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March 27, 2002

Mr. Chad A. Modesitt, P.E.
Project Manager
The HNTB Companies
111 Monument Circle
Indianapolis, IN 46204-5178

Re: Geotechnical Exploration and Engineering Services
INDOT Project No. CM-9945( ) & STP-N606( )
Des. No. 0100881 & 0088390
61st Avenue Widening and Improvements
Hobart, Lake County, Indiana
PSI Project No. 016-15159

Dear Mr. Modesitt:

We have completed the geotechnical exploration for the above referenced project. The purpose of the study was to obtain subsurface information from the site and develop recommendations to aid in design of the proposed roadway reconstruction and improvements. This report presents our soil boring logs, laboratory test results, and roadway recommendations.

We appreciate the opportunity to provide geotechnical engineering services for this project. If there are any questions regarding the information contained in this report, please contact us at (317) 216-7131.

Respectfully,

PROFESSIONAL SERVICE INDUSTRIES, INC.

Peter Lee

Peter S. Lee, Ph.D., P.E.
Senior Engineer

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Elizabeth M. Dwyre, P.E.
Regional Engineer

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SUMMARY OF GEOTECHNICAL EXPLORATION

1. Project Description

The City of Hobart plans a roadway widening and improvements along 61st Avenue (from about 200 feet east of Marcella Boulevard to about 750 feet east of Colorado Street), and Colorado Street near the intersection with 61st Avenue. We understand this project will include widening the existing two-lane roadway to mostly four lanes with additional left turn lanes at the intersections, resurfacing the existing pavement, storm sewer improvements, and culvert replacement. The western portion of the project (from Station 10+00 to 27+95.56, Line "A") is identified as INDOT Project No. CM-9945( ) with Designation No. 0100881. The eastern portion of the project (from Station 27+95.56 to Station 62+04, Line "A", and "S-Lines") is identified as Project No. STP-N606( ) with Designation No. 0088390.

2. Subsurface Conditions

Fill materials, such as silty clay and clay loam, were encountered below the surficial pavement materials to depths of about 8 feet (2.4 m) at Boring TB-1-SG. Below the surficial pavement and topsoil, cohesive fill materials or natural clay soils were generally encountered to depths of about 12 to 20 feet (3.7 to 6.1 m), elevation 597 to 622 feet (182.0 to 189.6 m), or to the explored depths of borings at Borings RB-8, RB-10-SG, and RB-11-SG. Below the natural clay soils, intermediate sand and sandy gravel soils were encountered at depths of about 12 to 18 feet to the explored depths of borings RB-1-SG through RB-7-SG and RB-9-SG. However, sand and sandy gravel soils were encountered between depths of about 22 to 42 feet (6.7 to 12.8 m) from existing grade at Borings TB-1-SG, or about 12 to 32 feet (3.7 to 9.8 m) at TB-2, or elevation 597 to 577 feet (182.0 to 175.9 m). Organic clay soils, such as silty clay loam (A-5) and loam (A-4) with little organic matter and trace marl, were encountered below the existing embankment fills near the existing culvert structure to a depth of about 22 feet (6.7 m) at Boring TB-1-SG, or below the surficial topsoil to a depth of about 12 feet (3.7 m) at Boring TB-2.

Based on the moisture state of the retrieved samples, the soil color change from brown to gray, the reported groundwater observations, we estimate the prevailing groundwater level is at or below depths ranging between about 1.5 to 16.5 feet (0.5 to 5.0 m) below existing grade, approximately elevation 609 to 624 feet (185.6 to 190.2 m).

3. Ground Improvements near the Proposed Box Culvert Structure

Based on Borings TB-1-SG and TB-2 performed for the proposed precast 4-sided box culvert, the organic clay soils were encountered below the embankment fill to a depth of about 22 feet (6.7 m) at TB-1-SG, and below the surficial topsoil to a depth of about 12 feet (3.7 m) at TB-2. Delineation of clay soils with marl/organic matter is not under our scope of works for this project, therefore, PSI did not perform delineation for cost estimate purposes.

Based on the proposed height of embankment fill and consolidation parameters of clay soils with marl/organic matter, we anticipate primary consolidation settlement up to about 14 inches (356 mm) could develop at Boring TB-2. We anticipate primary consolidation settlement may be achievable within 11½ years, after the placement of full-height of embankment fills. Secondary settlement of the these organic clay soils up to 30 years after construction could be in a range of about ½ to 1 inch (13 to 25 mm).

Therefore, we have considered soil improvements for the embankment and box culvert constructions near the existing creek. The selection of remedies was based on five (5) functions.

- Reducing settlement to a tolerable range without a long construction delay.
- Providing adequate embankment slope stability.
- Uniformly supporting the proposed precast 4-sided precast box culvert.
- Providing the support to the existing gas pressure main due to the potential of excessive settlement.
- Providing support to the storm sewer to be installed between Structure No. 187 and 196.

We anticipate excessive settlement could potentially damage the proposed new 4-sided precast concrete box culvert structure and sewers. In addition, 9-year waiting period prior to pavement construction is not practical for this project due to the high traffic volume on existing 61st Avenue. Based on the potential quantity of removal and replacement, or required waiting period of about nine years for at least about 93 percent of primary consolidation, or required adequate support to the proposed precast culvert structure and existing gas pressure main, we anticipate vibro-concrete columns (VCC) are likely a feasible alternative for this project.

Vibro Concrete Column (VCC) – To reduce the excessive settlement, to uniformly support the proposed precast 4-sided reinforced concrete box culvert and sewers, and to limit the risk of overstressing the existing gas pressure main, we consider Vibro Concrete Column (VCC) is a relatively fast and feasible scheme.

We anticipate VCC installed at a 6 feet by 6 feet grid may be required. The VCC grid should be adjusted or additional VCC elements added to provide concentric support along the box culvert and storm sewer alignments. The VCC elements below the box culvert and storm sewer must have their top of VCC elements set below the structure invert elevations. Other VCC elements that will support embankment fill could have top of VCC elements established near the existing grades. The VCC elements should also be spaced to avoid the gas main, and a reinforced concrete cap should be constructed to span between VCC elements to support the fill load directly over the gas main. Also, to uniformly support the proposed embankment fill, precast 4-sided reinforced concrete box culvert, and sewer over VCC, we recommend two layers of geogrid reinforced crushed aggregate (one foot for each layer) be placed over the installed VCC underneath the precast box culvert and sewer, and three layers of geogrid reinforced crushed aggregate underneath the proposed embankment fills. We anticipate dewatering by means of wellpoints or deep wells may be necessary along the culvert and storm sewer alignments in order to excavate for the structure and install the granular/geogrid blankets.

N-values of the existing embankment clay fill encountered at Boring TB-1-SG generally ranged from 2 to 11 bpf, with unconfined compressive strength ranging from ¼ to 1½ tsf. We anticipate pre-drilling through the existing roadway embankment may be required prior to VCC installation.

The organic soils were generally encountered near the existing ground surface in the widening areas near the creek. (see the attached Summary of Soundings) N-values of the existing organic soils generally ranged from weight of hammer (WHO) to 5 bpf. Therefore, we anticipate a drainage blanket will be required prior to the construction to provide an appropriate working platform and drainage path, and to protect the exposed portions of VCC from construction traffic and freezing temperatures. The working platform should be a granular material with maximum particle size between 1 and 2 inches, and less than 10 percent passing the No. 200 sieve, such as INDOT No. 2. The drainage blanket should be at least a continuous 24 to 36 inches (610 to 915 mm) thick. If the VCC and blanket are placed during the winter months then an additional layer of fill will be required to prevent the ends of the VCC from freezing.

For bidding purposes, the plan limits of VCC along the alignment should be assumed to extend from Station 50+00 to 52+50, Line "A". The actual limits may require revision based on encountered organic soil limits. The plan limits of VCC in width should extend a minimum of 6 feet beyond the toe of the embankment, or greater as determined by the VCC contractor. Plan limits of the VCC also must extend at least to the limits of the box culvert wingwalls.

The VCC contractor should submit a detailed plan for layout and method of installation of the VCC to the design engineer for review. Specific equipment and installation procedures to achieve the specified criteria are the contractor's responsibility. Special provision and recommendations for field inspection for Vibro-compacted concrete columns are included in the Appendix of this report. Specific modifications recommended to tailor the guide specifications to the requirements of this project are marked on the Special Provision. We strongly recommend review of the required contractor submittals be performed by PSI and INDOT Division of Materials and Tests. Full-time quality assurance during construction should be performed by a qualified engineering technician or staff engineer working under the direction of the project geotechnical consultant. We recommend full-time quality assurance during ground improvement construction be performed by PSI or by INDOT Division of Materials and Tests.

4. 4-Sided Precast Reinforced Concrete Box Culvert (Structure 191)

We recommend the bridge structure as well as streambed be protected from scouring and erosion with a minimum 1.2 m (4 feet) of riprap at both ends. We have assumed City of Hobart and design consultant, HNTB, will select VCC as the supports for the new culvert structure and roadway embankment. The vibro-concrete columns need to be penetrated the near surface marly soils to the underlying sand or sandy gravel, at about elevation 587 feet. The culvert foundations bearing on the geogrid-reinforced layer placed over the VCC may be proportioned using a net allowable pressure of 3,000 psf. The maximum net allowable soil bearing pressure is that pressure which may be transmitted to the bearing material in excess of the final, minimum surrounding overburden pressure. We estimate total settlement of the culvert structure supported on VCC deep foundation may be about ½ to 1 inch, with differential settlement of about half of the total settlement. In order to uniformly support the proposed culvert structure, we recommend at least two layers (12 inches each) of geogrid-reinforced crushed aggregate, such as INDOT 53, be placed underneath the proposed culvert structure.

We recommend the proposed wingwalls be supported on the same type of VCC deep foundation as the culvert structure. The geogrid-reinforced crushed aggregate should also be placed on top of the VCC to uniformly support the wingwalls. The following additional soil parameters are also provided for wingwall design, as requested in the Memorandum issued on April 12, 1999, by INDOT, Department of Materials and Tests.

- Friction Angle, $\delta = 30°$
- Friction Factor, $\tan \delta = 0.58$
- Angle of Internal Friction of the geogrid reinforced foundation soil, $\phi = 32°$
- Ultimate adhesion between the foundation soil and concrete footing, $C_a = N/A$
- Ultimate cohesion, $C_{ult} = N/A$

5. Storm Sewer and Sanitary Sewer Lines

Based on the soil conditions from borings performed along existing 61st Avenue, the soils at the bearing depth of manholes and sewer lines should generally be suitable for support of the structures except within the area where organic silty clay loam and loam soils were present between Station 50+00 and 52+50, Line "A". Adequate control of groundwater will be necessary to preserve subgrade stability, particularly in the sewer excavations between Station 25+00 and 55+00, Line "A". If loose sand is present at the proposed sewer bearing elevations, we recommend the proposed subgrades be undercut a minimum of 0.5 m (18 inches), and backfilled with compacted INDOT No. 53 crushed aggregate to the proposed pipe invert elevation. The purpose of the undercut and replacement is to aid in bridging the underlying loose sand and providing a stable base for the pipe. The aggregate pad should extend laterally a minimum of 0.5 m (18 inches) from the edge of the pipe for stability. The contractor should support the excavations with appropriate shoring to avoid undermining the soil supporting the roadway and existing utilities.

For the storm sewers located near the existing creek, organic silty clay loam soils are likely to be encountered at the proposed sewer bearing elevations. We recommend the proposed subgrades be undercut a minimum of 2 feet (0.6 m), and backfilled with two layers of geogrid reinforced INDOT No. 53 crushed aggregate to the proposed pipe invert elevation as recommended for the proposed box culvert structure 191.

The INDOT standard drainage structure installation details, Figure 16, is included in the Appendix. "B" Borrow surrounding all pipe structures in the excavated trenches should be compacted to 95 percent of the maximum dry density as determined by AASHTO T-99 (Standard Proctor). The soil in the bottom of the excavations, any bedding material and the engineered fill for structure backfill, should be tested to determine that tested locations comply with this density criterion. If 95 percent of the maximum dry density can not be obtained at the bottom of the excavations, or in the others areas, the Geotechnical Section of INDOT should be contacted for additional recommendations.

When the level of the fill reaches the top of the structure, two lifts, about 150 mm (6 inches) each, should be carefully spread and hand compacted over the structure without the use of heavy equipment. The backfill should be compacted to at least 95 percent of the maximum dry density as determined by AASHTO T-99 except the first 2 lifts above the structure. Mechanical compaction over the sewer structures may commence after the second lift is placed and compacted.

It is important to protect the sewer structures during construction. To avoid imposing concentrated loads far in excess of those the drainage structures would normally carry, heavy construction equipment should not cross the structures until fill placement and compaction is completed. Also, heavy vehicles moving too close to the walls of the structures can create an eccentric loading with potentially harmful results.

6. Recommended CBR Values

PSI evaluated the most critical and predominant plastic (cohesive) soil types encountered within the proposed new pavement areas along the proposed 61st Avenue alignment for subgrade strength, based on the California Bearing Ratio (CBR) tests. The most predominant plastic soil at subgrade elevations within the proposed pavement area was silty clay loam, with about 77 percent of silt and clay, and plasticity index (PI) of 10. Based on AASHTO classification system, the most predominant cohesive soils within the proposed new pavement area was classified as A-4.

The CBR value of the silty clay loam sample, compacted to 97 percent of the maximum dry density as determined by AASHTO T-99, Standard Proctor Method, are provided in the table below.

Location	Depth (ft)	Soil Type	% Max. Dry Density	Test CBR Value @ 97 %
RB-2	1 – 3	Silty Clay Loam, A-4(7)	97	3.3

In the Fill Areas

Based on the INDOT Design Memorandum, Subgrade Treatment Recommendations, dated August 23, 2001, we recommend 24 inches (600 mm) subgrade treatment for the fill areas in this project. Due to the presence of more cohesive silty clay and clay soils (A-7-6) with PI over 20, therefore, we recommend a CBR value of 2.5 be used for pavement design rather than the higher maximum value of 3.3.

In the Cut Areas

Based on the preliminary Road Plans provided by The HNTB Companies, the projected AADT on existing 61st Avenue ranged from about 11,680 vehicles per day (VPD) in 2003 to 15,650 VPD by 2023. The total subgrade treatment area is more than 10,000 yd^2. Based on Subgrade Treatment Guidelines prepared by INDOT, we recommend 16 inches (400 mm) chemical modification (or any alternative described in Section 207.04(a).1), with an estimated CBR value of 2.5 for the pavement design.

During the site preparation operations, the subgrade soil should be evaluated by the project geotechnical engineer to verify the soil type meets the design CBR criteria.

The owner/designer should not rely solely on this Executive Summary and must read and evaluate the entire contents of this report prior to utilizing our engineering recommendations in preparation of design/construction documents.

Report Prepared By:	Report Reviewed By:
Peter S. Lee, Ph.D., P.E. Senior Engineer	Elizabeth M. Dwyre, P.E. Regional Engineer

1. INTRODUCTION

1.1. Project Identification

The City of Hobart plans a roadway widening and improvements along 61st Avenue (from about 200 feet east of Marcella Boulevard to about 750 feet east of Colorado Street), and Colorado Street near the intersection with 61st Avenue. We understand this project will include widening the existing two-lane roadway to mostly four lanes with additional left turn lanes at the intersections, resurfacing the existing pavement, storm sewer improvements, and culvert replacement. The western portion of the project (from Station 10+00 to 27+95.56, Line "A") is identified as INDOT Project No. CM-9945( ) with Designation No. 0100881. The eastern portion of the project (from Station 27+95.56 to Station 62+04, Line "A", and "S-Lines") is identified as Project No. STP-N606( ) with Designation No. 0088390. The extent of the proposed construction is shown on the Site Location Plan included as Figure 1 in the Appendix.

1.2 Project Description

The proposed improvements along 61st Avenue begins at Station 10+00, Line "A", about 200 feet east of Marcella Boulevard, and ends at Station 62+04, Line "A", about 750 feet east of Colorado Street. In addition, this project also includes roadway improvements along Colorado Street, from Station 42+54 to Station 50+00, Line "S-4-A", at the intersection with 61st Avenue. The side street improvements along Line "A" include Line "S-1-A" (Liverpool Road), "S-2-A" (S. Minnesota Street), "S-3-A" (N. Minnesota Street), and "S-4-A" (Colorado Street). The total length of street improvements is approximately 1.14 mile (1.83 km), including about 0.34 mile (0.54 km) for the western portion of the project (Des. No. 0100881), about 0.65 mile (1.03 km) on the eastern portion of the project (Des. No. 0088390), and about 0.17 mile (0.26 km) on the side streets ("S-Lines").

Based on the provided preliminary Road Plans, the proposed storm sewer trunkline is located to the north of existing 61st Avenue, and is generally parallel to existing 61st Avenue. The proposed storm sewer manhole structures are generally founded at depths of about 8.5 to 18.0 feet (2.6 to 5.5 m) below existing grade, with bottom of invert elevation ranging from about 608.52 to 623.66 feet (185.5 to 190.1 m). The proposed sanitary sewer trunkline is also planned at depths of about 7.7 to 15.4 feet (2.3 to 4.7 m) below existing grade between station 14+00 to 28+10, Line "A". We understand the majority of the existing pavement will be removed to allow subgrade regrading within the existing right of ways. An existing 60-inch CMP culvert structure located at Station 51+05, Line "A" will be removed and replaced with a 160 feet long, 16 feet wide by 6 feet high four-sided reinforced concrete box culvert. Based on the provided preliminary Plans and Profiles, up to about 14 feet (4.3 m) of fills and about 4 feet (1.2 m) of cuts are planned within the project limits, with the deeper fills located in the area of the culvert replacement.

The geotechnical recommendations presented in this report are based on the available project information, locations of the proposed roadway widening and culvert structure, and the subsurface conditions described in this report. If any of the above-referenced information is incorrect, please inform PSI in writing so that we may amend the recommendations presented in this report if appropriate and if desired by the client. PSI will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

1.3 Scope of Services and Procedures

The scope of our services for this project included:

1. The performance of eleven (11) soil borings to depths of 7½ feet (2.3 m) to 25 feet (7.6 m) for the proposed roadway.
2. The performance of two (2) structure borings to depths of 40 to 45 feet (12.2 to 13.7 m) for the proposed culvert at Station 51+05, Line "A". In addition, six (4) soundings were performed on each end of the proposed culvert near the existing creek using a hand auger to evaluate the thickness of unsuitable materials.
3. The performance of appropriate laboratory tests, including AASHTO visual engineering classification, moisture content, loss on ignition (LOI), grain size analyses, Atterberg Limits, standard Proctor, CBR, and pH tests. One consolidation test was also performed on a Shelby

tube sample obtained from the structure boring, TB-2, which was performed close to the existing toe of the north embankment slope.

4. The provision of a written geotechnical report, including the following:
    - Findings and recommendations concerning the subgrade and pavement.
    - A discussion of potential settlement under the proposed embankment fill.
    - Recommended soil improvements for the support of new culvert structure and roadway embankments.
    - Recommended soil parameters for 3-sides box culvert with wing walls.
    - A discussion of the design and construction considerations associated with subgrade treatment.
    - Recommended CBR values for pavement design.
    - Evaluation of the stability of subgrades for support of the sewer line, and bedding and backfill recommendations.
    - Anticipated soil and groundwater related construction problems.
    - General construction considerations for fill placement and construction of the pavements.

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air on or below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes.

2. GENERAL SITE CONDITIONS

2.1. General Geology

The site is located within the U.S. Geological Survey (USGS) topographic map of Gary, Indiana 7.5-minute quadrangle, dated 1991, which is reproduced as Figure 2 in the Appendix. The general area is drained by Turkey Creek, which is located about ¼ to ½ miles north of the project site. The Turkey Creek stream valley is mapped as swampland in the USGS map, which suggests the potential presence of organic soils. Based on regional geologic mapping, the unconsolidated deposits are generally anticipated to be Lacustrine deposits consisting of clay, silt, and sand of former lake areas. The Lacustrine deposits may associate with older alluvial deposits, which may contain localized organic deposits, based on our past project experience in the area.

Based on the Map of Indiana Showing Thickness of Unconsolidated Deposits, the thickness of the unconsolidated deposits is mapped as ranging from 100 to 150 feet in this area. Based on regional geologic mapping, unconsolidated deposits in the area are underlain by Traverse and Detroit River Formations, which consist of mainly limestone, and dolomite. Based on the regional geologic information, no underground coal mines or solutioned bedrock enlargements are anticipated in the project area.

2.2 Topography and Site Conditions

Based on our site visit and review of the preliminary Road Plans prepared by HNTB, the existing grades along the existing 61st Avenue gently slope downward toward the tributary of Turkey Creek, with elevations ranging from 631.9 feet (192.6 m) at Station 10+00, to about 629.7 feet (191.9 m) at the intersection with Liverpool Road, to about 628.3 feet (191.5 m) at the intersection with Minnesota Street, to elevation 615.5 feet (187.6 m) at the existing culvert structure, to about elevation 625.0 feet (190.5 m) at the intersection with Colorado Street, and to elevation 628.7 feet (191.6 m) at the end of 61st Avenue alignment (Station 62+04).

An existing 10-inch gas pressure main is located on the south side of existing 61st Avenue, and generally parallel to existing 61st Avenue. This existing gas pressure main is about 43 feet (13.1 m) south of the proposed centerline "A" near the existing culvert structure. The depth of gas pressure main was not available at the time this report was prepared. However, based on the proposed top of footing elevation 606 feet, we anticipate the existing gas pressure main could be located close to or below the bottom of the proposed box culvert structure. We also understand City of Hobart plans not to relocate the existing gas pressure main due to the cost and service reasons.

3. PROCEDURES

3.1. Field Exploration

The exploration program included eleven (11) soil borings to depths of 7½ feet (2.3 m) to 7.6 m (25 feet) for the proposed roadway and storm sewers. Nine of the eleven roadway borings were performed along the proposed 61st Avenue, and the remaining two (2) roadway borings were performed along Colorado Street. Since these borings were proposed for storm sewer line installation and subgrade investigation, they were generally located at or near the location of sewer manhole structures, and ranged from about 400 to 600 feet on center. The proposed depths of the roadway borings were generally based on the depth of proposed storm sewers along the alignment. We also performed two (2) structure borings to depths of 40 to 45 feet (12.2 to 13.7 m) for the proposed box culvert Structure 191.

The boring and sounding locations were selected by PSI, in conjunction with INDOT, Division of Materials and Tests. Borings and soundings were located in the field by PSI using a calibrated measuring wheel and preliminary Road Plans provided by HNTB, not dated. Boring locations are shown on Figures 3 in the Appendix. Ground surface elevations at the boring locations were estimated from the topographic information shown on available plans and cross sections, and are shown on the boring logs in the Appendix. Sounding locations and estimated ground surface elevations are tabulated together sounding results in the Appendix.

The soil borings were performed with both ATV and truck mounted rotary type drill rigs using continuous flight hollow stem augers to advance the boreholes. Representative soil samples were obtained by means of the split barrel sampling procedures at 2½ feet (0.8 m) intervals in the upper 10 feet (3.1 meters), in general conformance with AASHTO T 206. The number of blows required to drive the sampler 12 inches (305 mm) with a 140 pounds (63.5 kg) hammer falling 30 inches (760 mm), after an initial seating 6 inches (150 mm), is termed the Standard Penetration Test (N) value. A graphical representation of the N-values is shown on the boring logs.

Soundings were performed in or near the existing creek to evaluate the thickness of unsuitable soils at the location of the proposed culvert. The soil soundings were performed by our driller with a hand auger for the purposes of determining the depth through unsuitable deposits in or near the existing tributary of Turkey Creek. Soil sampling was not required during sounding, therefore, soil descriptions on the Summary of Soundings are based solely on the driller; field classification, without further laboratory classification.

During the field operations, the drill crew maintained a log of the subsurface conditions, including changes in stratigraphy and observed groundwater level. After completion of the drilling operations, and observing water levels, the boreholes were backfilled with natural soils and asphalt patch. The soil samples were transported to our laboratory for testing and engineering classification.

3.2 Laboratory Testing

The purpose of this laboratory testing program was to evaluate the classification and physical properties of the soils encountered at the project site. The tests performed include loss on ignition (LOI), grain size (sieve and hydrometer) analyses, Atterberg limits, natural moisture content, pH, unconfined compression, standard moisture-density relationship (Standard Proctor), and California Bearing Ratio (CBR) tests. In addition, consolidation test was also performed on relatively undisturbed Shelby-tube samples to evaluate the soil physical properties. The laboratory tests were performed in general accordance with applicable AASHTO standards. The results of the laboratory tests are shown on the logs and in the Appendix.

The recovered soil samples were visually classified by a geotechnical engineer, based upon texture and plasticity in general conformance with the AASHTO classification system. A geotechnical engineer grouped the various soil types into major zones as noted on the boring logs. For more detail regarding the soil conditions at a particular location, refer to the individual boring logs.

4. RESULTS

4.1. General Subsoil Conditions

Pavement cores were not scheduled for this project, and therefore, were not obtained from the borings performed on the existing pavement. However, the thicknesses of the pavement materials were measured by our driller to provide general information for construction bidding purposes.

The existing roadway pavement encountered at borings consisted of about 3 to 18 inches (75 to 457 mm) of asphaltic concrete surface over 6 to 21 inches (150 to 533 mm) sand and gravel base course. However, Portland concrete cement (PCC) pavement, about 15 inches (381 mm) in thickness, was encountered at ground surface in Boring RB-1-SG. Our driller also reported about 12 inches (304 mm) of clayey topsoil was encountered at the ground surface in Boring RB-8-SG performed within the proposed widening area.

Fill materials, such as silty clay and clay loam, were encountered below the surficial pavement materials to depths of about 8 feet (2.4 m) at Boring TB-1-SG. Below the surficial pavement and topsoil, cohesive fill materials or natural clay soils were generally encountered to depths of about 12 to 20 feet (3.7 to 6.1 m), elevation 597 to 622 feet (182.0 to 189.6 m), or to the explored depths of borings at Borings RB-8, RB-10-SG, and RB-11-SG. Below the natural clay soils, intermediate sand and sandy gravel soils were encountered at depths of about 12 to 18 feet to the explored depths of borings RB-1-SG through RB-7-SG and RB-9-SG. However, sand and sandy gravel soils were encountered between depths of about 22 to 42 feet (6.7 to 12.8 m) from existing grade at Borings TB-1-SG, or about 12 to 32 feet (3.7 to 9.8 m) at TB-2, or elevation 597 to 577 feet (182.0 to 175.9 m). Organic clay soils, such as silty clay loam (A-5) and loam (A-4) with little organic matter and trace marl, were encountered below the existing embankment fills near the existing culvert structure to a depth of about 22 feet (6.7 m) at Boring TB-1-SG, or below the surficial topsoil to a depth of about 12 feet (3.7 m) at Boring TB-2.

The in-situ fill materials or natural clay soils, such as clay, silty clay, silty clay loam, clay loam, and silty loam, below the surficial pavement, topsoil, and fill materials at borings ranged from very soft to very stiff, with Standard Penetration Test values (N-values) ranging from 2 to 19 blows per foot (bpf). The moisture content of the in-situ clay soils generally ranged from 10 to 30 percent. Unconfined compressive strengths, as measured by a calibrated pocket penetrometer, ranged from ¼ to over 4½ tons per square foot (tsf). Grain size distribution test shows clay soils consists of about 70 to 99 percent fines (material passing a No. 200 mesh sieve). One unconfined compressive strength test was performed on a recovered split-spoon sample obtained at about 9 feet in TB-1-SG, and the strength was 1.68 tsf.

