal changes will occur that will affect the moisture content of the soils. Therefore, it is anticipated that some drying will be required where these cut soils are to be used as borrow material.

At Grade

Other roadway borings RB-10 (Station 7+940) and SL-6 (Station 10+400) drilled at the transition of fill and cut sections and at grade encountered at medium stiff, Silty Clay Loam, respectively. RB-10 was dry twenty-four (24) hours after completion of the boring while SL-6 indicated three and one-half (3½) feet of groundwater level. Therefore, any topsoil or soft soils encountered during earthwork construction is not considered to be suitable subgrade materials and should be removed and replaced with "B" Borrow to an elevation of two (2) feet (0.6m) above any ground water level.

General Embankment Construction Considerations

The subgrade soils encountered for this project are susceptible to rutting and pumping under heavy construction traffic. The moisture contents of the shallow soils in at grade and fill areas are above optimum. Areas of cut will likely encounter the shallow groundwater table. Therefore, even during the dry months, difficulty during construction should be expected. Therefore, it will be necessary that the earthmoving contractor build a haul road to complete the earthmoving phase of this project.

In general, roadway ditches wherever possible should be constructed earlier during the construction phase before placement of any embankment fill.

Subgrade Analysis and Recommendations for Pavement Design

The predominant materials encountered throughout the project were Silty Loam (A-4) and Silty Clay Loam (A-4).

The high silt content of Test 01 and Test 03, and low CBR value of the Clay soils will cause difficulties during earthmoving operations. Test 01 and Test 03 had silt contents of seventy-seven

(77) percent and sixty-four (64) percent, respectively. It should be noted that due to the high silt content, it is recommended that these predominant soil types not be utilized in the subgrade within twenty-four (24) inches (600mm) of the pavement section.

CBR and Resilient Modulus tests were performed on a sample obtained from RB-12. The material tested was a Clay, A-6 (Test 10). The CBR value from the test for 97 percent and 93 percent compaction were 3.2 and 5.7 respectively. The Resilient Modulus tests results indicate values well above those produced by the CBR test. An approximate value of 12,000 psi was obtained from the Resilient Modulus testing (confining stress ~2.5psi and deviator stress of 6psi). Therefore, a more conservative Resilient Modulus Value of 6500 psi is provided for design of the pavement. The summary results of the CBR and Resilient Modulus testing can be found in the appendix.

Special subgrade treatment Type A should be used with a Resilient Modulus Value of 6500 psi for pavement design. The design value is based upon subgrade soil compaction to 97% of AASHTO T-99 at optimum moisture content.

In areas of fill, 24 inches (600mm) of subgrade treatment with moisture density control can be utilized in designing the pavement section with a Resilient Modulus Value of 6500 psi. The subgrade preparation should extend throughout the pavement section including the shoulders.

Pavement Subsurface Drainage Recommendations

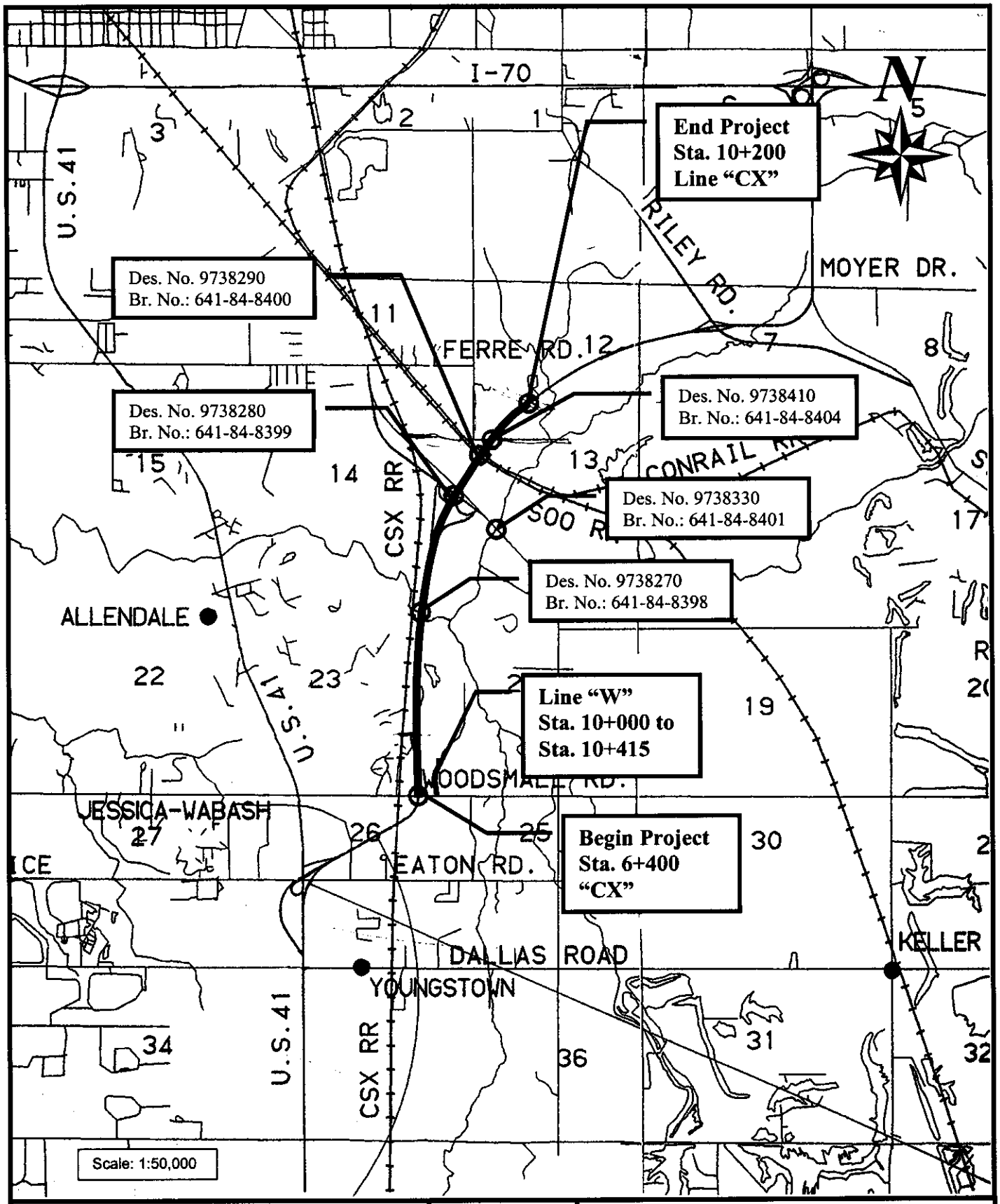
Borings indicate that Silty Loam and Silty Clay Loam are predominant at shallow depths throughout the site. It is recommended that subsurface drains and outlets be placed throughout the project length. A screen should be provided at the end of the outlets to prevent rodents from

entering the pipe. It is recommended that subsurface drains in areas of cuts be placed at a depth of four (4) feet (1.2m) where the existing topography allows them to be outletted. It is recommended that subsurface drains in fill areas be placed at a depth of two (2) feet (0.6m). Drains should be provided at the pavement edges as shown on the design plans. Due to the high silt contents encountered in the soils on the project, it is recommended that an approved geotextile fabric be used in conjunction with the subsurface drains. Lateral drains should be constructed at the interface of cut and fill sections. All subsurface drains should be placed in the earlier phase of the job before fills are being placed.

It is anticipated that major construction difficulties will be encountered if construction takes place during the wet season. The shallow subgrade soils are typically above optimum moisture content and may not pass a proofroll. Heavy construction traffic will further aggravate the problem. Therefore, it is recommended that a haul road be constructed prior to construction of embankments. It is recommended that the grading be conducted as early as possible in construction to facilitate drainage of surface runoff and prevent ponding of water across the project site.

APPENDIX

FIGURE 1: SITE LOCATION MAP



Prepared For: INDOT - Geotechnical Section	A&W	**Prepared By:** Alt & Witzig Engineering, Inc.	
Project Name: SR 641 Roadway (Des. No.: 9138220), Vigo County		**Project No:** 02IN1012	**Date:** 11/03

Boring Location Sheet

Boring No.	Station	Offset	Line	Depth (M)	Depth (ft)	Notes
RB-1	6+540	65m Rt.	CX	5.7	18.6	Structure # 21
RB-1A	6+600	0	CX	5.8	18.9	Roadway
RB-3	6+800	CL	CX	4.6	15.0	Roadway
RB-4	7+050	30m Rt	CX	3.0	10.0	Structure # 22
RB-5	7+050	30m Lt	CX	3.0	10.0	Structure # 22
RB-6	7+260	CL	CX	4.6	15.0	Roadway
RB-8	7+480	30m Lt	CX	3.0	10.0	Structure # 23
RB-9	7+760	CL	CX	11.8	38.8	Roadway
RB-10	7+940	CL	CX	3.0	10.0	Roadway
RB-11	8+350	CL	CX	3.0	10.0	Roadway
RB-12	8+600	CL	CX	6.0	20.0	Roadway
RB-13	9+060	CL	CX	7.6	25.0	Roadway
RB-14	9+380	CL	CX	3.0	10.0	Roadway
RB-15	9+550	CL	CX	3.0	10.0	Roadway
RB-17	9+900	50m Rt	CX	3.0	10.0	Structure # 27
RB-18	10+100	40m Rt	CX	3.0	10.0	Structure # 28
RB-19	10+100	40m Lt	CX	3.0	10.0	Structure # 28
SL-5	10+085	CL	W	3.0	10.0	Structure # 30
SL-6	10+400	CL	W	3.0	10.0	Roadway

* RB-2, RB-7, RB-16, and HA-1 were not drilled due to existing limitations.

LOG OF TEST BORING

Project	DES No. 9738220 - S.R. 641
Location	SR 641, Vigo County, Terre Haute, IN
Client	INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No.	RB-1
Surface Elevation	167.0m (547.8f)
Proj. #	STP-291-1(2)
AW Proj. #	02IN1012
Sheet	1 of 1

Str. No.	21	Station	6+540	Offset	65 m Rt	Line	CX
Datum	USGS	Weather	Partly Cloudy	Temperature	65 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS		100	2-3-2		Brown Mottled Gray, Moist, Soft, Silty Clay Loam A-4 Test 03						
2SS		100	1-13-39								
				5	Brown Mottled Gray, Hard, Weathered, Shale (Visual)						
3SS		100	22-50/3								
4SS		100	41-50/3								
				10	Gray, Hard, Weathered, Shale (Visual)						
5SS		100	50/5								
				15							
6SS		0	50/1		Driving on Rock at 18.5 feet (Sample 6SS) Auger Refusal at 18.6 feet						
				20							

WATER LEVEL OBSERVATIONS

While Drilling	▽ Dry	Upon Completion of Drilling	▼ Dry
Time After Drilling	24 hrs.		
Depth to Water	▽ 2.5 ft.	▼	▼ ▼
Depth to Cave in	10.0		

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 6/5/03 End 6/5/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project	DES No. 9738220 - S.R. 641
Location	SR 641, Vigo County, Terre Haute, IN
Client	INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No.	RB-1 A
Surface Elevation	163.6m (534.8f)
Proj. #	STP-291-1(2)
AW Proj. #	02IN1012
Sheet	1 of 1

Str. No.	N/A	Station	6+600	Offset	0	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	65 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	ɣ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS		100	1-2-2		Shelby Tube Pushed from 1.0 to 3.0 feet Brown Mottled Gray, Moist, Soft, Silty Loam A-4 Test 02						
2SS		80	1-1-1		Shelby Tube Pushed from 3.0 to 5.0 feet Gray Mottled Brown, Moist, Very Soft, Silty Loam A-4 Test 02						
3SS		100	2-9-18	5							
4SS		100	11-50/5		Gray Mottled Brown, Hard, Weathered, Shale (Visual)						
5SS		80	31-50/2	10							
6SS		50	50/4		Gray, Hard, Weathered, Shale (Visual)						
				15	Boring Terminated at 18.9 feet						
				20							

WATER LEVEL OBSERVATIONS

While Drilling ▽ 5.5 Upon Completion of Drilling ▼ 10.0
Time After Drilling 24 hrs.
Depth to Water ▽ ▼ ▼ ▼
Depth to Cave in 1.0

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 6/5/03 End 6/5/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RB-1 Aa
Surface Elevation 163.6m (534.8f)
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	N/A	Station	6+600	Offset	0	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	65 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1ST		90			Shelby Tube Pushed from 1.0 to 3.0 feet Brown Mottled Gray, Moist, Soft, Silty Loam A-4 Test 02	0.78	93.6	28.3			
2ST		90			Gray Mottled Brown, Moist, Very Soft, Silty Loam A-4 (4) Test 02 pH = 6.33	0.4	95.7	23.4	22	17	5
				5	Boring Terminated at 5.0 feet						
				10							

WATER LEVEL OBSERVATIONS

While Drilling	Dry	Upon Completion of Drilling	Dry	
Time After Drilling				
Depth to Water				
Depth to Cave in				

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 6/5/03 End 6/5/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks **Boring drilled to collect undisturbed samples.**

LOG OF TEST BORING

Project: DES No. 9738220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RB-3
Surface Elevation 168.0m (551.2f)
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	N/A	Station	6+800	Offset	0	Line	CX
Datum	USGS	Weather	Sunny	Temperature	65 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	100	3-4-4		Brown Mottled Gray, Moist, Medium Stiff, Silty Clay Loam A-4 Test 03						
2SS	X	100	2-3-4	5							
3SS	X	100	2-3-4		Brown, Moist, Medium Stiff to Soft, Silty Loam A-4 Test 01						
4SS	X	100	2-2-2	10							
5SS	X	100	2-4-4		Brown Mottled Gray, Moist, Medium Stiff, Silty Clay Loam A-4 Test 03						
				15	Boring Terminated at 15.0 feet						
				20							

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry Upon Completion of Drilling ● Dry
Time After Drilling 24 hrs.
Depth to Water ▽ 3.5 ft. ▼ ____ ▼ ____ ▼ ____
Depth to Cave in 6.0

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 6/5/03 End 6/5/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RB-4
Surface Elevation 166.6m (546.6f)
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	22	Station	7+050	Offset	30 m Rt	Line	CX
Datum	USGS	Weather	Sunny	Temperature	85 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS		100	2-3-3		Brown, Moist, Medium Stiff, Silty Clay Loam A-4 Test 03						
2SS		100	2-3-3	5							
3SS		100	2-4-4		Brown Mottled Gray, Moist, Medium Stiff, Silty Clay Loam A-4 Test 03						
4SS		100	2-3-4	10							
					Boring Terminated at 10.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry Upon Completion of Drilling ▼ Dry
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 7/2/03 End 7/2/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RB-5
Surface Elevation 166.6m (546.6f)
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	22	Station	7+050	Offset	30 m Lt	Line	CX
Datum	USGS	Weather	Sunny	Temperature	83 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS		60	3-2-3		Brown, Moist, Soft, Silty Clay Loam A-4 Test 03						
2SS		100	2-3-5	5							
3SS		100	3-6-6		Brown Mottled Gray, Moist, Medium Stiff to Stiff, Silty Loam A-4 Test 01						
4SS		100	2-4-4								
				10	Brown Mottled Gray, Moist, Medium Stiff, Silty Clay Loam A-4 Test 03						
					Boring Terminated at 10.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry Upon Completion of Drilling ▼ Dry
Time After Drilling 24 hrs.
Depth to Water ▽ Dry ▼ ▼ ▼
Depth to Cave in 8.5

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 7/2/03 End 7/2/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section
4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RB-6
Surface Elevation 165.2m (542.0f)
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	N/A	Station	7+260	Offset	20 m Rt	Line	CX
Datum	USGS	Weather	Sunny	Temperature	85 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	δ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	SS	100	5-8-10		Brown, Moist, Very Stiff, Silty Clay Loam A-4 Test 03						
2SS	SS	100	4-4-4	5							
3SS	SS	60	4-6-7		Stiff at 6.0 to 7.5 feet (Sample 3SS)						
4SS	SS	100	2-3-4	10	Brown Mottled Gray, Moist, Medium Stiff, Silty Clay Loam A-4 Test 03						
5SS	SS	100	4-6-8	15	Brown Mottled Gray, Moist, Stiff, Silty Loam A-4 Test 01						
					Boring Terminates at 15.0 feet						
				20							

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry Upon Completion of Drilling ▼ Dry
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 7/2/03 End 7/2/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project	DES No. 9738220 - S.R. 641
Location	SR 641, Vigo County, Terre Haute, IN
Client	INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No.	RB-8
Surface Elevation	161.2m (529.0f)
Proj. #	STP-291-1(2)
AW Proj. #	02IN1012
Sheet	1 of 1

Str. No.	23	Station	7+480	Offset	30 m LT	Line	CX
Datum	USGS	Weather		Temperature	80 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	δ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS		100	2-5-9		Brown, Moist, Stiff, Silty Clay Loam A-4 Test 03						
2SS		100	4-9-12	5	Brown Mottled Gray, Moist, Very Stiff, Silty Loam A-4 Test 01						
3SS		100	11-13-10		Sand Seam from 6.5 to 7.0 feet						
4SS		100	3-4-4		Brown Mottled Gray, Moist, Medium Stiff, Silty Loam A-4 Test 01						
				10	Boring Terminated at 10.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry Upon Completion of Drilling ▼ Dry

Time After Drilling

Depth to Water ▽ ▼ ▼ ▼

Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 7/18/03 End 7/18/03 Rig B-59

Driller Mike/James Editor D. Harness

Remarks 1.5 hour down time to access boring location (cut trees).

LOG OF TEST BORING

Project: DES No. 9738220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RB-9
Surface Elevation 168.2m (551.8f)
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	N/A	Station	7+760	Offset	0	Line	CX
Datum	USGS	Weather	Sunny	Temperature	75 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS		100	4-5-6								
2SS		100	4-5-7	5							
3SS		100	4-6-8		Stiff at 6.0 to 7.5 feet (Sample 3SS)						
					Brown, Moist, Medium Stiff, Silty Loam A-4 Test 01						
4SS		100	4-4-6	10							
5SS		100	6-14-14	15	Brown Mottled Gray, Moist, Very Stiff, Silty Clay Loam A-4 Test 03						
					Brown, Wet, Loose, Sandy Loam A-2-4 Test 04						
6SS		100	2-3-4	20							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 27.0 Upon Completion of Drilling ▼ 23.5
Time After Drilling
Depth to Water
Depth to Cave in 28.0

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 7/3/03 End 7/3/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RB-9
Surface Elevation 168.2m (551.8f)
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	N/A	Station	7+760	Offset	0	Line	CX
Datum	USGS	Weather	Sunny	Temperature	75 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
7SS	X	100	18-29-32		Brown Mottled Gray, Moist, Hard, Silty Loam						
				25	A-4						
					Test 02						
8SS	X	100	20-50/4								
				30							
					Gray Mottled Brown, Wet, Very Dense, Sandy Loam						
					A-4 (2)						
9SS	X	100	13-50/4		Test 07 pH = 7.76				22	12	10
				35							
10SS	X	100	50/3		Boring Terminated at 38.8 feet						
				40							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project	DES No. 9738220 - S.R. 641
Location	SR 641, Vigo County, Terre Haute, IN
Client	INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No.	RB-10
Surface Elevation	157.2m (515.7f)
Proj. #	STP-291-1(2)
AW Proj. #	02IN1012
Sheet	1 of 1

Str. No.	N/A	Station	7+940	Offset	0	Line	CX
Datum	USGS	Weather	Sunny	Temperature	83 F	Inspector	Tom Coffey

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES					
No.	Type	Rec (%)	Blow Count	Depth		qu (qp) (tsf)	δ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS		50	2-3-4		Brown, Moist, Medium Stiff, Silty Clay Loam A-4 Test 03						
2SS		100	1-2-1	5	Brown, Moist to Wet, Very Loose, Sandy Loam A-2-4 Test 04						
3SS		10	2-3-2								
4SS		60	1-2-4								
				10	Gray, Moist, Medium Stiff, Clay A-7-6 (38) Test 06						
					Boring Terminated at 10.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling ▽	6.0	Upon Completion of Drilling ●	5.0	
Time After Drilling	24 hrs.			
Depth to Water ▽	Dry	▼	▼	▼
Depth to Cave in	5.5			

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 7/3/03 End 7/3/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks 1.5 hour down time to access boring location (cut trees).

LOG OF TEST BORING

Project: DES No. 9738220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RB-11
Surface Elevation 152.6m (500.7f)
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	N/A	Station	8+350	Offset	0	Line	CX
Datum	USGS	Weather	Sunny	Temperature	85 F	Inspector	Tom Coffey

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES					
No.	Type	Rec (%)	Blow Count	Depth		qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS		60	5-4-4								
2SS		80	7-6-5		Brown Mottled Gray, Moist, Medium Stiff to Stiff, Silty Clay Loam A-4 Test 03						
				5							
3SS		10	4-6-6								
4SS		60	3-4-6		Gray, Wet, Medium Stiff, Silty Clay Loam A-4 Test 03						
				10							
					Boring Terminated at 10.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling ♀ Dry
Upon Completion of Drilling ● 6.5
Time After Drilling 24 hrs.
Depth to Water ▽ 4.5 ft.
Depth to Cave in 7.5

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 8/6/03 End 8/6/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project	DES No. 9738220 - S.R. 641
Location	SR 641, Vigo County, Terre Haute, IN
Client	INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No.	RB-12
Surface Elevation	153.0m (501.8f)
Proj. #	STP-291-1(2)
AW Proj. #	02IN1012
Sheet	1 of 1

Str. No.	N/A	Station	8+600	Offset	0	Line	CX
Datum	USGS	Weather	Sunny	Temperature	57 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	SS	50	2-2-5								
2SS	SS	100	3-4-5								
				5							
3SS	SS	80	2-3-3		Gray, Moist, Medium Stiff to Very Stiff, Clay A-6 (17) Test 10						
4SS	SS	90	5-9-12								
				10							
5SS	SS	100	6-7-8								
				15							
					Gray, Moist, Medium Dense, Fine, Sand A-2-4 Test 04						
6SS	SS	80	9-7-9								
				20							
					Boring Terminated at 20.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling ▽ 2.5 Upon Completion of Drilling ▼ 3.5

Time After Drilling				
Depth to Water	▽	▼	▼	▼
Depth to Cave in				

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 11/20/03 End 11/20/03 Rig ATV
Driller Mike/Khris Editor D. Harness
Remarks Bag sample collected from 2.0 to 6.0 feet.

LOG OF TEST BORING

Project: DES No. 9738220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RB-13
Surface Elevation 153.6m (504.0f)
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	N/A	Station	9+060	Offset	0	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	65 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
1SS	X	80	1-1-1		Topsoil (Visual)						
2SS	X	100	1-3-3		Dark Brown Mottled Gray, Moist, Medium Stiff, Silty Clay Loam A-4 Test 03						
3SS	X	100	1-4-4	5	Gray, Very Moist, Medium Stiff, Silty Loam A-4 Test 02						
4SS	X	100	4-7-10	10							
5SS	X	100	5-9-11	15	Gray, Very Moist, Very Stiff to Medium Stiff, Clay A-7-5 Test 05						
6SS	X	100	6-5-6	20							
7SS	X	100	3-4-5	25	Boring Terminated at 25.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling ▽ 10.5 Upon Completion of Drilling ● Dry
Time After Drilling 24 hrs.
Depth to Water ▽ ▽ ▽ ▽
Depth to Cave in 4.0

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 6/2/03 End 6/2/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RB-14
Surface Elevation 160.2m (525.6f)
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	N/A	Station	9+380	Offset	0	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	38 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS		80	0-1-1		Brown, Moist, Very Soft, Silty Clay Loam A-4 Test 03						
2SS		100	2-2-5		Brown, Moist, Medium Stiff to Stiff, Silty Loam A-4 Test 01						
				5							
3SS		100	4-8-11		Very Stiff at 6.0 to 7.5 feet (Sample 3SS)						
4SS		100	3-5-10								
				10	Boring Terminated at 10.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry Upon Completion of Drilling ▼ Dry
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 3/4/03 End 3/4/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RB-15
Surface Elevation 161.4m (529.5f)
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	N/A	Station	9+550	Offset	0	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	38 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS		100	1-4-7		Brown, Moist, Stiff, Silty Clay Loam A-4 Test 03						
2SS		100	6-10-15	5							
3SS		100	7-13-16		Brown, Moist, Very Stiff to Hard,Silty Loam A-4 Test 01						
4SS		100	6-13-18	10							
					Boring Terminated at 10.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry Upon Completion of Drilling ▼ Dry
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 3/4/03 End 3/4/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RB-17
Surface Elevation 160.0m (524.9f)
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	27	Station	9+900	Offset	50 m Rt	Line	CX
Datum	USGS	Weather	Clouds & Sun	Temperature		Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS		100	2-2-3		Brown, Very Moist, Soft, Silty Loam A-4 Test 01						
2SS		100	4-5-5		Red, Moist, Medium Stiff, Silty Clay Loam A-4 Test 03						
3SS		100	2-4-6	5							
4SS		100	2-4-5		Light Red, Moist, Loose, Sandy Loam A-2-4 Test 04						
				10	Boring Terminated at 10.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry — Upon Completion of Drilling ▼ Dry
Time After Drilling
Depth to Water
Depth to Cave in 5.5

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 6/10/03 End 6/10/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section
4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RB-18
Surface Elevation 161.4m (529.5f)
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	28	Station	10+100	Offset	40 m Rt	Line	CX
Datum	USGS	Weather	Mostly Sunny	Temperature	75 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS		100	2-3-3		Brown, Moist, Medium Stiff, Silty Loam A-4 Test 01						
2SS		100	2-4-4	5							
3SS		100	3-6-5		Brown, Moist, Medium Dense, Sandy Loam A-2-4 Test 04						
4SS		100	4-2-3		Gray, Moist, Soft, Silty Loam A-4 Test 02						
				10	Boring Terminated at 10.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry Upon Completion of Drilling ● Dry
Time After Drilling 24 hrs.
Depth to Water ▽ 3.5 ft. ▼ ▼ ▼
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 6/11/03 End 6/11/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RB-19
Surface Elevation 161.4m (529.5f)
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	28	Station	10+100	Offset	40 m Lt	Line	CX
Datum	USGS	Weather	Sunny	Temperature	75 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS		100	1-2-3								
					Gray Mottled Brown, Moist, Soft to Very Soft, Silty Clay Loam A-4 Test 03						
2SS		100	1-1-1								
				5							
3SS		100	10-14-13								
					Brown Mottled Gray, Very Stiff to Hard, Silty Loam A-4 Test 01						
4SS		100	22-38 50/5								
				10	Boring Terminated at 10.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling ▽ 5.0 Upon Completion of Drilling ● 4.0
Time After Drilling 24 hrs.
Depth to Water ▽ Surface ▼ ▼ ▼
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 6/11/03 End 6/11/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. SL-5
Surface Elevation 160.8m (527.6f)
Proj. # STP-291-1(2)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	30	Station	10+085	Offset	0	Line	W
Datum	USGS	Weather	Mostly Sunny	Temperature	65 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS		80	1-2-1		Brown Mottled Gray, Moist, Very Soft, Silty Loam A-4 Test 01						
2SS		100	1-2-3	5	Gray, Very Moist, Soft, Silty Loam A-4 Test 02						
3SS		100	1-4-6		Brown Mottled Gray, Moist, Medium Stiff to Stiff, Silty Clay Loam A-4 Test 03						
4SS		100	3-6-8	10							
					Boring Terminated at 10.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry Upon Completion of Drilling ▼ 5.0
Time After Drilling
Depth to Water
Depth to Cave in 6.0

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 6/5/03 End 6/5/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project	DES No. 9738220 - S.R. 641
Location	SR 641, Vigo County, Terre Haute, IN
Client	INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No.	SL-6
Surface Elevation	168.2m (551.8f)
Proj. #	STP-291-1(2)
AW Proj. #	02IN1012
Sheet	1 of 1

Str. No.	N/A	Station	10+400	Offset	0	Line	W
Datum	USGS	Weather	Sunny	Temperature	65 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS		100	2-3-5		Brown Mottled Gray, Moist, Medium Stiff, Silty Clay Loam A-4 Test 03						
2SS		100	2-2-1	5	Brown, Very Moist, Very Soft, Silty Loam A-4 Test 02						
3SS		100	2-3-4		Brown Mottled Gray, Moist, Medium Stiff, Silty Loam A-4 Test 01						
4SS		100	1-2-4	10	Boring Terminated at 10.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling	▽ 6.0	Upon Completion of Drilling	● Dry	
Time After Drilling		24 hrs.		
Depth to Water	▽	▼ 3.5	▽	▽
Depth to Cave in	5.0			

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 6/5/03 End 6/5/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

STATE GENERAL NOTES

SAMPLE IDENTIFICATION

The AASHTO M-145 Soil Classification System is used to identify the soils unless otherwise noted.

SOIL PROPERTY SYMBOLS

N:	Standard "N" penetration: Blows per foot of a 140-pound hammer falling 30 inches on a 2 inch O.D. split-spoon
Qu:	Unconfined Compressive Strength, TSF
γ:	Natural Dry Density, PCF
W:	Water content, %
LL:	Liquid Limit, %
PL:	Plastic Limit, %
PI:	Plasticity Index, %
$\Q$:	Apparent groundwater level at time noted while drilling
$\bullet$:	Apparent groundwater level at time noted upon completion of drilling
∇	Apparent groundwater level at time noted 24 hours after completion of drilling

DRILLING AND SAMPLING SYMBOLS

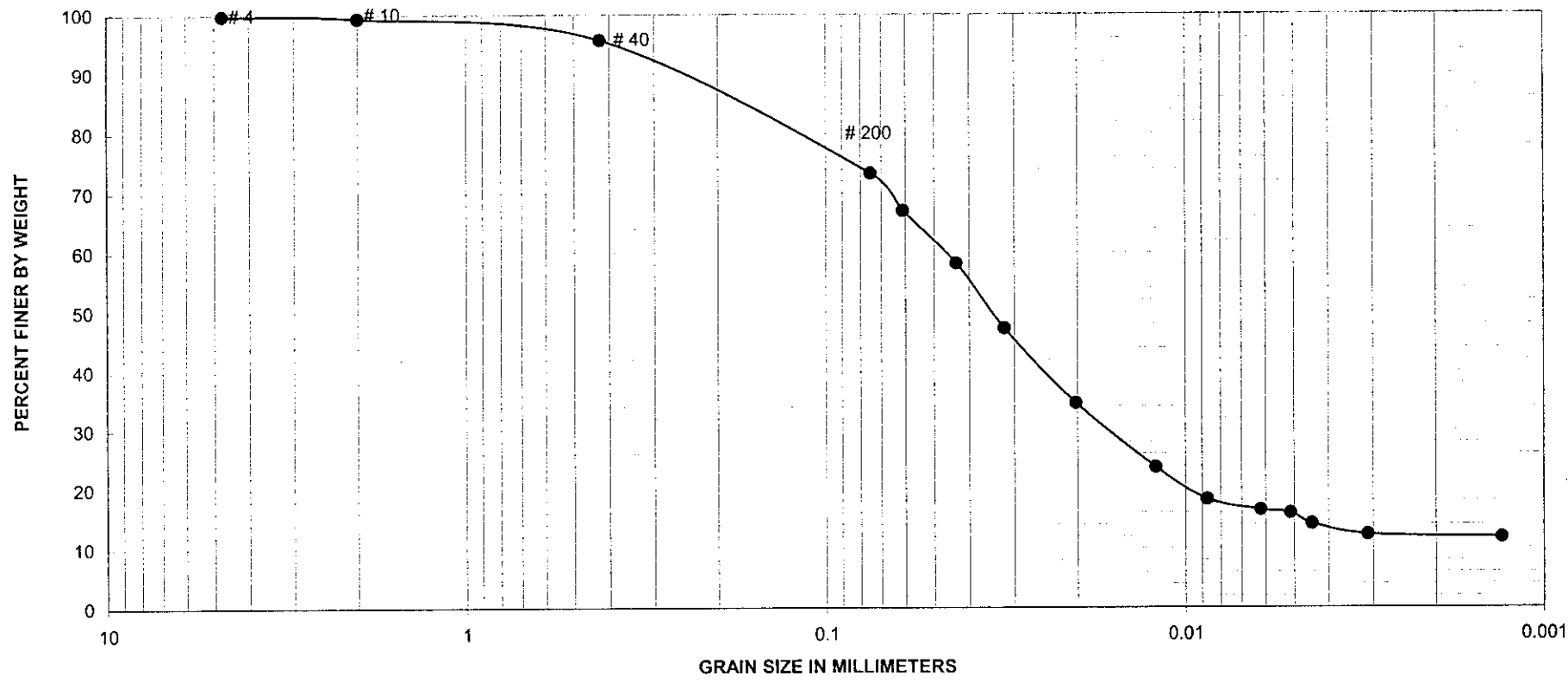
SS: Split-spoon - 1 3/8" I.D., 2" O.D., except where noted
ST: Shelby-tube - 3" O.D., except where noted
RC: Rock Core, 2" O.D., Except Where Noted
AU: Auger sample
DB: Diamond bit
CB: Carbide bit
WS: Washed Sample

RELATIVE DENSITY AND CONSISTENCY CLASSIFICATION

TERM (NON-COHESIVE SOILS)	BLOWS PER FOOT
Very loose	0 - 5
Loose	6 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very dense	51 or more

TERM (COHESIVE SOILS	BLOWS PER FOOT
Very soft	0 - 3
Soft	4 - 5
Medium	6 - 10
Stiff	11 -15
Very stiff	16 - 30
Hard	31 or more

Grain Size Distribution Curve



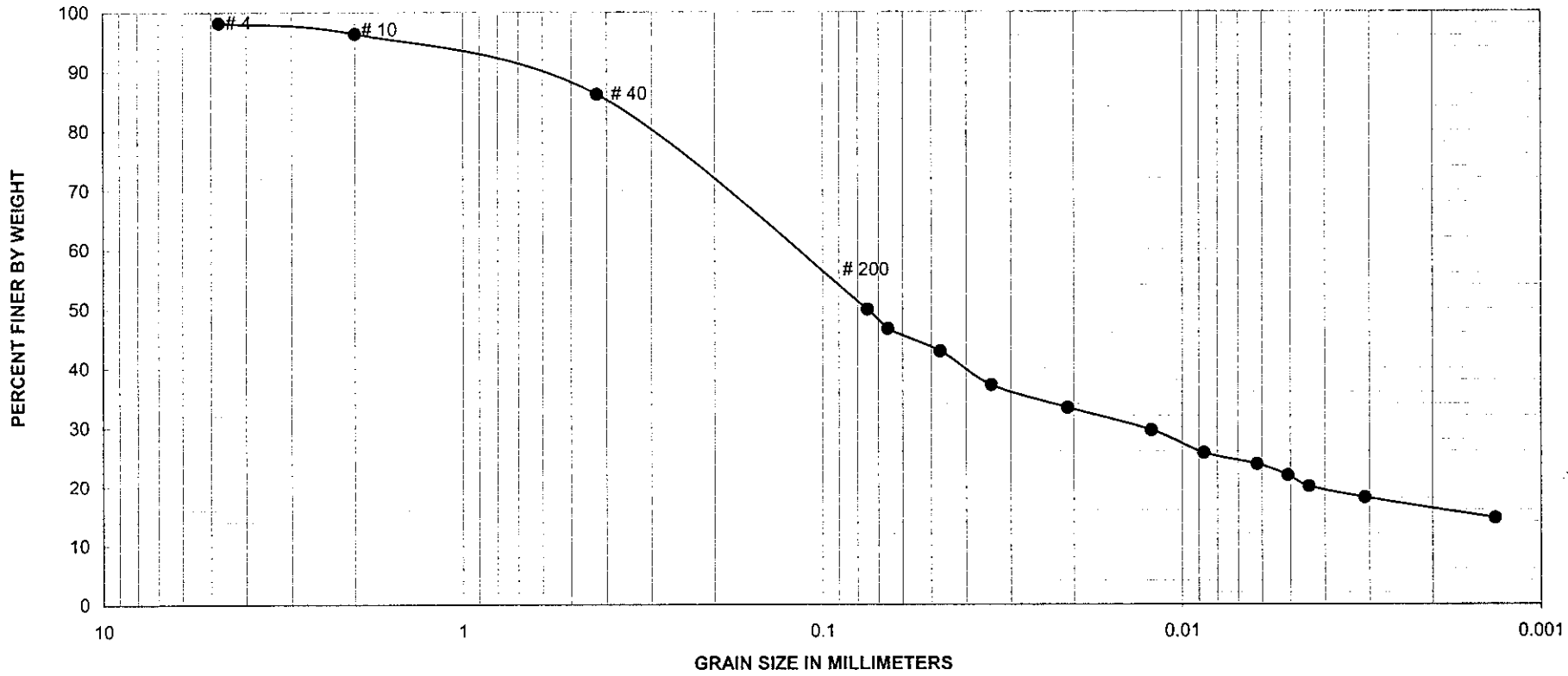
GRAVEL	SAND	SILT	CLAY

Boring No.	Sample No.	Elev or Depth	Nat w%	LL	PL	PI	Classification
RB-1A	2ST	3-5'		22	12	10	Silty Loam
							A-4 (4)
							Test 02

Project: SR-641 - 02IN1012

Date: 11/03

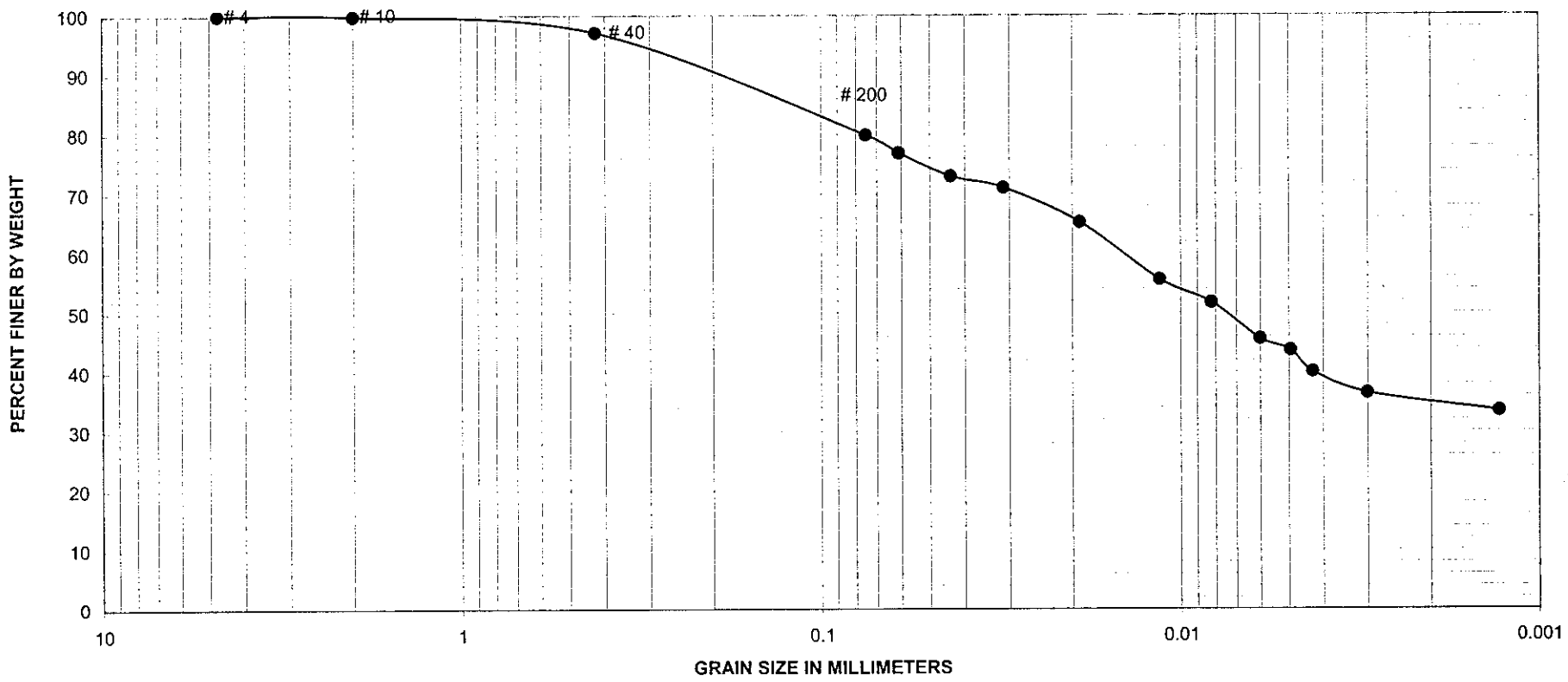
Grain Size Distribution Curve



GRAVEL	SAND	SILT	CLAY

Boring No.	Sample No.	Elev or Depth	Nat w%	LL	PL	PI	Classification	Project: SR-641 - 02IN1012
RB-9	9SS	33.5-35'		22	12	10	Sandy Loam	
							A-4 (2)	
							Test 07	
								Date: 11/03

Grain Size Distribution Curve



GRAVEL	SAND	SILT	CLAY

Boring No.	Sample No.	Elev or Depth	Nat w%	LL	PL	PI	Classification
RB-12	1 Bag	2-6'		40	17	23	Clay
							A-6 (17)
							Test 10

Project: SR-641 - 02IN1012

Date: 11/03

Project No.: STP-291-1 (2)
Des No.: 9738220
S.R. 641, Vigo County, Indiana
Alt & Witzig File: 02IN1012

SOIL CLASSIFICATION SUMMARY

Test No.	Boring Number	Sample & Depth	Description	Passing #10	Passing #40 / #200	> #10 % Gravel	#10-#200 % Sand	#200-.002mm % Silt	% <0.002mm (%) Clay	% <0.001mm Colloids	LL	PL	PI	AASHTO Classification
01	TB-26[1]	1ST 16 to 18 ft	Silty Loam	100	100 / 94	0	6	77	17	14	26	24	2	A-4 (1)
02	RB-1A	2ST 3.0 to 5.0 ft	Silty Loam	99	96 / 73	1	26	61	12	12	22	12	10	A-4 (4)
03	TB-23[2]	8SS 28.5 to 30 ft	Silty Clay Loam	99	97 / 84	1	15	64	20	19	26	20	6	A-4 (4)
04	TB-28[1]	7SS 23.5 to 25 ft	Sandy Loam	100	98 / 34	0	66	18	16	14	NP	NP	--	A-2-4 (0)
05	TB-26[1]	2ST 46 to 48 ft	Clay	100	100 / 100	0	0	40	60	55	50	36	14	A-7-5 (20)
06	TB-2[3]	9SS 33.5 to 35 ft	Clay	100	100 / 99	0	1	25	74	72	54	19	35	A-7-6 (38)
07	RB-9	9SS 33.5 to 35 ft	Sandy Loam	96	86 / 50	4	46	33	17	15	22	12	10	A-4 (2)
08	TB-13[4]	1ST 38 to 40 ft	Silty Clay	100	99 / 90	0	10	58	32	30	25	13	12	A-6 (8)
09	TB-10[4]	1ST 10-12 ft	Clay	100	100 / 96	0	4	40	56	49	37	28	9	A-4 (10)
10	RB-12	Bag 2-10 ft	Clay	100	97 / 80	0	20	45	35	33	40	17	23	A-6 (17)

Notes: 1: Soils from Des No.: 9738330, Structure 641-84-8401
2: Soils from Des No.: 9738410, Structure 641-84-8404
3: Soils from Des No.: 9738270, Structure 641-84-8398
4: Soils from Des No.: 9738280, Structure 641-84-8399

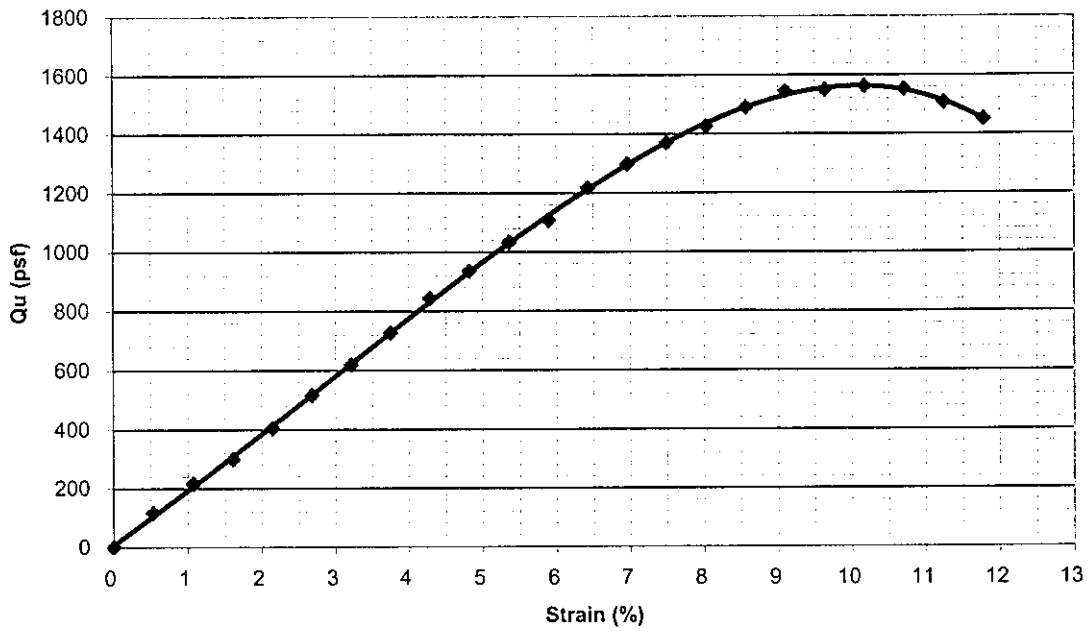
Project No.: STP-291-1 (2)
Des No.: 9738220
S.R. 641, Vigo County, Indiana
Alt & Witzig File: 02IN1012

SOIL CLASSIFICATION SUMMARY

Test No.	Boring Number	Sample & Depth	Description	Passing #10	Passing #40 / #200	> #10 % Gravel	#10-#200 % Sand	#200-.002mm % Silt	% <0.002mm (%) Clay	% <0.001mm Colloids	LL	PL	PI	AASHTO Classification
01	TB-26[1]	1ST 16 to 18 ft	Silty Loam	100	100 / 94	0	6	77	17	14	26	24	2	A-4 (1)
02	RB-1A	2ST 3.0 to 5.0 ft	Silty Loam	99	96 / 73	1	26	61	12	12	22	12	10	A-4 (4)
03	TB-23[2]	8SS 28.5 to 30 ft	Silty Clay Loam	99	97 / 84	1	15	64	20	19	26	20	6	A-4 (4)
04	TB-28[1]	7SS 23.5 to 25 ft	Sandy Loam	100	98 / 34	0	66	18	16	14	NP	NP	--	A-2-4 (0)
05	TB-26[1]	2ST 46 to 48 ft	Clay	100	100 / 100	0	0	40	60	55	50	36	14	A-7-5 (20)
06	TB-2[3]	9SS 33.5 to 35 ft	Clay	100	100 / 99	0	1	25	74	72	54	19	35	A-7-6 (38)
07	RB-9	9SS 33.5 to 35 ft	Sandy Loam	96	86 / 50	4	46	33	17	15	22	12	10	A-4 (2)
08	TB-13[4]	1ST 38 to 40 ft	Silty Clay	100	99 / 90	0	10	58	32	30	25	13	12	A-6 (8)
09	TB-10[4]	1ST 10-12 ft	Clay	100	100 / 96	0	4	40	56	49	37	28	9	A-4 (10)
10	RB-12	Bag 2-10 ft	Clay	100	97 / 80	0	20	45	35	33	40	17	23	A-6 (17)

Notes: 1: Soils from Des No.: 9738330, Structure 641-84-8401
2: Soils from Des No.: 9738410, Structure 641-84-8404
3: Soils from Des No.: 9738270, Structure 641-84-8398
4: Soils from Des No.: 9738280, Structure 641-84-8399

Unconfined Compression Test

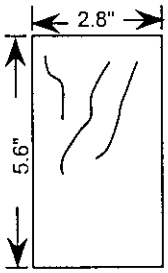


Sample Location RB-1A, 1ST

Depth 1.0 - 3.0 ft Moisture Content: 26.3 (%)

Strain Rate 2% min. Dry Unit Weight: 93.6 (pcf)

FAILURE SKETCH



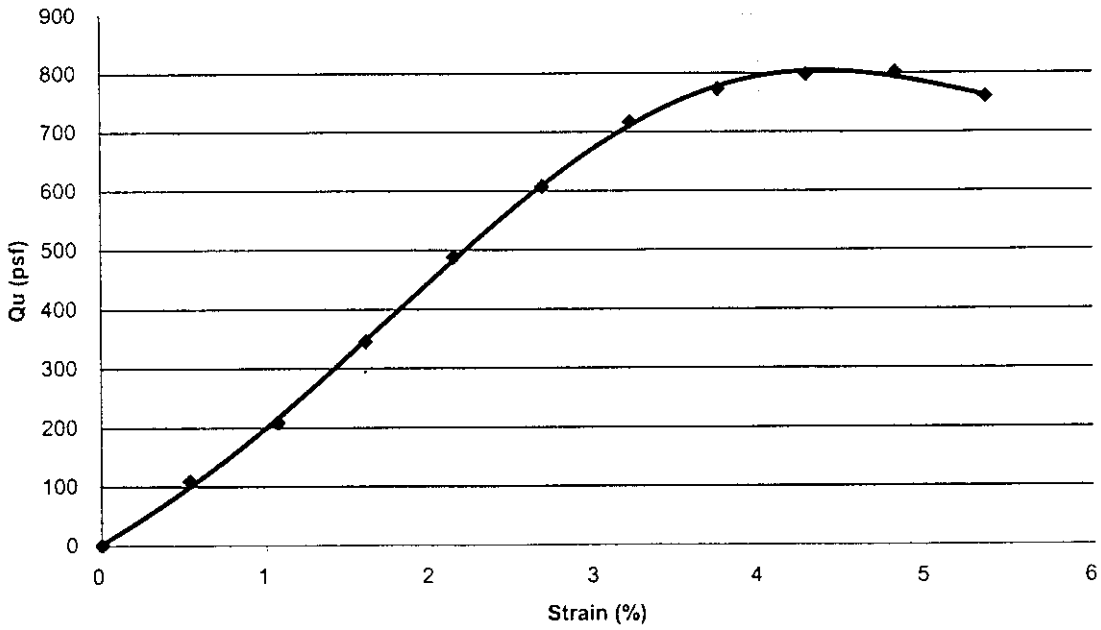
Soil Description Silty Loam, A-4, Test 02

Unconfined Compressive Strength (psf) 1,560

Failure Strain (%) 10.2

PREPARED FOR: INDOT-Geotechnical Division Indianapolis, Indiana		PREPARED BY: Alt & Witzig Engineering, Inc. Carmel, Indiana	
PROJECT NAME: S.R. 641 in Vigo County		PROJECT NO.: 02IN1012	DATE: 10/03

Unconfined Compression Test

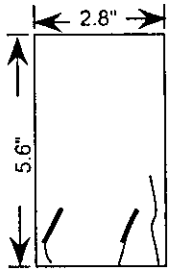


Sample Location RB-1A, 2ST

Depth 3.0 - 5.0 ft Moisture Content: 29.0 (%)

Strain Rate 2% min. Dry Unit Weight: 95.7 (pcf)

FAILURE SKETCH



Soil Description Silty Loam, A-4 (1), Test 02

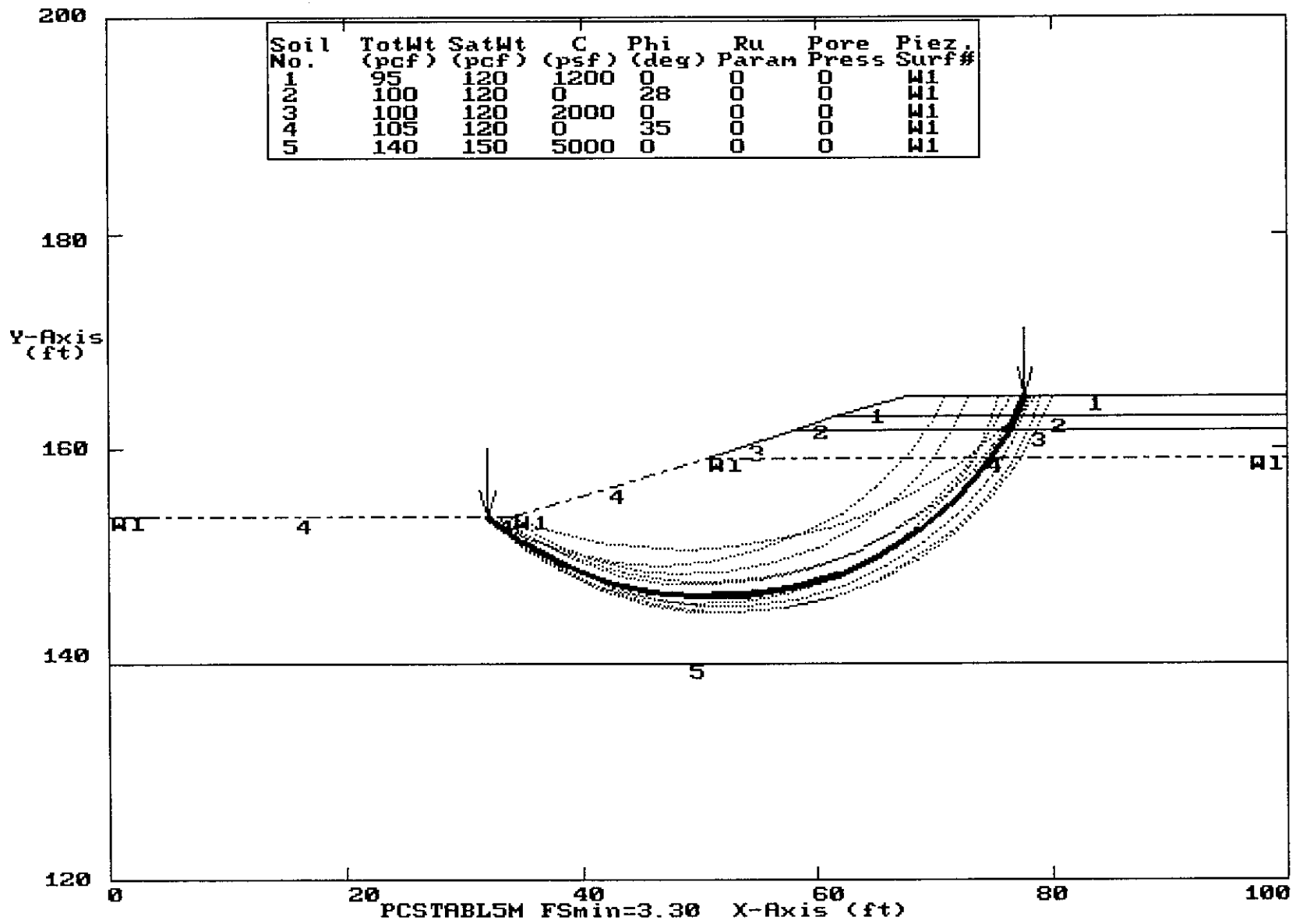
Unconfined Compressive Strength (psf) 800

Failure Strain (%) 4.5

PREPARED FOR: INDOT-Geotechnical Division Indianapolis, Indiana		PREPARED BY: Alt & Witzig Engineering, Inc. Carmel, Indiana	
PROJECT NAME: S.R. 641 in Vigo County		PROJECT NO.: 02IN1012	DATE: 10/03

SR641 Roadway (Cut at 7+880)
Ten Most Critical. C:SR641.PLT By: Kyu Ho Cho 11-17-03 9:41am

Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	95	120	1200	0	0	0	W1
2	100	120	0	28	0	0	W1
3	100	120	2000	0	0	0	W1
4	105	120	0	35	0	0	W1
5	140	150	5000	0	0	0	W1



PCSTABL5M FSmin=3.30 X-Axis (ft)

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	11-17-03
Time of Run:	9:41am
Run By:	Kyu Ho Cho
Input Data Filename:	C:SR641
Output Filename:	C:SR641.OUT
Unit:	ENGLISH
Plotted Output Filename:	C:SR641.PLT

PROBLEM DESCRIPTION SR641 Roadway (Cut at 7+880)

BOUNDARY COORDINATES
NOTE: User defined origin was specified.
Add 00.00 to X values and 120.00 to Y values listed.