Natural clay soils, such as silty clay, silty clay loam, silty loam, and clay loam, encountered below the pavement and fill materials were generally very soft to very stiff, with N-values ranging from 2 to 29 bpf. Unconfined compressive strengths, as measured by a calibrated pocket penetrometer, ranged from less than 1 to over 4½ tsf. Moisture contents of the natural clay soils ranged from 11 to 30 percent

Organic clay soils with trace to little organic matter and trace marl were encountered to an elevation about 596 feet (181.7 m) at Borings TB-1-SG and TB-2, with N-values ranging from Weight of Hammer (WOH) to 5 bpf. Moisture contents of the silty clay loam and clay loam soils ranged from 39 to 96 percent, loss on ignition (LOI) was about 7 to 10 percent, and Calcium and Magnesium Carbonate were about 7.6 to 8.1 percent. Unconfined compressive strengths, as measured by a calibrated pocket penetrometer, ranged from less than ¼ to 1 tsf. Three (3) unconfined compressive strength tests were performed on the recovered Shelby-tube samples obtained from Boring TB-2, and their strengths ranged from 0.23 to 0.73 tsf. A consolidation test was also performed on a sample from TB-2, and the results are included in the Appendix. The silty clay loam and clay loam soils were classified as A-5 and A-4, respectively, according to Exhibit "C" issued by INDOT, dated January 1997.

Very soft to soft clay soils, with N-values ranging from 3 to 5 bpf, are listed in the following table:

Boring No.	Depth (feet)	Soil Type	N (bpf)
TB-1-SG	6 - 10	Silty Clay	2 to 5
TB-1-SG	10 - 22	Silty Clay Loam with trace marl/organic matter	2 to 5
TB-2	1 - 8	Silty Clay Loam with trace marl/organic matter	4 to WOH
TB-2	8-12	Clay Loam with trace marl/organic matter	WOH
RB-1-SG	6 - 8	Silty Clay	5
RB-2-SG	2 - 5.5	Silty Clay Loam/Clay	2 to 5
RB-3-SG	5.5 - 8	Silty Clay	5
RB-4-SG	5.5 - 8	Clay	4
RB-7-SG	3 - 5	Silty Clay Loam	4
RB-9-SG	5.5 - 8	Silty Clay	5

The natural granular soils, such as sand and sandy gravel, ranged from loose to medium dense, with N-values ranging from 3 to 19 bpf. The sands were generally moist to wet below about 18 feet, about elevations 596 to 611 feet.

The above subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in the appendix should be reviewed for specific information at individual boring locations. These records include soil descriptions, stratifications, penetration resistances, locations of the samples and laboratory test data. The stratifications shown on the boring logs represent the conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. The stratifications represent the approximate boundary between subsurface materials and the actual transition may be gradual. Groundwater information obtained during field operations is also shown on these boring logs. The samples which were not altered by laboratory testing will be retained for 60 days from the date of this report and then will be discarded.

4.2 Groundwater Conditions

Water levels were measured in the borings during and at completion of drilling. The driller reported water at the ground surface to depths of about 21 feet (6.4 m) below existing grade, approximately elevation 598 to 612 feet (182.3 to 186.5 m), during drilling at Borings TB-1-SG, TB-2, RB-6-SG, RB-7-SG, and RB-9-SG. The water levels at completion of drilling, following removal of the augers from boreholes, ranged from about 4 to 17 feet (1.2 to 5.2 m) below existing grade, approximately elevation 605 to 614 feet (184.4 to 187.2 m). After 24 hours, groundwater was reported at depths of about 1.5 to 16.5 feet (0.5 to 5.0 m), approximately elevation 609 to 624 feet (185.6 to 190.2 m), in Borings TB-1-SG, RB-6-SG, RB-9-SG, and RB-11-SG. The remaining borings were "dry" during and upon completion of drilling, meaning that no free water was observed in the borehole or on the sampling tools. The "dry" conditions indicate that the continuous groundwater level at the site at the time of the exploration was either below the terminated depths or cave-in depths of the borings, or that the soils encountered were relatively impermeable. Soil cave-in depths were reported at about 5 to 18 feet (1.5 to 5.5 m) below existing grade in the boreholes, approximately elevation 598 to 620 feet (182.3 to 189.0 m).

Due to the relatively short period of time the boreholes remained open, and the generally fine-grained nature of soils throughout the entire length of shallow soil borings (less than 3 m in depth), the water level observations in the boreholes may not be representative of the groundwater level at the site. In our experience, fine-grained soils oxidize from brown to gray can sometimes be indicative of the long-term groundwater level. At this site, the soil color changes at depths of about 8 to 22 feet (2.4 to 6.7 m) below existing grade, at elevations of about 596 to 617 feet (181.7 to 188.1 m).

Based on the moisture state of the retrieved samples, the soil color change from brown to gray, the reported groundwater observations, we estimate the prevailing groundwater level is at or below depths ranging from about 1.5 to 16.5 feet (0.5 to 5.0 m) below existing grade, approximately elevation 609 to 624 feet (185.6 to 190.2 m). In general, the groundwater levels appears to follow topography, with the shallower groundwater encountered in the area of proposed box culvert. Limited volumes of perched water will likely be encountered at shallower depths, depending on seasonal conditions.

The prevailing hydrostatic groundwater level, as well as perched water levels and volumes, should be expected to fluctuate throughout the years, based on variations in precipitation, evaporation, surface run-off and other related hydrogeologic factors. The groundwater levels discussed herein, and indicated on the boring log, represent the conditions at the time the measurements were obtained.

4.3 Soil Subgrade Investigation Summary

The soil subgrade investigation was performed on eleven (11) of thirteen (13) borings, with suffix "SG" following their boring number. These borings for soil subgrade investigation purposes are RB-1-SG through RB-7-SG, RB-9-SG through RB-11-SG, and TB-1-SG.

The soil subgrade investigation consisted of continuous split spoon sampling below the pavement subbase material, with Shelby tubes pushed adjacent to the split spoon sampling when required based on soil type and Standard Penetration Test (N-values) criteria established by INDOT. A total of eleven (11) Shelby tube samples were obtained in the soil subgrade borings. A minimum of two consecutive split spoon samples were obtained below the pavement subbase material, with a third obtained when required based on N-values from the second. The boring was then terminated unless N-values were less than 5 blows per foot.

CBR and Proctor tests were performed on a bulk sample obtained from Boring RB-2-SG, at a depth of about 1 to 3 feet (0.3 to 0.9 m) below existing grade. The results of the CBR and Proctor tests are summarized below:

Boring No.	Depth (feet)	Soil Type	Opt. Moisture Content, %	Maximum Density, pcf	CBR @ 93 %	CBR @ 97 %
RB-2-SG	1.0 – 3.0	Silty Clay Loam A-4(0)	15.5	110	2.2	3.3

We compared the in-place density of the Shelby-tube soil samples to the above Proctor data, and provide a comparison estimate of degree of compaction, as tabulated in the following Summary of Subgrade Soil Conditions Table.

Summary of Subgrade Soil Conditions

Boring No.	Depth (feet)	Soil Type	Moisture Content (%)	Dry Density (PCF)	Difference to Opt. Moisture Content	% of Max. Dry Density
RB-2-SG	2 - 4	Silty Clay Loam, A-4	24.0	89.4	+9.7	81.3
RB-2-SG	4 - 6	Clay, A-7-6	25.9	95.0	+10.4*	86.4*
RB-4-SG	2 - 4	Silty Clay Loam, A-4	27.5	93.8	+12.0	85.3
RB-5-SG	1.5 - 3	Silty Clay Loam, A-4	26.7	97.2	+11.2	88.4
RB-6-SG	1.5 - 3	Silty Loam, A-4	24.3	98.2	+8.8*	89.3*
RB-7-SG	1.5 –3.5	Silty Clay Loam, A-4	24.5	98.6	+9.0	89.6
RB-7-SG	3.5 –5.5	Silty Clay Loam, A-4	27.5	94.1	+12.0	85.5
RB-9-SG	1.5 – 3.5	Silty Loam, A-4	20.9	102.3	+5.4*	93.0*
RB-10-SG	1 – 3	Silty Clay, A-6	21.9	105.3	+6.4*	95.7*
RB-11-SG	1 - 3	Silty Loam, A-4	19.4	109.6	+3.9*	99.6*

* - Standard Proctor test was not performed on clay, silty clay, and silty loam soils, therefore, the in-situ moisture content and dry density were compared to standard Proctor Test data of the most similar soil – silty clay loam.

We understand INDOT plans bituminous overlay and/or pavement reconstruction in the areas of existing pavement and full depth of bituminous pavement on the widening sections of the proposed roadway. Based on the current and projected Annual Average Daily Traffic (AADT), we anticipate 24-inch (610 mm) subgrade treatment as outlined in Section 5.3 of this report will be required. Compaction of the subgrade soils will be required for 610-mm (24-inch) subgrade treatment. Based on our test data, the moisture contents of in-situ clay soils were generally wetter than the optimum moisture content, up to about 12 percent over optimum. Therefore, we anticipate significant discing, drying and recompaction will be required to improve unstable subgrade conditions. To expedite the roadway construction, we recommend the 16 inch (400 mm) chemical modification method as outlined in Subgrade Treatment Recommendations issued by INDOT, dated August 23, 2001, for this project, instead of conventional 610-mm (24-inch) subgrade preparation for the existing and roadway widening sections.

5. ANALYSES AND RECOMMENDATIONS

5.1. Cut and Fill Sections

The profile grade along the proposed 61st Avenue alignment within project CM-9945( ), varies from about (631.9 feet (192.6 m) at the beginning of construction at Station 10+00, to about 629.7 feet (191.9 m) at the intersection with Liverpool Road, Station 27+95.96, Line "A". The maximum cuts within the project limits were about 2.8 feet (0.85 m), and maximum fills were about 2 feet (0.6 m) located in the existing drainage ditch areas.

Within project STP-N606( ), the proposed profile grade varies from about 629.7 feet (191.9 m) at the beginning of construction (Station 27+95.96, Line "A), to about 628.3 feet (191.5 m) at the intersection with Minnesota Street (Station 38+20, Line "A"), to elevation 622.5 feet (189.7 m) at the existing culvert structure (Station 51+20, Line "A") , to about elevation 624.0 feet (190.2 m) at the intersection with Colorado Street (Station , and to elevation 628.7 feet (191.6 m) at the end of 61st Avenue alignment (Station 62+04). The maximum cuts within the project limits were about 4.5 feet (1.4 m), and maximum fills were about 14 feet (4.3 m) located near the existing culvert structure (Station 51+50, Line "A").

Embankment slopes of 2½:1 and 3:1 (H:V), as shown in the Typical Pavement Sections, should generally be sufficient to provide stable slopes, provided the subgrade is properly prepared, and the existing slopes are properly benched prior to the placement of the fill. Slope stability are discussed in Section 5.2 of this report, particularly in the vicinity of existing creek where soft organic soils are present. Post-construction settlement is also discussed in Section 5.2.

Surficial organic topsoil, approximately 12 inches (0.3 m) in thickness, was generally encountered at the locations of borings in areas without existing pavement. Based on the soundings performed near the existing creek within the area for the proposed culvert structure, very soft silty clay with organic matter (or peat) and loose sand were generally present below the ground surface to the ½ to 3½ foot depths of soundings. Due to the presence of organic soils to significant depths, therefore, soundings were terminated shallower just for organic soil verification purposes. Based on Boring TB-2, which was performed at the toe of the existing slope within the area for the proposed structure, silty clay loam with little organic matter was encountered to a depth of about 12 feet below grade.

The organic topsoil, and loose or soft/loose soils encountered during the subgrade preparation should be removed prior to placing the proposed fill. We do not anticipate removal and replacement of organic soils in the area of the existing creek and proposed culvert is a practical and cost-effective method due to the significant undercut, dewatering, and sheeting/shoring required during construction.

Granular fill should not be used in the drainage ditches, or within 12 inches (305 mm) of the required finished surfaces of slopes, to reduce the risk of erosion. The embankment material should be a non-erodible, environmentally clean soil free from clods, debris, organic matter, and stones. Refer to Section 6.1 for further recommendations regarding subgrade preparation.

5.2 Ground Improvements

Based on the preliminary Road Plans prepared by HNTB, the proposed profile indicates significant embankment fills, about 14 feet (4.3 m) in thickness, will be required for the roadway widening at the existing culvert structure (Station 51+50, Line "A"). In addition, an existing 10-inch gas pressure main is located about 43 feet south of the proposed centerline "A", near the toe of existing south embankment slope. The depth of gas pressure main was not available at the time this report was prepared. However, based on the proposed top of footing elevation 606 feet, we anticipate the existing gas pressure main could be located close to or below the bottom of the proposed box culvert structure. We also understand City of Hobart plans not to relocate the existing gas pressure main due to the cost and service reasons.

Based on the proposed height of embankment fill and consolidation parameters of clay soils with marl/organic matter, we anticipate primary consolidation settlement up to about 14 inches (356 mm) could develop at Boring TB-2. We anticipate primary consolidation settlement may be achievable within 11½ years, after the placement of full-height of embankment fills. Secondary settlement of the these organic clay soils up to 30 years after construction could be in a range of about ½ to 1 inch (13 to 25 mm). For analysis purposes, we have assumed an allowable settlement of the box culvert structure to be 1 inch (25 mm). The time required for within 1 inch (25 mm) allowable post-construction settlement is about 9 years. (see settlement analysis in the Appendix) The above settlement estimate is based on the soil parameters obtained from a consolidation test performed on a relatively undisturbed Shelby tube sample of organic silty clay loam soil from Boring TB-2.

Therefore, we have considered soil improvements for the embankment and box culvert constructions near the existing creek. The selection of remedies was based on five (5) functions.

- Reducing settlement to a tolerable range without a long construction delay.
- Providing adequate embankment slope stability.
- Uniformly supporting the proposed precast 4-sided precast box culvert.
- Providing the support to the existing gas pressure main due to the potential of excessive settlement.
- Providing support to the storm sewer to be installed between Structure No. 187 and 196.

We anticipate excessive settlement could potentially damage the proposed new 4-sided precast concrete box culvert structure and sewers. In addition, 9-year waiting period prior to pavement construction is not practical for this project due to the high traffic volume on existing 61st Avenue. Based on the potential quantity of removal and replacement, or required waiting period of about nine years for at least about 93 percent of primary consolidation, or required adequate support to the proposed precast culvert structure and existing gas pressure main, we anticipate vibro-concrete columns (VCC) are likely a feasible alternative for this project. VCC as well as other improvement alternatives considered are discussed below.

(a). **Vibro Concrete Column (VCC)** – To reduce the excessive settlement, to uniformly support the proposed precast 4-sided reinforced concrete box culvert and sewers, and to limit the risk of overstressing the existing gas pressure main, we consider Vibro Concrete Column (VCC) is a relatively fast and feasible scheme.

The VCC process was first developed in Europe in 1976. Instead of feeding stone to the tip of the vibrator (as is done with stone columns), concrete is pumped through an auxiliary tube to the bottom of the hole. This method can offer the ground improvement advantages of the vibro systems with the load carrying characteristics of a deep foundation.

The VCC process employs a bottom feed depth vibrator that can penetrate the soils to a level suitable for bearing. Concrete is pumped through the vibrator assembly during initial withdrawal. The vibrator then repenetrates the concrete, displacing it into the surrounding soil to form a high-capacity, enlarged column base. The vibrator is then slowly withdrawn as concrete is pumped at maintained pressure to form a continuous shaft of concrete up to ground level. At ground level, a slight mushrooming of the concrete column is constructed to assist the transfer of the applied loading into the VCC.

We anticipate VCC installed at a 6 feet by 6 feet grid may be required. The VCC grid should be adjusted or additional VCC elements added to provide concentric support along the box culvert and storm sewer alignments. The VCC elements below the box culvert and storm sewer must have their top of VCC elements set below the structure invert elevations. Other VCC elements that will support embankment fill could have top of VCC elements established near the existing grades. The VCC elements should also be spaced to avoid the gas main, and a reinforced concrete cap should be constructed to span between VCC elements to support the fill load directly over the gas main. Also, to uniformly support the proposed embankment fill, precast 4-sided reinforced concrete box culvert, and sewer over VCC, we recommend two layers of geogrid reinforced crushed aggregate (one foot for each layer) be placed over the installed VCC underneath the precast box culvert and sewer, and three layers of geogrid reinforced crushed aggregate underneath the proposed embankment fills. We anticipate dewatering by means of wellpoints or deep wells may be necessary along the culvert and storm sewer alignments in order to excavate for the structure and install the granular/geogrid blankets.

N-values of the existing embankment clay fill encountered at Boring TB-1-SG generally ranged from 2 to 11 bpf, with unconfined compressive strength ranging from ¼ to 1½ tsf. We anticipate pre-drilling through the existing roadway embankment may be required prior to VCC installation.

The organic soils were generally encountered near the existing ground surface in the widening areas near the creek. (see the attached Summary of Soundings) N-values of the existing organic soils generally ranged from weight of hammer (WHO) to 5 bpf. Therefore, we anticipate a drainage blanket will be required prior to the construction to provide an appropriate working platform and drainage path, and to protect the exposed portions of

VCC from construction traffic and freezing temperatures. The working platform should be a granular material with maximum particle size between 1 and 2 inches, and less than 10 percent passing the No. 200 sieve, such as INDOT No. 2. The drainage blanket should be at least a continuous 24 to 36 inches (610 to 915 mm) thick. If the VCC and blanket are placed during the winter months then an additional layer of fill will be required to prevent the ends of the VCC from freezing.

For bidding purposes, the plan limits of VCC along the alignment should be assumed to extend from Station 50+00 to 52+50, Line "A". The actual limits may require revision based on encountered organic soil limits. The plan limits of VCC in width should extend a minimum of 6 feet beyond the toe of the embankment, or greater as determined by the VCC contractor. Plan limits of the VCC also must extend at least to the limits of the box culvert wingwalls.

The VCC contractor should submit a detailed plan for layout and method of installation of the VCC to the design engineer for review. Specific equipment and installation procedures to achieve the specified criteria are the contractor's responsibility. Special provision and recommendations for field inspection for Vibro-compacted concrete columns are included in the Appendix of this report. Specific modifications recommended to tailor the guide specifications to the requirements of this project are marked on the Special Provision. We strongly recommend review of the required contractor submittals be performed by PSI and INDOT Division of Materials and Tests. Full-time quality assurance during construction should be performed by a qualified engineering technician or staff engineer working under the direction of the project geotechnical consultant. We recommend full-time quality assurance during ground improvement construction be performed by PSI or by INDOT Division of Materials and Tests.

(b). **Complete Removal and Replacement** - The removal and replacement alternate consists of excavating the organic clay soils and replacing the excavated materials with compacted "B" Borrow engineered fill. The existing fill can be removed and stockpiled for reuse. We anticipate the limits of overexcavation are likely within Station 50+00 to 52+50, Line "A". The overexcavation of organic soils could extend to an elevation about 596 feet (181.7 m), or about 12 feet (3.7 m) below the groundwater table. Therefore, for the removal and replacement alternative, wellpoint or multiple deep well dewatering before and during the construction would be necessary. Dewatering for left side of the widening road poses a potential risk of settlement of the existing roadway on the right side, due to an increase in effective stress, which could create pavement distress during the construction period. In order to maintain 61st Avenue open for traffic, temporary sheet pile or solider pile and lagging retaining walls with tieback anchors would likely be necessary along the centerline of proposed alignment. Furthermore, since organic soils likely are present below the existing gas main, support or relocation of the gas main would be necessary.

The organic silty clay loam and loam soils should be removed to its full extent under the proposed roadway. From the edge of pavement at the bottom of the excavation, the sides of the excavation could be sloped to the proposed toe of embankment slope. The loose to very loose sand at the bottom of the excavation should be compacted with a vibratory roller prior to the placement of B Borrow backfill. The on site soils obtained from the culvert excavation or the roadway cuts should be categorized for reuse to facilitate compaction control. The engineered fill should be placed in lifts not exceeding 203 mm (8 inches) in loose thickness and be compacted to the required density as specified in the 1999 INDOT Standard Specifications.

A representative of the project geotechnical engineer must be on-site to observe the removal of organic silty clay loam and loam soils. No waiting period for consolidation is required for this method. Based on the estimated quantities of overexcavation, wellpoints dewatering, and anchored temporary retaining walls and support or relocation of the gas main, we anticipate the complete removal and replacement of in-situ organic soils could be costly and also time consuming.

(c). **Expanded Polystyrene (EPS Foam)** – EPS Foam is made from polymer in the form of blocks with extremely low unit weight of about 1.35 pounds per cubic feet (pcf). Construction of the roadway embankment with EPS foam could be relatively fast, and only cause minimal post-construction settlement. For a project on a rush basis, EPS foam initially may appear to provide an attractive alternative. However, we understand the existing creek serves as major storm water drainage from 61st Avenue to Turkey Creek. The 100-Year elevation at this site is 613.13 feet (186.9 m), which is about 8 feet (2.4 m) above the proposed invert elevations. Due to the potential significant buoyancy conditions under flooding, we do not anticipate EPS foam is a feasible scheme for the roadway embankment construction near the existing creek.

(d). **Wick Drains** - Wick drains can be best described as prefabricated vertical drains. Their primary use is to accelerate consolidation of soft saturated compressible soils under load. They can greatly decrease the settlement time of embankment over soft soils, and accelerate the rate of strength gain of the in-situ soft soils. Wick drains are generally used in consolidation situations where the soil to be treated is a moderate to highly compressible soil with low permeability and fully saturated in its natural state. The most common use of wick drains is to accelerate consolidation for roadway embankments at bridges or other embankment construction over soft soils, where the total post-construction settlement is not acceptable.

We have performed wick drain analysis for cost comparison purposes. Depending upon the wick drain spacing, we anticipate a minimum waiting time from 3 months to 1 year may be required, with spacing ranging from 1¼ to 2¼ feet, respectively, for about 93 percent of primary consolidation. The waiting time could be somewhat reduced or the wick drain spacing increased by placement of a temporary surcharge fill over the alignment. Therefore, as a contingency that City of Hobart is willing to close the road for construction, and accept the responsibility to maintain the roadway pavement annually, wick drains could be a feasible scheme for this project. However, the existing gas pressured main must be properly supported or relocated prior to the installation of wick drains due to the potential differential settlement along the main.

(e). **Compaction Grouting** – Structural compaction grouting can be used in a wide variety of applications including soil densification, raising of surficial structures, settlement control over tunnels or sinkholes, and for structural underpinning. In general, compaction grouting is effective in loose granular soils, loose unsaturated fine-grained soils, collapsible soils, and in void filling. Based on the test results of grain size distribution, the fines (particles fine than #200 sieve) within the in-situ organic soils generally range from about 58 to 88 percent. Based on the range of applicability of soil grouting techniques (Fig. 26, Ground Improvement Technical Summaries, Volume II, FHWA-SA-98-086), we do not anticipate structural compaction grouting can form structurally sound grout columns to support the box culvert and gas pressure main. The other concern was the high grouting pressure could potentially damage the existing gas pressure main.

(f). **Geopiers™** - Geopier™ elements are installed by drilling 30-inch diameter holes and ramming thin lifts of well-graded aggregate within the holes to form very stiff, high-density aggregate piers. The first lift of aggregate forms a bulb below the bottoms of the piers, thereby pre-stressing and pre-straining the soils to a depth of equal to a depth of equal to at least one-pier diameter below drill depths. Subsequent lifts are typically about 12 inches in thickness. Ramming takes place with a high-energy beveled tamper that densifies the aggregate and forces aggregate laterally into the sidewalls of the hole. This action increases the lateral stress in the surrounding soil; thereby further strengthening and stiffening the composite soil mass.

The depth of conventional Geopier™ construction is limited to 22 feet below grade. The depth limitation is controlled by the "reach" of conventional trackhoe mounted tamper. Due to the presence of organic soils to a depth of about 22 feet below the existing pavement grade at Boring TB-1-SG, we anticipate organic soils could be encountered deeper than 22 feet beyond the reach of a conventional trackhoe mounted tamper. Therefore, if this scheme is selected or permitted as a contractor alternate, we recommend further machine soundings be required to evaluate the depths of organic soils prior to bidding.

Considerations regarding arrangement of the elements below the box culvert and sewer, and spanning over the gas main, which applied to VCC also apply to Geopiers™. Also, a detailed submitted should be required from the Geopier™ specialty contractor, for review by PSI and INDOT, Material and Test Division. Protection of the gas main against lateral displacement during geopier™ installation and tamping will require particular attention.

(g). **Vibro-replacement (Stone Column)** – Stone columns are a technical and potentially economical alternative capable of improving sufficiently to allow less expensive embankment construction. Stone columns are also more economical than the removal and replacement of deep poor bearing soils, particularly on larger sites where the groundwater is close to the surface. However, stone columns are not a solution for all soft soil problems. Strata of peat, marl, mulch, and other organic soils, very soft clays with a thickness greater than the diameter of the stone column can be inappropriate for stone column construction as they offer inadequate lateral support. When the thickness of the organic layer is greater than 1 to 2 stone column diameters, the ability to develop consistent column diameters becomes questionable. Therefore, we do not consider stone column to be a feasible scheme for this project.

Based on the proposed 3 (horizontal) to 1 (vertical) embankment slope and VCC installed to a depth of about 18 feet below toe of the slope, or elevation 590 feet, at 6 feet by 6 feet grid, we do not anticipate slope failure is likely to occur. Therefore, we did not perform slope stability analysis near the proposed box culvert structure.

5.3 4-Sided Precast Reinforced Concrete Box Culvert (Structure No. 191)

The project also includes replacement of the existing culvert structure at about Station 50+95, Line "A". The existing structure is a 60-inch corrugated metallic pipe (CMP), with a span of about 60 feet (18.3 m) long. We understand, after the removal of the existing culvert structure, a 4-sided precast reinforced concrete box culvert, Structure No. 191, will be constructed at Station 51+10, Line "A". The proposed box culvert is about 160 feet long, with an opening of 16 feet (wide) by 6 feet (height). Two wingwalls are also proposed to be constructed at each end of the proposed culvert structure.

We understand the proposed flow line is about 607.2 to 608.0 feet at the north and south end of culvert, respectively, and the top of the footing elevations will be about 2 feet (0.6 m) below the flow line. Therefore, we anticipate the bottom of footing elevations could be at 603.2 to 604 feet at the north and south end of culvert, respectively.

We recommend the bridge structure as well as streambed be protected from scouring and erosion with a minimum 1.2 m (4 feet) of riprap at both ends. We have assumed City of Hobart and design consultant, HNTB, will select VCC as the supports for the new culvert structure and roadway embankment. The vibro-concrete columns need to be penetrated the near surface marly soils to the underlying sand or sandy gravel, at about elevation 587 feet. The culvert foundations bearing on the geogrid-reinforced layer placed over the VCC may be proportioned using a net allowable pressure of 3,000 psf. The maximum net allowable soil bearing pressure is that pressure which may be transmitted to the bearing material in excess of the final, minimum surrounding overburden pressure. We estimate total settlement of the culvert structure supported on VCC deep foundation may be about ½ to 1 inch, with differential settlement of about half of the total settlement. In order to uniformly support the proposed culvert structure, we recommend at least two layers (12 inches each) of geogrid-reinforced crushed aggregate, such as INDOT 53, be placed underneath the proposed culvert structure.

We recommend the proposed wingwalls be supported on the same type of VCC deep foundation as the culvert structure. The geogrid-reinforced crushed aggregate should also be placed on top of the VCC to uniformly support the wingwalls. The following additional soil parameters are also provided for wingwall design, as requested in the Memorandum issued on April 12, 1999, by INDOT, Department of Materials and Tests.

- Friction Angle, $\delta = 30°$
- Friction Factor, $\tan \delta = 0.58$
- Angle of Internal Friction of the geogrid reinforced foundation soil, $\phi = 32°$
- Ultimate adhesion between the foundation soil and concrete footing, C_a = N/A
- Ultimate cohesion, C_{ult} = N/A

5.4 General Pavement Design Considerations

For the widening or new roadway sections, the surficial topsoil and/or near-surface clay soils containing trace to little organic matter should be completely undercut with the exception of the areas between Station 50+00 and 52+50, Line "A", which will require VCC for ground improvements. Proofrolling would allow identification and undercutting of areas of weak subgrade soils.

With overlay methods directly over the existing asphalt pavement, no subgrade or drainage improvements are feasible. While pavement design is outside our scope of services for this project, we note that the existing pavement distress decreases the remaining life of the existing pavement to be credited in overlay design, and increases the risk of reflective cracking.

5.5 Recommended CBR Values

PSI evaluated the most critical and predominant plastic (cohesive) soil types encountered within the proposed new pavement areas along the proposed 61st Avenue alignment for subgrade strength, based on the California Bearing Ratio (CBR) tests. The cohesive soils encountered along the alignment included silty clay loam, silty loam, and silty clay. Two bag samples were obtained near the existing ground surface at Borings RB-2 and RB-8 for CBR tests, the sample from RB-2 was tested. The most predominant plastic soil at subgrade elevations within the proposed pavement area was silty clay loam, with about 77 percent of silt and clay, and plasticity index (PI) of 10. Based on AASHTO classification system, the most predominant cohesive soils within the proposed new pavement area was classified as A-4.

The CBR value of the silty clay loam sample, compacted to 97 percent of the maximum dry density as determined by AASHTO T-99, Standard Proctor Method, are provided in the table below.

Location	Depth (ft)	Soil Type	% Max. Dry Density	Test CBR Value @ 97 %
RB-2	1 – 3	Silty Clay Loam, A-4(7)	97	3.3

In the Fill Areas

Based on the INDOT Design Memorandum, Subgrade Treatment Recommendations, dated August 23, 2001, we recommend 24 inches (600 mm) subgrade treatment for the fill areas in this project. Due to the presence of more cohesive silty clay and clay soils (A-7-6) with PI over 20, therefore, we recommend a CBR value of 2.5 be used for pavement design rather than the higher maximum value of 3.3.

In the Cut Areas

Based on the preliminary Road Plans provided by The HNTB Companies, the projected AADT on existing 61st Avenue ranged from about 11,680 vehicles per day (VPD) in 2003 to 15,650 VPD by 2023. The total subgrade treatment area is more than 10,000 yd^2. Based on Subgrade Treatment Guidelines prepared by INDOT, we recommend 16 inches (400 mm) chemical modification (or any alternative described in Section 207.04(a).1), with an estimated CBR value of 2.5 for the pavement design.

During the site preparation operations, the subgrade soil should be evaluated by the project geotechnical engineer to verify the soil type meets the design CBR criteria.

5.6 Subsurface Drain Recommendations

Near surface soils generally encountered in borings varied from silty clay loam, silty clay, clay, and silty loam. The predominantly cohesive soils along the proposed alignment generally have poor drainage characteristics. Most of the near surface cohesive soils encountered along the proposed alignments had silt content over 50 percent except clay which had a silt content of 47 percent. If surface water which infiltrates through joints and cracks in the pavement and is allowed to pond on the subgrade, the subgrade will soften and contribute to the formation of frost lenses. The frost lenses will result in further softening during thaw periods with attendant reduction in the pavement life. Removal of infiltrating surface water by means of pavement subsurface drains can help to extend a pavement's useful life.

Current INDOT practice requires the use of geotextile filter fabric around surface drains only when the percentage of silt-size particle (0.074 to 0.002 mm) exceeds50 percent. Subsurface drains are required when soil conditions warrant, and the length of project is over 2,000 feet, and the AADT exceeds 3,000 VPD. Based on the on site soil conditions, length of the project, and provided traffic volume, we recommend that pavement subsurface drains with geotextile filter fabric be used throughout this project.

Subsurface drains should be perforated corrugated plastic pipe meeting the requirements of Section 718 of the INDOT 1999 Standard Specifications, Underdrains. We recommend the pipes be surrounded by a minimum of 150 mm (6 inches) of INDOT No. 8 aggregate, with the aggregate fully encased in a non-woven geotextile filter fabric meeting Section 913.19, Geotextile for Use with Underdrains, of the INDOT 1999 Standard Specifications. The Apparent Opening Size (AOS) should be compatible with the openings in the drain tile and the grain size of the surrounding soils, to reduce the risk of loss of fines into the drainage system and clogging. Outlets should be provided at regular intervals to convey the water collected in the subsurface drains. The subsurface drain outlets should be covered with screen.

The pavement section should be graded to prevent ponding of surface water. Subgrade slopes should follow surface slopes. We recommend a minimum slope of 2 percent, where feasible, to facilitate drainage.

6. CONSTRUCTION CONSIDERATIONS

6.1. Subgrade Preparation

The recommendations of this section apply to the pavement reconstruction, widening, and new extension areas, with the exception of the areas near the proposed box culvert, which require ground improvements.

In widening areas, all topsoil, wet or soft surface soils, and organic soils within the upper three feet should be stripped from the site within the construction limits prior to construction of the roadway, with the exception of the areas between Station 50+00 and 52+50, Line "A", which will require VCC for ground improvements. In areas where engineered fill will be placed, such as an area undercut due to organics present, proofrolling of the stripped ground surface should be performed in accordance with INDOT Standard Specifications, Section 203.26. All soft, loose, organic or otherwise unsuitable soils encountered during the proofrolling operations should be undercut and replaced with engineered fill.

The majority of the near surface subgrade soils at the site have been characterized as silty clay loam, silty clay, clay, clay loam, and silty loam soils, which will soften when exposed to repeated loadings, thus making grading difficult. If grading is performed during wet times of the year, we anticipate the near-surface soils will be difficult to work, that access may be difficult, and a greater amount of surface repairs will be required to improve soils judged to be unsuitable because of excessive moisture content.

At boring locations performed within the widening lane areas, the natural moisture contents of near surface silty clay loam, silty clay, clay, clay loam, and silty loam soils, generally ranged from 19 to 28 percent, and the majority were generally over the respective optimum moisture contents. Therefore, we anticipate discing, drying and recompaction will be required to improve unstable subgrade conditions. However, if the construction takes place in the hot dry summer season, additional water may need to be added to the soil to increase the moisture content to the desired optimum. The contractor should have equipment, such as a large non-agricultural disc, on site to allow thorough mixing of the soils and added water, if it becomes necessary.

Near-surface samples containing apparent organic matter (possible buried topsoil) were obtained from about 1 to 4 feet (0.3 to 1.2 m) in Borings RB-4-SG and RB-10-SG. The loss on ignition (LOI) organic content of the first soil sample from these two borings was about 5.8 to 5.9 percent. We recommend subgrade soils which contain organic matter be removed from the zone of seasonal moisture change and replaced with engineered fill. Typically, the zone of seasonal moisture change is approximately the upper 3.5 feet (1.1 m) below final grades.

Provided earthwork proceeds during a warm and dry period, we anticipate only limited areas of subgrade soils would be likely to fail proofrolling. However, if subgrade soils for localized small areas become unstable due to the presence of ponded water, we anticipate they may be stabilized through undercutting a minimum of 305 mm (12 inches) and replacing with compacted "B" Borrow or No. 53 crushed aggregate, in combination with a geogrid if necessary. Alternatively, we anticipate a minimum 406 mm (16 inches) lime kiln dust modification methods may be used, if large areas of wet or disturbed cohesive subgrade soils are encountered during construction.

Due to the presence of very soft organic soils with marl/organic matter, we do not recommend the embankment widening areas near the existing creek be proofrolled. Organic soil delineation was not included in our scope of work for this project, therefore, PSI did not perform marl delineation borings. However, we recommend Station 50+00 to 52+50, Line "A", be used for cost estimate purposes, based on site topography. Actual limits of the organic soils should be established during construction.

It is important the surficial dark brown to black topsoil material or clay soils with marl/organic content not be re-used as backfill. We recommend that a geotechnical field representative observe subgrade preparation and undercutting of organic soils, to evaluate the subgrade soils suitability and adequacy of the undercut.

6.2 Fill Placement and Compaction

The recommendations of this section apply to areas of pavement reconstruction or widening areas. Based on the provided preliminary Road Plans, we understand up to about 14 feet (4.3 m) of fills and about 4 feet (1.2 m) of cuts are planned within the project limits, with the deeper fills located in the area of the culvert replacement.

Engineered fill used on the project should be an approved, environmentally clean material, free of lumps, frozen soil, wood, roots, topsoil, or other deleterious material. The engineered fill should meet the requirement of borrow as specified in Section 203.08, INDOT 1999 Standard Specifications. The on site soils obtained from the culvert excavation or the roadway cuts should be categorized for reuse as recommended in Section 5.2, to facilitate compaction control. The engineered fill should be placed in lifts not exceeding 203 mm (8 inches) in loose thickness and be compacted to the required density as specified in the 1999 INDOT Standard Specifications.

Granular soils meeting INDOT specifications for "B" Borrow are suitable for use as engineered fill. On-site inorganic materials, such as silty clay loam and silty loam (A-4) and silty clay (A-6), would generally suitable for the embankment fill. Depending on the time of construction, significant aeration of the on-site fill material may be required before it can be placed as engineered fill according to the INDOT Specifications for fill placement. If may also be necessary to add moisture during extended periods of hot weather should the soil become too dry to achieve compaction.

6.3 Storm Sewer and Sanitary Sewer Lines

We understand storm and sanitary sewer lines are proposed along existing 61st Avenue (Line "A") between the proposed catch basins, manholes, and outlet structures. We understand the proposed inverts of storm and sanitary sewer lines and manholes generally range from about 8.5 to 19 feet (2.6 to 5.8 m) below the existing pavement grade.

We understand the storm sewer to be installed includes 15 to 48 inch (380 to 1200 mm) reinforced concrete pipes (RCP). A 16 feet by 6 feet reinforced concrete box culvert is planned at Station 51+10, Line "A", as discussed in a previous section of this report. The proposed sanitary sewer will include 0.3 to 10 inch PVC pipes. The proposed new sanitary sewer line will be connected the existing sanitary sewer trunkline route running parallel to the S. Liverpool Road.

In general, the placement of the sewer lines within the soil profile does not increase the load on the underlying soil. However, it is important to have proper support, and to maintain proper line and grade of the pipe to prevent the pipe from becoming over-stressed in hoop compression or bending. Also, where new fill causes settlement of soft natural soils, sewer lines also will settle, which can cause problems with flow and potentially can overstress the pipe, depending on the magnitude of different settlement.

Based on the soil conditions from borings performed along existing 61st Avenue, the soils at the bearing depth of manholes and sewer lines should generally be suitable for support of the structures except within the area where organic silty clay loam and loam soils were present in the vicinity of Structure No. 187 through 196. The following table shows the type of storm and sanitary sewer pipe structures, approximate locations, and proposed invert elevations, and type of bearing soil at the invert elevations as encountered at the boring locations.

Storm Sewer	From	To	Sewer Invert Elevation, ft	Borings	Bearing Soil at Boring Locations
15 inch RCP	Structure No. 100 (Sta. 11+00, "A")	Structure No. 111 (Sta. 17+07, "A")	623.66 to 621.20	RB-1-SG & RB-2-SG	Medium Stiff Clay to Silty Clay
18 to 24 inch RCP	Structure No. 111 (Sta. 17+07, "A")	Structure No. 136 (Sta. 27+76, "A")	621.10 to 617.24	RB-2-SG RB-3-SG RB-4-SG	Medium Stiff Silty Clay to Medium Dense Sand
30 inch RCP	Structure No. 136 (Sta. 27+76, "A")	Structure No. 167 (Sta. 38+60, "A")	617.14 to 612.84	RB-5-SG & RB-6-SG	Medium Dense to Loose Sand
36 inch RCP	Structure No. 167 (Sta. 38+60, "A")	Structure No. 191 (Sta. 51+23, "A")	612.74 to 608.00	RB-6-SG RB-7-SG TB-1-SG	Medium Dense to Loose Sand to Soft Organic Silty Clay Loam
48 inch RCP	Structure No. 191 (Sta. 51+23, "A")	Structure No. 212 (Sta. 60+98, "A")	607.2 to 614.70	TB-2 RB-8 RB-9-SG	Soft Organic Silty Clay Loam to Medium Stiff Silty Clay or Clay

Sanitary Sewer Type	From	To	Sewer Invert Elevation, ft	Borings	Bearing Soils at Boring Locations
10 inch PVC	Structure No. 300	Structure No. 308	622.75 to 616.73	RB-2-SG RB-3-SG RB-4-SG	Stiff to Soft Silty Clay to Medium Dense Sand

Adequate control of groundwater will be necessary to preserve subgrade stability, particularly in the sewer excavations between Station 25+00 and 55+00, Line "A". If loose sand is present at the proposed sewer bearing elevations, we recommend the proposed subgrades be undercut a minimum of 0.5 m (18 inches), and backfilled with compacted INDOT No. 53 crushed aggregate to the proposed pipe invert elevation. The purpose of the undercut and replacement is to aid in bridging the underlying loose sand and providing a stable base for the pipe. The aggregate pad should extend laterally a minimum of 0.5 m (18 inches) from the edge of the pipe for stability. The contractor should support the excavations with appropriate shoring to avoid undermining the soil supporting the roadway and existing utilities.

For the storm sewers located near the existing creek, organic silty clay loam soils are likely to be encountered at the proposed sewer bearing elevations. We recommend the proposed subgrades be undercut a minimum of 2 feet, and backfilled with two layers of geogrid reinforced INDOT No. 53 crushed aggregate to the proposed pipe invert elevation as recommended for the proposed box culvert structure 191.

The INDOT standard drainage structure installation detail, Figure 16, is included in the Appendix. "B" Borrow surrounding all pipe structures in the excavated trenches should be compacted to 95 percent of the maximum dry density as determined by AASHTO T-99 (Standard Proctor). The soil in the bottom of the excavations, any bedding material and the engineered fill for structure backfill, should be tested to determine that tested locations comply with this density criterion. If 95 percent of the maximum dry density can not be obtained at the bottom of the excavations, or in the others areas, the Geotechnical Section of INDOT should be contacted for additional recommendations.

When the level of the fill reaches the top of the structure, two lifts, about 150 mm (6 inches) each, should be carefully spread and hand compacted over the structure without the use of heavy equipment. The backfill should be compacted to at least 95 percent of the maximum dry density as determined by AASHTO T-99 except the first 2 lifts above the structure. Mechanical compaction over the sewer structures may commence after the second lift is placed and compacted.

It is important to protect the sewer structures during construction. To avoid imposing concentrated loads far in excess of those the drainage structures would normally carry, heavy construction equipment should not cross the structures until fill placement and compaction is completed. Also, heavy vehicles moving too close to the walls of the structures can create an eccentric loading with potentially harmful results.

6.4 Excavations

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, part 1926, Subpart P". This document was issued to better provide for the safety of workers entering trenches or excavations. This federal regulation mandates that excavations, whether they be utility trenches, basement excavation or footing excavations, be constructed in accordance with the OSHA guidelines. It is our understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

We are providing this information solely as a service to our client. PSI does not assume responsibility for construction site safety or the contractor's or other parties compliance with local, state, and federal safety or other regulations.

6.5 Groundwater Control

Fill placement for the roadway in areas, which are undercut due to organics or stabilization, must be performed in the dry. The Contractor should be prepared to control groundwater and surface water in order to perform all construction in the dry.

Based on the results from the subsurface exploration, we anticipate groundwater is likely to be encountered in the trench excavations at or below about 18 to 20 feet, or about elevation 609 feet to 612 feet (185.6 to 186.5 m). However, localized zones of apparent perched water were observed at about 6 feet (1.8 m) in boring RB-8, and may be present elsewhere at shallower depths depending on seasonal conditions. For the majority of the sewer excavation alignment, we anticipate infiltrating perched and trapped water and runoff can likely be handled with conventional sump and pump techniques.

However, portions of the sewer alignment extend deeper than about 18 to 20 feet below existing grade. Due to the presence of wet loose sand encountered at the storm sewer bearing elevation in the vicinity of Borings RB-6-SG and RB-7-SG, we anticipate shallow sumps will not be sufficient to control water seepage in this area. We anticipate water seepage can then be controlled using a dewatering system such as wellpoints or deep wells with a proper casing and filter system. We anticipate that water will need to be removed constantly during the entire period of construction. Failure to adequately control groundwater will result in severe subgrade instability in the loose sand.

The groundwater levels were encountered near the existing toe of slope near the proposed box culvert, at elevation about 609 feet (185.6 m). Therefore, we anticipate dewatering by means of wellpoints or deep wells will be necessary during the construction of the proposed culvert and storm sewers in order to excavate for the structures and install the granular/geogrid blankets. We

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

REPORT LIMITATIONS

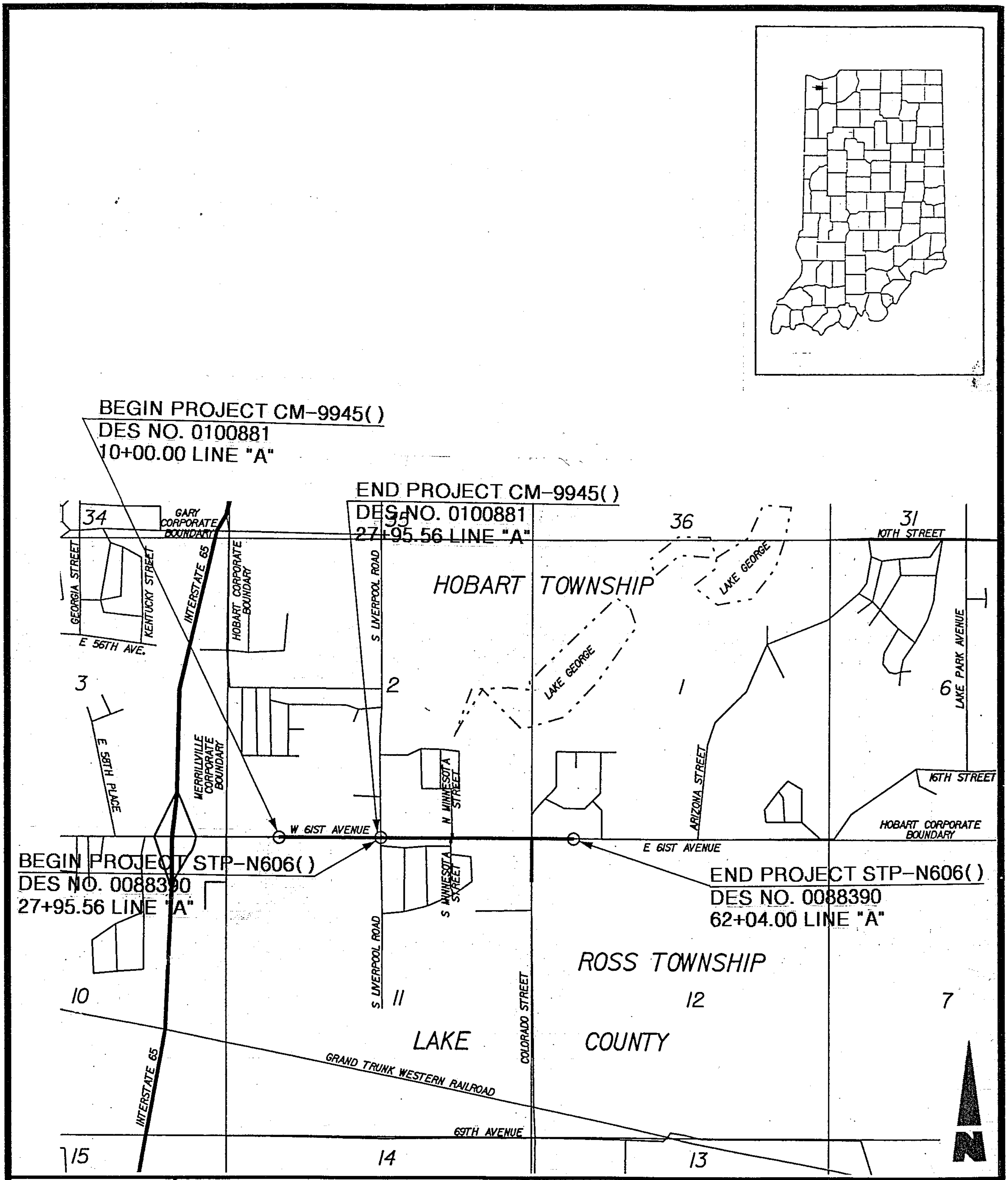
The recommendations submitted, in this report, are based on the available subsurface information obtained by PSI and design details furnished by The HNTB Companies for the proposed project. If there are any revisions to the plans for this project, or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine if changes in the foundation recommendations are required. If PSI is not notified of such changes, PSI will not be responsible for the impact of those changes on the project.

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

After the plans and specifications are more complete, the geotechnical engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At this time, it may be necessary to submit supplementary recommendations. PSI will perform this review using the INDOT Geotechnical Review of Final Check Prints form. This report has been prepared for the exclusive use of The HNTB Companies for the specific application to the proposed 61st Avenue widening and improvements project in Hobart, Indiana.

APPENDIX

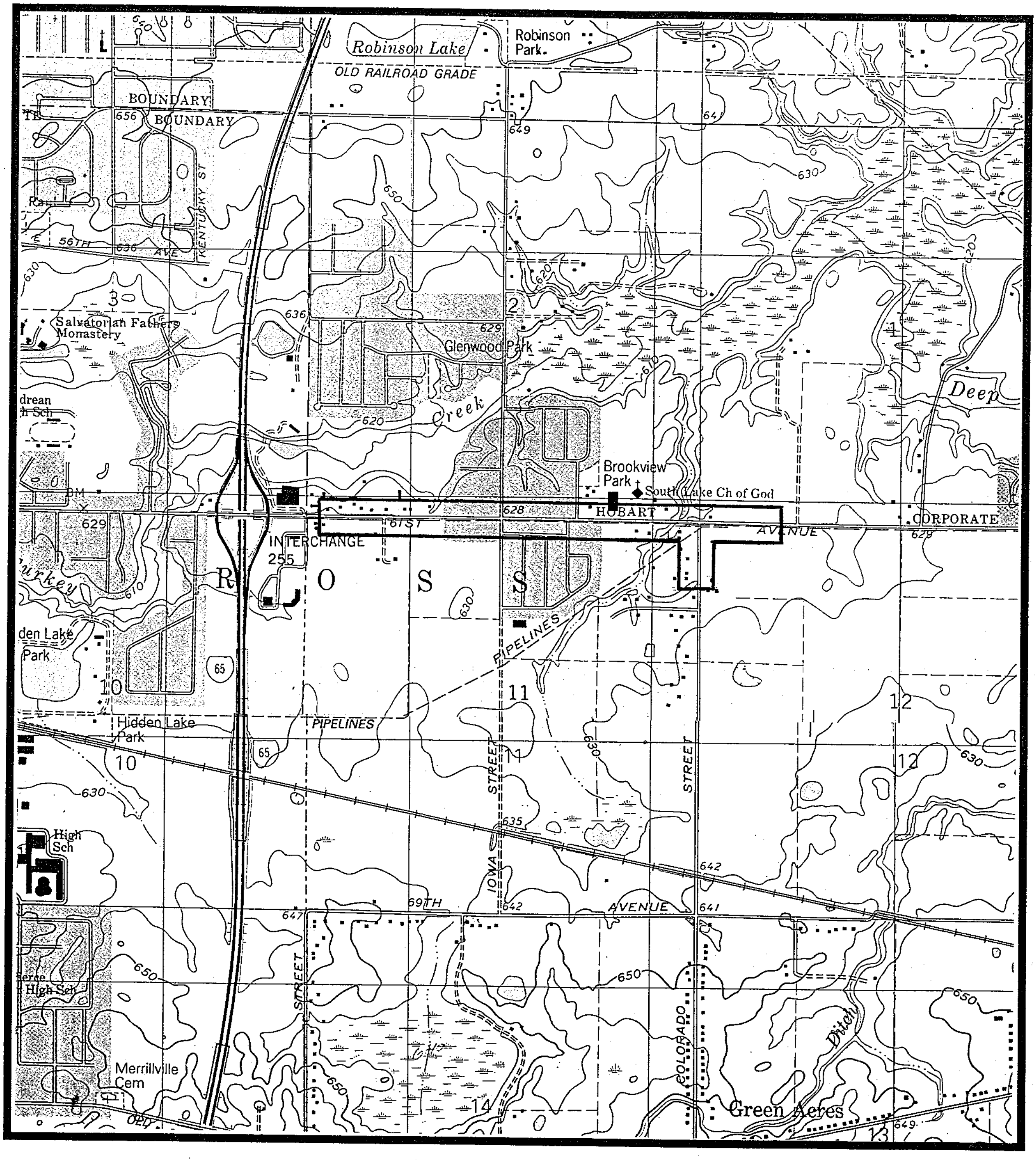
1. Figure 1, General Site Plan
2. Figure 2, Site Vicinity Map - USGS Topographic Map
3. Figures 3a and 3b, Soil Boring Location Plans
4. Boring Logs (RB-1-SG through RB-11-SG, TB-1-SG, and TB-2)
5. General Notes (AASHTO/INDOT)
6. Summary of Soundings (1)
7. Summary of Classification Test Results
8. Summary of Special Laboratory Test Results (5)
9. Figures 4 through 12, Particle Size Distribution Test Reports
10. Figure 13, Consolidation Test (TB-2, 2/ST)
11. Consolidation Test (TB-2, 2/ST)
12. Unconfined Compression Strength Tests (4)
13. Figure 14, Proctor Test Report (RB-2, 1/BS)
14. Summary of CBR Test Results (RB-2, 1/BS)
15. Figure 15, CBR Test Curve (RB-2, 1/BS)
16. Settlement Analyses (at Station 51+50, Line "A") (4)
17. Wick Drain Analysis
18. Bearing Capacity Analysis for Vibro-Concrete Column (VCC)
19. Figure 16, Drainage Structure Installation Details
20. Special Provision for Vibro-Compacted Concrete Columns



7225 Georgetown Road
Indianapolis, IN 46268
(317) 216 - 7131

Project: 61st Avenue Improvements
Client: HNTB, Inc.
Location: Lake County, Indiana
PSI Job No.: 016-15159
Figure 1
Date: 3/02
Project No.: STP-N606( ) & M-9945( )
Scale: 1"=2,000'±
DES No.: 0088390 & 0100881

general site plan



☐ Site Location

Source: U.S.G.S. Gary/Crown Point, Indiana 7½ Minute Topographic Quadrangle
Photorevised 1991/1992