7 Top Boundaries
11 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	33.80	33.20	33.80	4
2	33.20	33.80	34.20	33.80	4
3	34.20	33.80	50.70	39.30	4
4	50.70	39.30	58.20	41.80	3
5	58.20	41.80	61.80	43.00	2
6	61.80	43.00	67.80	45.00	1
7	67.80	45.00	100.00	45.00	1
8	61.80	43.00	100.00	43.00	2
9	58.20	41.80	100.00	41.80	3
10	50.70	39.30	100.00	39.30	4
11	.00	20.00	100.00	20.00	5

ISOTROPIC SOIL PARAMETERS

5 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	95.0	120.0	1200.0	.0	.00	.0	1
2	100.0	120.0	.0	28.0	.00	.0	1
3	100.0	120.0	2000.0	.0	.00	.0	1
4	105.0	120.0	.0	35.0	.00	.0	1
5	140.0	150.0	5000.0	.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	33.80
2	34.20	33.80
3	50.70	39.30
4	100.00	39.30

Searching Routine Will Be Limited To An Area Defined By 1 Boundaries
Of Which The First 1 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	20.00	100.00	20.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 32.00 ft.
and X = 40.00 ft.

Each Surface Terminates Between X = 60.00 ft.
and X = 80.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

4.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 15 Coordinate Points

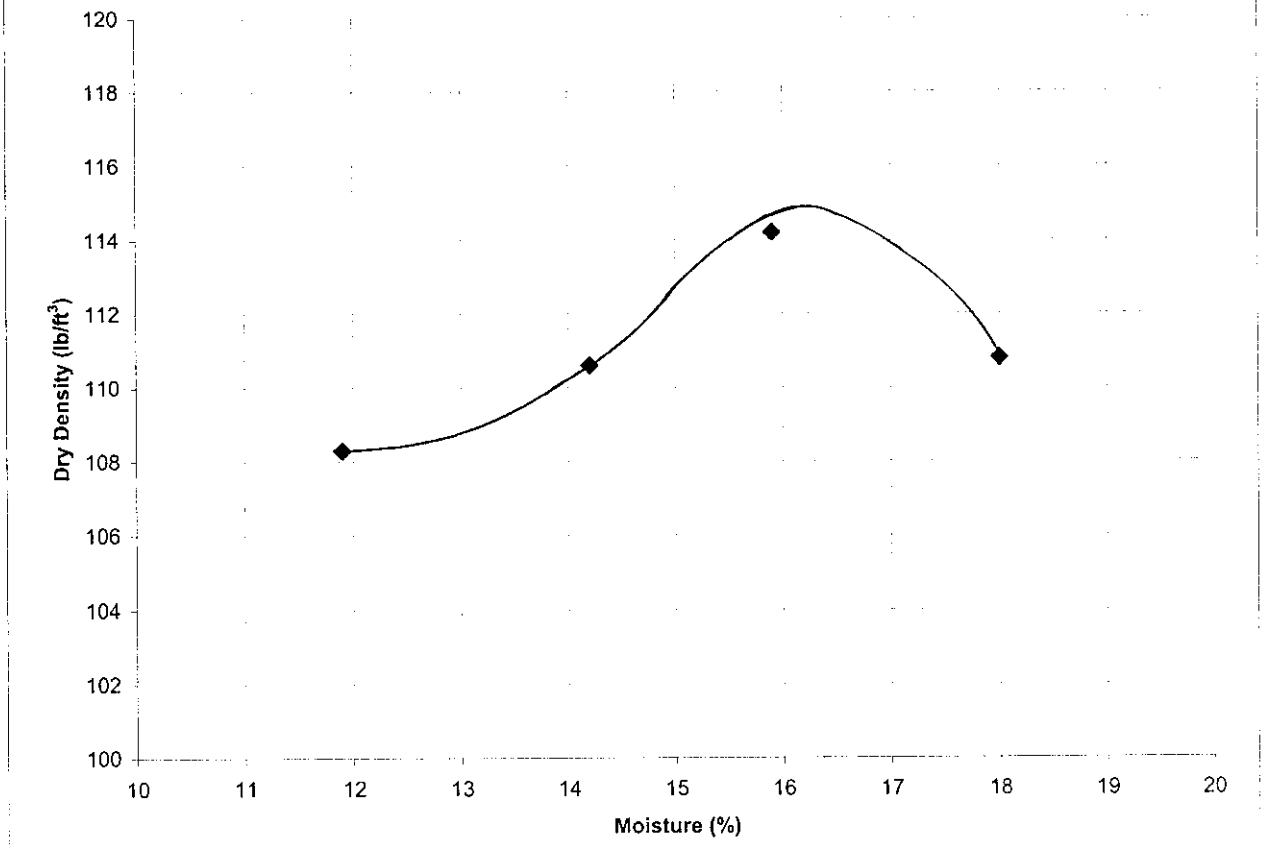
Point No.	X-Surf (ft)	Y-Surf (ft)
1	32.00	33.80
2	35.11	31.28
3	38.54	29.23
4	42.23	27.68
5	46.10	26.68
6	50.08	26.23
7	54.07	26.35
8	58.01	27.04
9	61.82	28.29
10	65.40	30.06
11	68.70	32.32
12	71.65	35.03
13	74.18	38.13
14	76.24	41.55
15	77.70	45.00

*** 3.299 ***

Individual data on the 23 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.2	70.1	.0	46.9	.0	.0	.0	.0	.0
2	1.0	165.5	.0	110.8	.0	.0	.0	.0	.0
3	.9	249.0	.0	159.4	.0	.0	.0	.0	.0

Moisture Density Relationship



Sample Location RB-12

Depth 2.0 - 6.0 ft., Bag Sample

Sample Brown, Clay, A-6

Test Method Standard Proctor

Maximum Dry Unit Weight 115.5 (lb/ft^3)

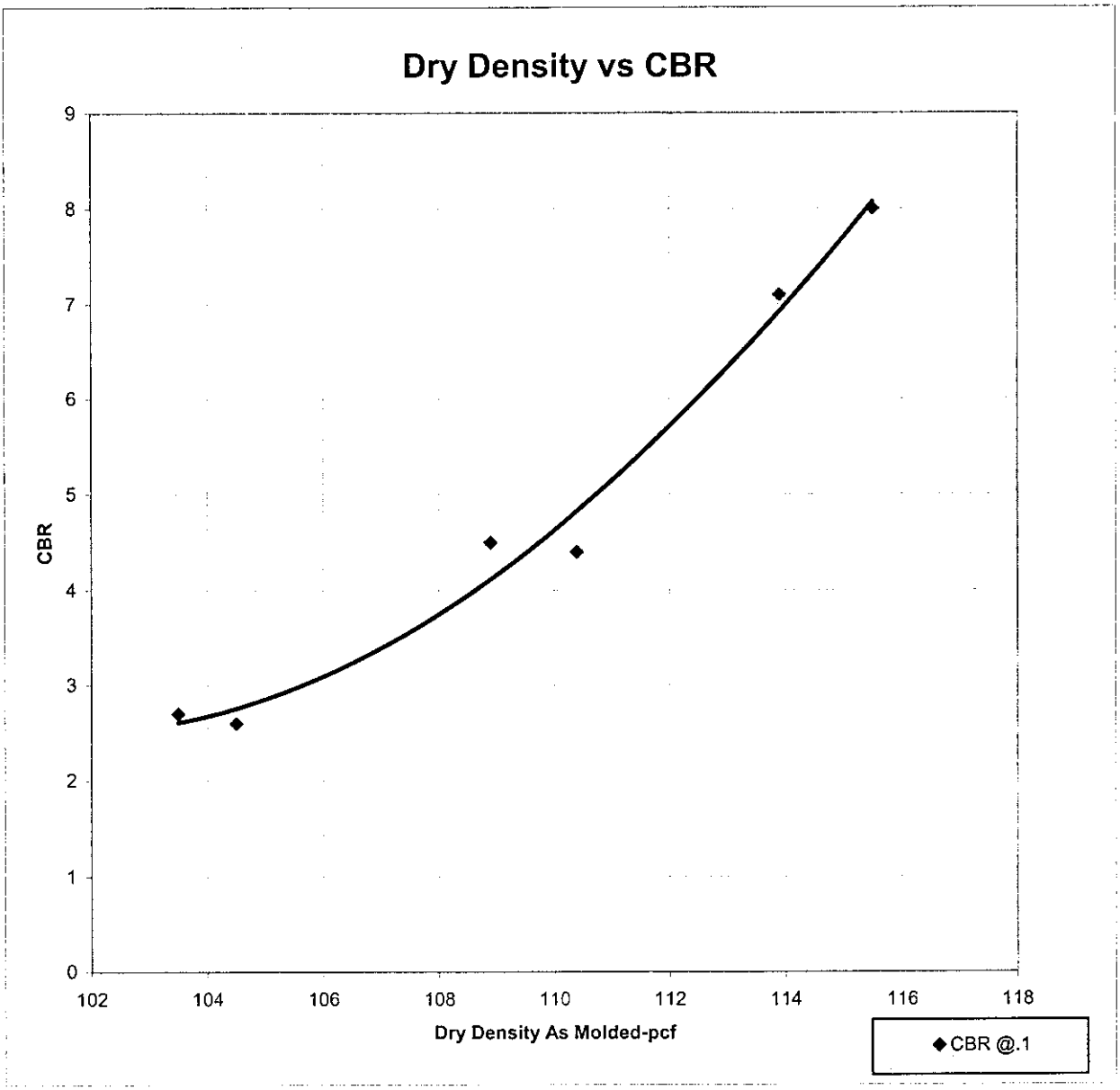
Optimum Moisture 16.1 (%)

PREPARED FOR: INDOT Indianapolis, Indiana		PREPARED BY: Alt & Witzig Engineering, Inc. Carmel, Indiana
PROJECT NAME: SR-641, Vigo County, Indiana		PROJECT NO.: 02IN1012 / DATE: 11/03

SUMMARY OF CBR TEST

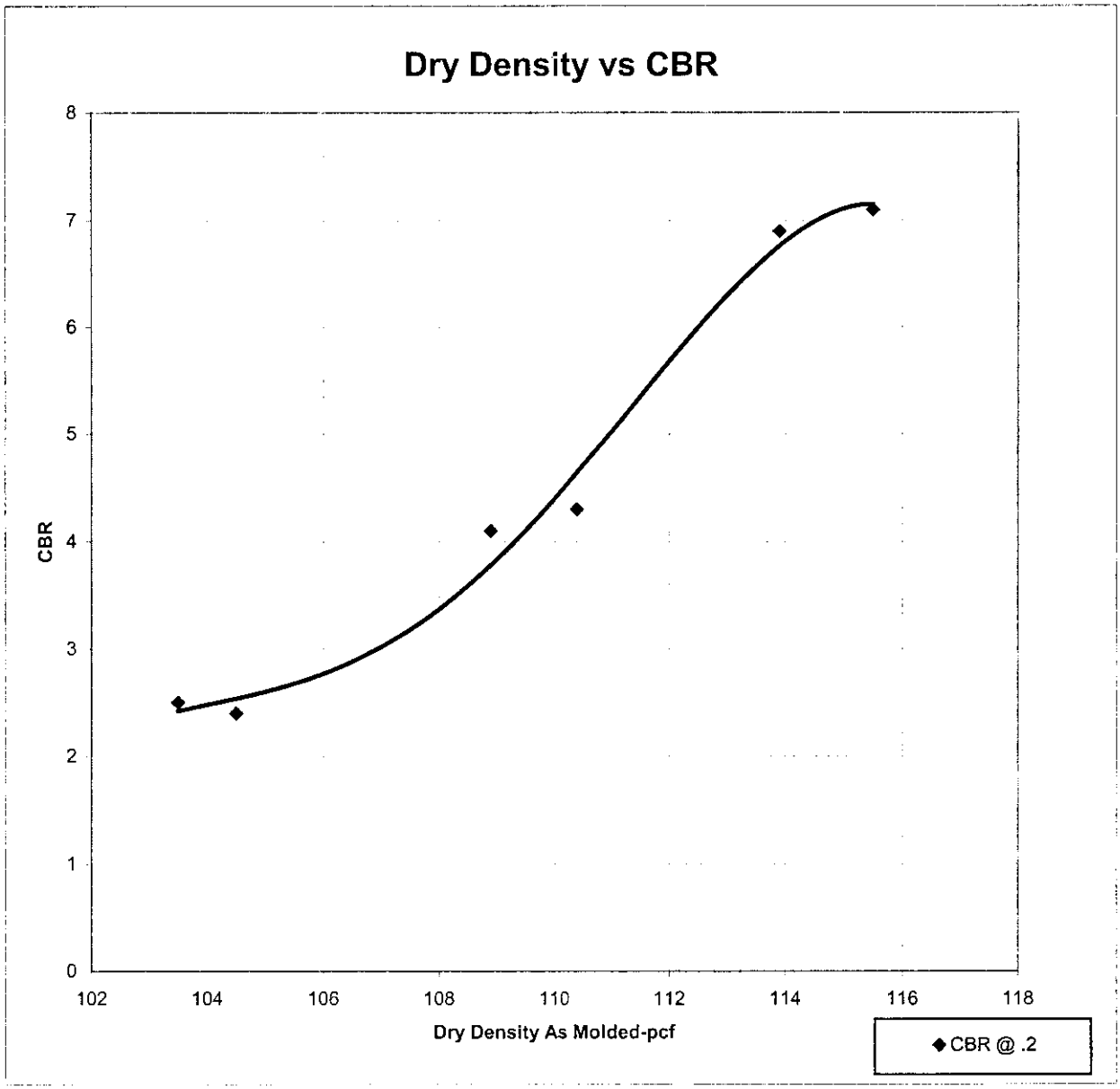
SUMMARY OF RB-12									
Sample Number	**Dry Density (pcf)**	**MC (%) Molded**	**% of Maximum Dry Density**	**Blows/Layer**	**Surcharge Load (lb)**	**MC After Soaking (%)**	**% Swell**	**CBR @ 0.1**	**CBR @ 0.2**
1	103.5	16.2	89.6	15	25	21.8	1.64	2.7	2.5
2	104.5	16.8	90.5	20	25	21.1	1.35	2.6	2.4
3	108.9	16.2	94.3	30	25	19.0	0.85	4.5	4.1
4	110.4	16.4	95.6	30	25	18.5	0.76	4.4	4.3
5	113.9	16.0	98.6	65	25	17.0	0.44	7.1	6.9
6	115.5	16.1	100	65	25	16.9	0.33	8.0	7.1

Project No.: 02IN1012



Sample Location	RB-12
Depth	Bag Sample: 2 -6 ft
Material Description	Clay, A-6
Test Method	AASHTO T-99
CBR @ 93%	3.6
CBR @ 95%	4.5
CBR @ 97%	5.7

PREPARED FOR: INDOT: Geotechnical Dept. Indianapolis, Indiana		PREPARED BY: Alt & Witzig Engineering, Inc. Carmel, Indiana	
PROJECT NAME: SR-641 Vigo County		PROJECT NO.: 02IN1012	DATE: 11/03



Sample Location	RB-12
Depth	Bag Sample: 2 -6 ft
Material Description	Clay, A-6
Test Method	AASHTO T-99
CBR @ 93%	3.2
CBR @ 95%	4.2
CBR @ 97%	5.7

PREPARED FOR: INDOT: Geotechnical Dept. Indianapolis, Indiana		PREPARED BY: Alt & Witzig Engineering, Inc. Carmel, Indiana	
PROJECT NAME: SR-641, Vigo County		PROJECT NO.: 02IN1012	DATE: 11/03

Geotechnical Test Report

SR-641 Project
Vigo County, IN

Prepared for:

Alt & Witzig Engineering, Inc.
Over 25 Years of Quality Service to Clients Throughout the Midwest.

Carmel, IN

Prepared by:

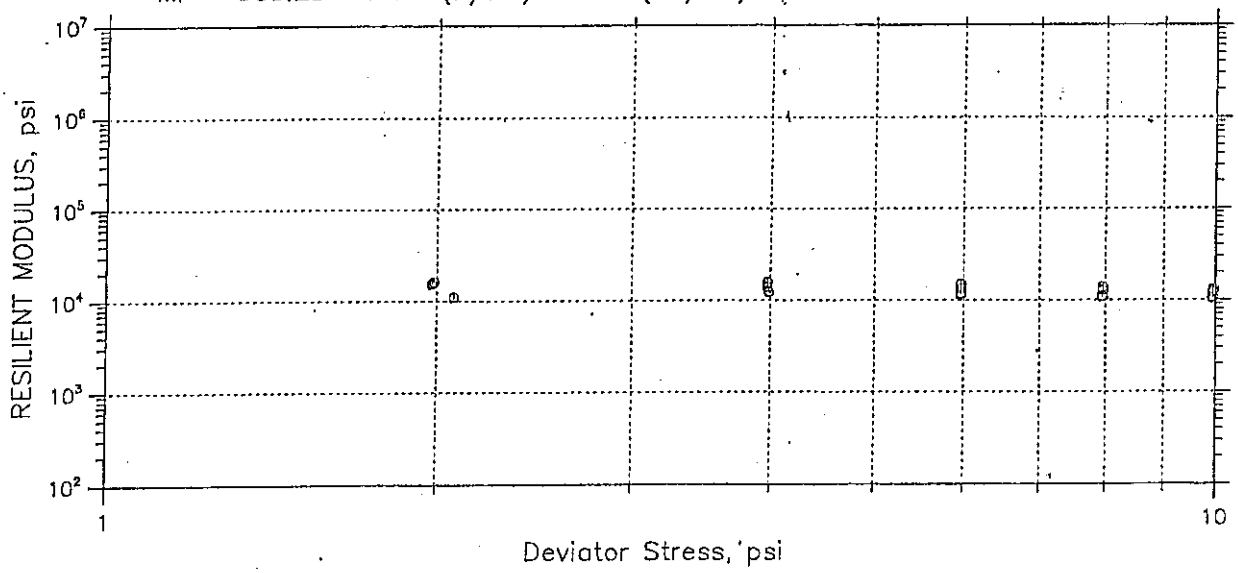
GeoTesting Express, Inc.
Boxborough, MA

December 5, 2003

RESILIENT MODULUS TEST DATA

SUMMARY REPORT

$$Mr = 669.23 * Pa * (B/Pa)^{0.362} * (Sd/Pa)^{-0.212}$$



Confining Stress S3 (psi)	Nom. Max. Deviator Stress (psi)	Mean Deviator Stress (psi)	Std. Dev. Deviator Stress (psi)	Mean Bulk Stress (psi)	Mean Resilient Strain (%)	Std. Dev. Resilient Strain (%)	Mean Resilient Modulus (psi)	Std. Dev. Resilient Modulus (psi)
6.089	2	1.988	0.0049	20.25	0.01	0.00	16114	1240.3
6.129	4	3.976	0.0204	22.36	0.02	0.00	15544	648.4
6.096	6	5.968	0.0170	24.26	0.04	0.00	14834	181.06
6.085	8	7.96	0.0243	26.22	0.05	0.00	13754	230.62
6.079	10	9.96	0.0310	28.2	0.07	0.00	12906	201.05
4.092	2	1.981	0.0100	14.26	0.01	0.00	15394	696.6
4.132	4	3.976	0.0156	16.37	0.03	0.00	13855	461.04
4.105	6	5.971	0.0229	18.29	0.04	0.00	13348	239.09
4.1	8	7.959	0.0263	20.26	0.06	0.00	12655	188.62
4.123	10	9.952	0.0254	22.32	0.08	0.00	12132	126.22
2.135	2	2.072	1.1516	8.477	0.02	0.01	10999	5553.7
2.121	4	3.987	0.0130	10.35	0.03	0.00	12408	178.75
2.12	6	5.966	0.0215	12.33	0.05	0.00	11724	207.01
2.124	8	7.951	0.0289	14.32	0.07	0.00	10857	73.882
2.121	10	9.949	0.0451	16.31	0.09	0.00	10537	158.44

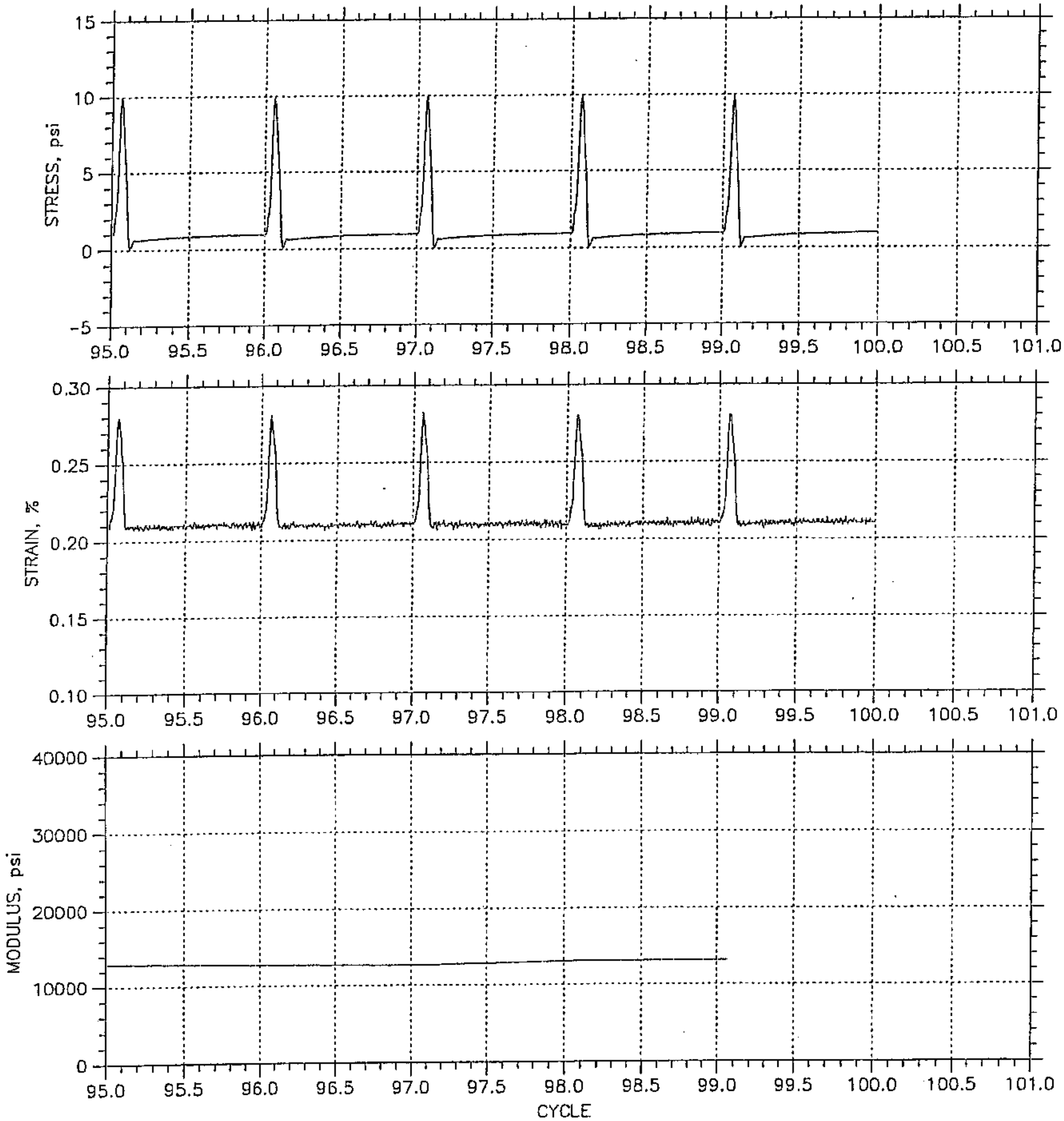
Project: SR-641	Location: Vigo County, IN	Project No.: GTX-4922
Boring No.: RB-12	Tested By: fy	Checked By: fph
Sample No.: RB-12	Test Date: 12/05/2003	Depth: ---
Test No.: RM1	Sample Type: Compacted	Elevation: ---
Description: Moist, Brown, Clay, A-6		
Remarks: Compacted to 95% of 115.5 pcf at 16.1% moisture (Optimum Moisture)		
File: G:\Gtx4922\4922-rm2.dat		

RESILIENT MODULUS TEST DATA

MODULUS CURVES

Sequence: 6 of 16

Deviator Stress: 10. psi

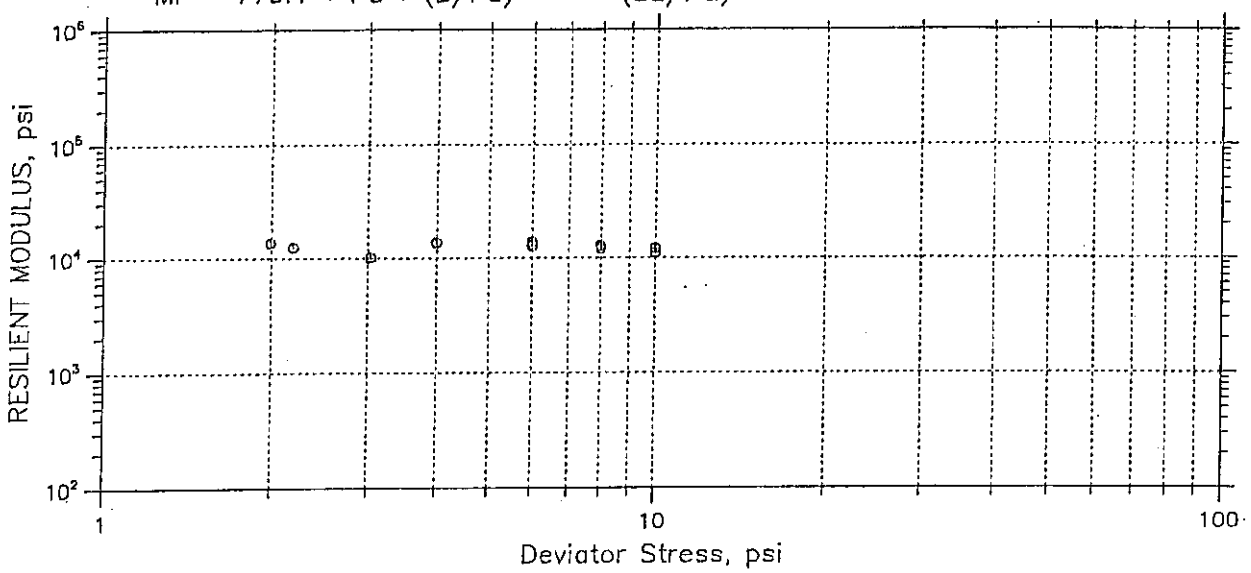


Project: SR-641	Location: Vigo County, IN	Project No.: GTX-4922
Boring No.: RB-12	Tested By: fy	Checked By: fph
Sample No.: RB-12	Test Date: 12/05/2003	Depth: ---
Test No.: RM1	Sample Type: Compacted	Elevation: ---
Description: Moist, Brown, Clay, A-6		
Remarks: Compacted to 95% of 115.5 pcf at 16.1% moisture (Optimum Moisture)		
File: G:\Gtx4922\4922-rm2.dat		