N

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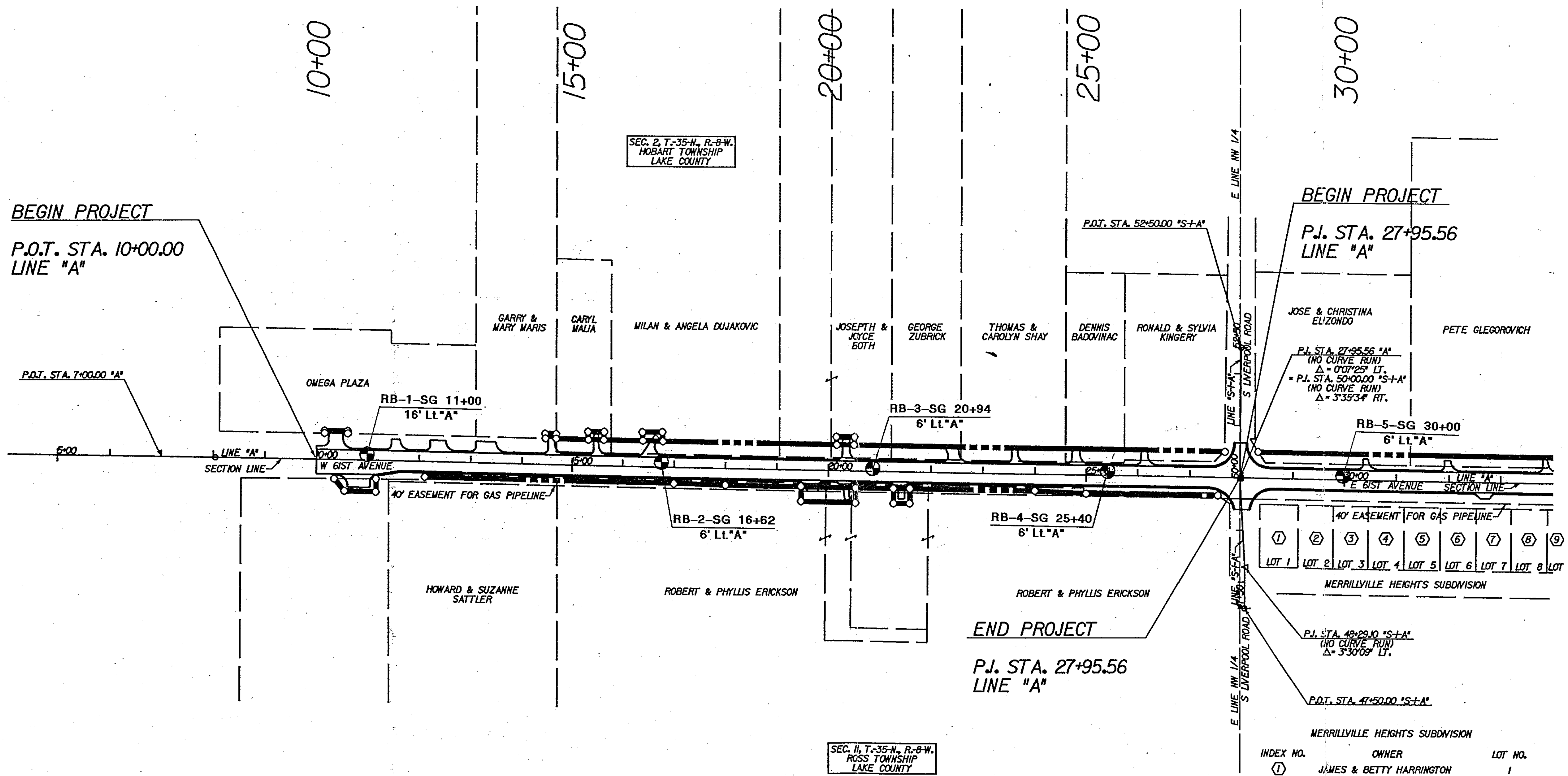
PSI Job No.: 016-15159
Date: 3/02
Scale: 1"=2,000'±

Figure 2
Project No.: STP-N606( ) & M-9945( )
DES No.: 0088390 & 0100881

site vicinity map



MERRILLVILLE HEIGHTS SUBDIVISION

INDEX NO.	OWNER	LOT NO.
①	JAMES & BETTY HARRINGTON	1
②	DAVID ROSAS	2
③	JOSEPTH & PHYLLIS MaJEDWARD	3
④	SHEILIA GREENBURG	4
⑤	JOSEPH & MARILYN HENDRICKSON	5
⑥	SIGISMUND & PHYLLIS STEFANKIEWICZ	6
⑦	BUDDY & IRENE RAMSEY	7
⑧	FRANK & FILOMENA MERVA	8
⑨	ANDY JACOB	9

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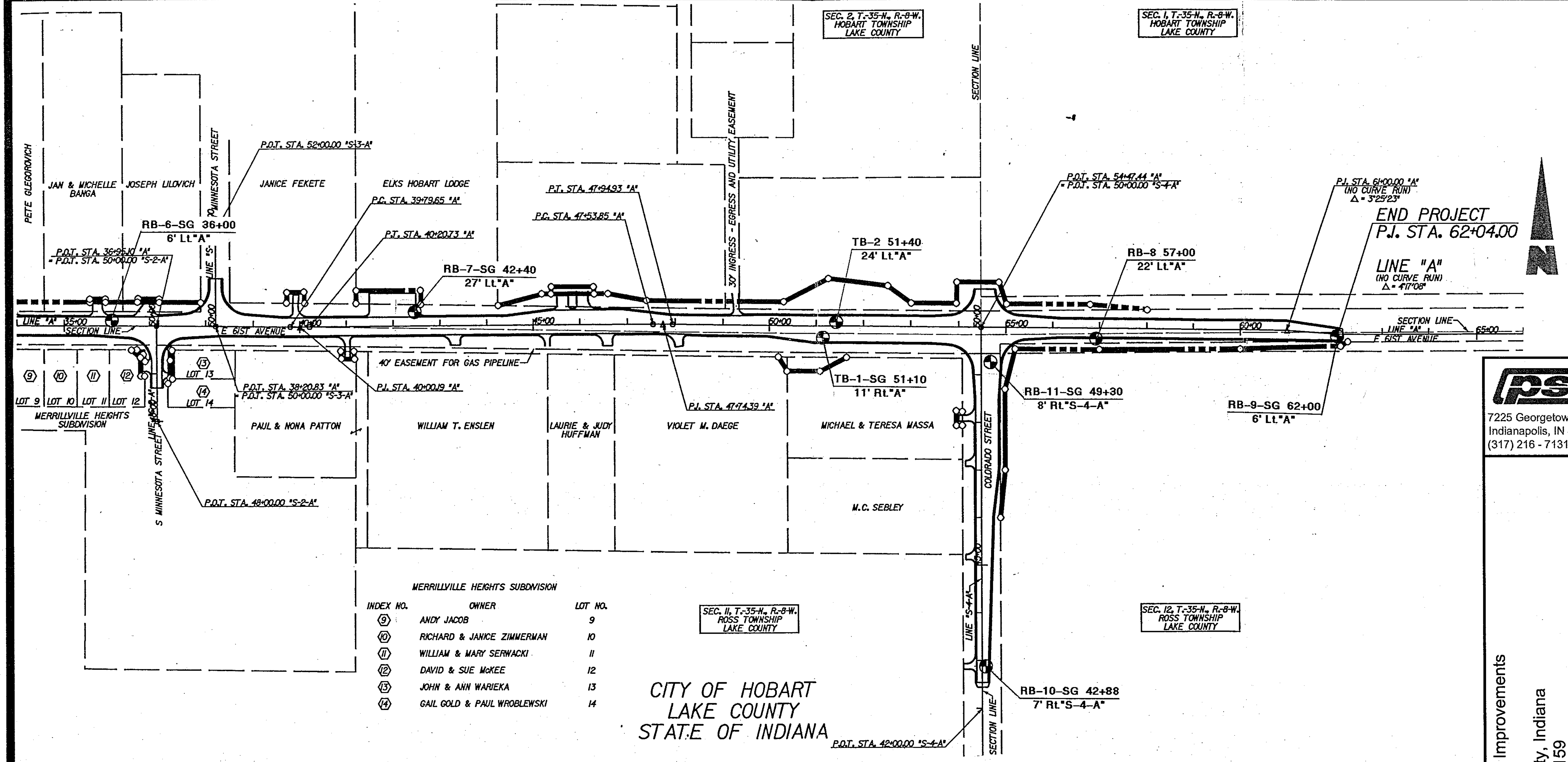
Project: 61st Avenue Improvements
Client: HNTB, Inc.
Location: Lake County, Indiana
PSI Job No.: 016-15159
Date: 3/02
Scale: 1"=200'±
Project No.: STP-N606( ) & CM-9945( )
DES No.: 0088390 & 0100881

soil boring location plan

Figure 3A



MERRILLVILLE HEIGHTS SUBDIVISION

INDEX NO.	OWNER	LOT NO.
⑨	ANDY JACOB	9
⑩	RICHARD & JANICE ZIMMERMAN	10
⑪	WILLIAM & MARY SERWACKI	11
⑫	DAVID & SUE McKEE	12
⑬	JOHN & ANN WARIEKA	13
⑭	GAIL GOLD & PAUL WROBLEWSKI	14

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Client: HNTB, Inc.
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Project No.: STP-N606( ) & CM-9945( )
DES No.: 0088390 & 0100881

soil boring location plan

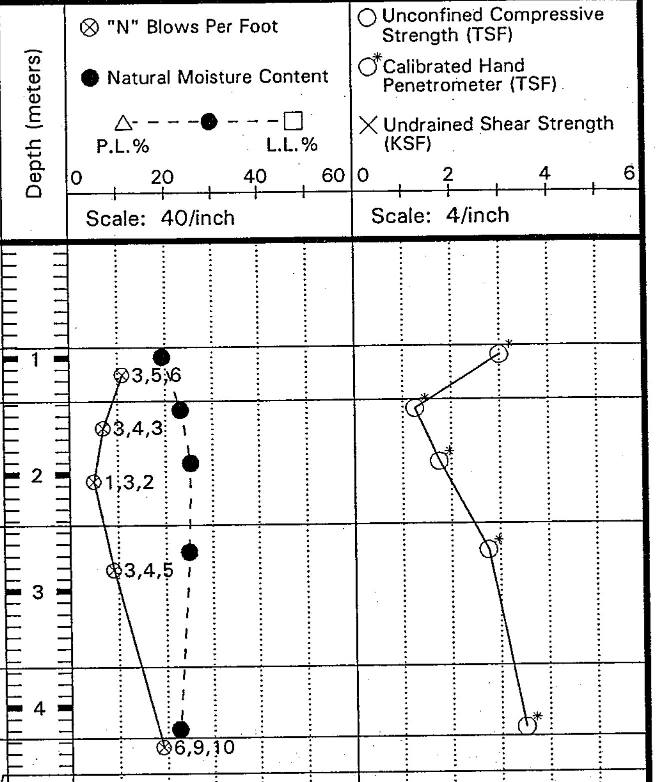
Figure 3B

Client: **The HNTB Companies**	Proj. #: **016-15159** Sheet: 1 of 1	Boring Log Number: **RB-1-SG**	**Professional Service Industries, Inc.**
Project: **Project No.: STP-N606()/CM-9945()** **DES No.: 0088390/0100881** **61st Avenue Widening & Improvements**	Location: **11+00, 16' Lt. "A"** **Lake County, Indiana**		

PCF Indicates Sample Dry Unit Weight in Pounds Per Cubic Foot

Surface Elevation **(USC & GS): 631.9'**

Sample No./Type	Sample Distance	Recovery	Depth (feet)	Description Of Material
				Driller reported 15" CONCRETE over 21" SAND & GRAVEL SUBGRADE (visual)
1/SS	▨	▨		SILTY CLAY LOAM - stiff - moist - brown A-4, Lab No. 8395SL
2/SS	▨	▨	5	SILTY CLAY - with interbedded fine sand seams - medium stiff to soft - moist to very moist below 6' - brown & gray A-6, Lab No. 8396SL
3/SS	▨	▨		
4/SS	▨	▨		CLAY - medium stiff - moist - brown A-7-6, Lab No. 8397SL
			10	
				SILTY CLAY - very stiff - moist - brown A-7-6, Lab No. 8399SL
5/SS	▨	▨		SAND - medium dense - moist - brown A-3, Lab No. 8398SL
			15	END OF BORING 15'



**Cave-in @ 11 1/2' following removal of augers. Dry to cave-in depth of 11 1/2'.
Weather: Cloudy.

Note: The stratification lines indicated herein are approximate; In-situ the transition between soil types may be gradual

Water Level Observation	Boring Started: **11-21-01**	Drawn By: **SW**	Approved:
Dry while drilling	Boring Completed: **11-21-01**	Office: **Indiana**	File: **15159**
** at completion	Rig: **CME-55 (Truck)**	Driller: **S. Benton**	
@ hrs. after completion	Note: Boring backfilled with soil cuttings unless otherwise noted.		

Client: **The HNTB Companies**

Proj. #: **016-15159**

Sheet: **1** of **1**

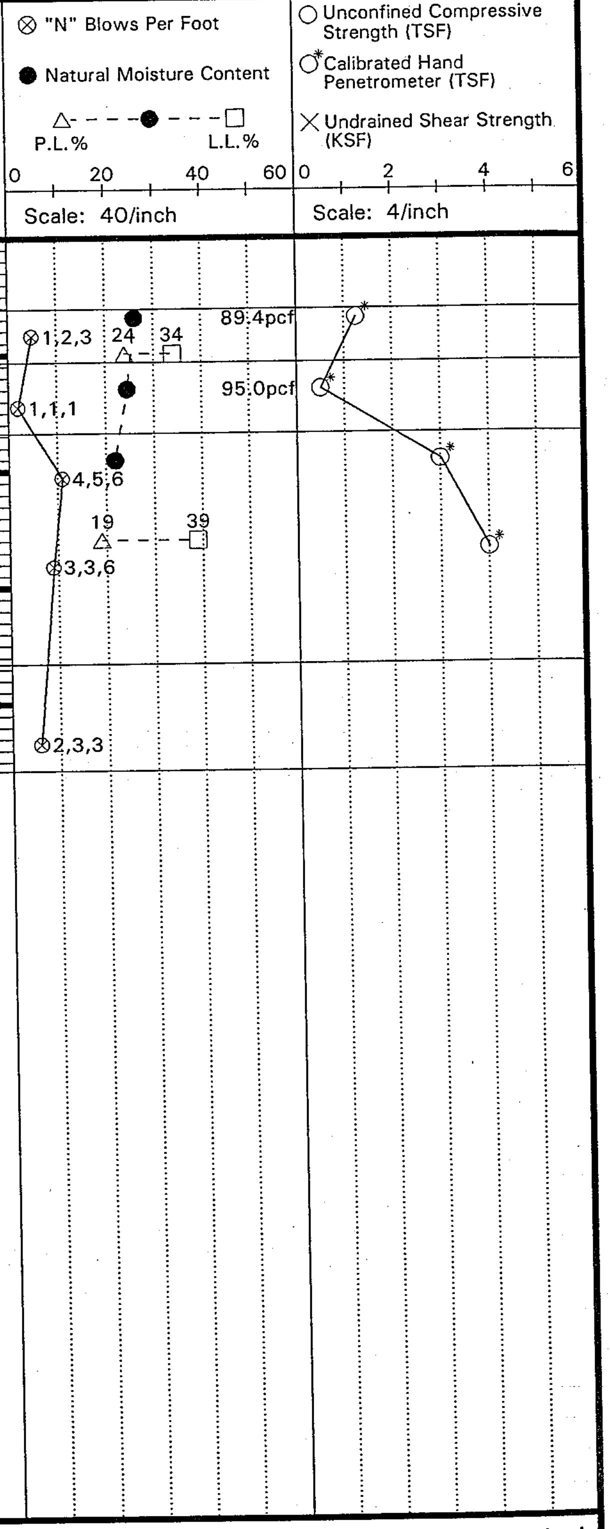
Boring Log Number: **RB-2-SG**

Professional Service Industries, Inc.

Project: **Project No.: STP-N606()/CM-9945()**
DES No.: 0088390/0100881
61st Avenue Widening & Improvements

Location: **16+62, 6' Lt. "A"**
Lake County, Indiana

Sample No./Type	Sample Distance	Recovery	Depth (feet)	PCF Indicates Sample Dry Unit Weight in Pounds Per Cubic Foot Description Of Material	Depth (meters)
				Surface Elevation **(USC & GS): 628.8'**	
				Driller reported 15" ASPHALT over 9" SAND & GRAVEL SUBGRADE (visual)	
1/SS	▨	▨		SILTY CLAY LOAM - soft - moist - dark gray A-4(7), Lab No. 8395SL	1
2/SS	▨	▨	5	CLAY - very soft - most - gray A-7-6, Lab No. 8397SL	
3/SS	▨	▨		SILTY CLAY - stiff to medium stiff - moist - gray A-6(21), Lab No. 8396SL	2
4/SS	▨	▨	10		3
				SAND - loose - very moist - brown A-3, Lab No. 8398SL	4
5/SS	▨	▨	15		
				END OF BORING 15'	



1/ST 2'-4' Recovery = 50%
MC = 24.0%, Dry Density = 89.4pcf
Lab No. 8473SL
2/ST 4'-6' Recovery = 100%
MC = 25.9%, Dry Density = 95.0pcf
Lab No. 8474SL
1/BS pH = 7.86
4/SS pH = 8.65

**Cave-in @ 13' following removal of augers.
Dry to cave-in depth of 13'.
Weather: Cloudy.

Note: The stratification lines indicated herein are approximate; In-situ the transition between soil types may be gradual

Water Level Observation
Dry while drilling
** at completion
@ hrs. after completion

Boring Started: **11-21-01**

Boring Completed: **11-21-01**

Rig: **CME-55 (Truck)**

Drawn By: **SW**

Approved:

Office: **Indiana**

File: **15159**

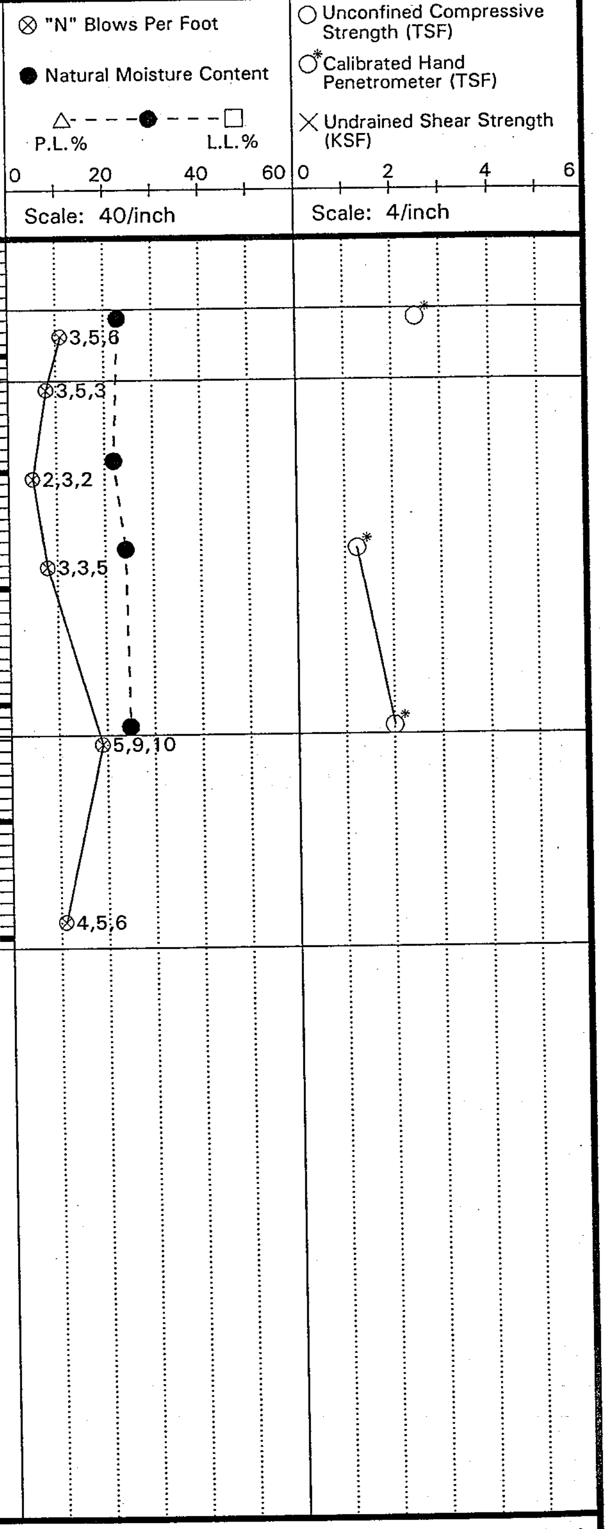
Driller: **S. Benton**

Note: Boring backfilled with soil cuttings unless otherwise noted.

Client: **The HNTB Companies**	Proj. #: **016-15159** Sheet: 1 of 1	Boring Log Number: **RB-3-SG**	**Professional Service Industries, Inc.**
Project: **Project No.: STP-N606()/CM-9945()** **DES No.: 0088390/0100881** **61st Avenue Widening & Improvements**	Location: 20+94, 6' Lt. "A" **Lake County, Indiana**		

PCF Indicates Sample Dry Unit Weight in Pounds Per Cubic Foot

Sample No./Type	Sample Distance	Recovery	Depth (feet)	Description Of Material Surface Elevation **(USC & GS): 631.6'**	Depth (meters)
				Driller reported 15" ASPHALT over 9" SAND & GRAVEL SUBGRADE (visual)	
1/SS	▨	▨		SILTY CLAY LOAM - stiff - moist - brown A-4, Lab No. 8395SL	1
2/SS	▨		5	SILTY CLAY - soft to very stiff - moist - brown A-6, Lab No. 8396SL	
3/SS	▨	▨			2
4/SS	▨	▨	10		3
					4
5/SS	▨	▨	15	SAND - medium dense - very moist - brown A-3, Lab No. 8398SL	5
6/SS	▨	▨	20		6
				END OF BORING 20'	



NOTE: Two attempts were make @ 2/SS without recovery.

**Cave-in @ 17' following removal of augers. Dry to cave-in depth of 17'.
Weather: Cloudy.

Note: The stratification lines indicated herein are approximate; In-situ the transition between soil types may be gradual

Water Level Observation	Boring Started: **11-21-01**	Drawn By: **SW**	Approved: PSL
Dry while drilling	Boring Completed: **11-21-01**	Office: **Indiana**	File: **15159**
** at completion	Rig: **CME-55 (Truck)**	Driller: **S. Benton**	
____ @ ____ hrs. after completion	Note: Boring backfilled with soil cuttings unless otherwise noted.		

Client: **The HNTB Companies**

Proj. #: **016-15159**

Sheet: 1 of 1

Boring Log Number: **RB-4-SG**

Professional Service Industries, Inc.

Project: Project No.: STP-N606()/CM-9945()
DES No.: 0088390/0100881
61st Avenue Widening & Improvements

Location: 25+40, 6' Lt. "A"
Lake County, Indiana

PCF Indicates Sample Dry Unit Weight in Pounds Per Cubic Foot

Surface Elevation (USC & GS): 633.8'

⊗ "N" Blows Per Foot

● Natural Moisture Content

△- - - -●- - - -□ P.L.% L.L.%

Scale: 40/inch

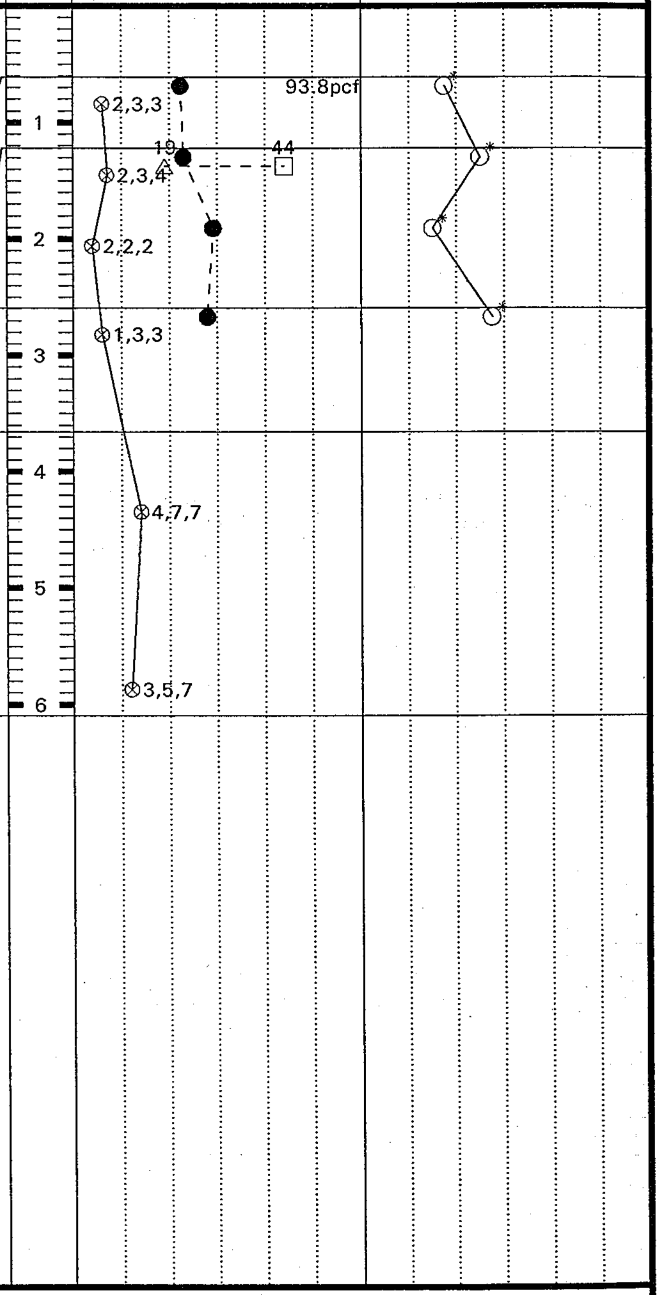
○ Unconfined Compressive Strength (TSF)

○* Calibrated Hand Penetrometer (TSF)

× Undrained Shear Strength (KSF)

Scale: 4/inch

Sample No./Type	Depth (feet)	Description Of Material
	0	Driller reported 9" ASPHALT over 5" CRUSHED AGGREGATE over 10" SAND & GRAVEL BASE COURSE (visual)
1/SS		SILTY CLAY LOAM - with trace organic matter - medium stiff - moist - dark brown to brown below 2.5' A-4, Lab No. 8395SL
2/SS	5	CLAY - medium stiff to soft - moist - brown A-7-6(22), Lab No. 8397SL
3/SS		
4/SS	10	SILTY CLAY - medium stiff - moist - brown A-7-6, Lab No. 8399SL
5/SS	15	SAND - medium dense - very moist - brown A-3, Lab No. 8398SL
6/SS	20	
		END OF BORING 20'



1/ST 2'-4' Recovery = 58%
MC = 27.5%, Dry Density = 93.8pcf
Lab No. 8475SL
LOI = 5.8%
2/SS pH = 8.22

**Cave-in @ 17' following removal of augers.
Dry to cave-in depth of 17'.
Weather: Cloudy.

Note: The stratification lines indicated herein are approximate; In-situ the transition between soil types may be gradual

Water Level Observation
Dry while drilling
** at completion
@ hrs. after completion

Boring Started: **11-21-01**

Boring Completed: **11-21-01**

Rig: **CME-55 (Truck)**

Drawn By: **SW**

Office: **Indiana**

Driller: **S. Benton**

Approved:

File: **15159**

Note: Boring backfilled with soil cuttings unless otherwise noted.

Client: **The HNTB Companies**

Proj. #: **016-15159**

Sheet: 1 of 1

Boring Log Number: **RB-5-SG**

Professional Service Industries, Inc.

Project: **Project No.: STP-N606()/CM-9945()**
DES No.: 0088390/0100881
61st Avenue Widening & Improvements

Location: **30+00, 6' Lt. "A"**
Lake County, Indiana

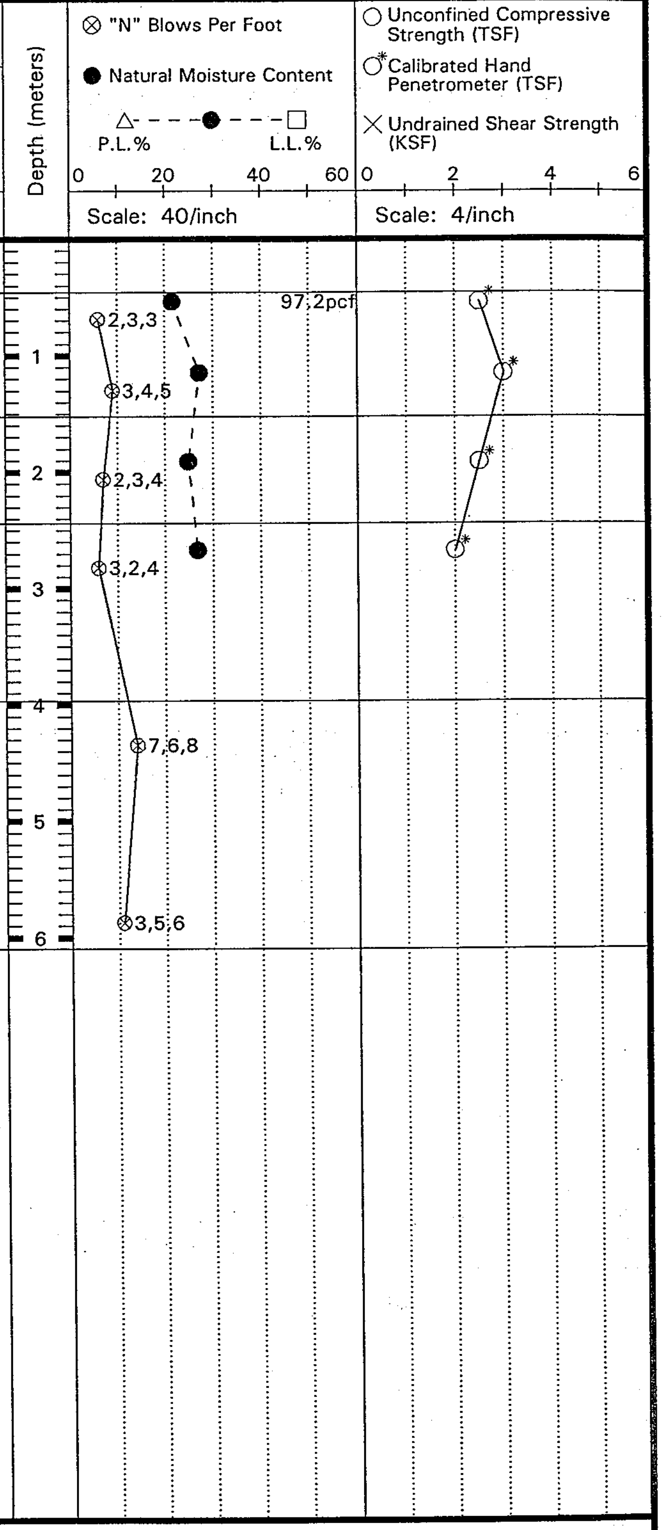
PCF Indicates Sample Dry Unit Weight in Pounds Per Cubic Foot

Surface Elevation **(USC & GS): 632.7'**

Sample No./Type	Depth (feet)	Description Of Material
		Driller reported 9" ASPHALT over 9" SAND & GRAVEL BASE COURSE (visual)
1/SS		SILTY CLAY LOAM - medium stiff to stiff - moist - brown A-4, Lab No. 8395SL
2/SS	5	
3/SS		SILTY CLAY - medium stiff - moist - brown A-6, Lab No. 8396SL
4/SS	10	SILTY CLAY - medium stiff - moist - brown A-7-6, Lab No. 8399SL
5/SS	15	SAND - medium dense - very moist - brown A-3, Lab No. 8398SL
6/SS	20	
		END OF BORING 20'

1/ST 1.5'-3.5' Recovery = 100%
MC = 26.7%, Dry Density = 97.2pcf
Lab No. 8467SL

**Cave-in @ 17' following removal of augers.
Dry to cave-in depth of 17'.
Weather: Cloudy.



Note: The stratification lines indicated herein are approximate; In-situ the transition between soil types may be gradual

Water Level Observation
Dry while drilling
** at completion
Dry @ 24 hrs. after completion

Boring Started: **11-20-01**
Boring Completed: **11-20-01**
Rig: **CME-55 (Truck)**
Drawn By: **SW**
Office: **Indiana**
Driller: **S. Benton**
Approved:
File: **15159**

Note: Boring backfilled with soil cuttings unless otherwise noted.

Client: **The HNTB Companies**

Proj. #: **016-15159**

Sheet: 1 of 1

Boring Log Number: **RB-6-SG**

Professional Service Industries, Inc.

Project: **Project No.: STP-N606()/CM-9945()**
DES No.: 0088390/0100881
61st Avenue Widening & Improvements

Location: **36+00, 6' Lt. "A"**
Lake County, Indiana

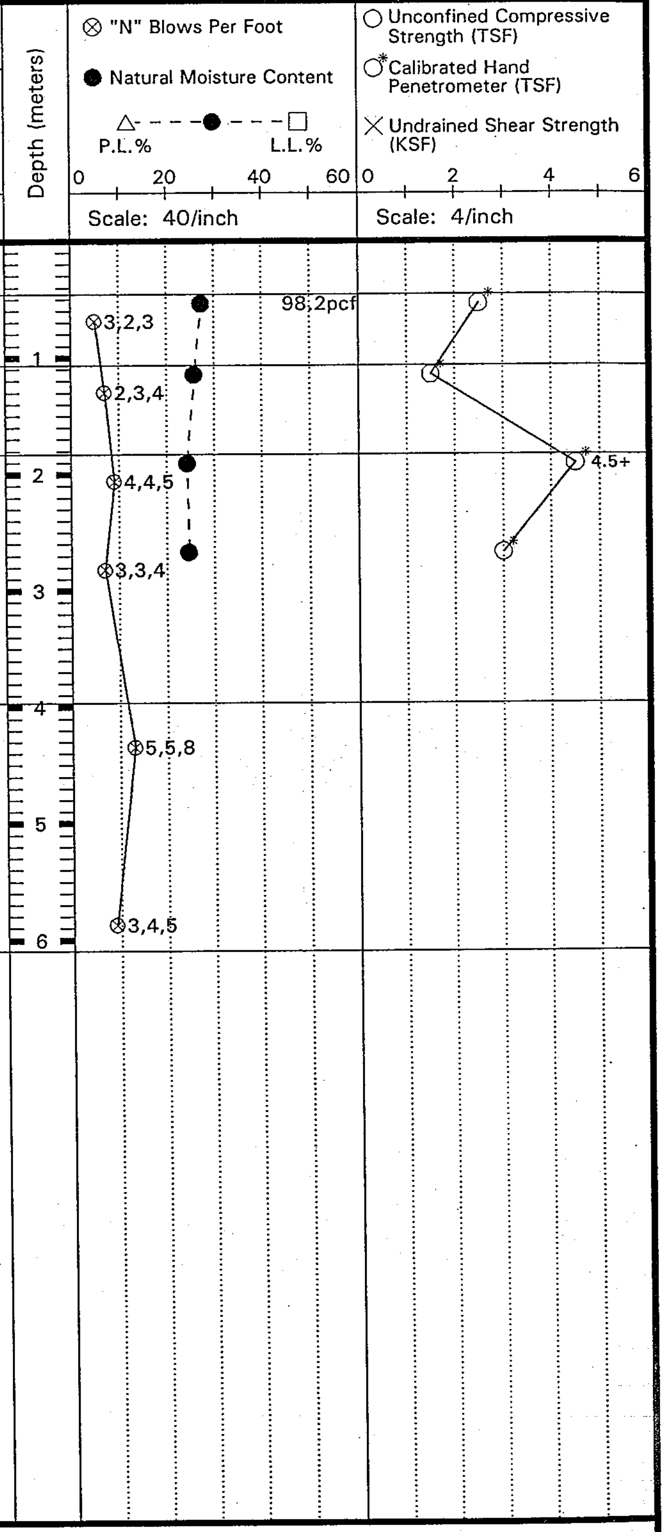
PCF Indicates Sample Dry Unit Weight in Pounds Per Cubic Foot

Surface Elevation **(USC & GS): 628.9'**

⊗ "N" Blows Per Foot
● Natural Moisture Content
△- - - -● - - - -□
P.L.% L.L.%
Scale: 40/inch

○ Unconfined Compressive Strength (TSF)
○* Calibrated Hand Penetrometer (TSF)
× Undrained Shear Strength (KSF)
Scale: 4/inch

Sample No./Type	Sample Distance	Recovery	Depth (feet)	Description Of Material
				Driller reported 12" ASPHALT over 6" SAND & GRAVEL BASE COURSE (visual)
1/SS	▨	▨		SILTY LOAM - soft - moist - brown A-4, Lab No. 8401SL
2/SS	▨	▨	5	SILTY CLAY - medium stiff - moist - brown A-6, Lab No. 8396SL
3/SS	▨	▨		SILTY CLAY - medium stiff - moist - brown A-7-6, Lab No. 8399SL
4/SS	▨	▨	10	
5/SS	▨	▨	15	SAND - medium dense to loose - very moist to wet below 18' - brown A-3, Lab No. 8298SL
6/SS	▨	▨	20	
				END OF BORING 20'



1/ST 1.5'-3.5' Recovery = 50%
MC = 24.3%, Dry Density = 98.2pcf
Lab No. 8477SL
5/SS pH = 8.51

**Cave-in @ 17' following removal of augers. Dry to cave-in depth of 17'.
Weather: Cloudy.

Note: The stratification lines indicated herein are approximate; In-situ the transition between soil types may be gradual

Water Level Observation
19 1/2' while drilling
** at completion
16 1/2' @ 24 hrs. after completion

Boring Started: **11-20-01**
Boring Completed: **11-20-01**
Rig: **CME-55 (Truck)**
Drawn By: **SW**
Office: **Indiana**
Driller: **S. Benton**
Approved:
File: **15159**

Note: Boring backfilled with soil cuttings unless otherwise noted.

Client: **The HNTB Companies**	Proj. #: **016-15159** Sheet: **1** of **1**	Boring Log Number: **RB-7-SG**	Professional Service Industries, Inc.
Project: **Project No.: STP-N606()/CM-9945()** **DES No.: 0088390/0100881** **61st Avenue Widening & Improvements**	Location: **42+40, 27' Lt. "A"** **Lake County, Indiana**		

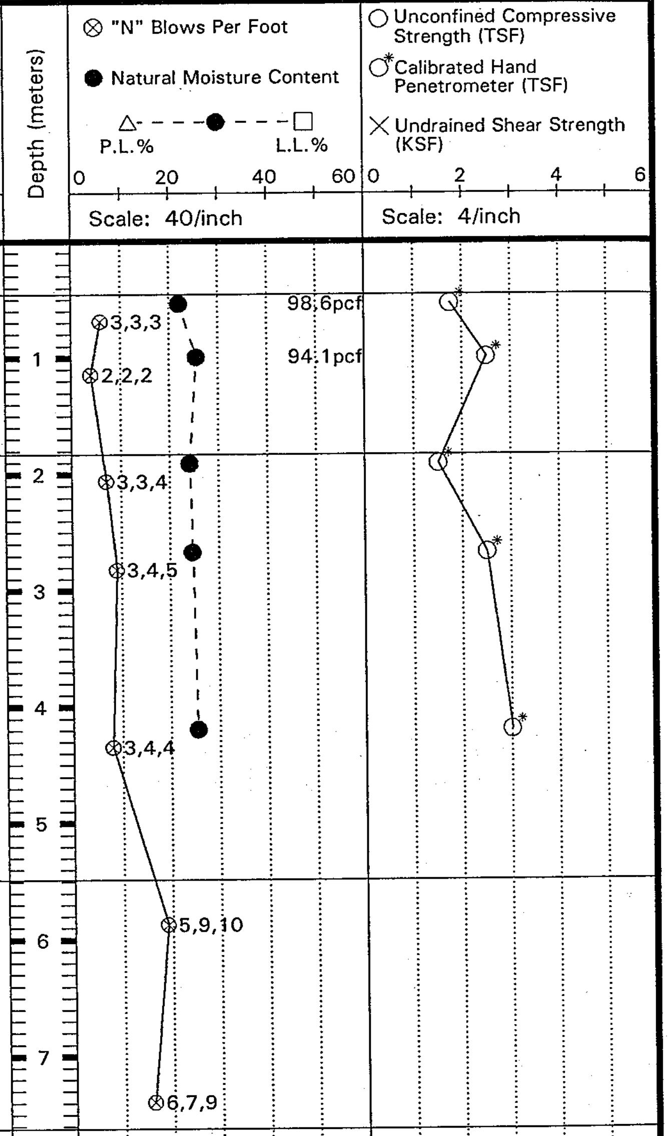
PCF Indicates Sample Dry Unit Weight in Pounds Per Cubic Foot

Surface Elevation **(USC & GS): 629.1'**

Sample No./Type	Depth (feet)	Description Of Material
		Driller reported 3" ASPHALT over 15" SAND & GRAVEL BASE COURSE (visual)
1/SS 2/SS		SILTY CLAY LOAM - medium stiff to soft - moist - brown A-4, Lab No. 8395SL
3/SS 4/SS 5/SS	5	SILTY CLAY - medium stiff - moist - brown to gray below 12' A-7-6, Lab No. 8399SL
6/SS 7/SS	10 15	SAND - medium dense - wet - brown A-3, Lab No. 8398SL
	20 25	END OF BORING 25'

1/ST 1.5'-3.5' Recovery = 100%
MC = 24.5%, Dry Density = 98.2pcf
Lab No. 8478SL
2/ST 3.5'-5.5' Recovery = 100%
MC = 27.5%, Dry Density = 94.1pcf
Lab No. 8479SL

**Cave-in @ 16' following removal of augers.
Weather: Cloudy.



Note: The stratification lines indicated herein are approximate; In-situ the transition between soil types may be gradual

Water Level Observation 18 1/2' while drilling 15 1/2'** at completion ____ @ ____ hrs. after completion	Boring Started: **11-28-01**	Drawn By: **SW**	Approved: DSL
	Boring Completed: **11-28-01**	Office: **Indiana**	File: **15159**
	Rig: **CME-55 (Truck)**	Driller: **S. Benton**	
	Note: Boring backfilled with soil cuttings unless otherwise noted.		

Client: **The HNTB Companies**	Proj. #: **016-15159** Sheet: **1** of **1**	Boring Log Number: **RB-8**	Professional Service Industries, Inc.
Project: **Project No.: STP-N606()/CM-9945()** **DES No.: 0088390/0100881** **61st Avenue Widening & Improvements**	Location: **57+00, 22' Lt. "A"** **Lake County, Indiana**		

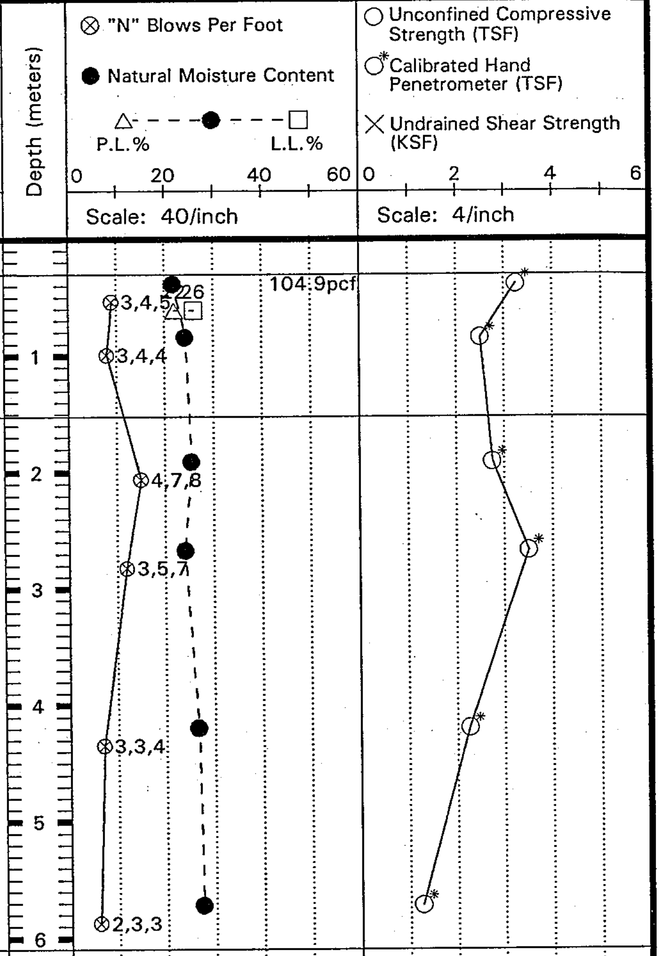
Sample No./Type | Sample Distance | Recovery | Depth (feet)

PCF Indicates Sample Dry Unit Weight in Pounds Per Cubic Foot

Description Of Material

Surface Elevation **(USC & GS): 625.0'**

Sample No./Type	Depth (feet)	Description Of Material
		Driller reported 12" brown CLAYEY TOPSOIL (visual)
1/SS 2/SS		SILTY LOAM - medium stiff - moist - brown A-4(1), Lab No. 8401SL
3/SS 4/SS 5/SS 6/SS	5 10 15	SILTY CLAY - stiff to medium stiff - moist to wet below 12' - brown to gray below 8' A-7-6, Lab No. 8399SL
	20	END OF BORING 20'



1/ST 1'-2.5' Recovery = 67%
MC = 21.6%, Dry Density = 104.9pcf
Lab No. 8480SL
1/BS pH = 8.46

**Cave-in @ 9' following removal of augers.
Dry to cave-in depth of 9'.
Weather: Cloudy.

Note: The stratification lines indicated herein are approximate; In-situ the transition between soil types may be gradual

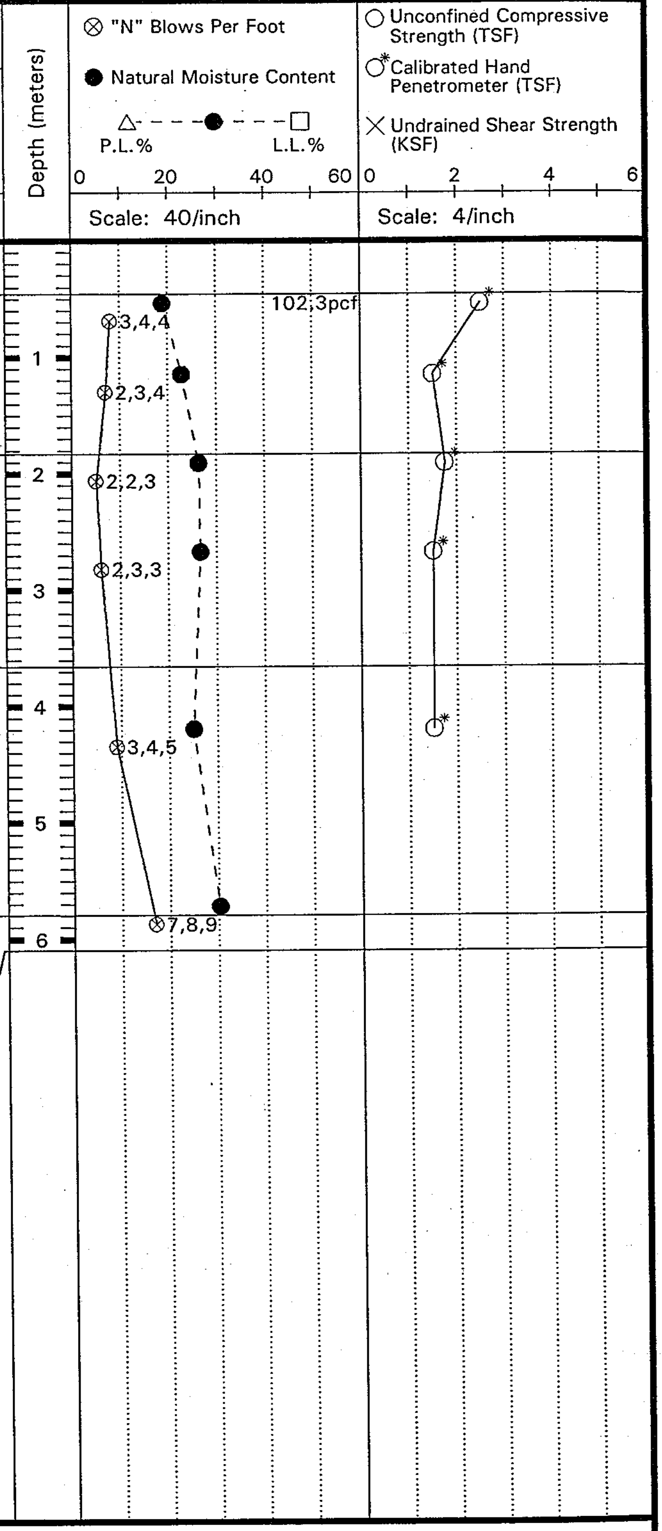
Water Level Observation 6' while drilling ** at completion ____ @ ____ hrs. after completion	Boring Started: **11-28-01**	Drawn By: **SW**	Approved: psr
	Boring Completed: **11-28-01**	Office: **Indiana**	File: **15159**
	Rig: **CME-55 (Truck)**	Driller: **S. Benton**	
	Note: Boring backfilled with soil cuttings unless otherwise noted.		

Client: The HNTB Companies	Proj. #: 016-15159 Sheet: 1 of 1	Boring Log Number: RB-9-SG	Professional Service Industries, Inc.
Project: Project No.: STP-N606()/CM-9945() DES No.: 0088390/0100881 61st Avenue Widening & Improvements	Location: 62+00, 6' Lt. "A" Lake County, Indiana		

PCF Indicates Sample Dry Unit Weight in Pounds Per Cubic Foot

Surface Elevation **(USC & GS): 628.7'**

Sample No./Type	Sample Distance	Recovery	Depth (feet)	Description Of Material
				Driller reported 18" ASPHALT (visual)
1/SS	▨	▨		SILTY LOAM - medium stiff - moist - brown & gray A-4, Lab No. 8401SL
2/SS	▨	▨	5	
3/SS	▨	▨		SILTY CLAY - with trace organic matter - soft to medium stiff - moist - brown & black A-6, Lab No. 8396SL
4/SS	▨	▨	10	
5/SS	▨	▨	15	CLAY - medium stiff - moist - gray A-7-6, Lab No. 8397SL
6/SS	▨	▨	20	SAND - medium dense - wet - gray A-3, Lab No. 8398SL
				END OF BORING 20'



1/ST 1.5'-3.5' Recovery = 58%
MC = 20.9%, Dry Density = 102.3pcf
Lab No. 8481SL
3/SS LOI = 4.4%

**Cave-in @ 18' following removal of augers.
Dry to cave-in depth of 18'.
Weather: Cloudy.

Note: The stratification lines indicated herein are approximate; In-situ the transition between soil types may be gradual

Water Level Observation	Boring Started: 11-19-01	Drawn By: SW	Approved:
17' while drilling	Boring Completed: 11-19-01	Office: Indiana	File: 15159
17'** at completion	Rig: CME-55 (Truck)	Driller: S. Benton	
5 1/2' @ 24 hrs. after completion	Note: Boring backfilled with soil cuttings unless otherwise noted.		

Client:
The HNTB Companies

Proj. #: **016-15159**
Sheet: 1 of 1

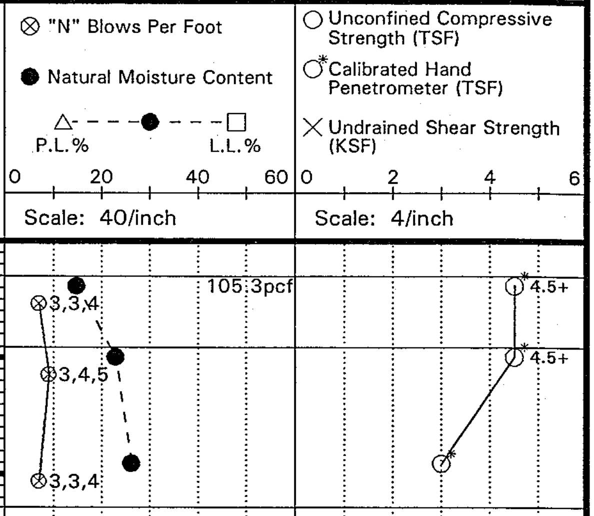
Boring Log Number: **RB-10-SG**

Professional Service Industries, Inc.

Project: **Project No.: STP-N606()/CM-9945()**
DES No.: 0088390/0100881
61st Avenue Widening & Improvements

Location: **42+88, 7' Rt. "S-4-A"**
Lake County, Indiana

Sample No./Type	Sample Distance	Recovery	Depth (feet)	PCF Indicates Sample Dry Unit Weight in Pounds Per Cubic Foot Description Of Material Surface Elevation **(USC & GS): 625.0'**	Depth (meters)
				Driller reported 12" ASPHALT (visual)	
1/SS	▨	▨		SILTY CLAY - with trace organic matter - medium stiff - moist - black A-6, Lab No. 8396SL	
2/SS	▨	▨		SILTY CLAY - medium stiff - moist - brown & gray A-7-6, Lab No. 8399SL	1
			5		
3/SS	▨	▨			2
				END OF BORING 7.5'	



1/SS LOI = 5.9%
1/ST 1'-3' Recovery = 100%
MC = 21.9%, Dry Density = 105.3pcf
Lab No. 8482SL

**Cave-in @ 5' following removal of augers.
Dry to cave-in depth of 5'.
Weather: Cloudy.

Note: The stratification lines indicated herein are approximate; In-situ the transition between soil types may be gradual

Water Level Observation
Dry while drilling
** at completion
Dry @ 24 hrs. after completion

Boring Started: **11-19-01**
Boring Completed: **11-19-01**
Rig: **CME-55 (Truck)**
Note: Boring backfilled with soil cuttings unless otherwise noted.

Drawn By: **SW**
Office: **Indiana**
Driller: **S. Benton**

Approved: DJL
File: **15159**

Client:
The HNTB Companies

Proj. #: **016-15159**

Sheet: 1 of 1

Boring Log Number: **RB-11-SG**

Professional Service Industries, Inc.