RESILIENT MODULUS TEST DATA

SUMMARY REPORT

$$Mr = 779.1 * Pa * (B/Pa)^{0.136} * (Sd/Pa)^{-0.0742}$$



Confining Stress S3 (psi)	Nom. Max. Deviator Stress (psi)	Mean Deviator Stress (psi)	Std. Dev. Deviator Stress (psi)	Mean Bulk Stress (psi)	Mean Resilient Strain (%)	Std. Dev. Resilient Strain (%)	Mean Resilient Modulus (psi)	Std. Dev. Resilient Modulus (psi)
5.897	2	1.992	0.0083	19.68	0.01	0.00	13626	676.96
5.898	4	4	0.0047	21.69	0.03	0.00	13597	567.53
5.92	6	5.998	0.0049	23.76	0.04	0.00	13779	330.7
5.893	8	7.988	0.0040	25.67	0.06	0.00	12894	112.57
5.885	10	9.991	0.0089	27.65	0.08	0.00	11978	174.85
3.917	2	2.201	1.2337	13.95	0.02	0.01	12470	4068.3
3.914	4	4.002	0.0033	15.75	0.03	0.00	13697	358.34
3.915	6	6.004	0.0033	17.75	0.04	0.00	13128	313.15
3.917	8	8.004	0.0083	19.75	0.06	0.00	12516	188.52
3.918	10	9.999	0.0040	21.75	0.08	0.00	12087	125.68
1.97	2	3.032	1.8347	8.942	0.02	0.01	10117	4856.3
1.923	4	3.986	0.0034	9.754	0.03	0.00	13718	257.37
1.925	6	6	0.0029	11.77	0.04	0.00	12670	201.9
1.93	8	8.002	0.0055	13.79	0.06	0.00	12021	234.25
1.928	10	10	0.0091	15.78	0.08	0.00	10980	109.51

Project: SR-641	Location: Vigo County, IN	Project No.: GTX-4922
Boring No.: RB-12	Tested By: fy	Checked By: fph
Sample No.: RB-12	Test Date: 12/04/2003	Depth: ---
Test No.: RM1	Sample Type: Compacted	Elevation: ---
Description: Moist, Brown, Clay, A-6		
Remarks: Compacted to 95% of 115.5 pcf at 18.1% moisture (+2% of Optimum Moisture)		
File: G:\Gtx4922\4922-rm1h.dat		

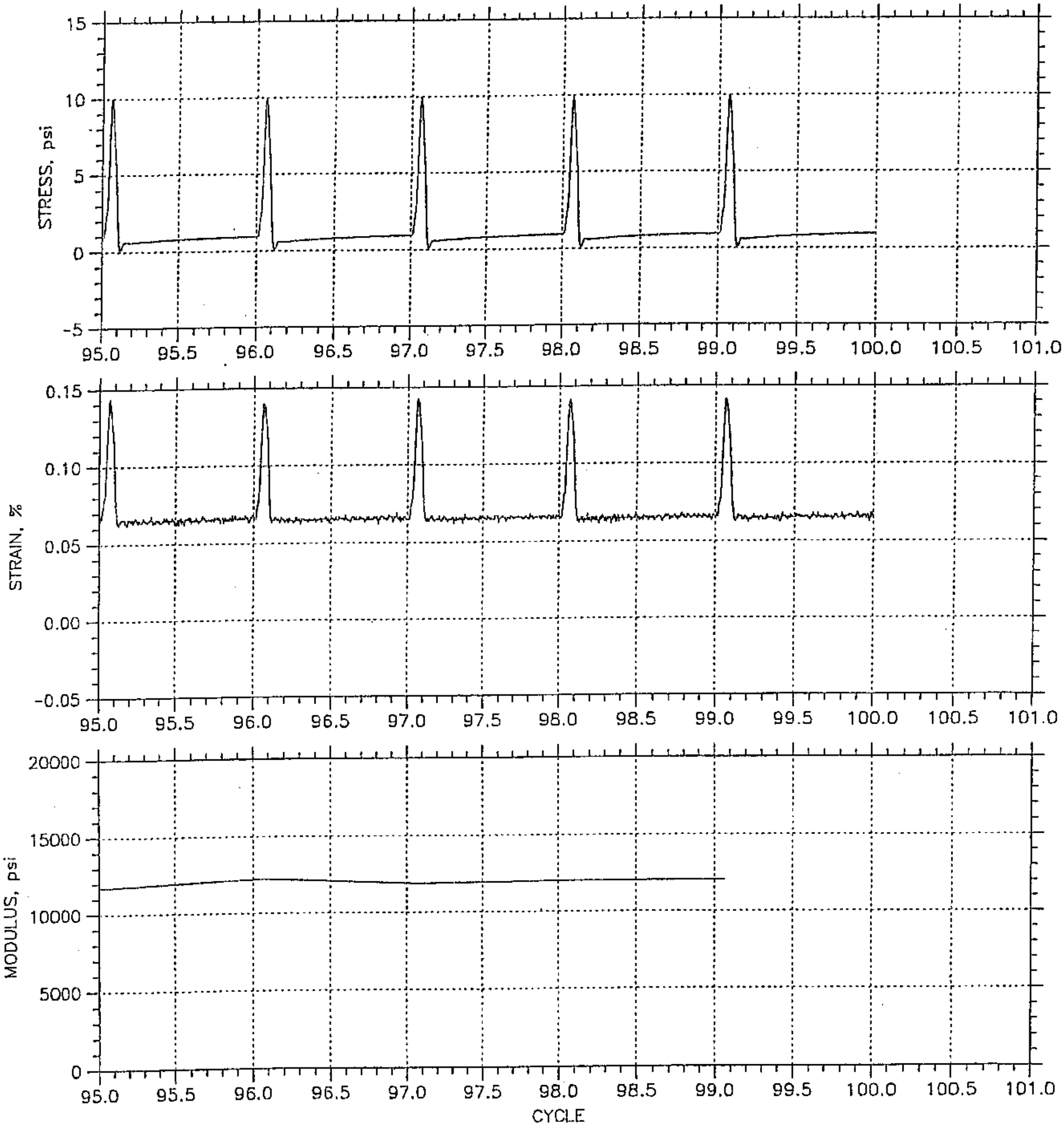
GeoTesting Express, Inc. • Boxborough, MA • (978) 635-0424 • Fax (978) 635-0266

RESILIENT MODULUS TEST DATA

MODULUS CURVES

Sequence: 6 of 16

Deviator Stress: 10. psi



Project: SR-641	Location: Vigo County, IN	Project No.: GTX-4922
Boring No.: RB-12	Tested By: fy	Checked By: fph
Sample No.: RB-12	Test Date: 12/04/2003	Depth: ---
Test No.: RM1	Sample Type: Compacted	Elevation: ---
Description: Moist, Brown, Clay, A-6		
Remarks: Compacted to 95% of 115.5 pcf at 18.1% moisture (+2% of Optimum Moisture)		
File: G:\Gtx4922\4922-rm1h.dat		

Summary of Moisture Contents

Project Name: SR-641 in Vigo County

Project Number: 02IN1012 Date Completed: 10/2003

Boring #	Sample Depth (ft)	Sample ID	Moisture Content
RB-1	1-2.5	1SS	17.0
RB-3	1-2.5	1SS	14.4
	3.5-5	2SS	20.1
RB-4	1-2.5	1SS	19.2
	3.5-5	2SS	25.9
RB-5	1-2.5	1SS	18.8
	3.5-5	2SS	19.9
RB-6	1-2.5	1SS	13.3
	3.5-5	2SS	22.3
RB-8	1-2.5	1SS	12.9
	3.5-5	2SS	13.6
RB-9	1-2.5	1SS	16.6
	3.5-5	2SS	18.3
	6-7.5	3SS	15.6
	8.5-10	4SS	16.9
	13.5-15	5SS	9.9
RB-10	1-2.5	1SS	20.6
	3.5-5	2SS	18.2
RB-11	1-2.5	1SS	17.6
	3.5-5	2SS	23.1
RB-12	1-2.5	1SS	24.1
	3.5-5	2SS	18.5
	6-7.5	3SS	15.6
RB-13	3.5-5	2SS	21.7
	6-7.5	3SS	13.5
RB-14	1-2.5	1SS	19.9
RB-15	1-2.5	1SS	12.7
RB-17	1-2.5	1SS	18.3
RB-18	1-2.5	1SS	14.7
RB-19	1-2.5	1SS	23.8
	3.5-5	2SS	25.6
SL-5	1-2.5	1SS	23.5
	3.5-5	2SS	19
SL-6	1-2.5	1SS	17.1
	3.5-5	2SS	23.2

Summary of pH's

Project Name: SR-641 in Vigo County

Project Number: 02IN1012 Date Completed: 10/2003

Boring #	Depth	pH
RB-1A	3-5'	6.33
B-9	35.0'	7.76

Summary of Unit Weights

Project Name: SR-641 in Vigo County

Project Number: 02IN1012 Date Completed: 10/2003

Boring #	Sample Depth	Moisture Content	Wet Density	Dry Density
RB-1A	1-3'	28.3	120.1	93.6
RB-1A	3-5'	23.4	118.0	95.7

Summary of Atterberg Limits

Project Name: SR-641 in Vigo County

Project Number: 02IN1012 Date Completed: 11/2003

Boring #	Sample Depth	Liquid Limit	Plastic Limit	Plasticity Index
B-1A	3-5'	22	17	5
B-9	35'	22	12	10
RB-12	2-6'	40	17	23

Indiana Department of Transportation

Materials and Tests Division

120 South Shortridge Road P. O. Box 19389
Indianapolis, Indiana 46219-0389
Phone: (317) 610-7251 Fax: (317) 356-9351

December 14, 2005

To: Tom Caplinger, P.E.
INDOT Design Division

From: Mir Zaheer, P.E.
INDOT Geotechnical Section

Ref: SR 641 – Des. No's. 9738280 & 9138220
Wick Drains Installation
Station 8+640 to Station 9+160 Line "CX", Ramps 4, 5, & 6, and Line "C"

The original recommendations were provided in the geotechnical reports published under Designation No's. 9138220 and 9738280 on December 05, 2003 and on October 31, 2003. Also, I have attempted to answer most of your queries through my previous emails to you. However, we would like to include additional detailed information regarding the presence of stiff or dense soil strata and the approximate revised tip elevations for wick drains within this area.

We have performed CPT drilling at three locations within this area. CPT corings C-3, C-2 and C-1 were done at Stations 8+580, 8+680 and 8+780 at 35 m to 65 m offsets right of Line "CX". The following information presented in the table below, should help the contractor to better equip themselves and help our design team to estimate the quantities for the wick drains.

STATION	Tip Elevation of Wick Drain	Dense/Stiff to Very Stiff Strata Elevation
8+640 "CX"	143.50	-----
8+680 "CX"	136.50	148.50 to 149.00 144.75 to 146.90
8+780 "CX"	136.20	147.80 to 149.00
8+900 "CX"	136.20	151.20 to 152.20
8+910 "CX"	136.20	148.40 to 150.20
8+930 "CX"	136.20	147.90 to 152.40
8+940 "CX"	136.20	146.40 to 151.60
8+950 "CX"	136.20	148.90 to 151.00
9+060 "CX"	138.50	148.40 to 151.00
9+150 "CX"	142.00	-----
9+160 "CX"	142.00	147.60 to 148.20 150.60 to 151.80
Line "C" West of Line "CX"	142.00 to 136.20	145.40 to 148.00
Ramp 5 & Ramp 6 West of Line "CX"	142.00 to 136.20	145.40 to 148.00

The draft drawing for the wick drains sent to us is okay. However, we recommend that the above information should be included in the contract documents if possible. If you have any further questions, Please feel free to contact me.

Thanks

cc:

File

DES NO: 9738280/9138220,
PROJECT NO: STP-291-(2)
STRUCTURE NO: 7
BRIDGE NO. 641-84-8399– S.R. 641 OVER MCDANIEL ROAD,
S.R. 641 RAMPS AT MCDANIEL ROAD, AND MCDANIEL ROAD
VIGO COUNTY, INDIANA
A & W PROJECT NO: 02IN1012 D

PREPARED FOR
INDIANA DEPARTMENT OF TRANSPORTATION
INDIANAPOLIS, INDIANA

OCTOBER 31, 2003

SUMMARY OF RECOMMENDATIONS

DES NO: 9738280/9138220

PROJECT NO: STP-291-(2)

STRUCTURE NO: 7

BRIDGE NO. 641-84-8399– S.R. 641 OVER MCDANIEL ROAD,

S.R. 641 RAMPS AT MCDANIEL ROAD, AND MCDANIEL ROAD

VIGO COUNTY, INDIANA

A foundation investigation has been performed for the proposed new S.R. 641 Bridge over McDaniel Road in Vigo County, Indiana. The following approximate table illustrates the approximate bedrock elevations and estimated pile tip elevations for driven H-piles:

Table 1: Summary of Approximate Bedrock and Pile Tip Elevations

Bent or Pier #	Boring Number	Station	Offset "CX"	Ground Surface Elevation, m (ft)	Approximate Bedrock Elevation, m (ft)
B1-SB	TB-9	8+903	8m LT	154 (505)	126.8 (416)
B1-NB	TB-10	8+906	25m RT	153 (502)	127.1 (417)
P2-SB	TB-11	--	--	--	--
P2-NB	TB-12	9+930	8m RT	154 (505)	127.0 (416.5)
B3-SB	TB-13	8+944	3m LT	154 (505)	127.4 (418)
B3-NB	TB-14	8+954	25m RT	155 (509)	128.2 (420.5)

The foundations for this new bridge may be founded on steel H-piles driven to the bedrock at approximate elevations as shown in Table 1. The final tip elevation should be determined by dynamic pile load testing using the methods outlined in Section 701.06 (c) of the INDOT Standard Specifications.

Wick drains have been recommended to speed the rate of consolidation to approximately one month below embankments greater than twenty (20) feet in height.

The MSE Walls at both abutments should have adequate factors of safety against overturning, sliding, bearing capacity, and global stability if minimum strip lengths of 0.70H are utilized. For the design of the foundation pad, a net allowable bearing pressure of 4,275 psf can be used.

The shallow, natural soils encountered over most of the project site were predominantly Silty Loam, A-4. The shallow soils in some of the borings indicate soft to stiff material. Some undercutting and replacing of the shallow soft material with compacted "B" Borrow will be necessary for the construction of the MSE Wall and preparation for the embankment fills. Foundation soils for drainage pipe structures are adequate. However, consideration should be given to the anticipated differential settlements along the length of these structures.

Alt & Witzig Engineering, Inc.
4105 West 99th Street • Carmel, Indiana 46032
(317) 875-7000 • Fax (317) 876-3705

October 31, 2003

Indiana Department of Transportation
120 South Shortridge Road
P.O. Box 19389
Indianapolis, Indiana 46219-0389
ATTN: Mr. Athar A. Kahn

RE: Subsurface Investigation
and Recommendations
Des No: 9738280/9138220
Project No: STP-291-(2)
Structure 7
Bridge No. 641-84-8399
S.R. 641 over McDaniel Road,
S.R. 641 Ramps at McDaniel Road,
and McDaniel Road
Vigo County, Indiana
Alt & Witzig File: 02IN1012

Gentlemen:

In compliance with your request, we have completed six (6) structure borings and six (6) roadway borings at the above referenced site. It is our pleasure to transmit herewith a copy of the report.

Purpose and Procedures

This report presents the results of a geotechnical investigation for the new bridge in Vigo County, Indiana for Phase II of the S.R. 641 Project. The site of the proposed project is southeast of Terre Haute, Indiana near McDaniel Road west of Little Honey Creek. The bridge is one of several structures proposed for the S.R. 641 Project. This investigation was conducted for the Indiana Department of Transportation.

The purpose of this foundation investigation was to determine the various soils profile components, the engineering characteristics of the foundation materials and to provide criteria for use by the design engineers in preparing roadway, retaining wall, and bridge design.

The field investigations to determine the engineering characteristics of the foundation materials included a reconnaissance of the project site, drilling borings as shown on the soil profile drawings, performing standard penetration tests, and obtaining soil samples retained in the standard split-spoon and Shelby tube samplers.

The bridge borings were offset slightly due to obstructions and specific requests of the property owner. Proposed borings TB-11 and RW-2 were not conducted because of the existing limitations. The apparent groundwater level and the ground surface elevation at the boring locations were also determined. The field investigation was started on May 8, 2003, and completed on August 13, 2003.

The soil borings were performed with a drilling rig equipped with a rotary head. Conventional hollow-stem augers were used to advance the holes. Representative samples were obtained employing split-spoon and Shelby tube sampling procedures in accordance with ASTM Procedures D-1586 and D-1587.

During the sampling procedure, standard penetration tests were performed at regular intervals to obtain the standard penetration value of the soil. The standard penetration value is defined as the number of blows a 140 lb hammer, falling 30 inches, required to advance the split-spoon sampler 12 inches into the soil. The results of the standard penetration tests indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

In addition to the field investigations, a supplemental laboratory investigation was conducted to ascertain additional pertinent engineering characteristics of the subsurface materials necessary in analyzing the behavior of the proposed bridge structure. All phases of the laboratory investigation were conducted in general accordance with applicable AASHTO Specifications and INDOT Exhibit "C". The laboratory testing program included supplementary visual classification on all samples. Atterberg limit tests, unit weight tests, unconfined compression tests, a consolidation test, a consolidated undrained triaxial test, moisture content tests, pH tests, and grain size analyses were performed on selected soil samples.

Proposed Bridge Structure

Design plans indicate that two, two span bridge structures (North and South bound) are to be constructed with this project. The bridges are to be Prestressed Concrete Beam Type IV Bridges with a span of 77 feet (23.5m). The borings drilled for this new structure (TB-9, TB-10, TB-12, TB-13, and TB-14) indicated shale and siltstone bedrock beneath approximately eighty five (85) to eighty nine (89) feet of mostly medium stiff to very soft, Silty Loam and Clay soils. The end bents and piers for this new bridge may be founded on steel H-piles driven to the bedrock. Hardened pile tip protectors should be used for piles installed at this site. The approximate bedrock elevations are shown in Table 1.

Table 1: Summary of Approximate Bedrock and Pile Tip Elevations

Bent or Pier #	Boring Number	Station	Offset "CX"	Ground Surface Elevation, m (ft)	Approximate Bedrock Elevation, m (ft)
B1-SB	TB-9	8+903	8m LT	154 (505)	126.8 (416)
B1-NB	TB-10	8+906	25m RT	153 (502)	127.1 (417)
P2-SB	TB-11	--	--	--	--
P2-NB	TB-12	9+930	8m RT	154 (505)	127.0 (416.5)
B3-SB	TB-13	8+944	3m LT	154 (505)	127.4 (418)
B3-NB	TB-14	8+954	25m RT	155 (509)	128.2 (420.5)

* TB-11 not conducted due to site obstructions and at request of property owner.

The bedrock elevations given above are only approximate elevations determined at the exact structure boring locations and should be used only as a guide. The final tip elevation should be determined by dynamic pile load testing using the methods outlined in Section 701.06 (c) of the INDOT Standard Specifications. The piles shall be monitored by a pile driving analyzer (PDA) during installation.

Consolidation Considerations

Approximately 33 feet (10 m) of fill will be required to construct the embankment approach at bents No. 1 and No. 2. Approximately eight feet (2.4 m) of fill will be present at the location of Pier No. 2 (at the centerline of the re-aligned McDaniel Road, Line "C"). Due to the soft clays present at approximately forty (40) to sixty (60) feet (12.2 to 18.3m) below grade, consolidation due to embankment construction was considered.

A consolidation test was performed on the very soft to soft Clay, A-7-5, encountered in TB-13 at a depth of 38-40 feet below existing grade. The results of this test and settlement analyses can be found in the appendix. These soft clay soils are present in all of the structure borings for this bridge and terminate at a minimum elevation of 445 ft (135.6m). The maximum height of the embankment to be constructed at the location of the structure is approximately 33 feet (10m). Other areas on Line "C" near Station 100+640 and Line "CX" Station 9+140 have similarly proposed embankment heights. Furthermore, roadway boring RB-13 also indicates soft surficial soils that will be susceptible to settlement on Line "CX" at Station 9+060.

Based upon our consolidation test and the height of the embankment, total settlements in the range of six (6) to ten (10) inches (0.15 to 0.25m) can be expected with normal weight fill materials. Approximately one and one-half (1 ½) inches are expected to occur in the shallow silty loam soils immediately above the softer clays. Elastic compression of the soils above the soft clays and silty loams was not considered, as this "settlement" will take place immediately upon placement of the fill.

Based upon a recommended "after construction" settlement value of one (1) inch, we must consider the time for 90% consolidation (U=0.90) for the worst-case settlement of approximately ten (10) inches. The time for 90% consolidation was calculated to be approximately 56 months. Therefore, it is recommended that prefabricated vertical drains, or wick drains, be installed to speed the rate of consolidation.

Our wick drain calculations and assumptions are provided in the appendix for the maximum embankment height. Based upon a residual settlement of one (1) inch and a one-month time of consolidation from completion of the embankment fills, it is recommended that the spacing for wick drains be as follows:

Table 2: Parameters for Wick Drain Installation

Station to Station	Line	Offset, m (ft)	Wick Drain Spacing (ft)	Elevation of Wick Drain Tip, m (ft)
8+640 to 8+910	CX	25 Lt to 25 Rt	6	136.2 (447)
1+240 to 1+270	4	5 Lt to 20 Rt	6	136.2 (447)
1+000 to 1+130	5	See Note 2	6	136.2 (447)
8+950 to ~9+160	CX	35 Lt to 35 Rt	6	136.2 (447)
1+270 to 1+302	4	27 Lt to 8 Rt	6	136.2 (447)
1+000 to 1+140	6	See Note 1	6	136.2 (447)
100+520 to 100+662 Near 100+520	C	25 Lt to 25 Rt See Note 3	6	136.2 (447)

Note 1: Line 6, near proposed line "CX" embankment, offsets not clear on plans
Note 2: Line 5, near proposed line "C" embankment, offsets not clear on plans
Note 3: Line C, near the intersection of lines "5" and "6", offsets not clear on plans

In general, the wick drains are proposed where embankment fills exceed twenty (20) feet (6m). Other fill heights will also impart settlements, but are not expected to exceed the preconsolidation pressure of the underlying soft clays. Therefore, the settlements in other embankment areas should be expected to be less than two inches.

Prior to installation of the wick drains, a two (2) foot (0.6m) drainage blanket should be constructed on the exposed subgrade. The drainage blanket should be comprised of "B" Borrow. The exposed subgrade should be graded to allow gravity drainage. All topsoil and wet or soft surface soils should be stripped from the site within construction limits. Proofrolling of the exposed subsurface should be performed in accordance with Section 203.26 in the area where new fill for the walls will be placed. Any soft, loose or unstable soils encountered during proofrolling operations, which will not readily compact, should be removed and replaced with "B" Borrow.

Our analysis assumes that the wick drains will be installed in an equilateral triangle pattern. The rate of consolidation should be monitored by settlement plates and toe stakes that are constructed, installed, and monitored in accordance with section 204.03 of the Standard Specifications. Because of the short time frame of consolidation, piezometers are not recommended at this location.

If the recommendations for the wick drains are followed, the effect of negative skin friction on the proposed driven piles is significantly decreased. Furthermore, the piles should be installed such that the negative skin friction from the MSE Wall backfill does not impact the pile. Sleeves through the fill materials should be installed or friction-reducing coatings should be applied to the piles. Furthermore, it is recommended that the piles be driven after 90% consolidation of the natural soils as indicated by the settlement plates. Thus, it is conservatively recommended that only the upper ten (10) feet (3m) of the natural soils be considered as contributing *negative* skin friction to the piles at the end bents. The interior pier, Bent 2, will not have negative skin friction due to the small amount of fill to be placed. However, the piles for Bent 2 should be installed in conjunction, and not before, the end bent piles. The table below lists pile-driving parameters.

Table 3: Parameters for Pile Driving

Bent	No. 1	No. 2	No. 3
Design Load (Tons)	55/70/90	55/70/90	55/70/90
Factor of Safety	2.0	2.0	2.0
Factored Design Load (Tons)	110/140/180	110/140/180	110/140/180
Friction in Scour Zone (Tons)	N/A	N/A	N/A
Down Drag Friction	* 16x2	N/A	* 20x2
Ultimate Load (Tons)	142/172/212	110/140/180	150/180/220
Testing Method	Std. Spec. 701.06 (c)		

* As per Mir Z. on 1/22/04, Down Drag Friction will be ignored if wick drains are installed @ 6' c-c spacing

Our analysis is based upon a steel H-pile section with F_y=36ksi. Higher capacity may be achieved through the use of F_y=50ksi steel, if desired. HP 12x53's were assumed for the 55 and 70 ton piles while HP 12x74's were assumed for the 90 ton piles.

Piles that are driven to the shale bedrock should be restruck. The restrike should be completed after a minimum of 7 days after initial drive. Additionally, to minimize the effects of the disturbed end-bearing stratum, a minimum spacing of the piles should be 6 feet (1.8m). This will ensure that end bearing capacities are not jeopardized by disturbance of the bedrock during driving of adjacent piles.

MSE Wall Recommendations

As indicated by the design plans, MSE Retaining Walls are proposed at the end bents of the bridge structures. These MSE Walls run parallel to the new alignment of McDaniel Road (Line C) and are approximately 340 to 350 feet (103.3 to 106.4m) in length. Boring RW-1 was conducted to analyze the soil in areas furthest away from structure borings.

An external stability analysis of the proposed retaining walls was performed at the most critical section, which corresponds to the highest section of the wall above grade, 26.5 feet (8.12m) at the south MSE wall (Bent 1). A total wall height of 28.2 feet was used for the analysis. A traffic surcharge load of 250 psf was used in the design calculations.

Fill will be required to establish the foundation elevations of the MSE Walls. Prior to construction of the walls, all topsoil and wet or soft surface soils should be stripped from the site within construction limits. Proofrolling of the exposed subsurface should be performed in accordance with Section 203.26 in the area where new fill for the walls will be placed. Any soft, loose or unstable soils encountered during proofrolling operations, which will not readily compact, should be removed and replaced with "B" Borrow.

The MSE Walls at both abutments should have adequate factors of safety against overturning, sliding, bearing capacity failure, and global stability if minimum strip lengths of **0.70H** are utilized. The letter H refers to the height of the MSE Wall. For the design of the foundation pad, a net allowable bearing pressure of 4,275 psf can be used. The calculations and graphical representations of our analysis are presented in the Appendix of the report.

The design engineer should address evaluation of the internal stability of the walls against three standard modes of failure. These include pullout of the strips, tensile overstress for the strip and wall/strip connection, and corrosion of the steel reinforcement strip. The backfill for these structures is to be structure backfill as outlined in INDOT Standard Specifications. Soil parameters used for the backfill in the internal stability analysis are assumed to be $\phi = 34°$, $c = 0$, and unit weight (γ) = 125pcf. Behind the reinforced soil mass, additional "B" Borrow backfill should be placed. This material should rise from the heel of the MSE wall on a 1:1 slope. Any loose sand exposed in the foundation excavation should be compacted with a heavy vibrating roller before construction of the MSE wall. Careful consideration when compacting and placing the backfill should be given in order to minimize the increase in lateral earth pressure. Furthermore, tracked construction equipment should not be operated directly on the strips. A minimum backfill thickness of six (6) inches (150mm) is required prior to operation of tracked vehicles over the strips. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the backfill and damaging the strips. Rubber-tired equipment may pass over the reinforcement at slow speed, less than 5mph. Sudden braking and sharp turning should be avoided.