Project: **Project No.: STP-N606()/CM-9945()**
DES No.: 0088390/0100881
61st Avenue Widening & Improvements

Location: 49+30, 8' Rt. "S-4-A"
Lake County, Indiana

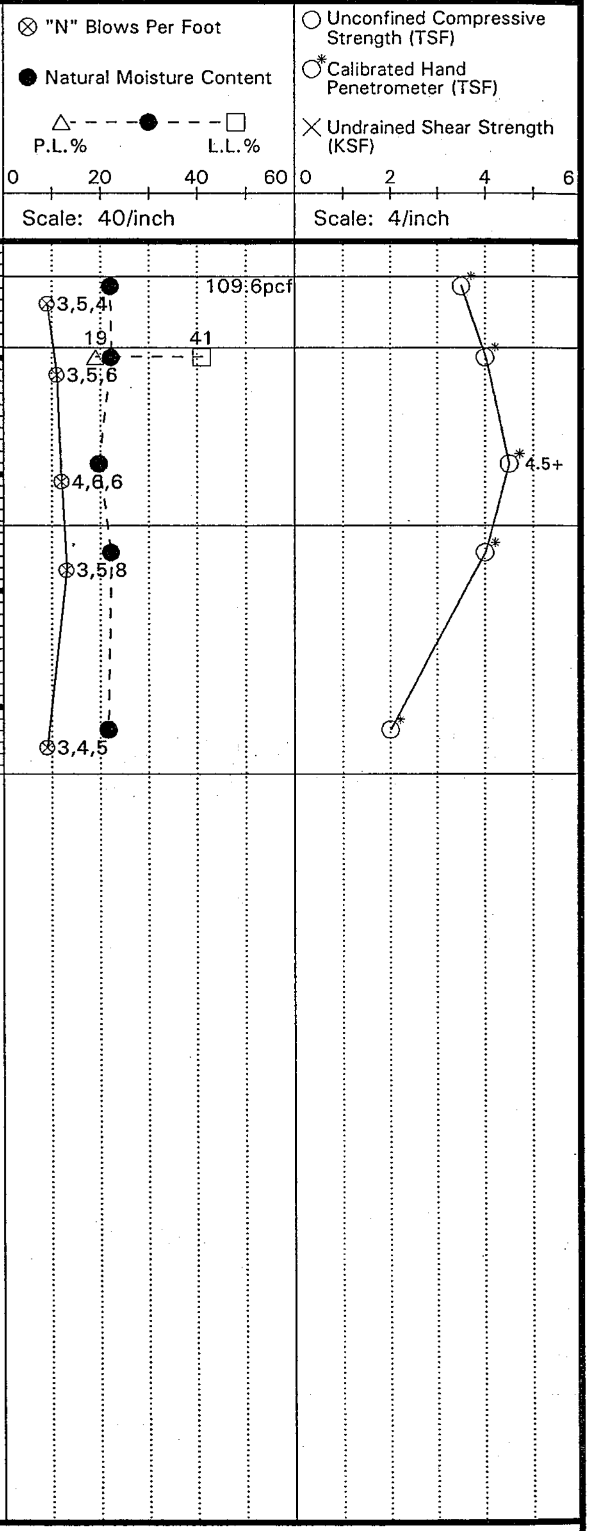
PCF Indicates Sample Dry Unit Weight in Pounds Per Cubic Foot

Surface Elevation **(USC & GS): 625.9'**

Sample No./Type	Sample Distance	Recovery	Depth (feet)	Description Of Material	Depth (meters)
				Driller reported 12" ASPHALT (visual)	
1/SS	▨	▨		SILTY LOAM - medium stiff - moist - brown A-4, Lab No. 8401SL	
2/SS	▨	▨		SILTY CLAY - stiff - moist - brown A-7-6(22), Lab No. 8399SL	1
			5		
3/SS	▨	▨			2
4/SS	▨	▨		CLAY - stiff to medium stiff - moist - brown to gray below 13' A-7-6, Lab No. 8397SL	
			10		3
					4
5/SS	▨	▨			
			15	END OF BORING 15'	

1/ST 1'-3' Recovery = 50%
MC = 19.4%, Dry Density = 109.6pcf
Lab No. 8483SL
2/SS pH = 8.42

**Cave-in @ 12' following removal of augers.
Dry to cave-in depth of 12'.
Weather: Cloudy.



Note: The stratification lines indicated herein are approximate; In-situ the transition between soil types may be gradual

Water Level Observation
Dry while drilling
** at completion
1.5' @ 24 hrs. after completion

Boring Started: **11-19-01**	Drawn By: **SW**	Approved:	
Boring Completed: **11-19-01**	Office: **Indiana**	File: **15159**	
Rig: **CME-55 (Truck)**	Driller: **S. Benton**		

Note: Boring backfilled with soil cuttings unless otherwise noted.

Client:
The HNTB Companies

Proj. #: **016-15159**

Sheet: **1** of **2**

Boring Log Number: **TB-1-SG**

Professional Service Industries, Inc.

Project: Project No.: STP-N606()/CM-9945()
DES No.: 0088390/0100881
61st Avenue Widening & Improvements

Location: 51+10, 11' Rt. "A"
Lake County, Indiana

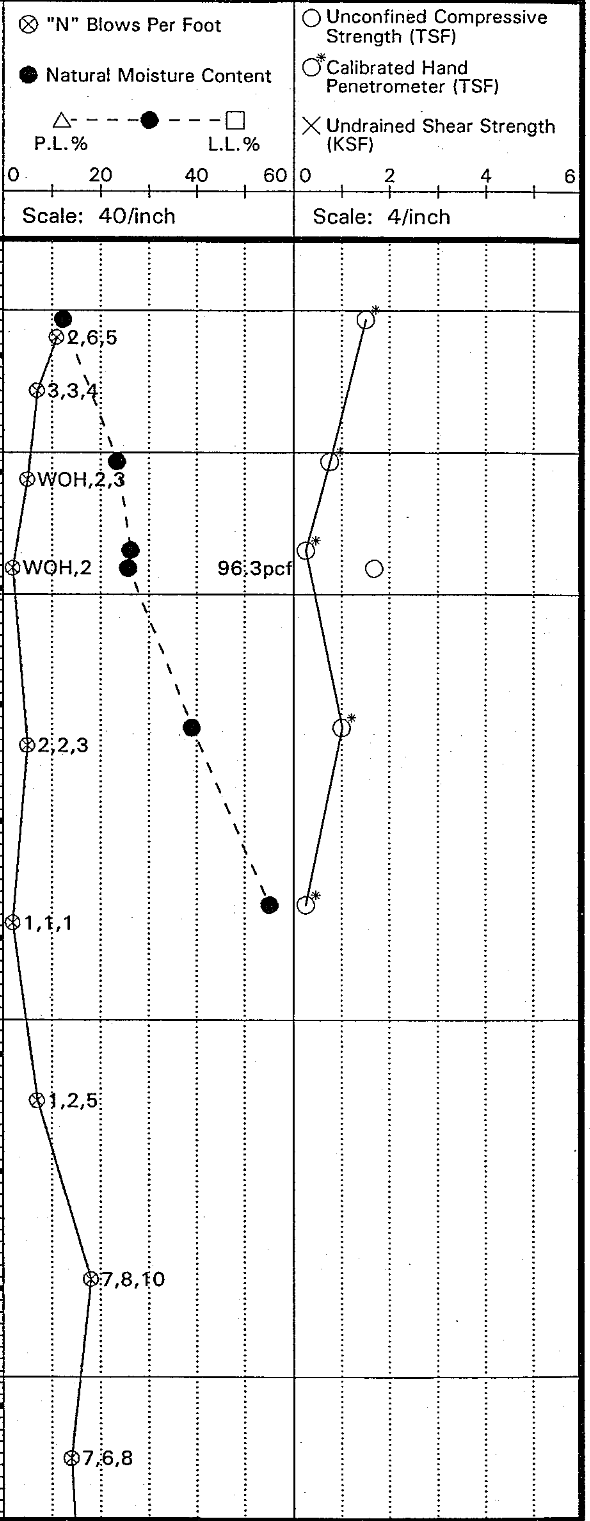
PCF Indicates Sample Dry Unit Weight in Pounds Per Cubic Foot

Surface Elevation (USC & GS): 618.5'

Sample No./Type	Description Of Material
	Driller reported 6" ASPHALT over 18" brown SAND & GRAVEL Base Course (visual)
1/SS 2/SS	CLAY LOAM FILL - stiff to medium stiff - moist - black & brown (visual)
3/SS 4/SS	SILTY CLAY - soft to very soft - moist to very moist - brown & gray (possible fill) A-6, Lab No. 8396SL
5/SS 6/SS	SILTY CLAY LOAM - with trace marl - with little organic matter - soft to very soft - wet - black A-5, Lab No. 8412SL
7/SS 8/SS	SAND - loose to medium dense - wet - gray A-3, Lab No. 8398SL
9/SS	SANDY GRAVEL - medium dense - wet - gray A-1-a, Lab No. 8400SL

Depth (feet): 5, 10, 15, 20, 25, 30, 35

Depth (meters): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10



Note: The stratification lines indicated herein are approximate; In-situ the transition between soil types may be gradual

Water Level Observation
20 1/2' while drilling
10 1/2'** at completion
10' @ 24 hrs. after completion

Boring Started: **11-20-01**

Boring Completed: **11-20-01**

Rig: **CME-55 (Truck)**

Drawn By: **SW**

Office: **Indiana**

Driller: **S. Benton**

Approved:

File: **15159**

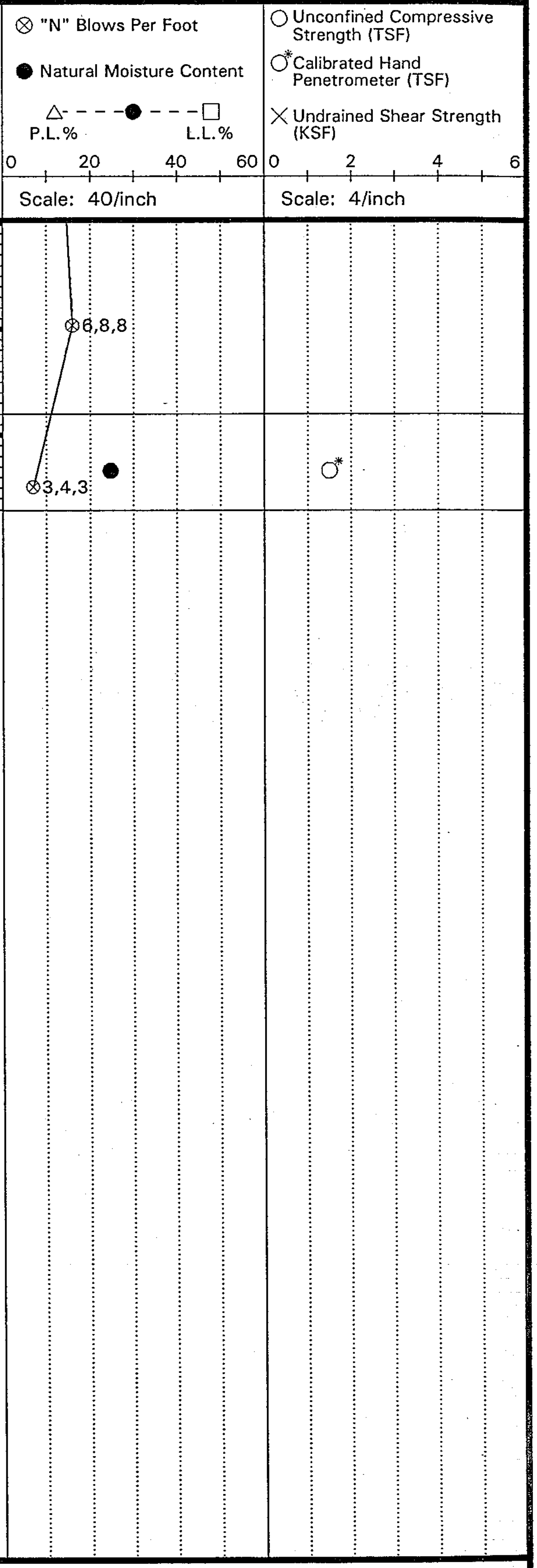
Note: Boring backfilled with soil cuttings unless otherwise noted.

Client: The HNTB Companies	Proj. #: 016-15159 Sheet: 2 of 2	Boring Log Number: TB-1-SG	Professional Service Industries, Inc.
Project: Project No.: STP-N606()/CM-9945() DES No.: 0088390/0100881 61st Avenue Widening & Improvements	Location: 51+10, 11' Rt. "A" Lake County, Indiana		

PCF Indicates Sample Dry Unit Weight in Pounds Per Cubic Foot

Surface Elevation **(USC & GS): 618.5'**

Sample No./Type	Sample Distance	Recovery	Depth (feet)	Description Of Material	Depth (meters)
				SANDY GRAVEL - medium dense - wet - gray A-1-a, Lab No. 8400SL	
10/SS	▨	▨	40		12
				SILTY CLAY - medium stiff - moist - gray A-7-6, Lab No. 8399SL	13
11/SS	▨	▨	45		
				END OF BORING 45'	



1/ST 8'-10' Recovery = 29%
5/SS LOI = 9.5%
6/SS LOI = 7.7%, CA & MG = 7.6%
10/SS pH = 7.95

NOTE: Two attempts were made on 2/SS, 5/SS & 8/SS with no recovery @ 2/SS.

**Cave-in @ 16 1/2' following removal of augers.
Weather: Cloudy.

Note: The stratification lines indicated herein are approximate; In-situ the transition between soil types may be gradual

Client: **The HNTB Companies**

Proj. #: **016-15159**

Sheet: **1** of **2**

Boring Log Number: **TB-2**

Professional Service Industries, Inc.

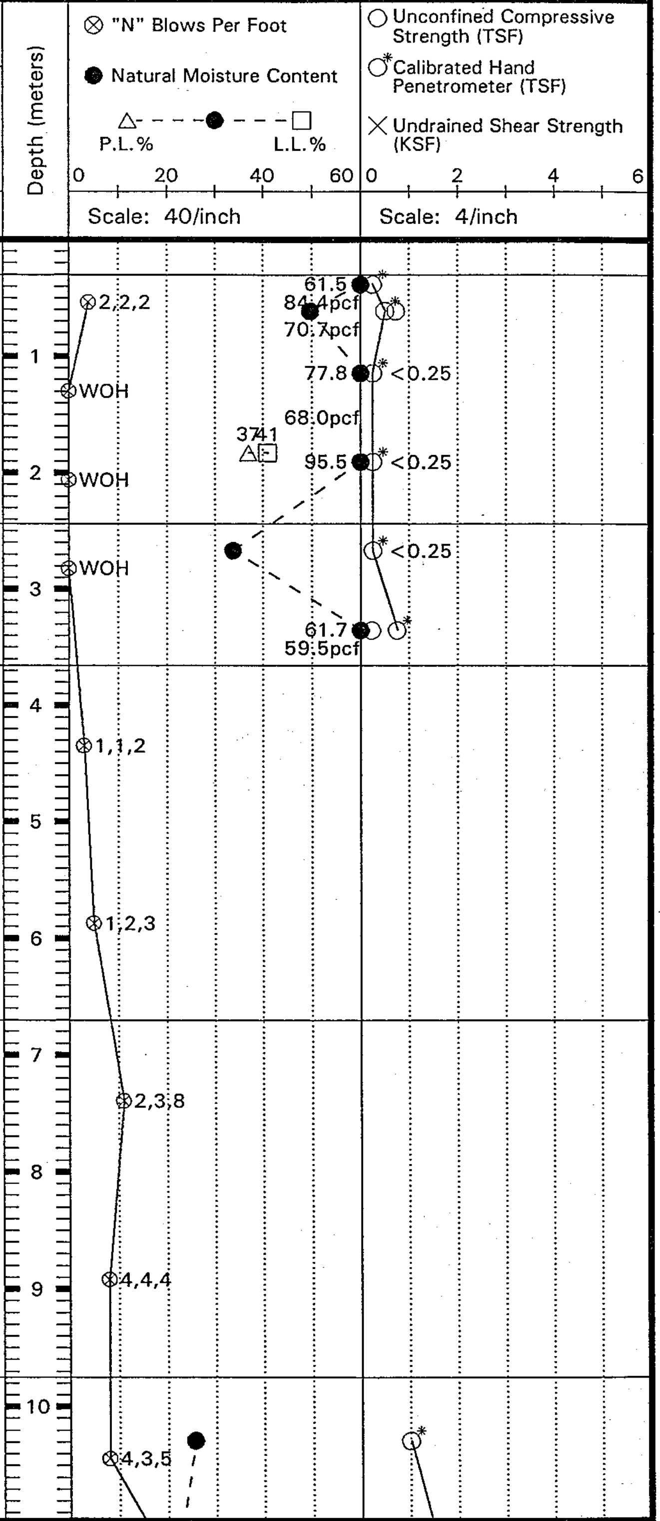
Project: **Project No.: STP-N606()/CM-9945()**
DES No.: 0088390/0100881
61st Avenue Widening & Improvements

Location: **51+40, 24' Lt. "A"**
Lake County, Indiana

PCF Indicates Sample Dry Unit Weight in Pounds Per Cubic Foot

Surface Elevation **(USC & GS): 609.1'**

Sample No./Type	Sample Distance	Recovery	Depth (feet)	Description Of Material
				Driller reported 12" dark gray CLAYEY TOPSOIL (visual)
1/SS				SILTY CLAY LOAM - with trace marl & little organic matter - soft to very soft - wet - dark brown to black A-5(6), Lab No. 8412SL
2/SS				
			5	
3/SS				
4/SS				LOAM - with trace marl & organic matter - very soft - wet - dark brown A-4(1), Lab No. 8415SL
			10	
				SAND - very loose - wet - gray A-3, Lab No. 8398SL
5/SS				
			15	
6/SS				
			20	
				SANDY GRAVEL - medium dense to loose - wet - gray A-1-a, Lab No. 8400SL
7/SS				
			25	
8/SS				
			30	
				SILTY CLAY - medium stiff to very stiff - very moist - gray A-7-6, Lab No. 8399SL
9/SS				
			35	



Note: The stratification lines indicated herein are approximate; In-situ the transition between soil types may be gradual

Water Level Observation
Surface while drilling
4'** at completion
______ @ ____ hrs. after completion

Boring Started: **11-29-01**

Boring Completed: **11-29-01**

Rig: **CME-55 (Truck)**

Drawn By: **SW**

Office: **Indiana**

Driller: **S. Benton**

Approved:

File: **15159**

Note: Boring backfilled with soil cuttings unless otherwise noted.

Client: The HNTB Companies	Proj. #: 016-15159 Sheet: 2 of 2	Boring Log Number: TB-2	Professional Service Industries, Inc.
Project: Project No.: STP-N606()/CM-9945() DES No.: 0088390/0100881 61st Avenue Widening & Improvements	Location: 51+40, 24' Lt. "A" Lake County, Indiana		

PCF Indicates Sample Dry Unit Weight in Pounds Per Cubic Foot

Surface Elevation **(USC & GS): 609.1'**

⊗ "N" Blows Per Foot

● Natural Moisture Content

△- - - -●- - - -☐
P.L.% L.L.%

0 20 40 60

Scale: 40/inch

○ Unconfined Compressive Strength (TSF)

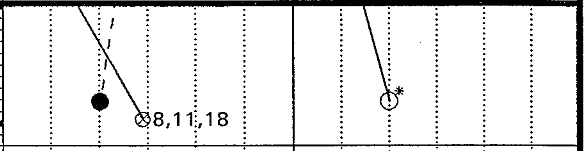
○* Calibrated Hand Penetrometer (TSF)

× Undrained Shear Strength (KSF)

0 2 4 6

Scale: 4/inch

Sample No./Type	Sample Distance	Recovery	Depth (feet)	Description Of Material	Depth (meters)
				SILTY CLAY - medium stiff to very stiff - very moist - gray A-7-6, Lab No. 8399SL	
10/SS	▨	▨			12
			40	END OF BORING 40'	



1/ST 1'-2.5' Recovery = 100%
MC = 49.7%, Dry Density = 70.7pcf
Qu = 0.73 tsf
LOI = 8.0%
2/ST 5'-7' Recovery = 100%
MC = 60.0%, Dry Density = 68.0pcf
Qu = 0.25 tsf
LOI = 7.3%, CA & MG = 8.1%
3/ST 10'-11.5' Recovery = 25%
Qu = 0.23 tsf
2/SS LOI = 10.0%
4/SS Qu = 1.68 tsf
LOI = 4.5%, CA & MG = 8.1%

**Cave-in @ 11 1/2' following removal of augers.
Weather: Cloudy.

Note: The stratification lines indicated herein are approximate; In-situ the transition between soil types may be gradual

General Notes – AASHTO/INDOT

psi Information To Build On
Engineering • Consulting • Testing

DRILLING & 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
PA	Power Auger
PS	Piston Sample – 3" diameter
WB	Wash Boring
WS	Wash Sample
HA	Hand Auger Boring
BS	Bag Sample
RC	Rock Core with Diamond Bit, NX size, except where noted
RB	Roller Bit
N/A	Not applicable or available

Standard Penetration Test "N" Value – Blows per foot after an initial 6" seating of a 140 pound hammer falling 30" on a 2" O.D. split spoon, except where noted.

Water Level Measurement Notations & Symbols

First	When noted during drilling or sampling process
Completion	After all drilling tools are removed from borehole
HR	Number of hours after completion
N/R	Not Recorded
Dry	No measurable water level found in borehole

Water levels indicated on the boring logs are the levels measured in the boring at the time indicated. The accurate determination of ground water levels may not be possible with short term observations, especially in impervious soils. The levels shown may fluctuate throughout the year with variations in precipitation, evaporation, runoff, and other hydrogeologic factors.

Particle Sizes

Boulder	Greater than 6" (>152.4mm)
Cobbles	3" to 6" (76.2mm to 152.4mm)
Gravel	#10 to 3" (2.0mm to 76.2mm)
Coarse Sand	#40 to #10 (0.425mm to 2.0mm)
Fine Sand	#200 to #40 (0.074mm to 0.425mm)
Silt/Clay	Minus #200 The term "silty" is applied to fine material having a plasticity index of 1.0 or less and the term "clayey" is applied to fine material having a plasticity index of 11 or greater.

CLASSIFICATION

Cohesionless Soil

Relative Density		"N" Value (Blows/ft)
Very Loose	-	0-5
Loose	-	6-10
Medium Dense	-	11-30
Dense	-	31-50
Very Dense	-	51 or more

Cohesive Soil

Consistency		"N" Value (Blows/ft)
Very Soft	-	0-3
Soft	-	4-5
Medium	-	6-10
Stiff	-	11-15
Very Stiff	-	16-30
Hard	-	31 or more

Soils are classified in accordance with AASHTO M145. The Classification of Soils and Soil Aggregate-Mixtures for highway construction purposes.

Classification System for Organic Soils

With trace organic matter	1% to 6%
With little organic matter	7% to 12%
With some organic matter	13% to 18%
Organic soil (A-8)	19% to 30%
Peat (A-8)	More than 30%

Classification System for Marly Soils

With trace marl	1% to 9%
With little marl	10% to 17%
With some marl	18% to 25%
Marly soil (A-8)	26% to 40%
Marl (A-8)	More than 40%

Professional Service Industries, Inc.
Geotechnical, Environmental & Material Consultants

Summary of Soundings

psi Information To Build On
Engineering • Consulting • Testing

CLIENT: The HNTB Companies
PROJECT: 61st Avenue Widening and Improvements
PROJECT NO.: CM-9945( ) & STP-N606( )
DESIGNATION NO.: 0100881 & 0088390
LOCATION: Hobart, Lake County, Indiana

AUGER DATE	AUGER METHOD	SOUNDING NUMBER	STATION	OFFSET	APPROX. SURFACE ELEV. (ft)	DEPTH (ft)	DESCRIPTION* (Field Observation)
11/29/01	Hand Auger	S-1	50+65	55’ Rt. “A”	609±	0 – 2.0	Loose Dark Gray Sand/marl
11/29/01	Hand Auger	S-2	50+90	45’ Rt. “A”	609±	0 – 0.5	Clay with organic matter/marl
11/29/01	Hand Auger	S-3	51+00	40’ Rt. “A”	609±	0 – 3.5	Clay with organic matter/marl
11/29/01	Hand Auger	S-4	51+50	40’ Lt. “A”	609±	0 – 3.0	Peat/marl
11/29/01	Hand Auger	S-5	51+60	47’ Lt. “A”	609±	0 – 2.0	Peat/marl
11/29/01	Hand Auger	S-6	51+70	50’ Lt. “A”	609±	0 – 1.0	Clay with organic matter/marl

Summary of Classification Test Results

PSI PROJECT NO.: 016-15159
CLIENT: The HNTB Companies
PROJECT: 61st Avenue Widening and Improvements
LOCATION: Lake County, Indiana
PROJECT NO.: CM-9945( ) & STP-N606( )
DESIGNATION NO.: 0100881 & 0088390

Lab No.	Boring No.	Station	Offset	Sample No.	Sample Depth (feet)	Classification		% Passing			% Gravel	% Sand	% Silt	% Clay	pH	LL	PL	PI	Opt. Moist.(%)	Max. Dry Dens., (pcf)	CBR @ 93%	CBR @ 97%
						Textural	AASHTO	No.10	No.40	No.200	76.2 - 2.0 mm	2.00 - 0.074 mm	0.074 - 0.002 mm	Below 0.002 mm								
8395SL	RB-2-SG	16+62	6' Lt. Line "A"	1/BS	1.0-3.0	Silty Clay Loam	A-4 (7)	92.8	88.9	76.7	7.2	16.1	55.4	21.3	7.86	34	24	10	15.5	110.0	2.2	3.3
8396SL	RB-2-SG	16+62	6' Lt. Line "A"	4/SS	8.5-10.0	Silty Clay	A-6 (21)	99.9	99.7	99.3	0.1	0.6	59.6	39.7	8.65	39	19	20	-	-	-	-
8397SL	RB-4-SG	25+40	6' Lt. Line "A"	2/SS	4.0-5.5	Clay	A-7-6 (22)	99.1	94.8	86.7	0.9	12.4	47.0	39.7	8.22	44	19	25	-	-	-	-
8398SL	RB-6-SG	36+00	6' Lt. Line "A"	5/SS	13.5-15.0	Sand	A-3	99.8	83.0	5.0	0.2	94.8	5.0		8.51	NP	NP	NP	-	-	-	-
8401SL	RB-8	57+00	22' Lt. Line "A"	1/BS	2.0-3.0	Silty Loam	A-4 (1)	99.4	96.2	70.3	0.6	29.1	56.7	13.6	8.46	26	22	4	-	-	-	-
8399SL	RB-11-SG	49+30	8' Rt. Line "S-4-A"	2/SS	3.0-4.5	Silty Clay	A-7-6 (22)	99.4	97.4	95.2	0.6	4.2	60.3	34.9	8.42	41	19	22	-	-	-	-
8400SL	TB-1	51+10	11' Rt. Line "A"	10/SS	38.5-40	Sandy Gravel	A-1-a	45.6	18.4	6.2	54.4	39.4	6.2		7.95	NP	NP	NP	-	-	-	-
8412SL	TB-2	51+40	24' Lt. Line "A"	2/ST	5.0 – 7.0	Silty Clay Loam w/little organic matter & trace marl	A-5(6)	99.3	97.8	87.5	0.7	11.8	66.5	21.0	8.03	41	37	4	-	-	-	-
8415SL	TB-2	51+40	24' Lt. Line "A"	3/ST	10.0 – 11.5	Loam w/little organic matter & trace marl	A-4(1)	98.4	95.0	58.4	1.6	40.0	40.0	18.4	7.94	25	20	5	-	-	-	-