Where high water tables are indicated on the boring logs, sump pumps or other means of dewatering will be necessary to maintain a dry excavation. It should be noted the above design values are assuming proper drainage is occurring. Therefore, during construction of the retaining walls, it is recommended that a permanent subsurface drainage system be installed at or near the base of the retaining wall. It is important that the drainage system be protected by some form of filter to prevent fines from clogging the pipe.

Slope Stability

A slope stability analysis was performed as part of the MSE Wall calculations. The analysis found the proposed design to be adequate. Additionally, the stability of the embankment fill with respect to the natural soils is considered adequate due to the installation of wick drains.

S.R. 641 Ramps

Lines "3", "4", "5", and "6" comprise the on and off ramps at the interchange of the proposed S.R. 641 (Line "CX") at McDaniel Road (Line "C"). The ramps are located to the south of McDaniel Road. Borings SL-1, SL-2, SL-3, and SL-4 were conducted at the proposed ramp lines to investigate the soil conditions. Each of the ramp lines will receive fill to raise the ramps to line "CX" and or line "C".

The soils encountered at lines "3" and "4" on the east side of line "CX" were soft to stiff, Clay Loam, A-4. Boring SL-3, for line "5", encountered Clay, A-7-5, at a shallow depth while boring SL-4 for line "6" encountered Sandy Loam, A-4. Wick drains have been proposed for embankments higher than approximately twenty (20) feet (6m). The subgrades in these areas should be prepared in the same fashion as embankments for the main line "CX".

Drainage Structures

Six drainage structures are proposed at this project location. The structures range in size from 900 to 1800 mm (3-6 feet) diameter pipes, with lengths of approximately 36 to 126 m. Preliminary invert or footing elevations for these structures are indicated on the plans. The pipe structures are in areas of moderate to deep fills. Based on the anticipated depths of the future structures, the foundation soils encountered should provide adequate bearing capacity. However, consideration must be given to the settlement in this area. Shorter lengths of pipe may be required to accommodate the differential settlement along the drainage structure.

Any loose or soft soils encountered along the drainage pipes should be undercut a maximum of 0.6 meters (2 feet) and replaced with "B" Borrow. All of the soils surrounding the structures should be compacted to a minimum of 95% of the maximum dry density as determined in accordance with Section 203.24 of INDOT Standard Specifications.

It is important to protect the drainage structure during construction because maximum strength does not develop until the fill consolidates. It is necessary to avoid imposing concentrated loads far in excess of those the drainage structure would normally carry. Heavy vehicles moving too close to the walls of the drainage structure can create an eccentric loading with harmful results.

Re-alignment of McDaniel Road, Line "C"

McDaniel Road will be re-aligned from its current location beginning just east of the proposed bridge structure. In general, the grade is to be raised. No borings were conducted in the existing roadway specifically for the purposes of reconstruction. Additionally, the borings for the structure can be referenced where the road crosses beneath S.R. 641. One boring, SL-7, was conducted near the western extent of line "C", where a proposed 33 feet (10m) of fill is proposed. This fill is part of an embankment and bridge over the railroad that is not part of this investigation.

The soils along the re-alignment are generally medium stiff, Silty Loam and Sandy Loam. These soils should be treated as the subgrade soils for line "CX" as far as preparation for fills. The large embankment near the end line "C" for this phase may require wick drains, as indicated in Table 2. However, deep, structure borings have not been conducted at this location. Although soft clays are likely present at this location as well, it is recommended that structure borings be conducted prior to the construction of the embankment in this area.

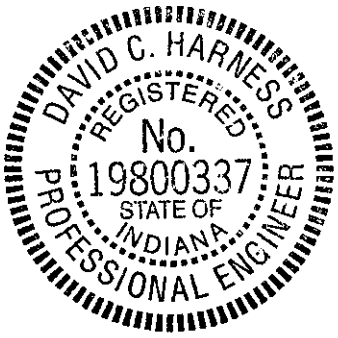
Benching

Benching will be necessary for areas where existing slopes are steeper than 4:1. Benches shall be a minimum of ten (10) feet wide. Benching of natural slopes and existing embankment slopes steeper than 4:1 shall be performed in accordance with Section 203.21 and 22 of the INDOT Standard Specifications.

Often, because of design and construction details that occur on a project, questions arise concerning the soil conditions. If we can give further service in these matters, please contact us at your convenience.

Very truly yours,

ALT & WITZIG ENGINEERING, INC.



David C. Harness, P.E.

Appendix

Boring Location Plans

Logs of Test Borings

Summary of Laboratory Strength Tests

Consolidation Test Results

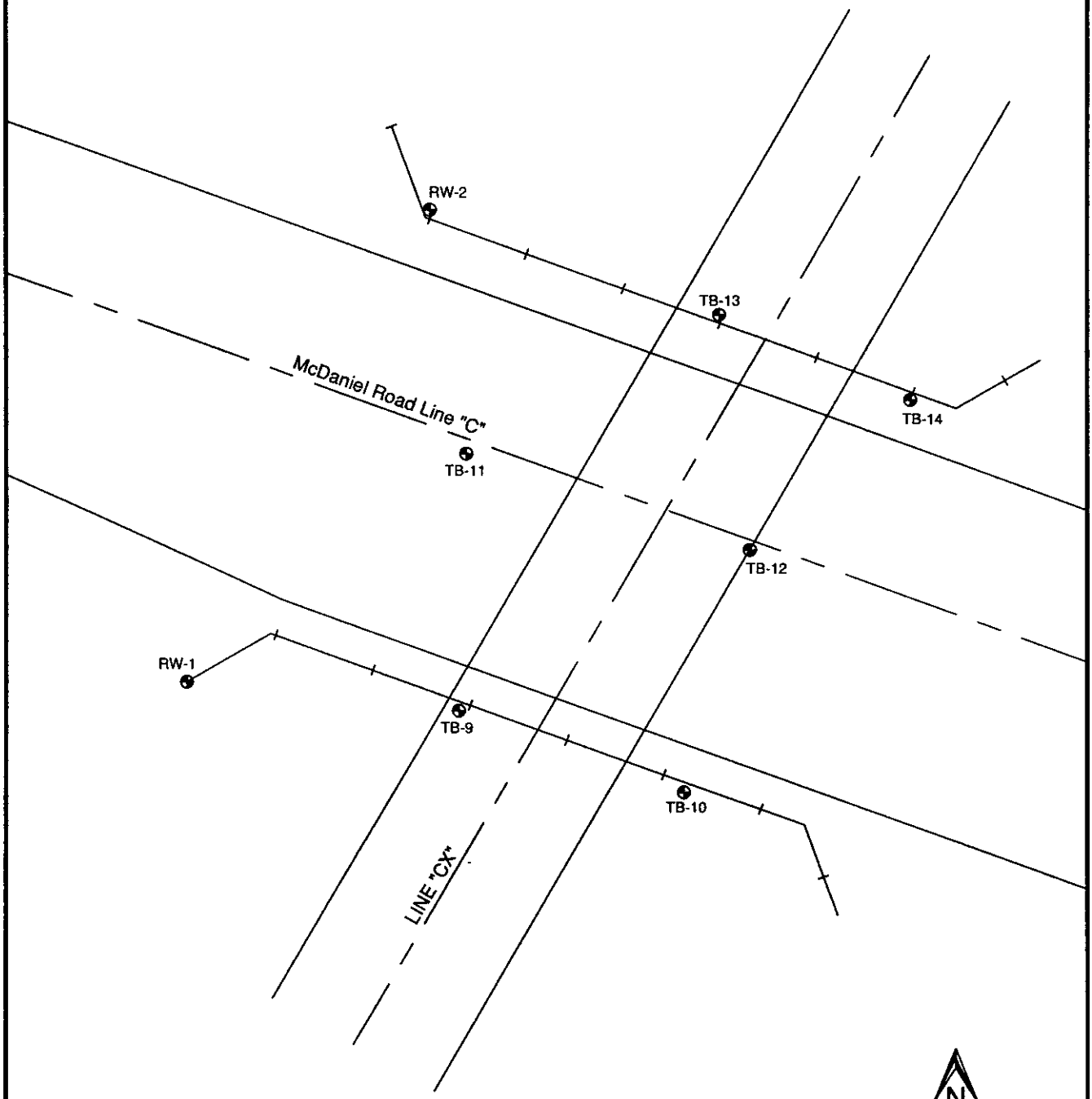
Settlement Calculations

Wick Drain Calculations

SPILE Printouts for Pile Down Drag

MSE Wall Analysis

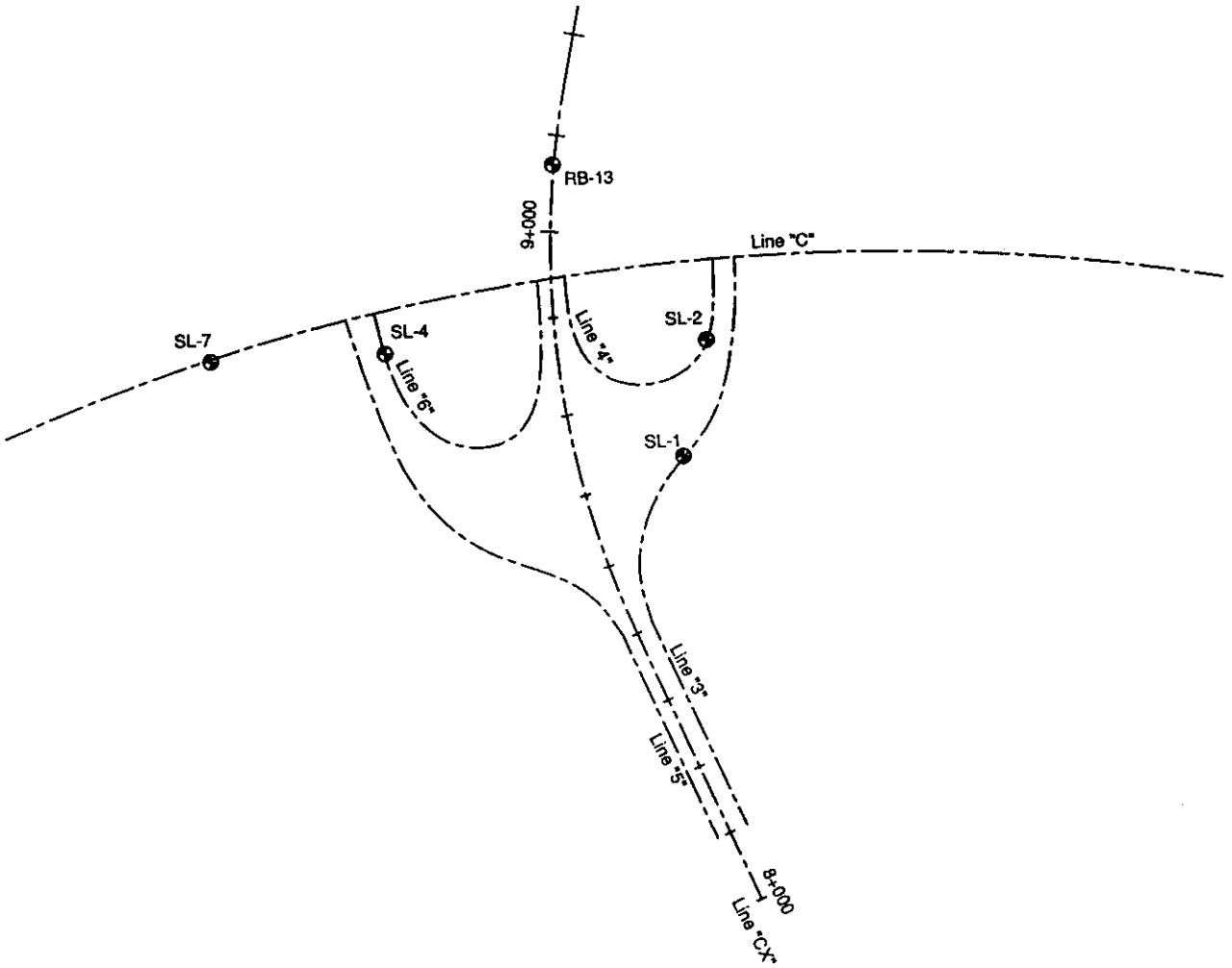
BORING LOCATION PLAN



Note:
TB-11 and RW-2 were not conducted because of existing limitations

Prepared For: INDOT - Geotechnical Section		Prepared By: Alt & Witzig Engineering, Inc.	
Project Name: SR 641 over McDaniel Road		Project No: 02IN1012	Date: 10/03

BORING LOCATION PLAN 2



N

Not to Scale

Prepared For: INDOT - Geotechnical Section		Prepared By: Alt & Witzig Engineering, Inc.	
Project Name: SR 641 over McDaniel Road		Project No: 02IN1012	Date: 10/03

LOG OF TEST BORING

Project: DES No. 9738280 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-9
Surface Elevation 154.0 m(505 f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8399	Station	8+903	Offset	8 m Lt.	Line	CX
Datum	USGS	Weather	Cloudy	Temperature		Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	ɣ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Brown Sand and Gravel with Cinders (Visual)						
1SS	X	100	2-3-4			2.3					
					Brown, Moist, Medium Stiff, Silty Clay Loam						
2SS	X	60	2-4-5		A-4						
				5	Test 03						
3SS	X	100	3-5-5		Brown, Wet, Loose, Sandy Loam	3.7					
					A-2-4						
4SS	X	100	3-7-9		Test 04						
				10	Brown Mottled Gray, Moist, Medium Stiff to Stiff, Silty Clay Loam						
					A-4						
5SS	X	100	3-4-6		Test 03						
				15							
6SS	X	80	4-6-8		Gray, Moist, Medium Stiff to Stiff, Clay		110.3	17.7			
				20	A-7-5						
7SS	X	100	3-5-6		Test 05						
				25							
8SS	X	100	2-3-4				114.9	15.0			
				30							
					Gray, Wet, Medium Stiff to Soft, Silty Loam						
9SS	X	80	1-2-3		A-4						
				35	Test 02						
10SS	X	100	2-3-4		Medium Stiff at 38.5 to 40.0 feet (Sample 10SS)	4.3					
				40							
11SS	X	100	1-1-2		Gray, Moist, Very Soft, Clay						
				45	A-7-5						
					Test 05						
12SS	X	100	1-1-2								
				50							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 15.5 Upon Completion of Drilling ▽ 4.0
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 5/8/03 End 5/8/03 Rig
Driller Mike/James Editor D. Harness
Remarks Boring backfilled after completion at request of property owner.

LOG OF TEST BORING

Project: DES No. 9738280 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-9
Surface Elevation 154.0 m(505 f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8399	Station	8+903	Offset	8 m Lt.	Line	CX
Datum	USGS	Weather	Cloudy	Temperature		Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
				55	Gray, Moist, Very Soft, Clay A-7-5 Test 05						
13SS	X	100	1-1-2								
					Gray, Wet, Sandy Loam (Visual)						
14SS	X	100	1-1-1	60			100.5	20.0			
					Gray, Moist, Very Soft to Medium Stiff, Silty Loam A-4 Test 01						
15SS	X	100	2-4-4	65							
16SS	X	100	3-4-16	70	Very Stiff at 68.5 feet (Sample 16SS)						
					Gray Mottled Brown, Wet, Dense, Sandy Loam A-2-4 Test 04						
17SS	X	100	7-16-17	75							
18SS	X	100	13-45 50/3	80	Gray Weathered Shale (Visual)						
19SS	X	0	50/3	85							
20SS	X	0	50/2	90	Auger Refusal at 88.7 feet						
				95							
				100							
				105							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738280 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-10
Surface Elevation 153 m(502 f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8399	Station	8+906	Offset	25 m Rt.	Line	CX
Datum	USGS	Weather	Sunny	Temperature		Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
1SS	X	100	2-2-2		Topsoil (Visual)						
2SS	X	100	2-3-3	5	Gray Mottled Brown, Moist, Medium Stiff,Silty Clay Loam A-4 Test 03						
3SS	X	100	2-4-6								
4SS	X	100	3-5-9		Gray, Moist, Medium Stiff to Stiff, Clay A-4 (10) Test 09 pH = 7.40						
1ST	■	100		10		2.9	110.1	20.3	37	28	9
5SS	X	80	4-11-12	15							
6SS	X	100	3-4-4								
7SS	X	100	2-4-6	20	Gray, Wet, Very Stiff to Medium Stiff, Silty Loam A-4 Test 02						
8SS	X	100	2-3-4	25							
9SS	X	100	1-3-3	30	Gray, Moist, Medium Stiff , Clay A-7-5 Test 05						
10SS	X	100	1-2-3	35							
11SS	X	100	1-1-1	40	Gray, Moist, Soft to Very Soft, Clay A-7-5 Test 05						
12SS	X	100	1-2-2	45							
				50							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 13.5 Upon Completion of Drilling ● 2.0
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 5/9/03 End 5/9/03 Rig
Driller Mike/James Editor D. Harness
Remarks Boring backfilled after completion at request of property owner.

LOG OF TEST BORING

Project: DES No. 9738280 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-10
Surface Elevation 153 m(502 f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8399	Station	8+906	Offset	25 m Rt.	Line	CX
Datum	USGS	Weather	Sunny	Temperature		Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	ɣ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Gray, Moist, Soft to Very Soft, Clay A-7-5 Test 05						
13SS	X	100	1-3-4	55							
14SS	X	100	2-3-3	60	Gray, Moist, Soft to Very Stiff, Silty Loam A-4 Test 01						
15SS	X	100	5-9-12	65							
16SS	X	100	16-27-31	70	Gray, Moist, Very Dense to Dense, Sandy Loam A-2-4 Test 04						
17SS	X	100	3-14-22	75	8.0 foot Heave at 75.0 feet (Sample 17SS)						
				80	Gray Weathered Shale (Visual)						
				85	Auger Refusal at 85.0 feet						
				90							
				95							
				100							
				105							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738280 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-12
Surface Elevation 154 m(505 f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8399	Station	8+930	Offset	8 m Rt.	Line	CX
Datum	USGS	Weather	Cloudy	Temperature		Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1ST						0.50	98.0	23.2			
					Brown, Moist, Soft, Silty Clay Loam						
1SS	X	80	2-2-3	5	A-4	3.3	108.6	18.9			
					Test 03						
2SS	X	100	2-5-9								
3SS	X	100	5-7-9	10							
					Brown Mottled Gray, Moist, Stiff to Very Stiff, Silty Loam						
4SS	X	60	6-12-13	15	A-4						
					Test 01						
5SS	X	40	8-11-13	20							
6SS	X	80	3-3-2	25	Soft at 23.5 feet (Sample 6SS)		95.4	28.1			
7SS	X	50	7-6-5	30							
					Gray, Moist, Stiff to Medium Stiff, Silty Loam						
8SS	X	100	2-4-4	35	A-4						
					Test 01						
9SS	X	100	3-5-5	40		4.3					
10SS	X	100	2-1-2	45	Gray, Moist, Very Soft to Soft, Clay						
					A-7-5						
					Test 05						
11SS	X	100	0-1-2	50		0.7					

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 6.0 Upon Completion of Drilling ▼ 5.0
Time After Drilling
Depth to Water
Depth to Cave in 64.0

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 7/23/03 End 7/23/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks Boring backfilled after completion at request of property owner.

LOG OF TEST BORING

Project: DES No. 9738280 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-12
Surface Elevation 154 m(505 f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8399	Station	8+930	Offset	8 m Rt.	Line	CX
Datum	USGS	Weather	Cloudy	Temperature		Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
				55	Gray, Moist, Very Soft to Soft, Clay A-7-5 Test 05						
12SS	X	100	3-3-2								
13SS	X	80	3-9-6	60							
14SS	X	100	6-7-6	65	Gray, Moist, Stiff, Silty Loam A-4 Test 01						
15SS	X	100	7-16-15	70							
16SS	X	100	10-15-17	75	Gray, Wet, Dense to Medium Dense, Sandy Loam A-2-4 Test 04						
17SS	X	100	7-11-14	80							
18SS	X	0	50/0	85	Gray, Weathered, Silty Shale (Visual)						
1RC		100	RQD. = 20%	90	Auger Refusal at 88.5 feet Rock Core Initiated at 88.5 feet Gray Siltstone (Visual)						
					Black Fissile Shale (Visual)						
				95	Rock Core Terminated at 93.5 feet						
				100							
				105							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738280 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-13
Surface Elevation 154 m(505 f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8399	Station	8+944	Offset	3 m Lt.	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	75 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	80	3-3-3								
2SS	X	100	2-3-5	5	Brown Mottled Gray, Moist, Medium Stiff, Silty Loam A-4 Test 01						
3SS	X	100	2-4-4								
4SS	X	100	4-5-7	10							
5SS	X	100	5-8-12	15	Gray, Moist, Stiff to Very Stiff, Clay A-4 Test 09						
6SS	X	100	7-12-13	20							
7SS	X	60	4-8-7	25							
8SS	X	100	1-3-5	30	Gray, Moist, Medium Stiff, Silty Clay A-6 Test 08						
9SS	X	100	1-3-4	35							
1ST	■	100		40	Consolidation Test Performed on 1ST	0.86	93.1	20.3	25	13	12
10SS	X	100	2-2-2	45	Gray, Moist, Soft to Very Soft, Silty Clay A-6 (8) Test 08 pH = 7.56 S.G. = 2.764						
11SS	X	100	0-1-2	50							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ♀ 12.0 Upon Completion of Drilling ● 10.0
Time After Drilling 24 hrs
Depth to Water ▽ 4.0
Depth to Cave in 14.0

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 7/22/03 End 7/22/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks Boring backfilled after 24 hour water level reading.

LOG OF TEST BORING

Project: DES No. 9738280 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-13
Surface Elevation 154 m(505 f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8399	Station	8+944	Offset	3 m Lt.	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	75 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
				55	Gray, Moist, Soft to Very Soft, Silty Clay A-6 (8) Test 08 pH = 7.56 S.G. = 2.764						
12SS	X	100	0-2-1								
13SS	X	100	1-2-4	60							
14SS	X	100	1-2-3	65	Gray, Moist, Medium Stiff to Soft, Clay A-7-5 Test 05						
15SS	X	100	3-5-5	70							
16SS	X	100	7-11-13	75	Gray Mottled Brown, Wet, Loose to Medium Dense, Sandy Loam A-2-4 Test 04						
17SS	X	100	12-6-13	80							
18SS	X	60	50/3	85	Black Shale (Visual)						
					Auger Refusal at 87.0 feet						
				90							
				95							
				100							
				105							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738280 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-14
Surface Elevation 155 m(509 f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 2

Str. No.	641-84-8399	Station	8+954	Offset	25 m Rt.	Line	CX
Datum	USGS	Weather	Sunny	Temperature	65 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Asphalt and Crushed Stone (Visual)						
1SS	X	100	3-4-3								
2SS	X	100	3-4-5	5	Brown, Moist, Medium Stiff to Soft, Silty Loam A-4 Test 01						
3SS	X	100	2-2-2								
4SS	X	100	1-3-4	10	Gray Mottled Brown, Moist, Medium Stiff, Silty Clay Loam A-4 Test 03						
5SS	X	100	5-9-11	15	Very Stiff at 13.5 to 15.0 feet (Sample 5SS)						
6SS	X	100	4-8-6	20							
7SS	X	100	2-3-7	25	Gray, Moist, Stiff to Medium Stiff, Clay A-7-5 Test 05						
8SS	X	100	1-2-4	30							
9SS	X	100	3-3-2	35							
10SS	X	100	1-2-2	40	Gray, Moist, Soft to Very Soft, Clay A-7-5 Test 05						
11SS	X	100	1-2-3	45							
12SS	X	100	1-1-2	50							

Continued Next Page

WATER LEVEL OBSERVATIONS

While Drilling ▽ 12.5 Upon Completion of Drilling ▼ 6.0
Time After Drilling
Depth to Water ▽ ▼ ▼ ▼
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 5/12/03 End 5/12/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9738280 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. TB-14
Surface Elevation 155 m(509 f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 2 of 2

Str. No.	641-84-8399	Station	8+954	Offset	25 m Rt.	Line	CX
Datum	USGS	Weather	Sunny	Temperature	65 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
13SS	SS	100	1-1-2	55	Gray, Moist, Soft to Very Soft, Clay A-7-5 Test 05						
14SS	SS	100	0-1-1	60							
15SS	SS	100	1-1-1	65	Very Loose at 63.5 to 65.0 feet (Sample 15SS)						
16SS	SS	100	6-7-8	70	8.0 foot Heave at 70.0 feet (Sample 16SS)						
17SS	SS	100	4-8-8	75	5.0 foot Heave at 75.0 feet (Sample 17SS) Gray, Wet, Medium Dense, Sandy Loam A-2-4 Test 04						
18SS	SS	100	3-6-9	80	5.0 foot Heave at 80.0 feet (Sample 18SS)						
19SS	SS	100	4-7-9	85	Gray Shale (Visual) Auger Refusal at 88.0 feet						
				90							
				95							
				100							
				105							

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

LOG OF TEST BORING

Project: DES No. 9738280 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RW-1
Surface Elevation 154.5 m(507 f)
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	641-84-8399	Station	8+892	Offset	40 m Lt.	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	80 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	100	5-6-9		Brown, Moist, Stiff, Clay A-7-5 Test 05						
2SS	X	60	3-3-6	5	Brown Mottled Gray, Medium Stiff to Very Stiff, Silty Loam A-4 Test 01						
3SS	X	100	5-9-9								
4SS	X	100	3-4-8	10							
5SS	X	100	3-7-7	15	Gray, Moist, Stiff to Very Stiff, Clay A-7-5 Test 05						
6SS	X	60	4-8-10	20							
7SS	X	100	3-7-7	25							
8SS	X	80	3-6-5	30	Gray, Moist, Stiff to Medium Stiff, Clay A-7-6 Test 06						
9SS	X	100	2-3-3			1.7					
				35	Boring Terminated at 35.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling ▽ 22.5 Upon Completion of Drilling ● 12.0
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 8/13/03 End 8/13/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9138220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. RB-13
Surface Elevation 153.8 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	N/A	Station	9+060	Offset	Center Line	Line	CX
Datum	USGS	Weather	Cloudy	Temperature	65 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	δ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
1SS	SS	80	1-1-1		Topsoil (Visual)						
2SS	SS	100	1-3-3	5	Dark Brown Mottled Gray, Moist, Medium Stiff, Silty Clay Loam A-4 Test 03						
3SS	SS	100	1-4-4		Gray, Very Moist, Medium Stiff, Silty Loam A-4 Test 02						
4SS	SS	100	4-7-10	10							
5SS	SS	100	5-9-11	15							
6SS	SS	100	6-5-5	20	Gray, Very Moist, Very Stiff to Medium Stiff, Clay with Wet Sand Seams A-7-5 Test 05						
7SS	SS	100	3-4-5	25							
					Boring Terminated at 25.0 feet						

WATER LEVEL OBSERVATIONS

While Drilling ▽ 10.5 Upon Completion of Drilling ▼ Dry
Time After Drilling 24 hrs.
Depth to Water ▽ ▼ ▼ ▼
Depth to Cave in 4.0

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 6/2/03 End 6/2/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9138220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. SL-1
Surface Elevation 152.6 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	N/A	Station	1+203	Offset	Center Line	Line	3
Datum	USGS	Weather	Partly Cloudy	Temperature	80 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	ɣ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	SS	60	2-3-4								
2SS	SS	100	1-2-3								
				5	Brown, Moist, Medium Stiff to Soft, Silty Clay Loam A-4 Test 03						
3SS	SS	100	2-3-4								
4SS	SS	100	2-2-3								
				10	Boring Terminated at 10.0 feet						
				15							
				20							
				25							

WATER LEVEL OBSERVATIONS

While Drilling	Dry	Upon Completion of Drilling	Dry	
Time After Drilling	2.0 hrs.	24 hrs.		
Depth to Water	Dry	Dry		
Depth to Cave in				

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 8/13/03 End 8/13/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9138220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. SL-2
Surface Elevation 152.8 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	N/A	Station	1+100	Offset	Center Line	Line	4
Datum	USGS	Weather	Partly Cloudy	Temperature	80 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	SS	60	3-6-6								
2SS	SS	100	3-3-4	5	Brown, Moist, Stiff to Medium Stiff, Silty Clay Loam A-4 Test 03						
3SS	SS	100	3-3-4								
4SS	SS	100	2-2-3	10	Gray Mottled Brown, Very Moist, Soft, Silty Loam A-4 Test 01						
					Boring Terminated at 10.0 feet						
				15							
				20							
				25							

WATER LEVEL OBSERVATIONS

While Drilling	Dry	Upon Completion of Drilling	9.0	
Time After Drilling	2.0 hrs.	24 hrs.		
Depth to Water	8.0	8.0		
Depth to Cave in				

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 8/13/03 End 8/13/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

LOG OF TEST BORING

Project: DES No. 9138220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. SL-3
Surface Elevation 152.6 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	N/A	Station	1+300	Offset	Center Line	Line	5
Datum	USGS	Weather	Partly Cloudy	Temperature	80 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	100	3-4-5		Brown, Moist, Medium Stiff, Clay A-7-5 Test 05						
2SS	X	100	2-2-3	5	Brown, Very Moist, Soft, Silty Clay Loam A-4 Test 03						
3SS	X	100	2-3-4		Gray Mottled Brown, Moist, Medium Stiff to Very Stiff, Clay A-7-5 Test 05						
4SS	X	100	6-8-10	10	Boring Terminated at 10.0 feet						
				15							
				20							
				25							

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry Upon Completion of Drilling ▼ 6.5
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 8/12/03 End 8/12/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks Boring backfilled after completion.