SUMMARY OF SPECIAL LABORATORY TEST RESULTS

Project: 61st Avenue Widening & Improvements
Client: The HNTB Companies
Location: Lake County, Indiana
Project No.: CM-9945( )/STP-N606( )
Designation No.: 0100881/0088390
PSI Project No.: 016-15159

Laboratory Number	Boring Number	Sample Number	Depth (ft)	Moisture Content	pH Value	LOI	Dry Density (pcf)
8414SL	RB-1-SG	1/ SS	3.00 - 4.50	19.4			
8414SL	RB-1-SG	2/ SS	4.50 - 6.00	23.2			
8414SL	RB-1-SG	3/ SS	6.00 - 7.50	25.3			
8414SL	RB-1-SG	4/ SS	8.50 - 10.00	24.9			
8414SL	RB-1-SG	5/ SS	13.50 - 15.00	22.6			
8395SL	RB-2-SG	1/ BS	1.00 - 3.00		7.86		
8414SL	RB-2-SG	1/ SS	2.00 - 3.50	25.2			
8473SL	RB-2-SG	1/ ST	2.00 - 4.00	24.0			89.4
8414SL	RB-2-SG	2/ SS	4.00 - 5.50	26.1			
8474SL	RB-2-SG	2/ ST	4.00 - 6.00	25.9			95.0
8414SL	RB-2-SG	3/ SS	6.00 - 7.50	24.5			
8396SL	RB-2-SG	4/ SS	8.50 - 10.00	21.9	8.65		
8414SL	RB-3-SG	1/ SS	2.00 - 3.50	22.9			
8414SL	RB-3-SG	3/ SS	6.00 - 7.50	21.9			
8414SL	RB-3-SG	4/ SS	8.50 - 10.00	24.3			
8414SL	RB-3-SG	5/ SS	13.50 - 15.00	24.9			
8414SL	RB-4-SG	1/ SS	2.00 - 3.50	22.3			
8475SL	RB-4-SG	1/ ST	2.00 - 4.00	27.5		5.8	93.8

SUMMARY OF SPECIAL LABORATORY TEST RESULTS

Project: 61st Avenue Widening & Improvements
Client: The HNTB Companies
Location: Lake County, Indiana
Project No.: CM-9945( )/STP-N606( )
Designation No.: 0100881/0088390
PSI Project No.: 016-15159

Laboratory Number	Boring Number	Sample Number	Depth (ft)	Moisture Content	pH Value	LOI	Dry Density (pcf)
8414SL	RB-4-SG	2/ SS	4.00 - 5.50	22.9	8.22		
8414SL	RB-4-SG	3/ SS	6.00 - 7.50	29.2			
8414SL	RB-4-SG	4/ SS	8.50 - 10.00	28.0			
8414SL	RB-5-SG	1/ SS	1.50 - 3.00	21.6			
8476SL	RB-5-SG	1/ ST	1.50 - 3.50	26.7			97.2
8414SL	RB-5-SG	2/ SS	3.50 - 5.00	27.2			
8414SL	RB-5-SG	3/ SS	6.00 - 7.50	24.9			
8414SL	RB-5-SG	4/ SS	8.50 - 10.00	26.8			
8414SL	RB-6-SG	1/ SS	1.50 - 3.00	27.3			
8477SL	RB-6-SG	1/ ST	1.50 - 3.50	24.3			98.2
8414SL	RB-6-SG	2/ SS	3.50 - 5.00	25.8			
8414SL	RB-6-SG	3/ SS	6.00 - 7.50	24.3			
8414SL	RB-6-SG	4/ SS	8.50 - 10.00	24.6			
8398SL	RB-6-SG	5/ SS	13.50 - 15.00		8.51		
8414SL	RB-7-SG	1/ SS	1.50 - 3.00	22.0			
8478SL	RB-7-SG	1/ ST	1.50 - 3.50	24.5			98.6
8414SL	RB-7-SG	2/ SS	3.00 - 4.50	25.6			
8479SL	RB-7-SG	2/ ST	3.50 - 5.50	27.5			94.1

SUMMARY OF SPECIAL LABORATORY TEST RESULTS

Project: 61st Avenue Widening & Improvements
Client: The HNTB Companies
Location: Lake County, Indiana
Project No.: CM-9945( )/STP-N606( )
Designation No.: 0100881/0088390
PSI Project No.: 016-15159

Laboratory Number	Boring Number	Sample Number	Depth (ft)	Moisture Content	pH Value	LOI	Dry Density (pcf)
8414SL	RB-7-SG	3/ SS	6.00 - 7.50	24.1			
8414SL	RB-7-SG	4/ SS	8.50 - 10.00	24.6			
8414SL	RB-7-SG	5/ SS	13.50 - 15.00	25.5			
8414SL	RB-8-SG	1/ SS	1.00 - 2.50	21.7			
8401SL	RB-8-SG	1/ BS	2.00 - 3.00		8.46		
8480SL	RB-8-SG	1/ ST	1.00 - 2.50	21.6			104.9
8414SL	RB-8-SG	2/ SS	2.50 - 4.00	24.2			
8414SL	RB-8-SG	3/ SS	6.00 - 7.50	25.4			
8414SL	RB-8-SG	4/ SS	8.50 - 10.00	24.0			
8414SL	RB-8-SG	5/ SS	13.50 - 15.00	26.6			
8414SL	RB-8-SG	6/ SS	18.50 - 20.00	27.4			
8414SL	RB-9-SG	1/ SS	1.50 - 3.00	19.0			
8481SL	RB-9-SG	1/ ST	1.50 - 3.50	20.9			102.3
8414SL	RB-9-SG	2/ SS	3.50 - 5.00	22.9			
8405SL	RB-9-SG	3/ SS	6.00 - 7.50	26.4		4.4	
8414SL	RB-9-SG	4/ SS	8.50 - 10.00	26.7			
8414SL	RB-9-SG	5/ SS	13.50 - 15.00	25.1			
8414SL	RB-9-SG	6/ SS	18.50 - 20.00	30.3			

SUMMARY OF SPECIAL LABORATORY TEST RESULTS

Project: 61st Avenue Widening & Improvements
Client: The HNTB Companies
Location: Lake County, Indiana
Project No.: CM-9945( )/STP-N606( )
Designation No.: 0100881/0088390
PSI Project No.: 016-15159

Laboratory Number	Boring Number	Sample Number	Depth (ft)	Moisture Content	pH Value	LOI	Dry Density (pcf)
8406SL	RB-10-SG	1/ SS	1.00 - 2.50	14.8		5.9	
8482SL	RB-10-SG	1/ ST	1.00 - 3.00	21.9			105.3
8414SL	RB-10-SG	2/ SS	3.00 - 4.50	22.9			
8414SL	RB-10-SG	3/ SS	6.00 - 7.50	26.2			
8414SL	RB-11-SG	1/ SS	1.00 - 2.50	22.0			
8483SL	RB-11-SG	1/ ST	1.00 - 3.00	19.4			109.6
8399SL	RB-11-SG	2/ SS	3.00 - 4.50	22.2	8.42		
8414SL	RB-11-SG	3/ SS	6.00 - 7.50	19.7			
8414SL	RB-11-SG	4/ SS	8.50 - 10.00	22.2			
8414SL	RB-11-SG	5/ SS	13.50 - 15.00	21.6			
8414SL	TB-1-SG	1/ SS	2.00 - 3.50	12.3			
8414SL	TB-1-SG	3/ SS	6.00 - 7.50	23.4			
8414SL	TB-1-SG	4/ SS	8.50 - 10.00	26.2			
8407SL	TB-1-SG	5/ SS	13.50 - 15.00	39.0		9.5	
8408SL	TB-1-SG	6/ SS	18.50 - 20.00	55.1		7.7	
8400SL	TB-1-SG	10/ SS	38.50 - 40.00		7.95		
8414SL	TB-1-SG	11/ SS	43.50 - 45.00	24.7			
8414SL	TB-2	1/ SS	1.00 - 2.50	61.5			

SUMMARY OF SPECIAL LABORATORY TEST RESULTS

Project: 61st Avenue Widening & Improvements
Client: The HNTB Companies
Location: Lake County, Indiana
Project No.: CM-9945( )/STP-N606( )
Designation No.: 0100881/0088390
PSI Project No.: 016-15159

Laboratory Number	Boring Number	Sample Number	Depth (ft)	Moisture Content	pH Value	LOI	Dry Density (pcf)
8402SL	TB-2	1/ ST	1.00 - 3.00	49.7		8.0	70.7
8410SL	TB-2	2/ SS	3.50 - 5.00	77.8		10.0	
8412SL	TB-2	2/ ST	5.00 - 7.00	60.0	8.03	7.3	68.0
8414SL	TB-2	3/ SS	6.00 - 7.50	95.5			
8411SL	TB-2	4/ SS	8.50 - 10.00	33.8		4.5	
8415SL	TB-2	3/ ST	10.00 - 11.50	61.7			59.5
8414SL	TB-2	9/ SS	33.50 - 35.00	25.6			
8414SL	TB-2	10/ SS	38.50 - 40.00	20.2			

PARTICLE SIZE DISTRIBUTION TEST REPORT

% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	7.2	16.1	55.4	21.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
#4	97.9		
#10	92.8		
#16	92.2		
#30	91.5		
#40	88.9		
#50	85.9		
#100	80.4		
#200	76.7		

* (no specification provided)

Soil Description

Silty Clay Loam

Atterberg Limits

PL= 24 LL= 34 PI= 10

Coefficients

D_{85}= 0.271 D_{60}= 0.0147 D_{50}= 0.0107
D_{30}= 0.0039 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= A-4(7)

Remarks

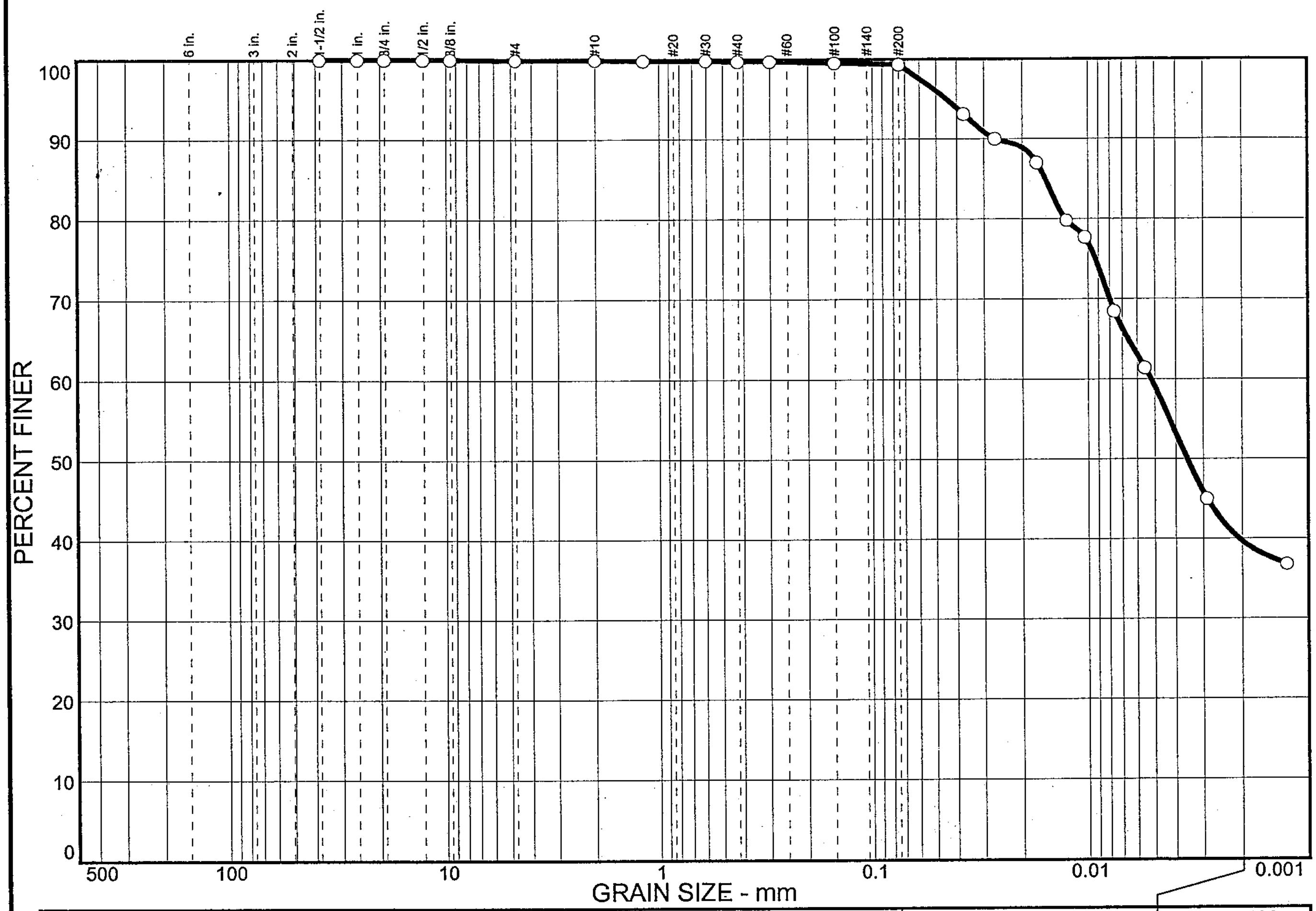
Lab No. 8395SL
pH = 7.86

Sample No.: 1/BS **Source of Sample:** RB-2-SG **Date:** 12/11/01
Location: Station 16+62, 6' Lt., Line "A" **Elev./Depth:** 2'-3'

PROFESSIONAL SERVICE INDUSTRIES, INC.

Client: The HNTB Companies
Project: 61st Avenue Widening and Improvements
Project No: CM-9945() & STP- **Figure Number** 4

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	0.6	59.6	39.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
#4	99.9		
#10	99.9		
#16	99.8		
#30	99.8		
#40	99.7		
#50	99.7		
#100	99.5		
#200	99.3		

* (no specification provided)

Soil Description

Silty Clay

Atterberg Limits

PL= 19 LL= 39 PI= 20

Coefficients

D_{85}= 0.0157 D_{60}= 0.0052 D_{50}= 0.0036
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= OL AASHTO= A-6(21)

Remarks

Lab No. 8396SL
pH = 8.65

Sample No.: 4/SS **Source of Sample:** RB-2-SG **Date:** 12/11/01
Location: Station 16+62, 6' Lt., Line "A" **Elev./Depth:** 8.5'-10'

PROFESSIONAL SERVICE INDUSTRIES, INC.

Client: The HNTB Companies
Project: 61st Avenue Widening and Improvements
Project No: CM-9945() & STP- **Figure Number** 5

PARTICLE SIZE DISTRIBUTION TEST REPORT

% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.9	12.4	47.0	39.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
#4	99.9		
#10	99.1		
#16	96.5		
#30	95.5		
#40	94.8		
#50	94.0		
#100	89.4		
#200	86.7		

* (no specification provided)

Soil Description

Clay

Atterberg Limits

PL= 19 LL= 44 PI= 25

Coefficients

D_{85}= 0.0641 D_{60}= 0.0070 D_{50}= 0.0044
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

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

Remarks

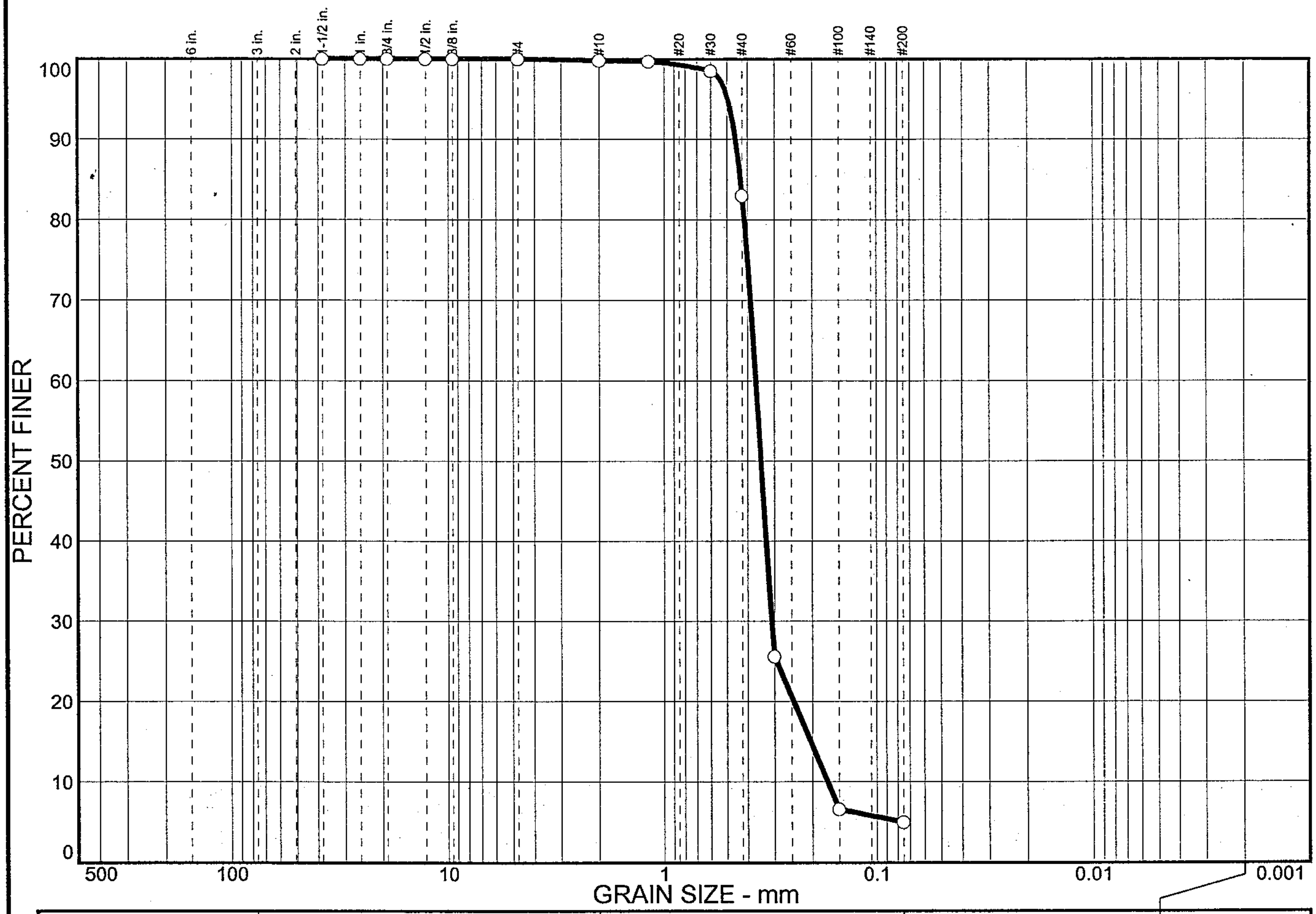
Lab No. 8397SL
pH = 8.22

Sample No.: 2/SS **Source of Sample:** RB-4-SG **Date:** 12/11/01
Location: Station 25+40, 6' Lt., Line "A" **Elev./Depth:** 4'-5.5'

PROFESSIONAL SERVICE INDUSTRIES, INC.

Client: The HNTB Companies
Project: 61st Avenue Widening and Improvements
Project No: CM-9945() & STP- **Figure Number** 6

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.2	94.8	5.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
#4	100.0		
#10	99.8		
#16	99.7		
#30	98.5		
#40	83.0		
#50	25.6		
#100	6.6		
#200	5.0		

* (no specification provided)

Soil Description

Sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 0.432 D_{60}= 0.367 D_{50}= 0.347
D_{30}= 0.309 D_{15}= 0.204 D_{10}= 0.170
C_u= 2.16 C_c= 1.53

Classification

USCS= SP-SM AASHTO= A-3

Remarks

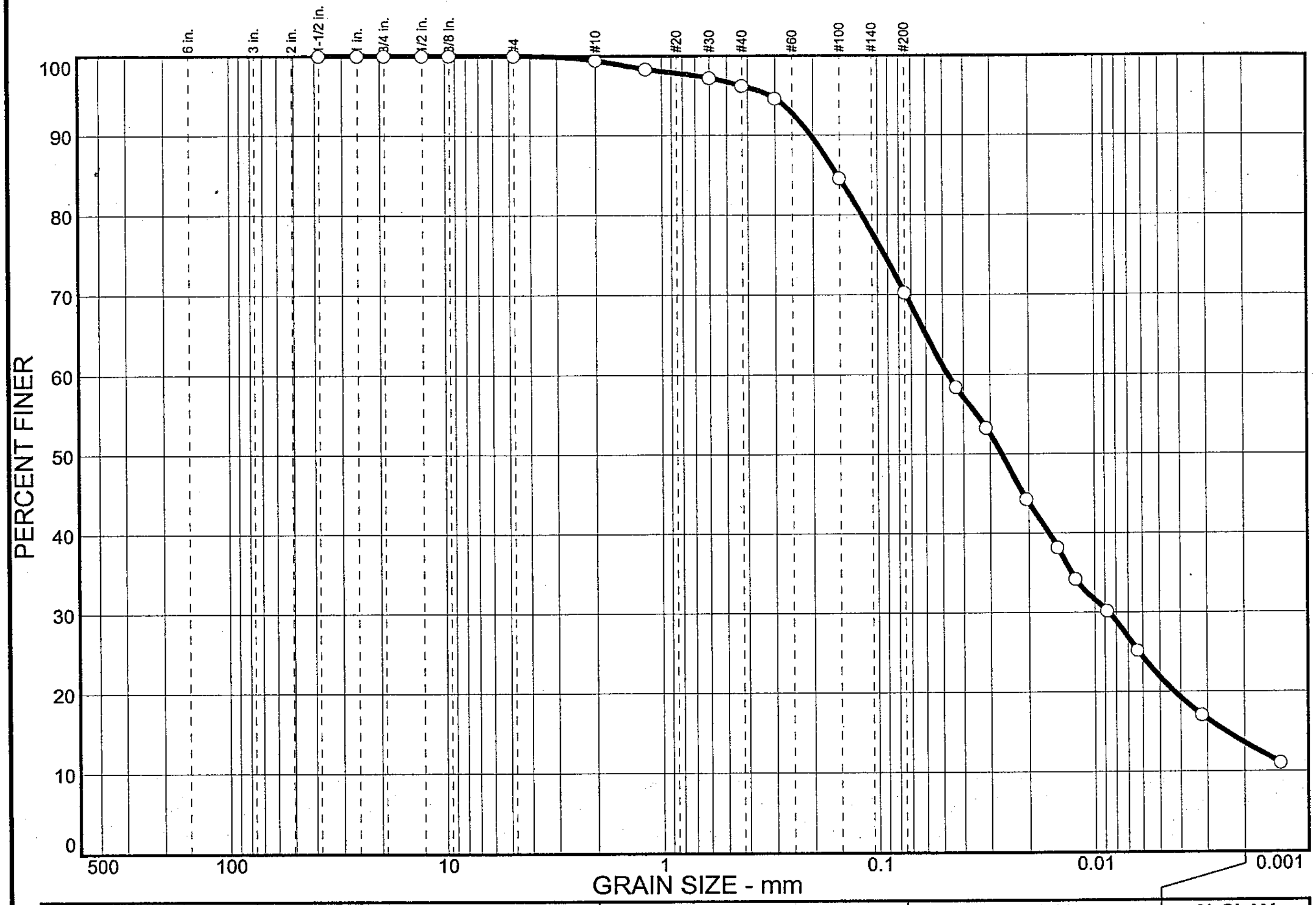
Lab No. 8398SL
pH = 8.51

Sample No.: 5/SS **Source of Sample:** RB-6-SG **Date:** 12/11/01
Location: Station 36+00, 6' Lt., Line "A" **Elev./Depth:** 13.5'-15'

PROFESSIONAL SERVICE INDUSTRIES, INC.

Client: The HNTB Companies
Project: 61st Avenue Widening and Improvements
Project No: CM-9945() & STP- **Figure Number** 7

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.6	29.1	56.7	13.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
#4	100.0		
#10	99.4		
#16	98.3		
#30	97.2		
#40	96.2		
#50	94.6		
#100	84.6		
#200	70.3		

* (no specification provided)

Soil Description

Silty Loam

Atterberg Limits

PL= 22 LL= 26 PI= 4

Coefficients

D_{85}= 0.153 D_{60}= 0.0474 D_{50}= 0.0266

D_{30}= 0.0086 D_{15}= 0.0024 D_{10}=

C_u= C_c=

Classification

USCS= ML AASHTO= A-4(1)

Remarks

Lab No. 8401SL

pH = 8.46

Sample No.: 1/BS **Source of Sample:** RB-8 **Date:** 12/22/01

Location: Station 57+00, 22' Lt., Line "A" **Elev./Depth:** 2'-3'

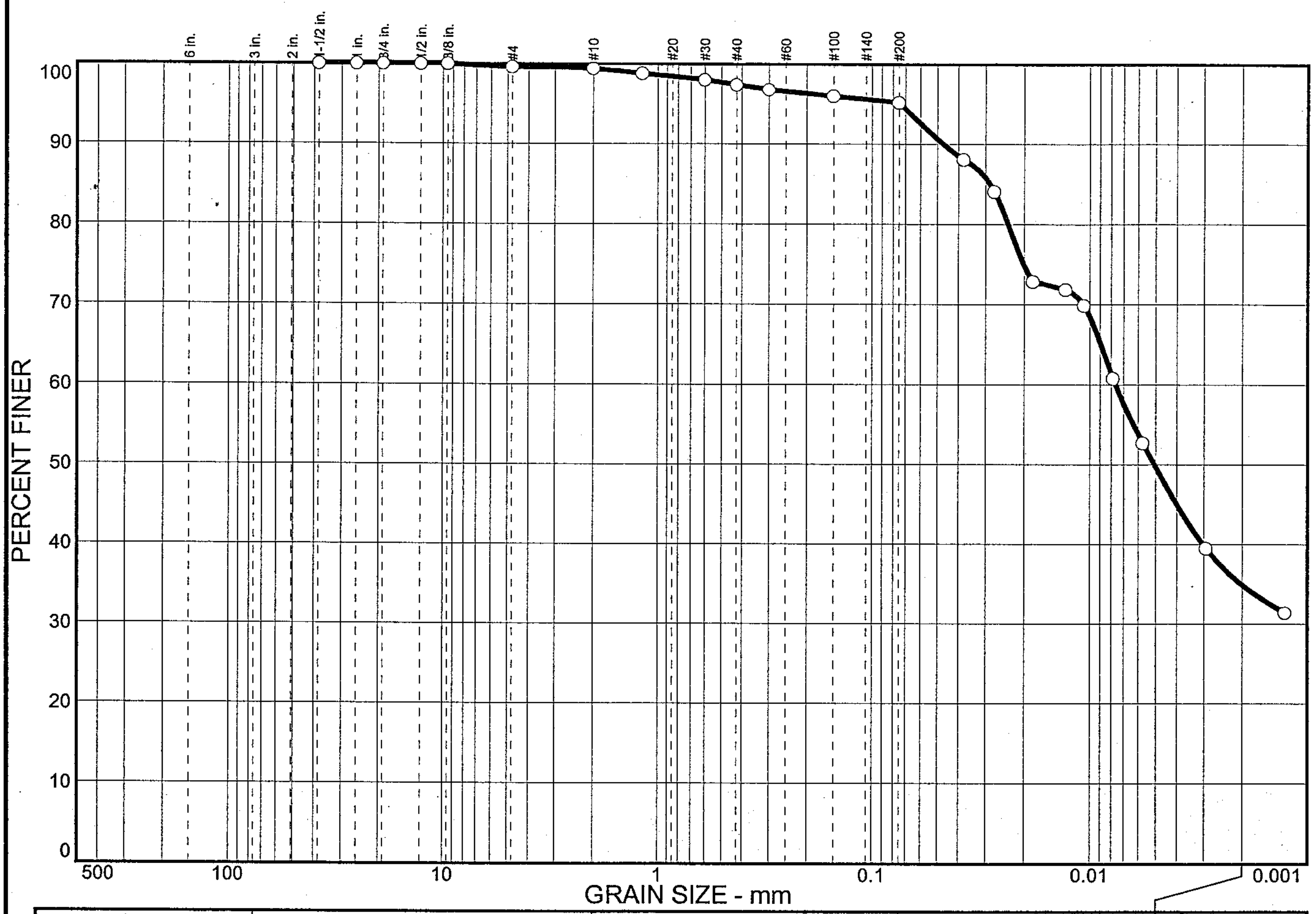
PROFESSIONAL SERVICE INDUSTRIES, INC.