LOG OF TEST BORING

Project: DES No. 9138220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. SL-4
Surface Elevation 154.7 m
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	N/A	Station	1+300	Offset	Center Line	Line	6
Datum	USGS	Weather	Partly Sunny	Temperature	80 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	ɣ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS	X	90	3-7-6		Brown, Moist, Medium Dense, Sandy Loam A-4 Test 07						
2SS	X	60	3-4-4	5							
3SS	X	100	4-10-7		Brown, Very Moist, Loose to Medium Dense, Sandy Loam A-4 Test 07						
4SS	X	100	1-2-5		Gray, Moist, Medium Stiff, Silty Loam A-4 Test 01						
				10	Boring Terminated at 10.0 feet						
				15							
				20							
				25							

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry Upon Completion of Drilling ▼ 6.5
Time After Drilling
Depth to Water
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 8/12/03 End 8/12/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks Boring backfilled after completion.

LOG OF TEST BORING

Project: DES No. 9138220 - S.R. 641
Location: SR 641, Vigo County, Terre Haute, IN
Client: INDOT, Geotechnical Section

4105 West 99th Street Carmel, Indiana 46032
317-875-7040/317-870-0314(Fax)

Boring No. SL-7
Surface Elevation
Proj. # STP-291-1(005)
AW Proj. # 02IN1012
Sheet 1 of 1

Str. No.	N/A	Station	100+630	Offset	Center Line	Line	C
Datum	USGS	Weather	Cloudy	Temperature	80 F	Inspector	Tom Coffey

SAMPLE No.	Type	Rec (%)	Blow Count	Depth	DESCRIPTION/CLASSIFICATION and REMARKS	qu (qp) (tsf)	γ (pcf)	W (%)	LL (%)	PL (%)	PI (%)
					Topsoil (Visual)						
1SS		100	4-4-3		Brown Mottled Gray, Moist, Medium Stiff, Silty Loam A-4 Test 01						
2SS		100	2-3-4	5	Brown Mottled Gray, Moist, Loose, Sandy Loam A-2-4 Test 04						
3SS		100	3-4-4								
4SS		100	2-4-8	10	Gray Mottled Brown, Moist, Medium Stiff to Stiff, Silty Clay Loam A-4 Test 03						
5SS		100	5-5-7	15	Gray, Very Moist, Stiff to Very Stiff, Clay A-7-5 Test 05						
6SS		100	5-9-10	20	Boring Terminated at 20.0 feet						
				25							

WATER LEVEL OBSERVATIONS

While Drilling ▽ 11.5 Upon Completion of Drilling ▼ 7.5
Time After Drilling 24 hrs.
Depth to Water ▽ 6.0 ▼ ▼ ▼
Depth to Cave in

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 8/12/03 End 8/12/03 Rig B-59
Driller Mike/James Editor D. Harness
Remarks

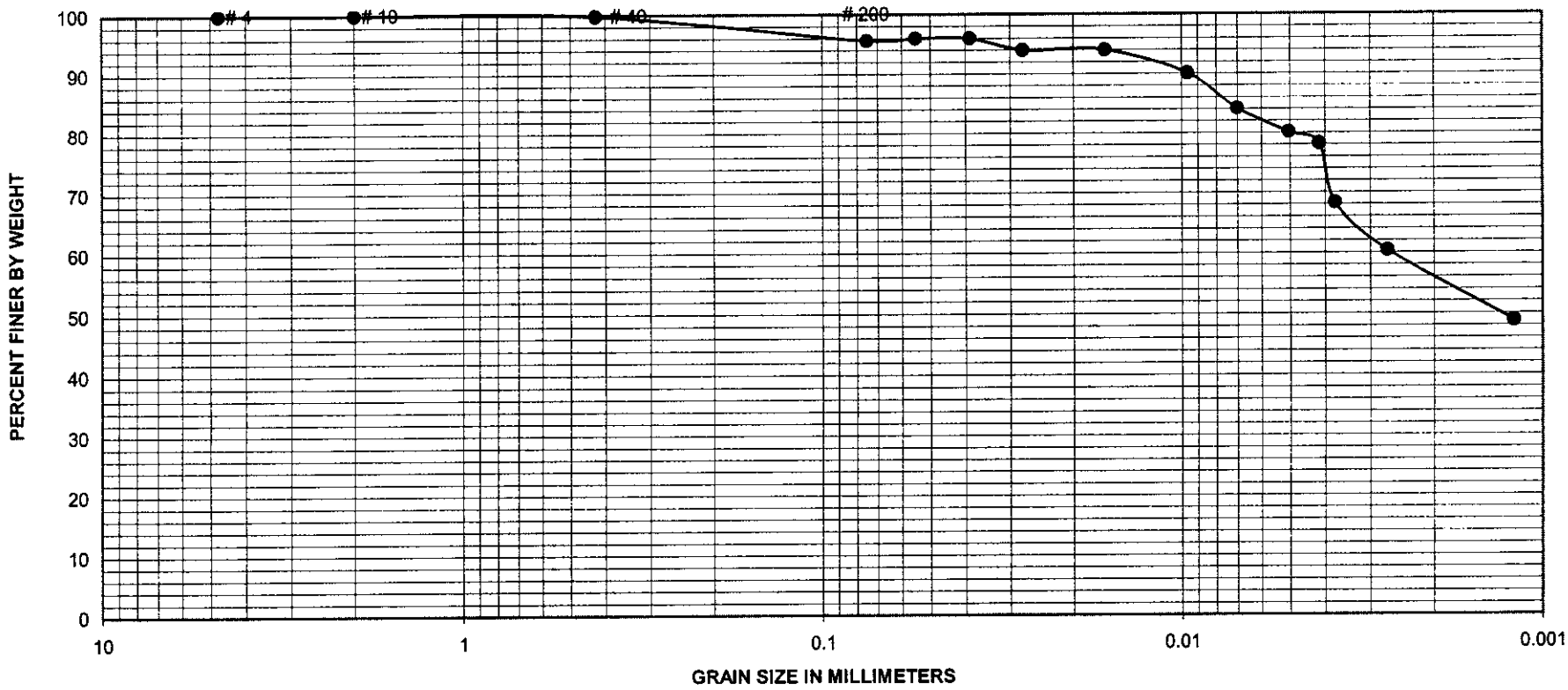
Project No.: STP-291-1 ( )
Des No.: 9738280
S.R. 641, Vigo County, Indiana
Alt & Witzig File: 02IN1012

SOIL CLASSIFICATION SUMMARY

Test No.	Boring Number	Sample & Depth	Description	Passing #10	Passing #40	> #10 % Gravel	#10-#200 % Sand	#200-.002mm % Silt	% <0.002mm (%) Clay	% <0.001mm Colloids	LL	PL	PI	AASHTO Classification
01	TB-26[1]	1ST 16 to 18 ft	Silty Loam	100	100	0	6	77	17	14	26	24	2	A-4 (1)
02	TB-26[1]	3SS 5.0 to 7.5 ft	Silty Loam	100	99	0	22	61	17	17	24	18	6	A-4 (3)
03	TB-23[2]	8SS 28.5 to 30 ft	Silty Clay Loam	99	97	1	15	64	20	19	26	20	6	A-4 (4)
04	TB-28[1]	7SS 23.5 to 25 ft	Sandy Loam	100	98	0	66	18	16	14	NP	NP	--	A-2-4 (0)
05	TB-26[1]	2ST 46 to 48 ft	Clay	100	100	0	0	40	60	55	50	36	14	A-7-5 (20)
06	TB-2[3]	9SS 33.5 to 35 ft	Clay	100	100	0	1	25	74	72	54	19	35	A-7-6 (38)
07	TB-4[3]	14SS 58.5 to 60 ft	Sandy Loam	89	71	11	53	22	14	12	23	21	2	A-4 (0)
08	TB-13[4]	1ST 38 to 40 ft	Silty Clay	100	99	0	10	58	32	30	25	13	12	A-6 (8)
09	TB-10[4]	1ST 10-12 ft	Clay	100	100	0	4	40	56	49	37	28	9	A-4 (10)

Notes:
1: Soils from Des No.: 9738330, Structure 641-84-8401
2: Soils from Des No.: 9738410, Structure 641-84-8404
3: Soils from Des No.: 9738270, Structure 641-84-8398
4: Soils from Des No.: 9738280, Structure 641-84-8399

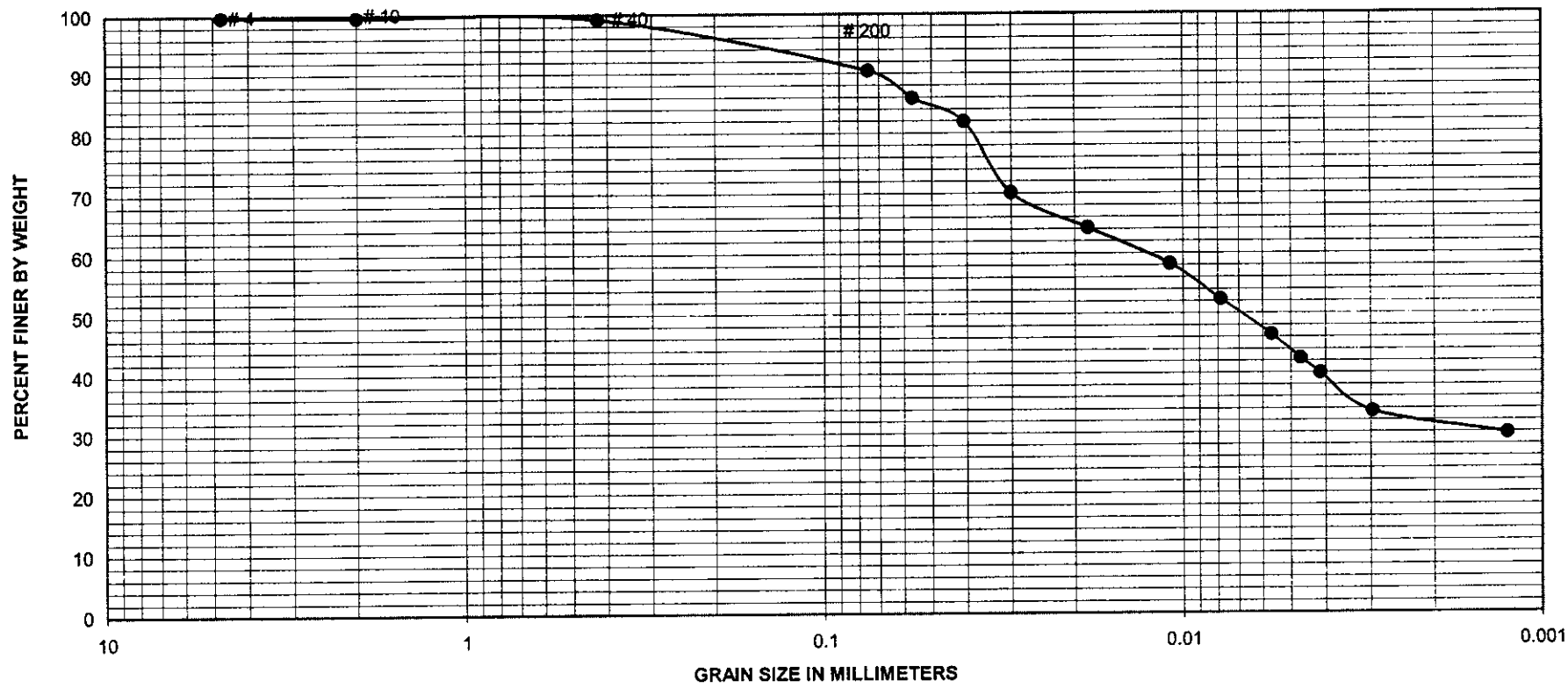
Grain Size Distribution Curve



GRAVEL	SAND	SILT	CLAY

Boring No.	Sample No.	Elev or Depth	Nat w%	LL	PL	PI	Classification-TEST 09	Project: SR-641 - 02IN1012
TB-10	1ST	10-12'	18.4	37	28	9	Clay	
							A-4 (10)	
							pH 7.40	
								Date: 10/03

Grain Size Distribution Curve



GRAVEL	SAND	SILT	CLAY

Boring No.	Sample No.	Elev or Depth	Nat w%	LL	PL	PI	Classification-Test 08
TB-13	1ST	38-40'	30.4	25	13	12	Silty Clay
							A-6 (8)
							pH = 7.56

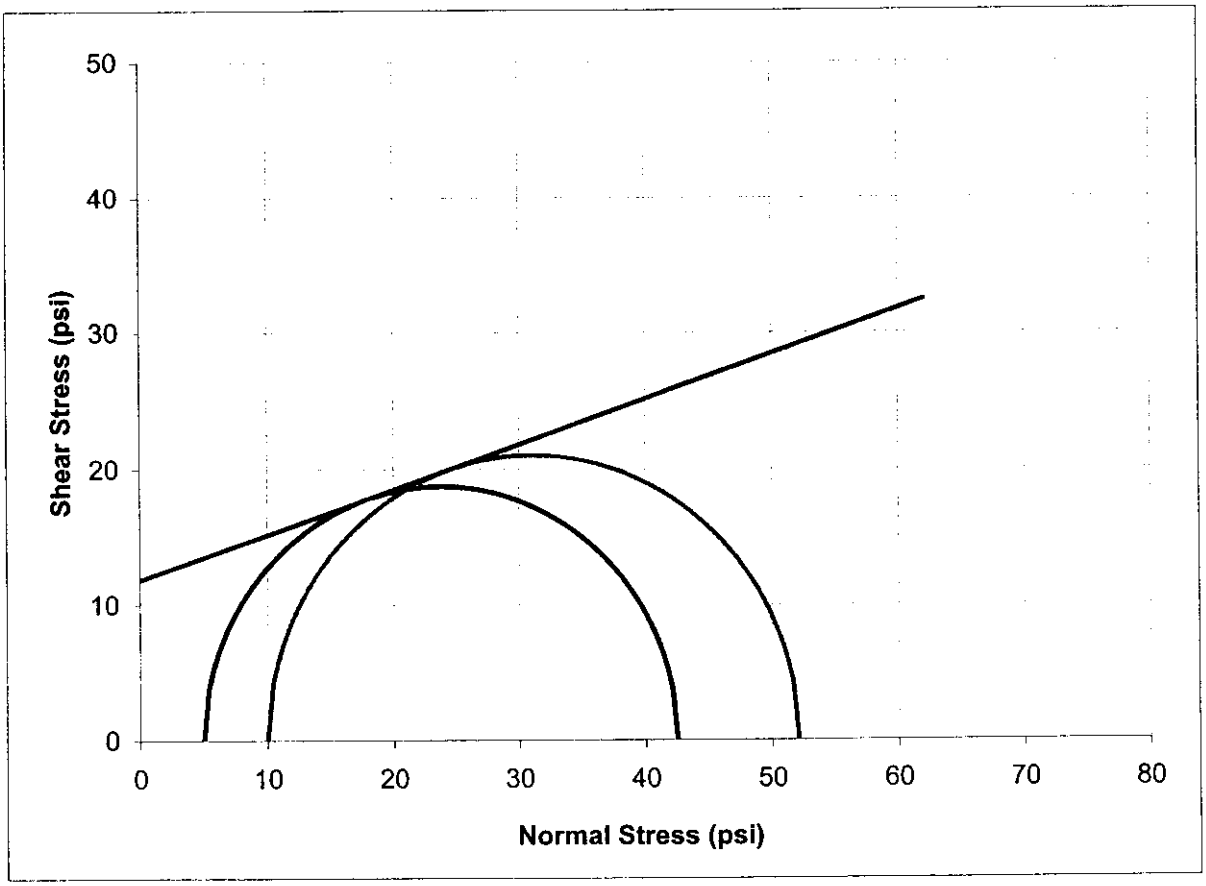
Project: SR-641 - 02IN1012

Date: 10/03

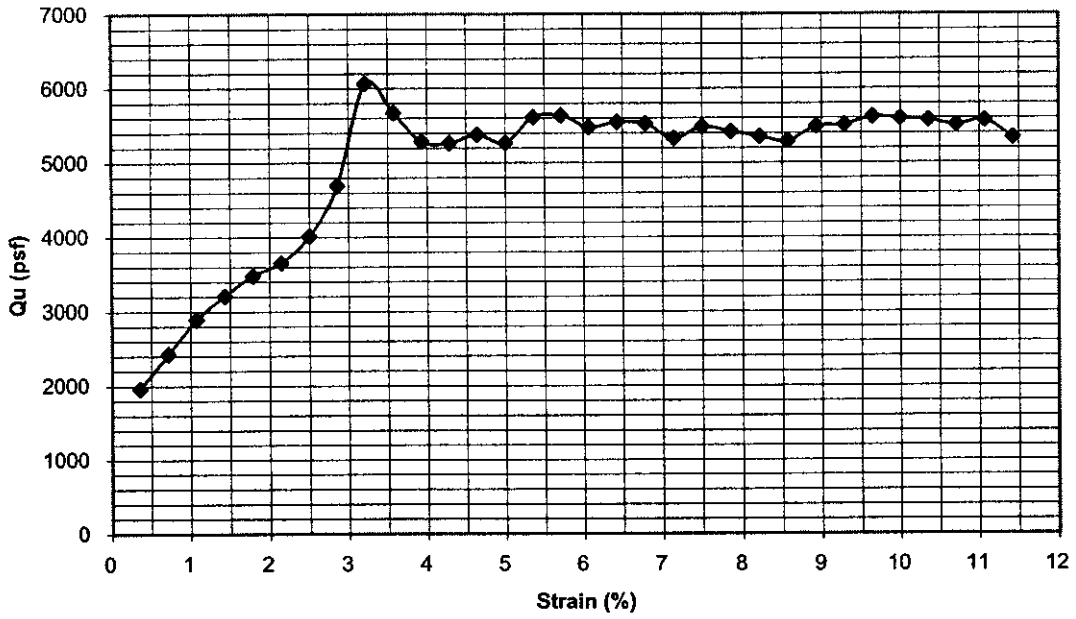
Mohr's Circle Diagram

				From Strain/Stress
Test 1	σ1	42.50 psi	Maximum Strength 1 (psf):	5,400
	σ3	5.0 psi	Confining Pressure 1 (psi):	5
Test 2	σ1	52.08 psi	Maximum Strength 2 (psf):	6,060
	σ3	10.0 psi	Confining Pressure 2 (psi):	10

	Δσ1	Δσ3	
Step 1	9.58	5.00	
	$\tan^2(45+\phi/2)$	$\tan(45+\phi/2)$	ϕ
Step 2	1.92	1.38	**18.32**
	$2c\tan(45+\phi/2)$	2c	c
Step 3	32.92	28.78	**11.89** psi



Consolidated-Undrained Triaxial

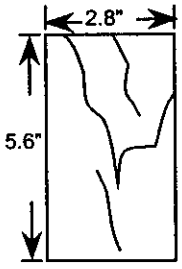


Sample Location TB-13

Depth 38 - 40' Moisture Content: 29.4 (%)

Strain Rate 2% min. Dry Unit Weight: 93.1 (pcf)

FAILURE SKETCH



Soil Description Silty Clay, Test 08

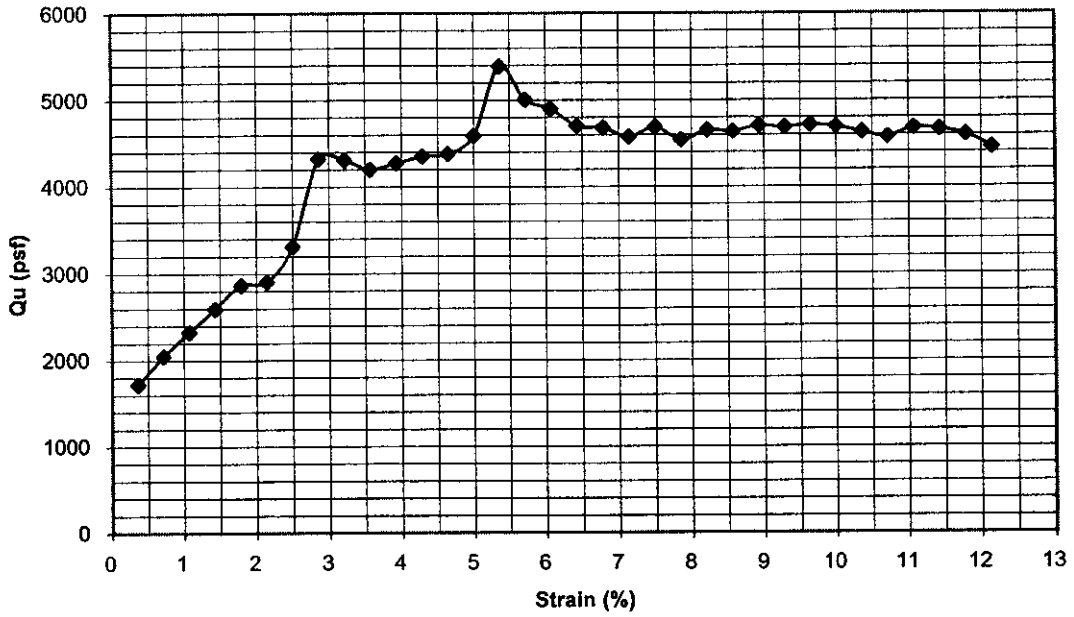
Confining Pressure (psi) 10

Ultimate Strength (psf) 6,060

Failure Strain (%) 3.2

PREPARED FOR: INDOT-Geotechnical Division, Indianapolis, Indiana	A&W	PREPARED BY: Alt & Witzig Engineering, Inc., Carmel, Indiana	
PROJECT NAME: SR 641, Terre Haute, Indiana		PROJECT NO.: 02IN1012	DATE: 10/03

Consolidated-Undrained Triaxial

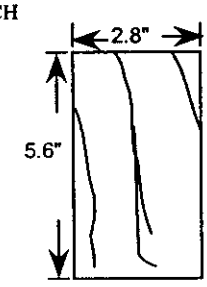


Sample Location TB-13

Depth 38 - 40' Moisture Content: 30.4 (%)

Strain Rate 2% min. Dry Unit Weight: 93.1 (pcf)

FAILURE SKETCH



Soil Description Silty Clay, Test 08

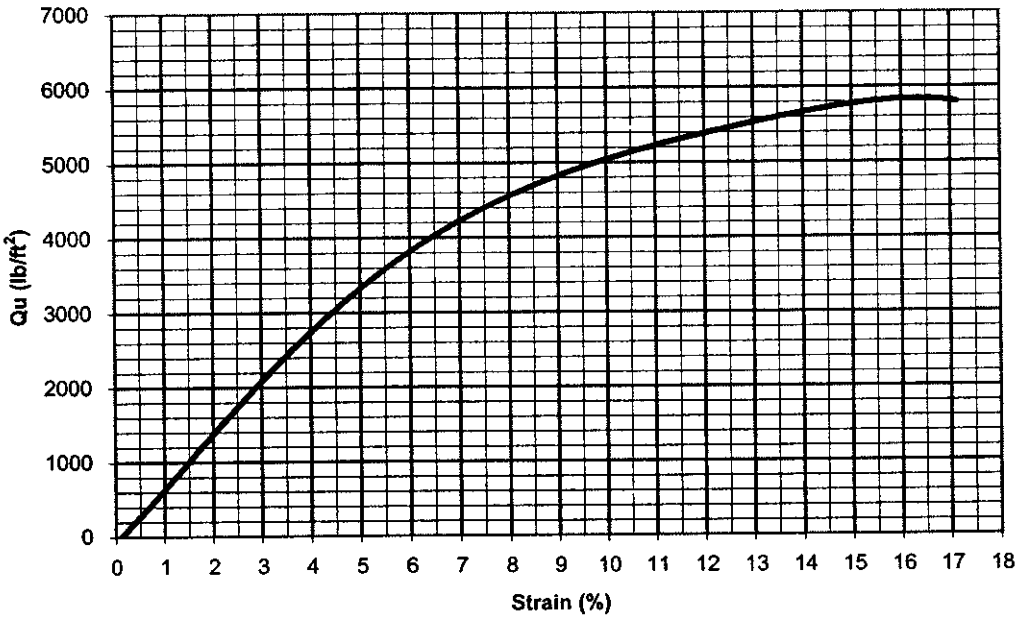
Confining Pressure (psi) 5

Ultimate Strength (psf) 5,400

Failure Strain (%) 5.4

PREPARED FOR: INDOT-Geotechnical Division Indianapolis, Indiana	A&W	PREPARED BY: Alt & Witzig Engineering, Inc. Carmel, Indiana	
PROJECT NAME: SR 641 Terre Haute, Indiana		PROJECT NO.: 02IN1012	DATE: 10/03

Unconfined Compression Test

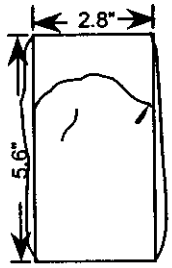


Sample Location: TB-10

Depth: 10-12 ft Moisture Content: 20.3 (%)

Strain Rate: 2% min. Dry Unit Weight: 110.1 (lb/ft^3)

FAILURE SKETCH



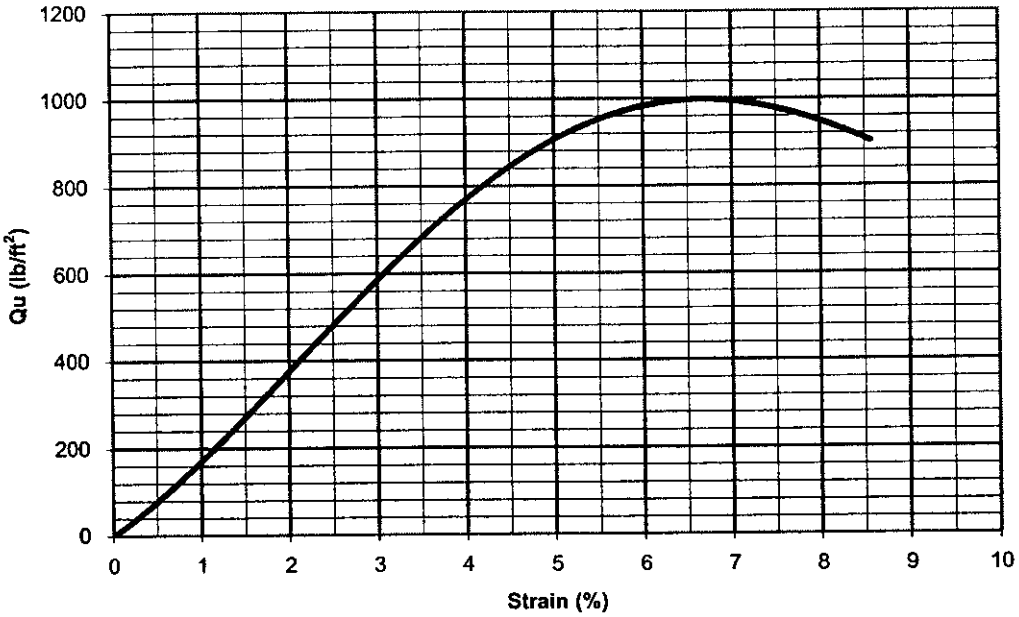
Soil Description: Gray Clay A-4, Test 09

Unconfined Compressive Strength (lb/ft^2): 5,800

Failure Strain (%): 15.0

PREPARED FOR: INDOT-Geotechnical Division, Indianapolis, Indiana	A&W	PREPARED BY Alt & Witzig Engineering, Inc. Carmel, Indiana	
PROJECT NAME: SR-641, Terre Haute, Indiana		PROJECT NO.: 02IN1012	DATE: 10/03

Unconfined Compression Test

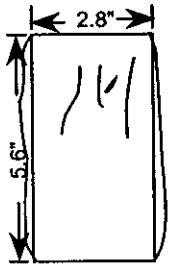


Sample Location: TB-12

Depth: 1-3 ft Moisture Content: 23.2 (%)

Strain Rate: 2% min. Dry Unit Weight: 98.0 (lb/ft^3)

FAILURE SKETCH



Soil Description: Silty Clay Loam, A-4, Test 03

Unconfined Compressive Strength (lb/ft^2): 990

Failure Strain (%): 7.0

PREPARED FOR: INDOT-Geotechnical Division, Indianapolis, Indiana	A&W	PREPARED BY: Alt & Witzig Engineering, Inc., Carmel, Indiana	
PROJECT NAME: SR-641, Terre Haute, Indiana		PROJECT NO.: 02IN1012	DATE: 10/03

Summay of Unconfined Compressive Strength on Split Spoon Samples

Project Name: SR-641over McDaniel Road

Project Number: 02IN1012 Date Completed: 10/03

Boring #	Sample Depth	Unconfined Compresssive Strength (psf)	Failure Strain (%)
RW-1	35'	3,370	15.4
TB-9	2.5'	4,660	10.0
TB-9	7.5'	7,450	7.1
TB-9	40'	8,550	7.1
TB-12	7.5'	6,600	10.0
TB-12	40'	8,550	5.4
TB-12	50'	1,360	13.2

Summary of Unit Weights

Project Name: SR-641over McDaniel Road

Project Number: 02IN1012 Date Completed: 10/2003

Boring #	Sample Depth	Moisture Content	Wet Density	Dry Density
TB-9	20'	17.7	129.8	110.3
TB-9	30'	15.0	132.1	114.9
TB-9	60'	20.0	120.6	100.5
TB-10	10-12'	20.3	132.5	110.1
TB-12	5'	18.9	129.1	108.6
TB-12	1-3'	23.2	120.8	98.0
TB-12	25'	28.1	122.2	95.4
TB-13	38-40'	30.4	121.4	93.1

Summary of Specific Gravity

Project Name: SR-641 over McDaniel Road

Project Number: 02IN1012 Date Completed: 10/2003

Boring #	Sample Depth	Specific Gravity
TB-13	38-40	2.764

Summary of Atterberg Limits

Project Name: SR-641 over McDaniel Road

Project Number: 02IN1012 Date Completed: 6/13/2003

Boring #	Sample Depth	Liquid Limit	Plastic Limit	Plasticity Index
TB-10	10-12'	37	28	9
TB-13	38-40'	25	13	12

Summary of pH's

Project Name: SR-641 641 over McDaniel Road

Project Number: 02IN1012 Date Completed: 6/13/2003

Boring #	Depth	pH
TB-10	10.0-12.0	7.4
TB-13	38-40	7.56

Alt Witzig File 02IN1012

Consolidation Test Dial Readings

SR 641 over McDaniel Road

		Height of solids, H_s	0.53536	p water	62.4
Project Name:	SR 641 over McDaniel Road	Initial Specimen Height=	1	M% init.	28.10%
Project #:	02IN1012	Specimen Diameter=	2.5	M% end	23.20%
Sample ID	TB-13, 1ST, 38-40'	Weight of dry specimen=	118.97	G_s	2.764

Dial Reading at Given Load, TSF

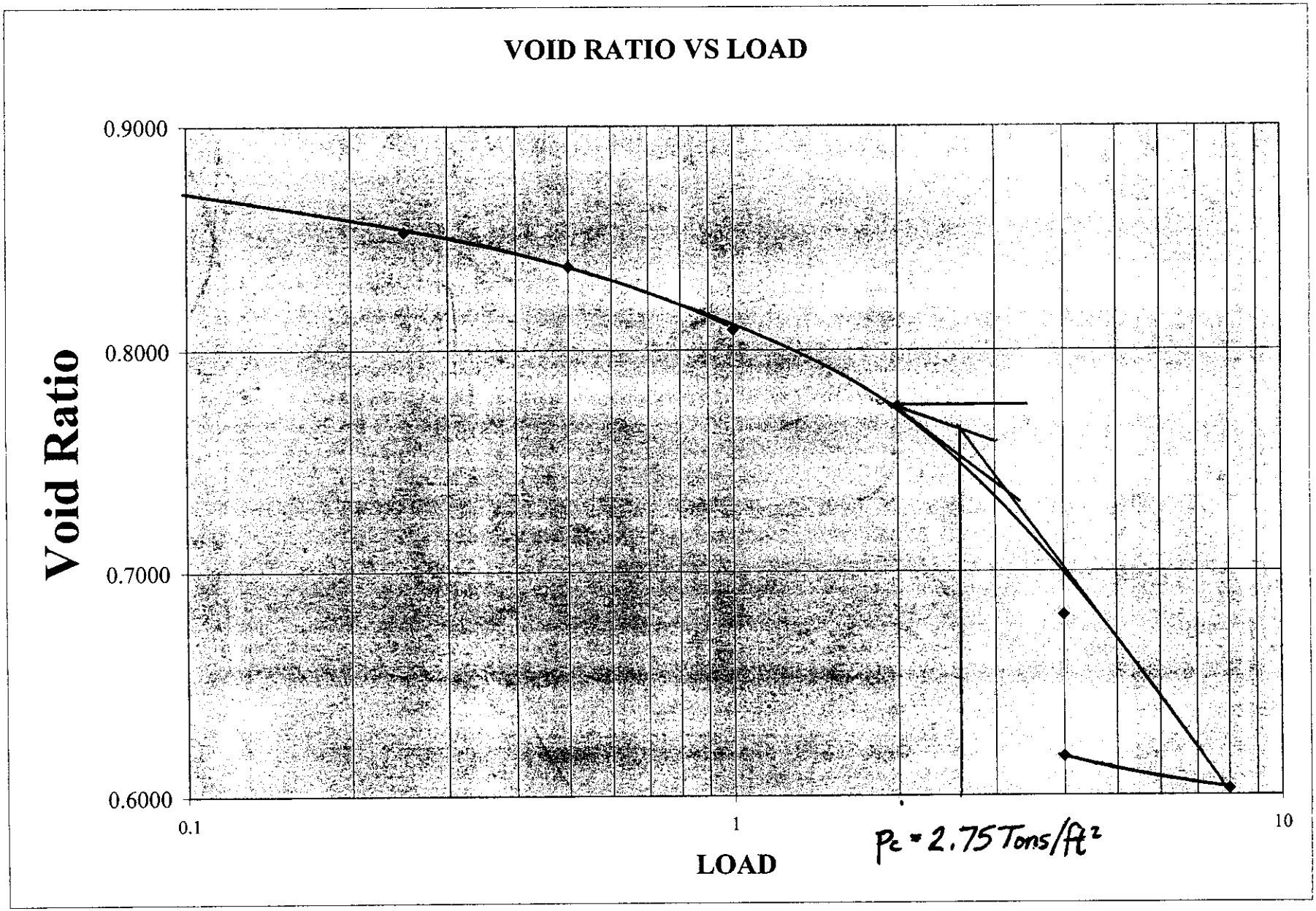
T (sec)	T (min)	0.25	0.5	1	2	4	8	16	4	1	0.25	Sqrt T(sec)
0	0	0	0.0082	0.0165	0.0315	0.0501	0.1004	0.1419	0.1435	0.134	0.1198	0
6	0.1	0.0035	0.009	0.0213	0.0362	0.0571	0.106	0.1424	0.1382	0.1314	0.1184	2.44949
12	0.2	0.0039	0.0091	0.022	0.0369	0.058	0.107	0.1424	0.1379	0.1311	0.1181	3.464102
30	0.5	0.0045	0.0095	0.023	0.038	0.0598	0.1089	0.1426	0.1374	0.1306	0.1177	5.477226
60	1	0.005	0.0102	0.0241	0.0392	0.062	0.1114	0.1426	0.1367	0.1299	0.1173	7.745967
120	2	0.0054	0.0104	0.025	0.0408	0.0652	0.1154	0.1427	0.136	0.1292	0.1167	10.95445
240	4	0.0059	0.0107	0.0263	0.0422	0.0685	0.1201	0.1427	0.1352	0.1278	0.115	15.49193
480	8	0.0064	0.0129	0.027	0.0441	0.0724	0.1278	0.1427	0.1347	0.1255	0.1136	21.9089
900	15	0.0067	0.0139	0.0276	0.0452	0.0752	0.1313	0.1428	0.134	0.1245	0.1108	30
1800	30	0.0069	0.0143	0.0282	0.0464	0.0776	0.1349	0.1428	0.1338	0.1228	0.1076	42.42641
3600	60	0.0073	0.0147	0.0286	0.0469	0.0789	0.1371	0.1428	0.1336	0.1215	0.1046	60
7200	120	0.0075	0.015	0.0293	0.0477	0.08	0.1392	0.1429	0.1338	0.1211	0.1002	84.85281
14400	240	0.0077	0.0152	0.0299	0.0487	0.0811	0.1399	0.1429	0.134	0.1206	0.099	120
28800	480	0.008	0.0155	0.0306	0.0495	0.0821	0.1407	0.143	0.1353	0.1202	0.0973	169.7056
86400	1440	0.0082	0.0165	0.0315	0.0501	0.1004	0.1419	0.1435	0.134	0.1198	0.0945	293.9388

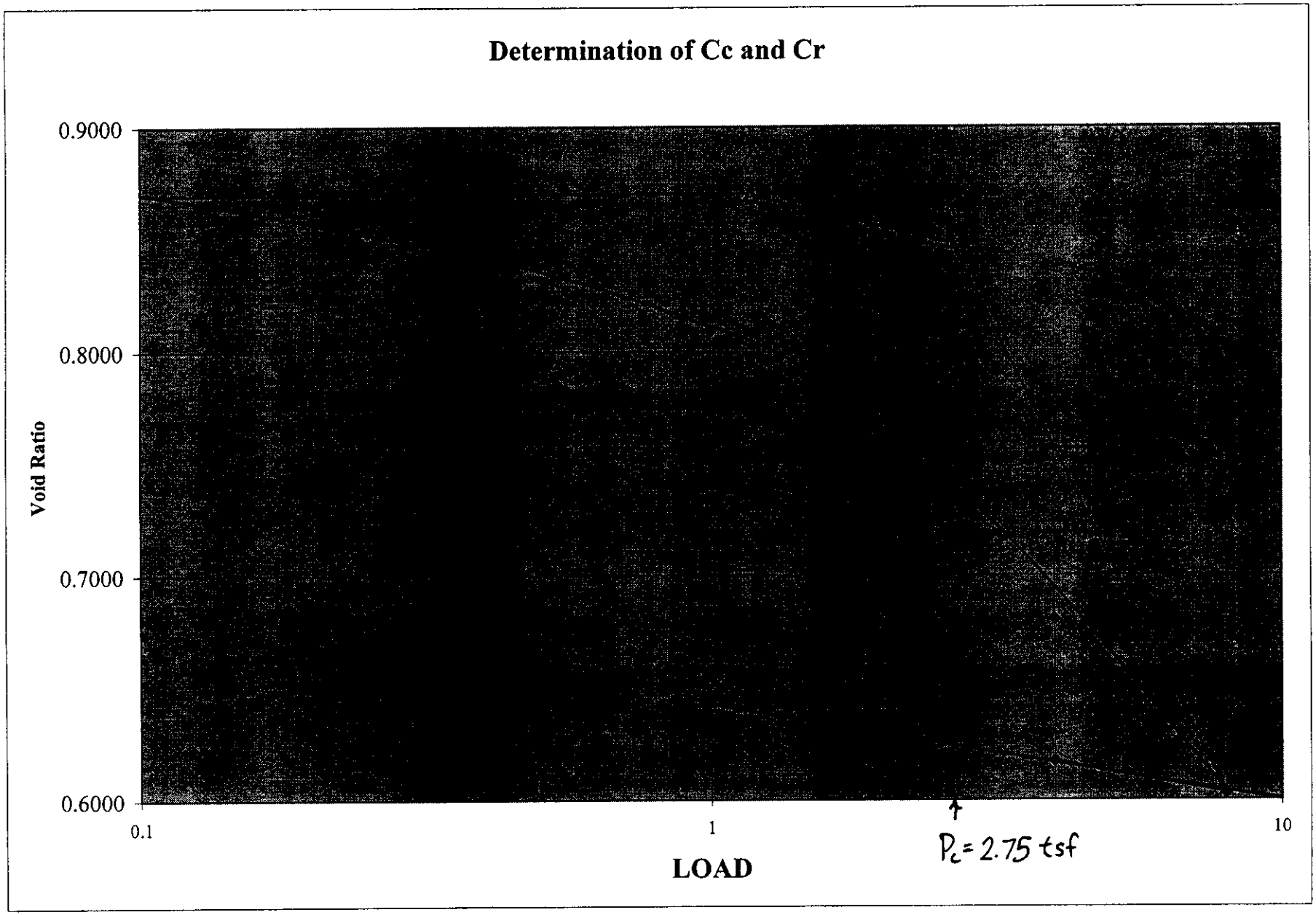
Alt Witzig File 02IN1012

Consolidation Test Results

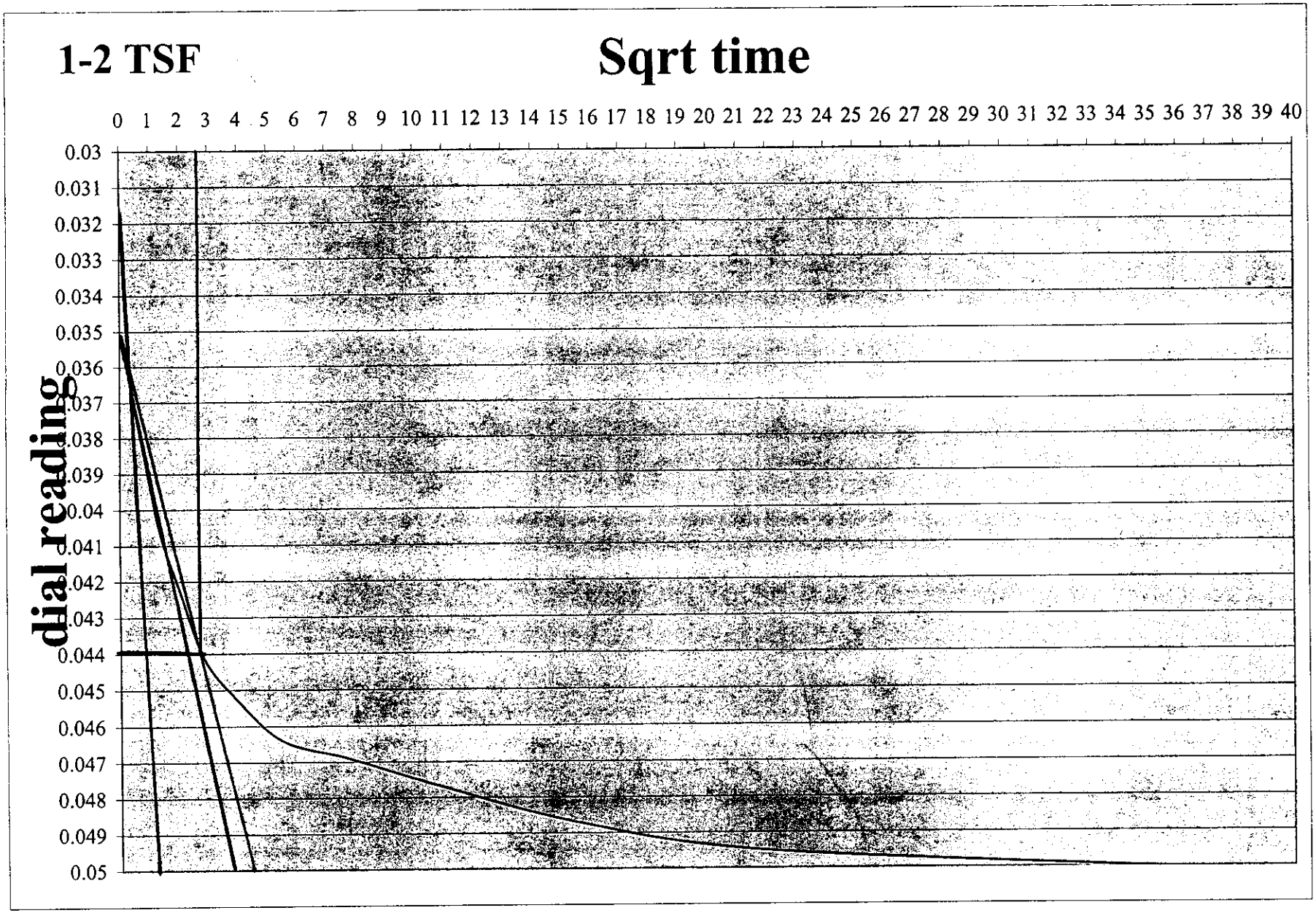
SR 641 over McDaniel Road

Pressure, P tsf	Final Dial Reading inches	Change in specimen height (in)	Final specimen height (in)	Height of void (Hv) inches	Final void ratio e	Avg height Ht inches	Fitting Time (sec)		Cv x 10^{-3}	
							t_{90}	t_{50}	t_{90}	t_{50}
0	0		1	0.4646	0.8679					
		0.0082				0.9959			#DIV/0!	#DIV/0!
0.25	0.0082		0.9918	0.4564	0.8526					
		0.0083				0.9877			#DIV/0!	#DIV/0!
0.5	0.0165		0.9835	0.4481	0.8371					
		0.015				0.9760			#DIV/0!	#DIV/0!
1	0.0315		0.9685	0.4331	0.8091					
		0.0186				0.9592	454	210	0.430	0.216
2	0.0501		0.9499	0.4145	0.7743					
		0.0503				0.9248	540	240	0.336	0.175
4	0.1004		0.8996	0.3642	0.6804					
		0.0415				0.8789	864	255	0.190	0.149
8	0.1419		0.8581	0.3227	0.6028					
		0.0016				0.8573				
16	0.1435		0.8565	0.3211	0.5998					
		-0.0095				0.8613				
4	0.134		0.866	0.3306	0.6176					
		-0.0142				0.8731				
1	0.1198		0.8802	0.3448	0.6441					
		-0.0253				0.8929				
0.25	0.0945		0.9055	0.3701	0.6914					


VOID RATIO VS LOAD
Void Ratio
0.9000
0.8000
0.7000
0.6000
0.1
1
10
LOAD
Pc = 2.75 Tons/ft²

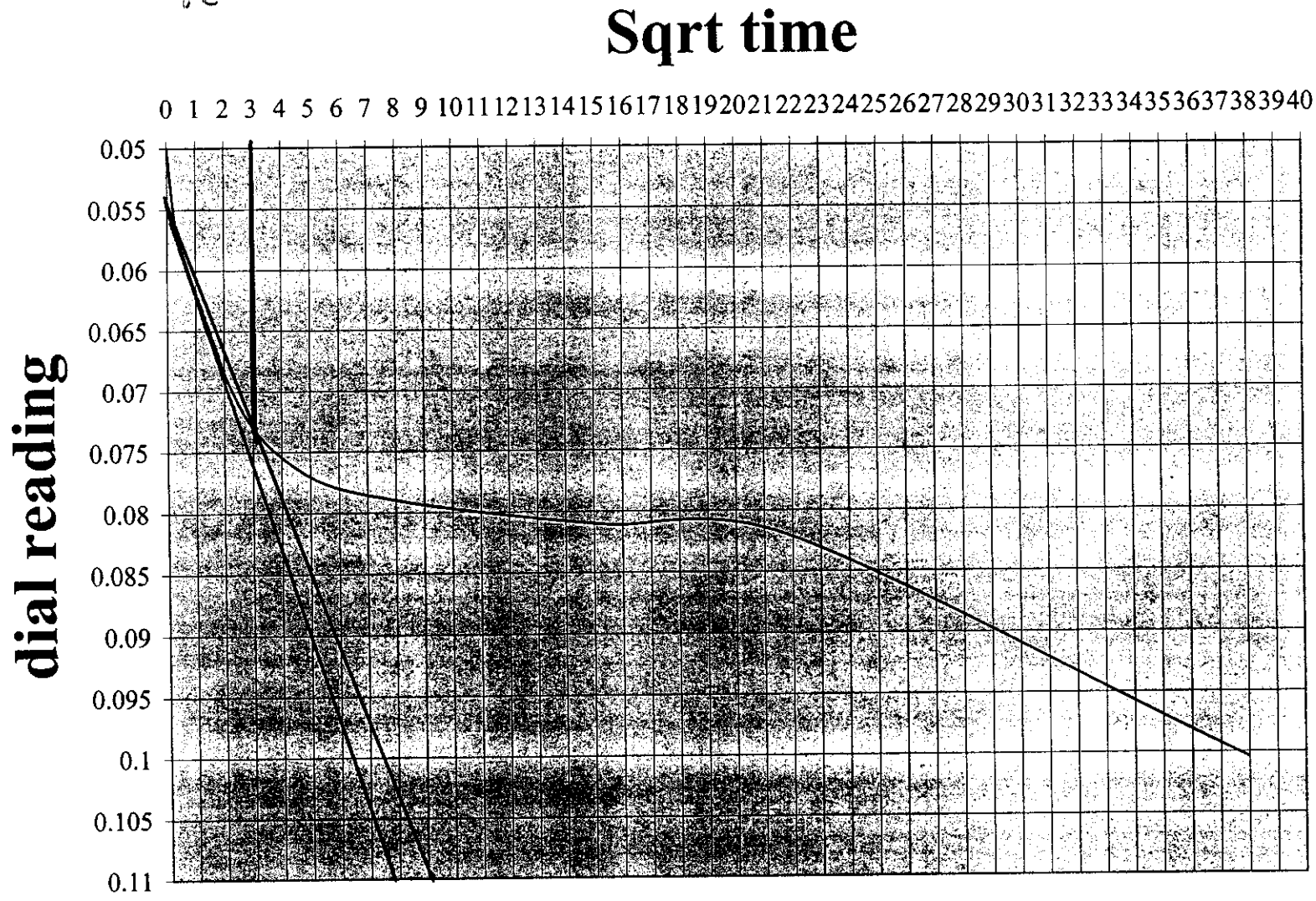

Determination of Cc and Cr
0.9000
0.8000
0.7000
0.6000
Void Ratio
0.1
1
10
LOAD
Pc = 2.75 tsf

$2.75 = \sqrt{t}$ t_{90} 7.56 min

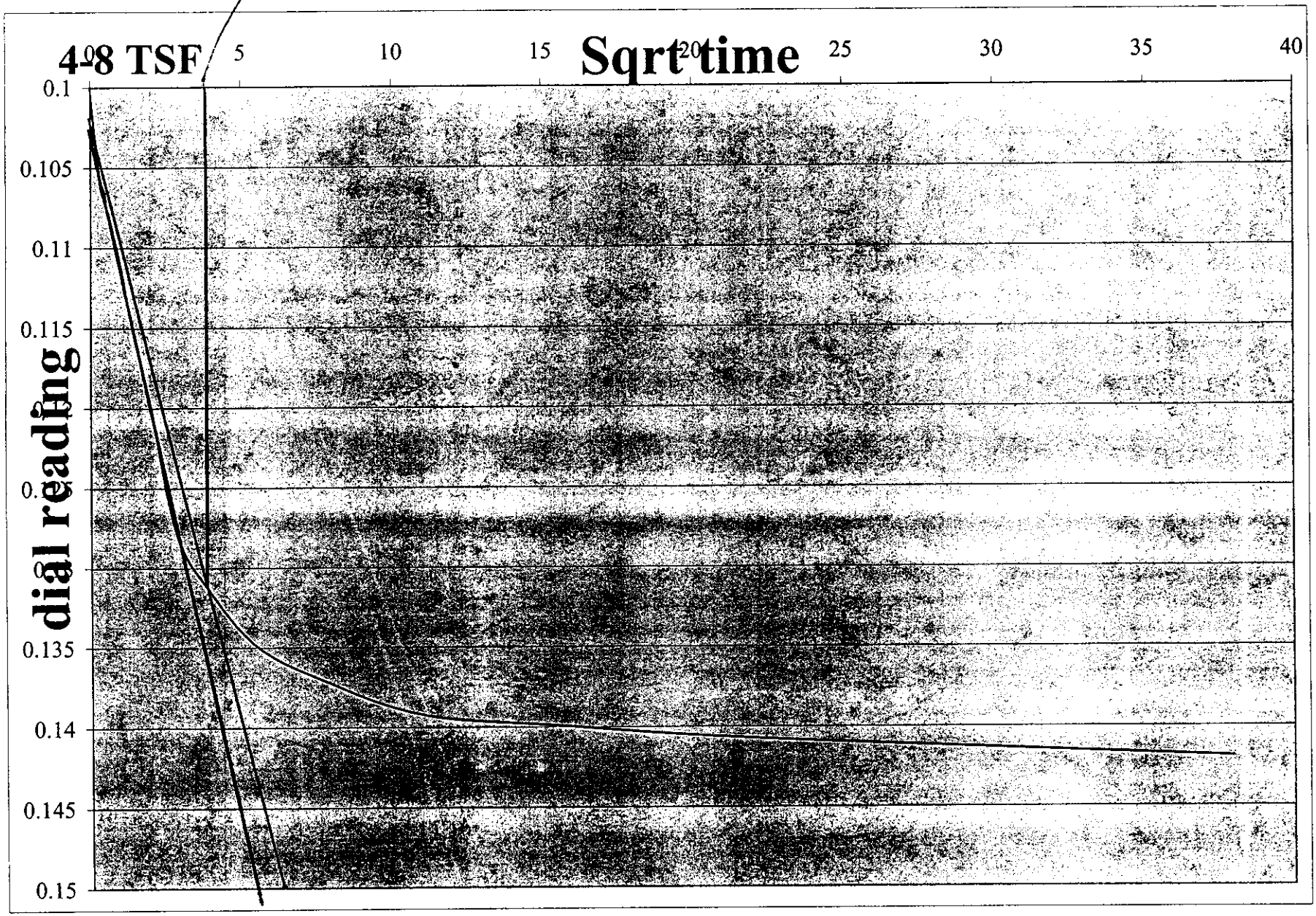


2-4 TSF

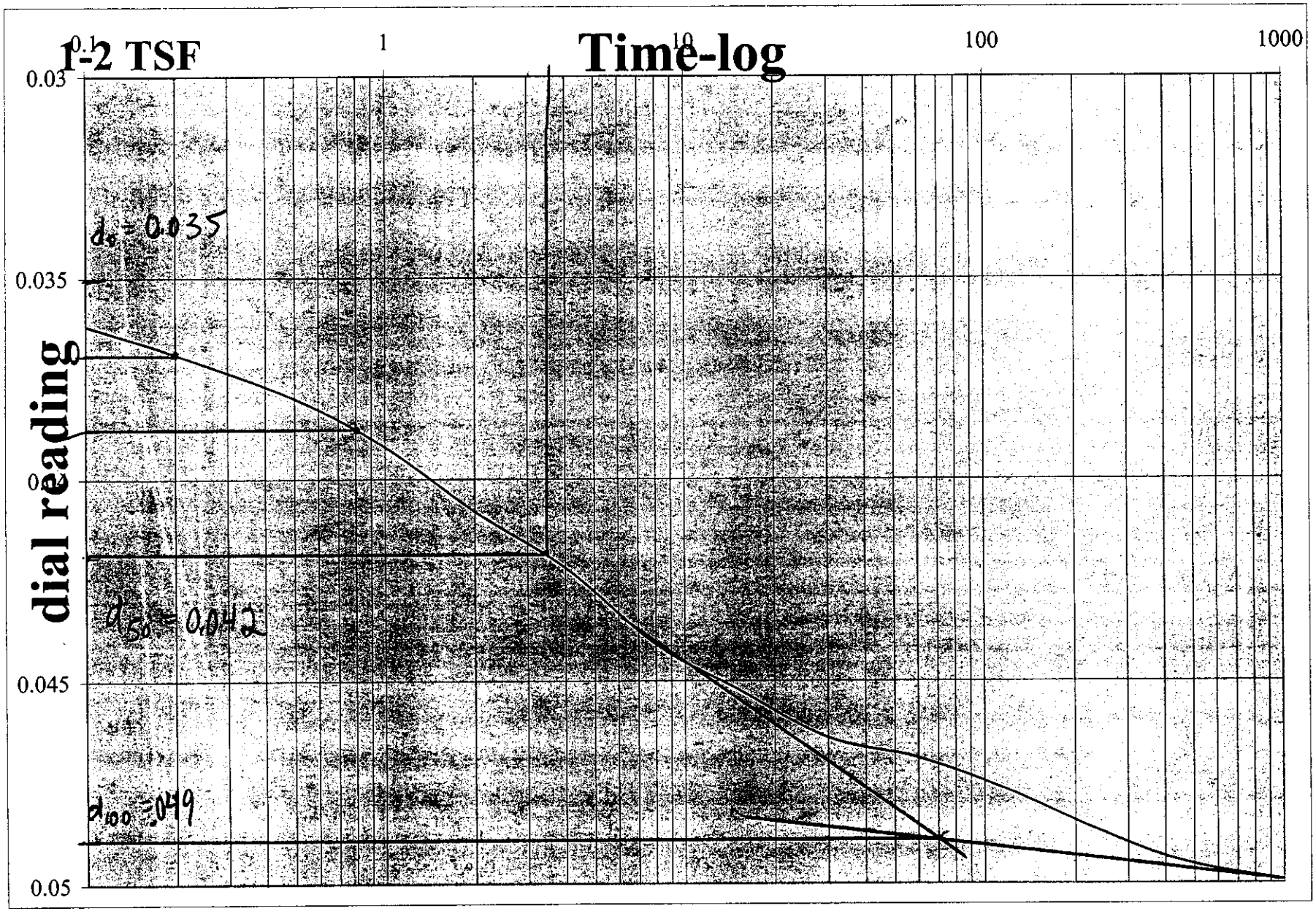
$\sqrt{t} = 3 = 9\text{min} = t_{90}$



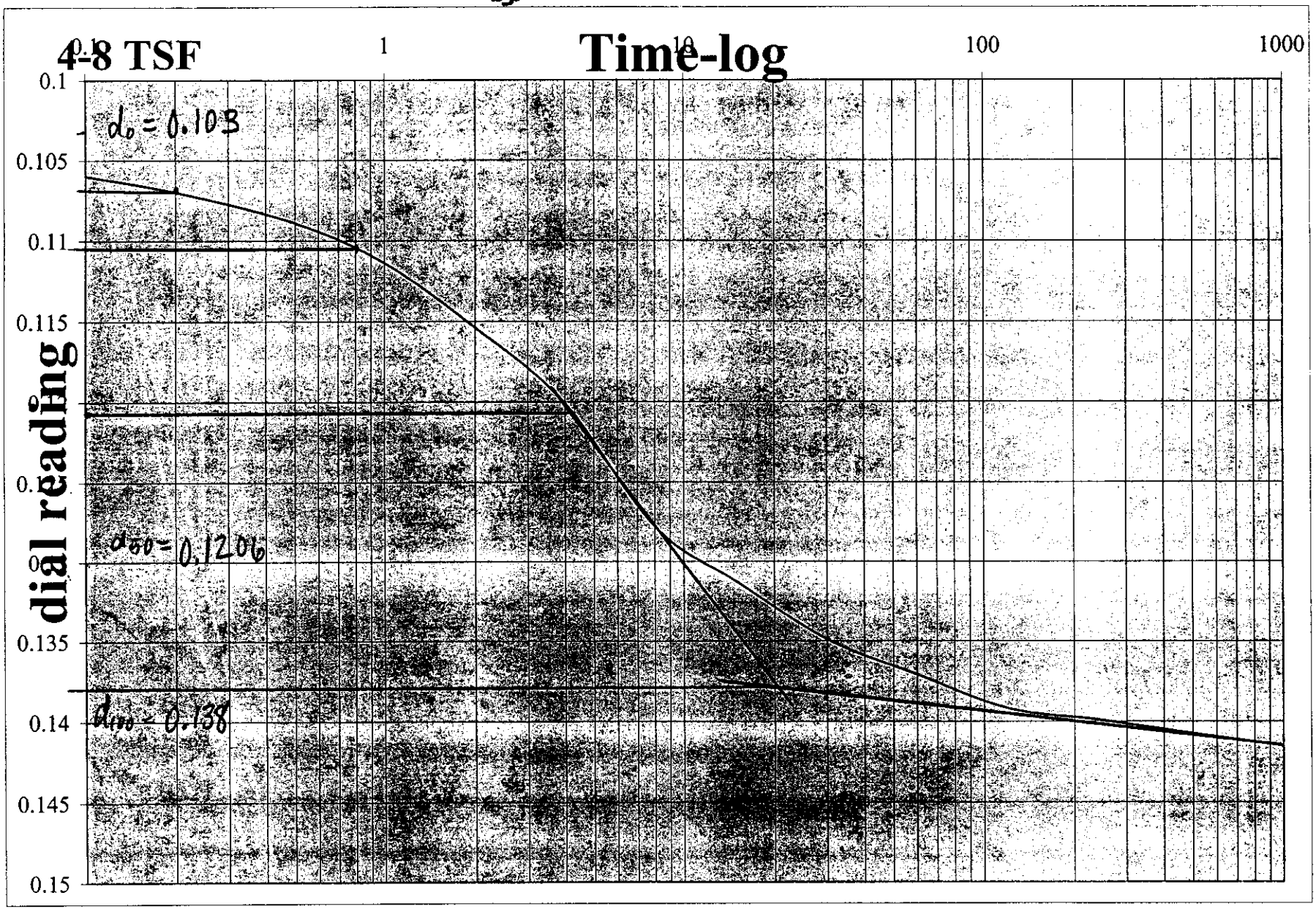
$3.8 = \sqrt{t} = 14.4\,min = t_{90}$



t_{50} = 3.5 min


1-2 TSF
Time-log
dial reading
0.1
1
10
100
1000
0.03
0.035
0.04
0.045
0.05
d_0 = 0.035
d_{50} = 0.042
d_{100} = 049

t_{50} = 4.25min


4-8 TSF
Time-log
dial reading
0.1
1
10
100
1000
0.1
0.105
0.11
0.115
0.12
0.135
0.14
0.145
0.15
d_0 = 0.103
d_{50} = 0.1206
d_{100} = 0.138

Alt and Witzig Project No. 02IN1012

SETTLEMENT CALCULATIONS

SR 641 over McDaniel Road

Des No. 9738280

Clay consolidation test results from 1ST, TB-13

Given: Maximum height of embankment is 32.8 feet at Bridge Structure 641-84-8399

Assume unit weight of embankment fill is 125pcf

Bents

Clay				Silty Loam			
			P_{eff} (psf)				P_{eff} (psf)
Cc	0.5187	$P_{initial}$ - TB-9	3180	Cc	0.15	$P_{initial}$ - TB-9	2220
Cr	0.04	$P_{initial}$ - TB-10	2910	Cr	0.02	$P_{initial}$ - TB-10	2190
e_o	0.87	$P_{initial}$ - TB-13	3120	e_o	0.7	$P_{initial}$ - TB-13	2160
P_{delta}	3860	$P_{initial}$ - TB-14	3535	P_{delta}	4100	$P_{initial}$ - TB-14	2275
P_{pc}	5500			P_{pc}	5500		

	Clay				Silty Loam				Total Settlement
Boring Number	Beginning Depth	Ending Depth	Thickness of Layer	Settlement (inches)	Beginning Depth	Ending Depth	Thickness of Layer	Settlement (inches)	(inches)
TB-9	38	60	22	9.19	28	38	10	1.20	10.39
TB-10	40	53	13	4.83	29	40	11	1.30	6.13
TB-13	38	58	20	8.15	26	38	12	1.40	9.56
TB-14	45	63	18	8.59	33	45	12	1.46	10.05

Therefore, settlement at the center of the embankments at maximum height are expected to range from six (6) to ten (10) inches.

Assume: Cc=0.15 for Silty Loam, Cr=0.02 for Silty Loam, e_o=0.7 for Silty Loam

Piers About 8.25 feet of fill will be placed at the location of the interior piers as part of re-alignment of McDaniel Road

TB-11

TB-12

Clay			
Cc	0.5187	$P_{initial}$ -TB-12	3300
Cr	0.04		
e_o	0.87		
P_{delta}	1000		
P_{pc}	5500		

H = 16 feet

S= 0.47 inches is expected at the interior pier locations

Note: Pressure due to fill does not exceed calculated Preconsolidation Pressure

Determination of Wick Drain Spacing

Alt Witzig File: 02IN1012 SR 641 over McDaniel Road Des No.: 9738280

The calculations on this sheet depict the benefit of wick drains to speed consolidation of the natural soils at the location of thick embankment fills in the general vicinity of SR 641 over McDaniel Road.

In general, this equation is used for time of consolidation:
Time = $(H_{dr})^2 * T_v/c_v$, where:
H_{dr} is the length of the drainage path. For this project, the layer is single drainage.
T_v= Time Factor
c_v = Coefficient of Consolidation (from consolidation test)

Assume wick drains installed to elevation 447 ft (approximately 60 feet below existing grade)

$T_{v\,@\,90\%}$= 0.85 (unitless)

c_v = 3.40E-04 in^2/sec Permeability (cm/s), k = 3.70E-08

Assume a horizontal Coefficient of Consolidation: For this evaluation, $c_h = c_v$

Therefore, c_h = 3.40E-04 in^2/sec

Use Barrons forumula, modified to neglect the effective diameter when considering the value $(d/D)^2$ (which is less than2.5E-3 and of little influence) to calculate influence diameter.

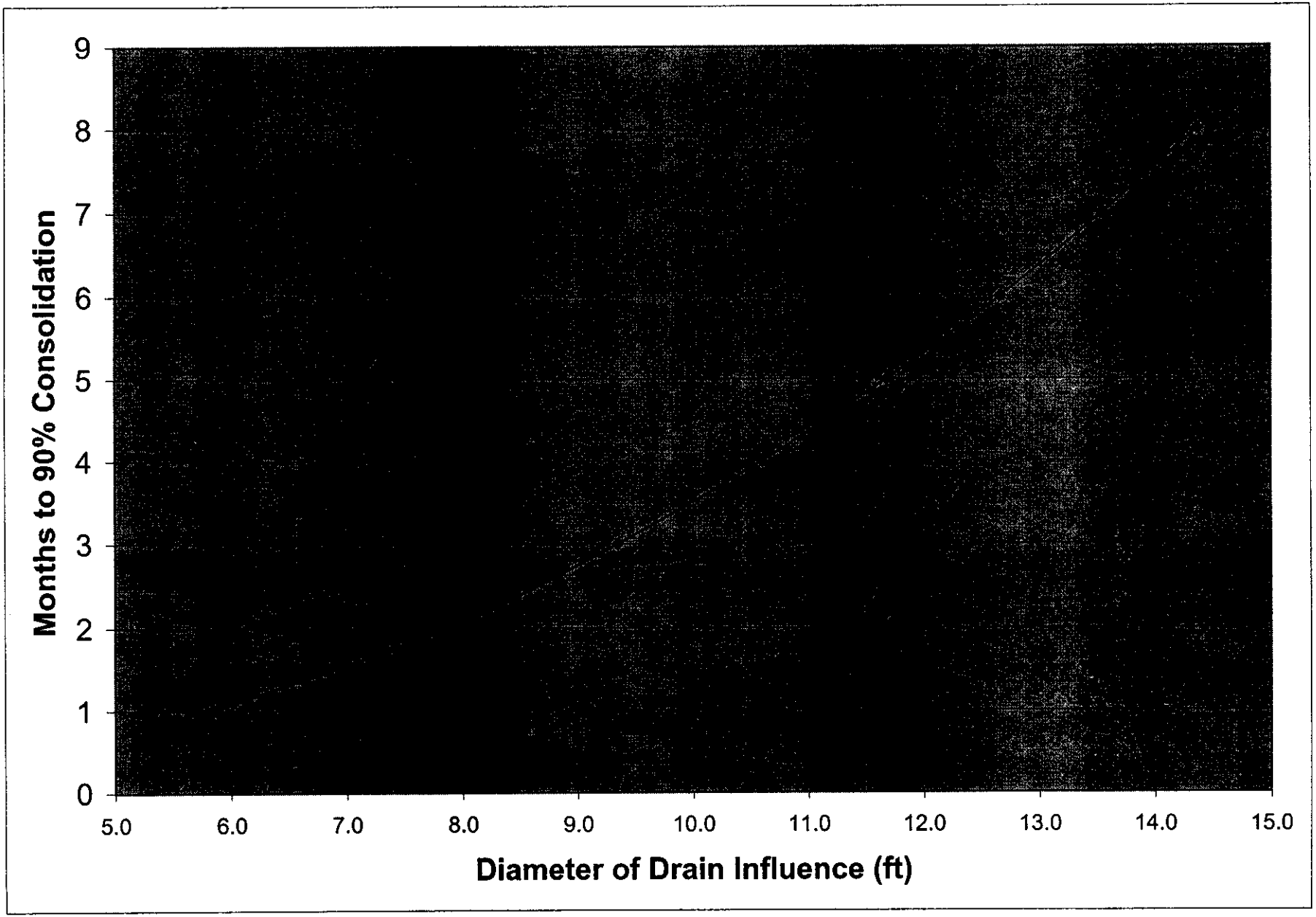
$c_h = D^2/8t * [\ln (D/d) - 0.75] * \ln (1/(1-U))$

D= diameter of drain influence
d= Equivalent diameter of wick drain (~2")
U=Average Degree of Consolidation
t=Consolidation Time

Condition	Center to Center, Triangular Spacing (ft)	H_{dr} (ft)	Time for 90% Consolidation (months)
Without Wick Drains	N/A	20	56
Wick Drains installed at the following spacing, assuming triangular arrangement:	14.4	7.2	7
	13.5	6.8	6
	12.7	6.3	6
	11.7	5.8	5
	10.6	5.3	4
	9.4	4.7	3
	7.9	3.9	2
	5.8	2.9	1

Time for 90% Consolidation of the deep Clay versus Diameter of Drain Influence

Alt Witzig File 02IN1012 SR 641 over McDaniel Road Des No: 9738280



Down drag Bent 1 S.R. 641 over McDaniel Road

-------- ULTIMATE STATIC PILE CAPACITY/Federal Highway Administration --------+
Nordlund (1963, 1979) and Tomlinson (1979, 1980) methods

Project Name	: SR641 Over McDaniel	Client	: INDOT
File Name	: 641-8399	Project Manager	: David Harness
Date	: 10/ 9/10	Computed by	: dch

Depth of Top of Pile = 0.00 ft. Pile length = 10.00 ft.
Depth to Water Table = 0.00 ft.
Type of Pile = H Pile
HP 12x53

SKIN FRICTION CONTRIBUTION

Layer	Soil Type	Thickness (ft)	Effective Stress (psf)	Internal Friction Angle	N-SPT	Pile Perimeter (ft)
1	Cohesive	10.00	288.00	---	--	3.97

Layer	Soil Type	Undrained Shear Strength (psf)	Adhesion	Pile Taper	Sliding Friction Angle	Skin Resistance (Kips)
1	Cohesive	3000.00	790.00	----	-----	31.36

Total Side Friction : 31.36

POINT RESISTANCE CONTRIBUTION

Effective Stress at pile Tip (psf)	Undrained Shear Strength (psf)	SPT Value	Pile End Area (ft*ft)	Bearing Capacity Factor Nq	End Bearing Resistance (Kips)
576.00	3000.00	----	0.11	----	2.91

Ultimate Static Pile Capacity : 34.27

+----- Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu -----+

Down drag Bent 3 S.R. 641 over McDaniel Road

-------- ULTIMATE STATIC PILE CAPACITY/Federal Highway Administration --------+
Nordlund (1963, 1979) and Tomlinson (1979, 1980) methods

Project Name	: SR641 Over McDaniel	Client	: INDOT
File Name	: 641-8399	Project Manager	: David Harness
Date	: 10/ 9/10	Computed by	: dch

Depth of Top of Pile = 0.00 ft. Pile length = 10.00 ft.
Depth to Water Table = 0.00 ft.
Type of Pile = H Pile
HP 12x53

SKIN FRICTION CONTRIBUTION

Layer	Soil Type	Thickness (ft)	Effective Stress (psf)	Internal Friction Angle	N-SPT	Pile Perimeter (ft)
1	Cohesive	10.00	288.00	---	--	3.97

Layer	Soil Type	Undrained Shear Strength (psf)	Adhesion	Pile Taper	Sliding Friction Angle	Skin Resistance (Kips)
1	Cohesive	2500.00	1000.00	----	-----	39.70

Total Side Friction : 39.70

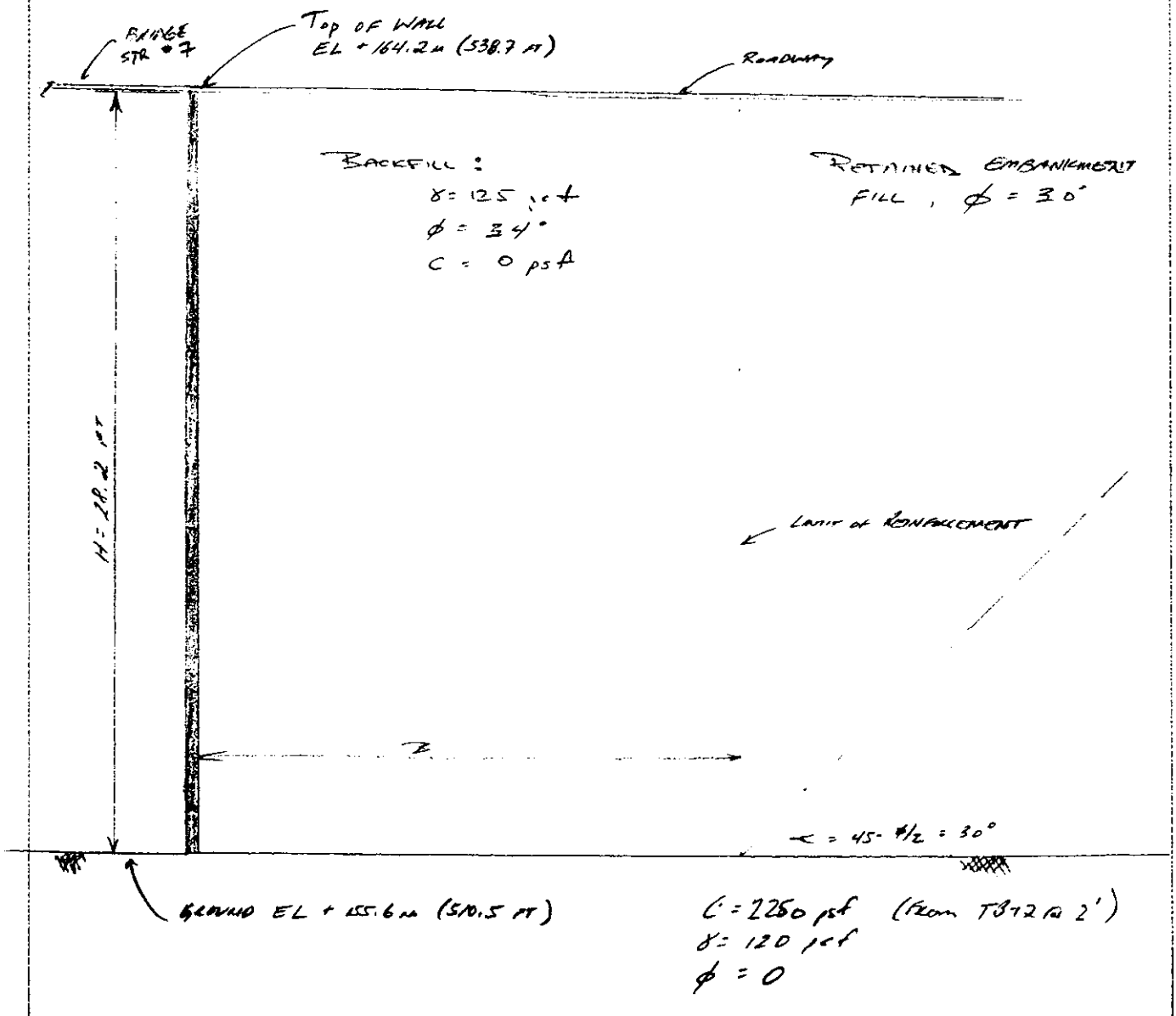
POINT RESISTANCE CONTRIBUTION

Effective Stress at pile Tip (psf)	Undrained Shear Strength (psf)	SPT Value	Pile End Area (ft*ft)	Bearing Capacity Factor Nq	End Bearing Resistance (Kips)
576.00	3000.00	----	0.11	----	2.91

Ultimate Static Pile Capacity : 42.61

------ Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu -----+

- CRITICAL SECTION TAKEN FROM LINE-C SECTION @ 100+320, RIGHT SIDE. TOP OF WALL @ EL 164.2m (538.7 FT); TOE @ EL 155.6 m (510.5 FT)
- ASSUME GROUND SURFACE TO LEFT & RIGHT OF FRONT FACE IS FLAT @ EL + 155.6 m (510.5 FT) ~ i.e. McDANIEL ROAD NOT GRADED
- APPLY 250 psf TRAFFIC LOAD ($q_{traffic}$)
- SAY $c = 2,250$ psf IN FOUNDATION SOILS TO BEGIN. SEE TB-12 @ 2'. NOTE THAT TOP 3 TO 5' MAY BE UNDERCUT. UNCONFINED TESTS ON SS SAMPLES INDICATE $q_u = 4,500$ psf ($c = 2,250$ psf) IN TOP 20 FT. SEE ALSO TB-10 @ 12 FT WHERE $q_u = 2.9$ TSF = 5,800 psf ($c = 2,900$ psf).



Look @ Driving Force:

P_1 = Retained Soil Pressure Σ $P_a = P_1 + P_2$
P_2 = Surcharge Pressure

$$K_a = \tan^2(45 - \phi/2) = \tan^2(45 - 30/2) = 0.33$$

$$P_a = P_1 + P_2 = 1/2\, K_a \gamma H^2 + K_a q H$$

$$= 1/2\,(0.33)(125\ pcf)(28.2\ ft)^2 + (0.33)(250\ psf)(28.2\ ft)$$

$$P_a = 16{,}401\ lb/ft + 2{,}492\ lb/ft = 18{,}894\ lb/ft$$

Point of Application (z) from toe of wall

$$z = \frac{P_1(H/3) + P_2(H/2)}{P_a} = \frac{(16{,}401)(28.2/3) + (2{,}492)(28.2/2)}{18{,}894}$$

$$z = 10.0\ ft$$

$P_a = 18{,}894\ lb/ft$
$z = 10.0\ ft$

Sliding Failure Check

$$FS_{sliding} = \frac{\Sigma P_{resist}}{\Sigma P_{drive}} = \frac{W_1 \tan\delta + cB}{P_a}$$

w/ W_1 = Weight of Stabilized Fill
c = Cohesion of Foundation Soils
B = Width of Stabilized Mass
P_a = P_a
δ = $2/3\,\phi = 2/3\,(30) = 20°$

Assume $B = 0.7 \times H = 0.7 \times 28.2\ ft = 19.7\ ft = 20\ FT$

$W_1 = \gamma H B = (125\ pcf)(28.2\ ft)(20\ ft) = 70{,}500\ lb/ft$
$c = 2{,}250\ psf$
$B = 20\ ft$
$P_a = 18{,}894\ lb/ft$
$\delta = 20°$

$$FS_{SLIDING} = \frac{70{,}500 \tan(20) + (2250\,psf)(20\,ft)}{18{,}894\ lb/ft} = \frac{70{,}659}{18{,}894}$$

$$FS_{SLIDING} = 3.74 > 1.5 \quad \checkmark \text{ OKAY}$$

BEARING CAPACITY CHECK

$$q_{ULT} = c N_c$$

w/ $c = 2250$ psf
$N_c = 5.7$

$$q_{ULT} = 12{,}825\ psf \quad \therefore q_{all} = \frac{12{,}825}{3} = 4{,}275$$

Look @ eccentricity: $e = \frac{B}{2} - \frac{\Sigma M_{RESIST} - \Sigma M_{OVER}}{\Sigma V}$

w/ $B = 20$ FT

$\Sigma M_{RESIST} = W_1 \times B/2 = 70{,}500 \times 20/2 = 705{,}000$ lb-ft/ft
$\Sigma M_{OVER} = P_a \times Z = 188{,}940$ lb-ft/ft
$\Sigma V = W_1 = 70{,}500$

$$e = \frac{20}{2} - \frac{705{,}000 - 188{,}940}{70{,}500} = 10 - 7.32 = 2.68$$

$e = 2.68 < B/6 = 3.33 \quad \checkmark$ OKAY

$$q_{MAX} = \frac{W_1 + q_{TRAFFIC} \times H}{B - 2e} = \frac{70{,}500 + 250 \times 28.2}{28.2 - (2)(2.68)}$$

$$q_{MAX} = 3{,}395\ psf$$

$$F.S._{BEARING} = \frac{12{,}825}{3{,}395} = 3.8 \quad \text{OK, ACCEPTABLE}$$

over Mt. Daniel Rd Analysis CHK: 4/4

OVERTURNING CHECK

$$F.S._{OTM} = \frac{\Sigma M_{RESIST}}{\Sigma M_{DRIVE}} = \frac{705,000}{188,140} = 3.7 > 1.5 \checkmark \text{ OKAY}$$

641 over McDaniel Road 02IN1012 Vigo County, IN
Ten Most Critical. F:64191.PLT By: tjc 10-31-03 10:36am

Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	125	125	2250	0	0	0	
2	125	125	0	34	0	0	
3	125	125	0	30	0	0	
4	125	125	1000	0	0	0