Client: The HNTB Companies

Project: 61st Avenue Widening and Improvements

Project No: CM-9945() & STP- **Figure Number** 8

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.6	4.2	60.3	34.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	100.0		
.75 in.	100.0		
.5 in.	100.0		
.375 in.	100.0		
#4	99.6		
#10	99.4		
#16	98.8		
#30	98.0		
#40	97.4		
#50	96.8		
#100	96.0		
#200	95.2		

* (no specification provided)

Soil Description

Silty Clay

Atterberg Limits

PL= 19 LL= 41 PI= 22

Coefficients

D_{85}= 0.0286 D_{60}= 0.0076 D_{50}= 0.0051

D_{30}= D_{15}= D_{10}=

C_u= C_c=

Classification

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

Remarks

Lab No. 8399SL

pH = 8.42

Sample No.: 2/SS **Source of Sample:** RB-11-SG **Date:** 12/11/01

Location: Station 49+30, 8' Rt., Line "S-4-A" **Elev./Depth:** 3'-4.5'

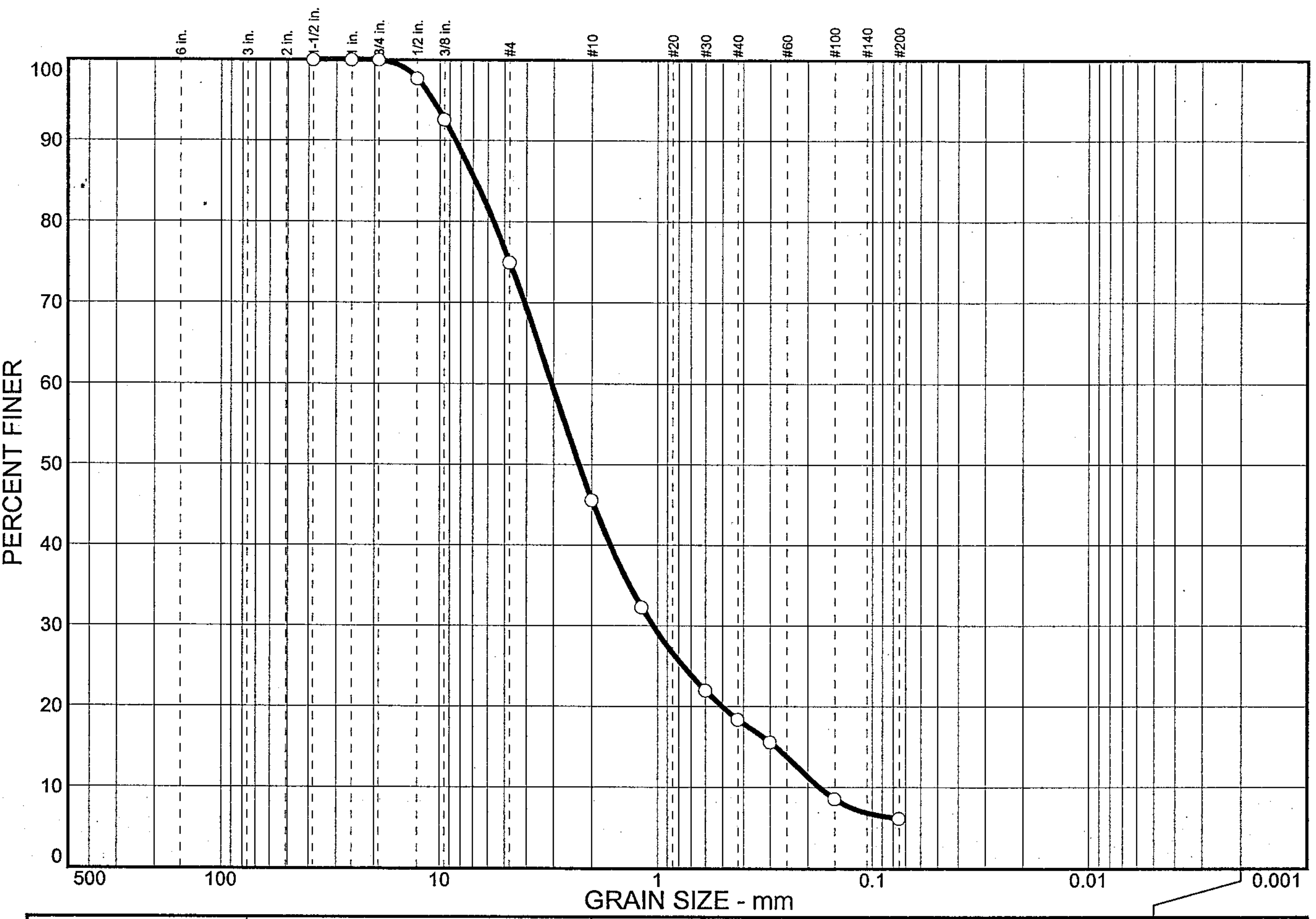
PROFESSIONAL SERVICE INDUSTRIES, INC.

Client: The HNTB Companies

Project: 61st Avenue Widening and Improvements

Project No: CM-9945() & STP- **Figure Number** 9

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	54.4	39.4	6.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	100.0		
.75 in.	100.0		
.5 in.	97.7		
.375 in.	92.6		
#4	75.0		
#10	45.6		
#16	32.3		
#30	22.0		
#40	18.4		
#50	15.6		
#100	8.6		
#200	6.2		

* (no specification provided)

Soil Description

Sandy Gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 6.81 D_{60}= 3.06 D_{50}= 2.29
D_{30}= 1.05 D_{15}= 0.281 D_{10}= 0.176
C_u= 17.40 C_c= 2.03

Classification

USCS= SW-SM AASHTO= A-1-a

Remarks

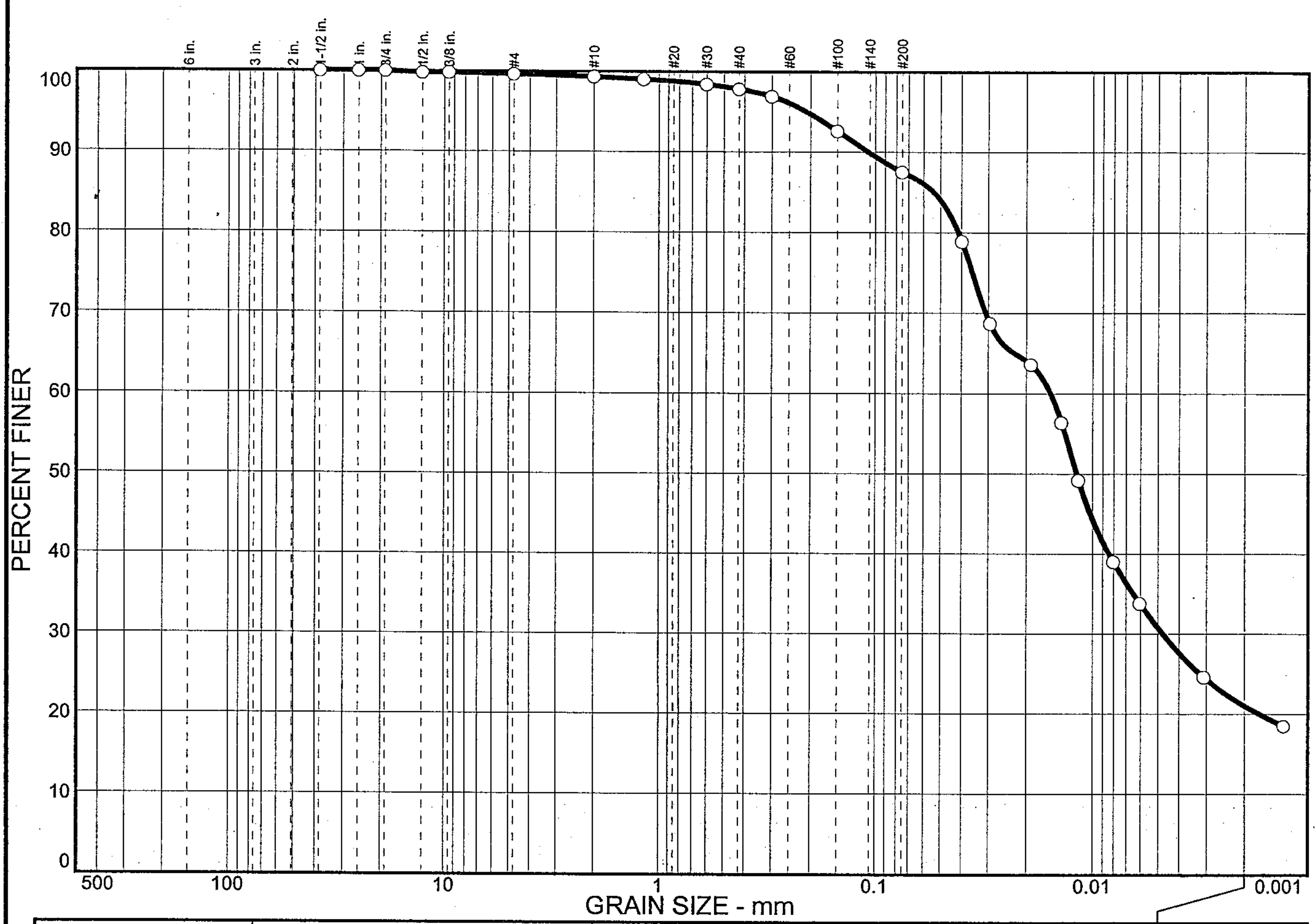
Lab No. 8400SL
pH = 7.95

Sample No.: 10/SS **Source of Sample:** TB-1 **Date:** 12/11/01
Location: Station 51+10, 11' Rt., Line "A" **Elev./Depth:** 38.5'-40'

PROFESSIONAL SERVICE INDUSTRIES, INC.

Client: The HNTB Companies
Project: 61st Avenue Widening and Improvements
Project No: CM-9945() & STP- **Figure Number** 10

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.7	11.8	66.5	21.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	100.0		
.75 in.	100.0		
.5 in.	99.8		
.375 in.	99.8		
#4	99.6		
#10	99.3		
#16	99.0		
#30	98.4		
#40	97.8		
#50	96.9		
#100	92.6		
#200	87.5		

* (no specification provided)

Soil Description

Silty Clay Loam with little organic matter and trace marl

Atterberg Limits

PL= 37
LL= 41
PI= 4

Coefficients

D_{85}= 0.0537
D_{60}= 0.0155
D_{50}= 0.0118
D_{30}= 0.0047
D_{15}=
D_{10}=
C_u=
C_c=

Classification

USCS= ML
AASHTO= A-5(6)

Remarks

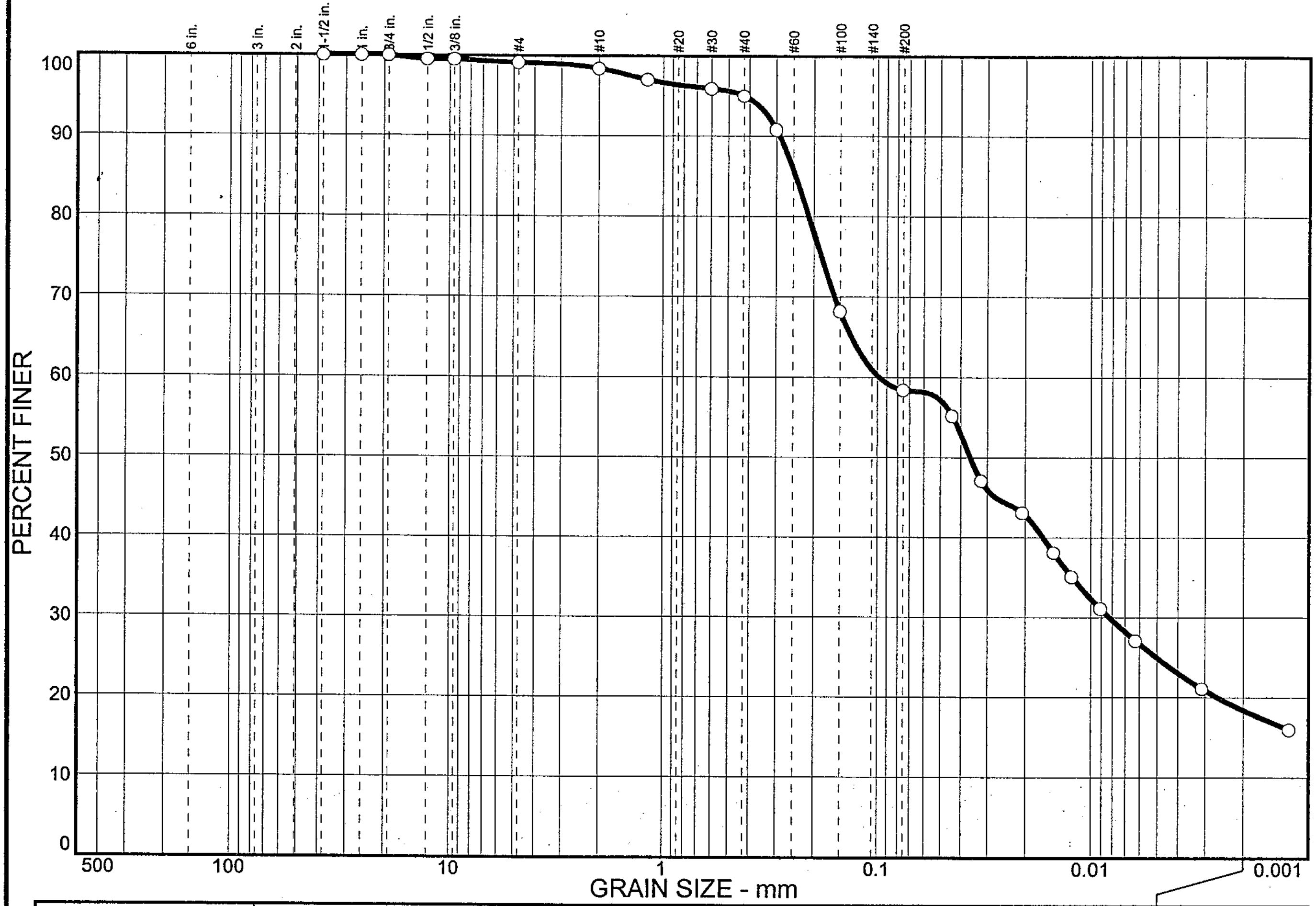
Lab No. 8412SL
pH = 8.03
LOI = 7.3

Sample No.: 2/ST
Source of Sample: TB-2
Date: 02/04/2002
Location: Station 51+40, 24' Lt., Line "A"
Elev./Depth: 5.0'-7.0'

PROFESSIONAL SERVICE INDUSTRIES, INC.

Client: The HNTB Companies
Project: 61st Avenue Widening and Improvements
Project No: CM-9945() & STP-
Figure Number 11

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.6	40.0	40.0	18.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	100.0		
.75 in.	100.0		
.5 in.	99.5		
.375 in.	99.5		
#4	99.1		
#10	98.4		
#16	97.0		
#30	95.9		
#40	95.0		
#50	90.8		
#100	68.2		
#200	58.4		

* (no specification provided)

Soil Description

Loam

Atterberg Limits

PL= 20 LL= 25 PI= 5

Coefficients

D_{85}= 0.244 D_{60}= 0.0978 D_{50}= 0.0361
D_{30}= 0.0082 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL-ML AASHTO= A-4 (1)

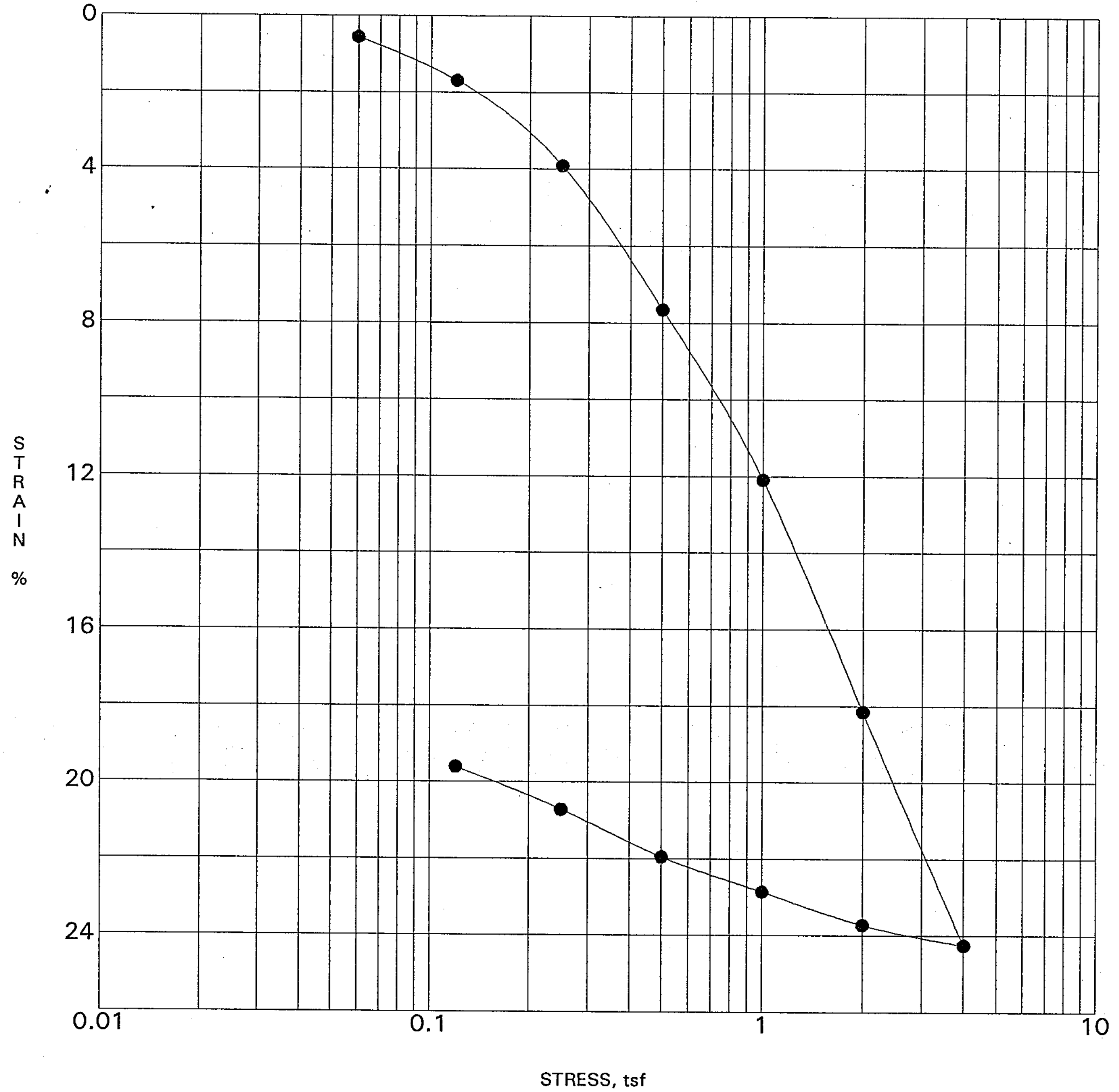
Remarks

Lab No. 8415SL
pH = 7.94

Sample No.: 3/ST **Source of Sample:** TB-2 **Date:** 01/24/2002
Location: Station 51+40, 24' Lt., Line "A" **Elev./Depth:** 10.0'-11.5'

PROFESSIONAL SERVICE INDUSTRIES, INC.

Client: The HNTB Companies
Project: 61st Avenue Widening and Improvements
Project No: CM-9945() & STP- **Figure Number** 12



Tested in accordance with ASTM D-2435 & AASHTO T216.

Boring No.: TB-2		Natural Water Content: 51.8%		
Station & Offset: 51+40, 24' Lt. "A"		Liquid Limit:	41%	Po: 0.7 ksf
Sample No.: 2/ST	Depth: 6.0'-6.1'	Plastic Limit:	37%	Pc: 0.7 ksf
Laboratory No.: 8412SL		Plasticity Index:	4%	CC: 0.202
Soil Classification: Silty Clay Loam w/trace marl		Specific Gravity:	2.59	CR: 0.031

PROJECT **61st Avenue Widening & Improvements** JOB NO. **016-15159**
LOCATION **Lake County, Indiana** DATE **2/25/02**

CONSOLIDATION TEST

Professional Service Industries, Inc.
Indianapolis, Indiana

Figure 13

Reviewed By: PSL

CONSOLIDATION TEST

CLIENT: HNTB Companies
PROJECT: 61st Street Improvements
PROJECT # 016-15159
SAMPLE NO.: 2/ST
BORING NO. TB-2
DEPTH ft: 6.0-6.1
DATE TESTED: 2/25/02
TESTED BY: WC
REVIEWED BY: PSL
DESCRIPTION OF SAMPLE: Silty Clay Loam with little organic matter

SAMPLE HT.:	0.748	in.	SPEC. GRAV.:	2.59	Tested	
	1.90	cm.	ATTERBERG LIMITS:	LL - 41	PI -	4
RING AREA:	4.8305	in^2	DRY DENSITY:	71.90	pcf	
	31.16	cm^2		1151.66	kg/m^3	

				Initial	Final
Cup No.	1-HR		Wt. Ring + Soil Wet	177.66 g	167.4 g
Wt. Cup + Soil Wet	85.70	g	Wt. Ring + Soil Dry	142.30 g	142.30 g
Wt. Cup + Soil Dry	61.20	g	Wt. Ring	74.15 g	74.15 g
Wt Water	24.50	g	Wt. Soil (Wet)	103.51 g	93.25 g
Wt. of Cup	13.90	g	Wt. Soil (Dry)	68.15 g	68.15 g
Wt. Dry Soil	47.30	g	Hgt. of Solids	0.332 in.	0.332 in.
Initial Moisture (%)	51.80%		Void Ratio (e)	1.249	-----

APPLIED PRESSURE (tsf)	APPLIED PRESSURE (psf)	CUMULAT. DISPLACE. (in.)	CHANGE V. RATIO (delta e)	VOID RATIO (e)	STRAIN (%)	H (in.)	T90 (min.)	Cv * (in^2/min)
0	0	0	0	1.249	0	0.748	--	--
0.0625	125	0.0042	0.0127	1.236	0.56	0.744	37.2	0.0032
0.125	250	0.0127	0.0383	1.211	1.70	0.735	59.3	0.0019
0.25	500	0.0293	0.0883	1.161	3.92	0.719	53.3	0.0021
0.5	1000	0.05725	0.1725	1.076	7.65	0.691	85.6	0.0012
1	2000	0.0905	0.2727	0.976	12.10	0.658	94.1	0.0010
2	4000	0.1358	0.4092	0.840	18.16	0.612	86.5	0.0009
4	8000	0.1814	0.5466	0.702	24.25	0.567	98	0.0007
2	4000	0.17745	0.5347	0.714	23.72	0.571		
1	2000	0.171	0.5153	0.734	22.86	0.577		
0.5	1000	0.16415	0.4946	0.754	21.95	0.584		
0.25	500	0.155	0.4671	0.782	20.72	0.593		
0.125	250	0.1467	0.4421	0.807	19.61	0.601		

* Cv values are based on our interpretation of the plotted data.

UNCONFINED COMPRESSION STRENGTH

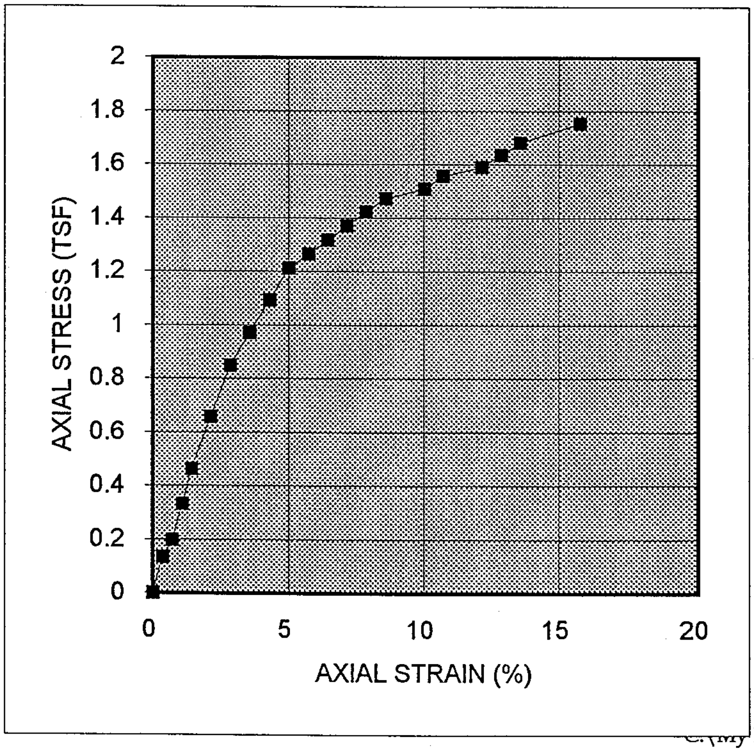
Project: 61st Ave. Widening & Improv.
Client: The HNTB Companies
Date Tested: 12/02/01
Project No.: 016-15159

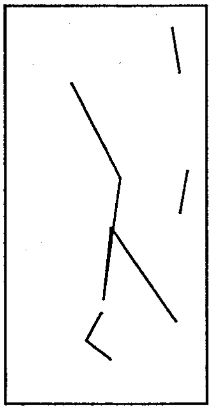
Soil Description: Silty Clay
Tested By: WC
Reviewed By: AJM
Boring #: TB-1-SG
Sample No.: 4/SS
Depth (ft): 9 (2.7) meters
LAB NO.: 8403SL
Qp(tsf): 0.75
Wet Weight(g): 138.8

Height: 2.80 inches 70.99 mm
Diameter: 1.41 inches 35.81 mm
Moisture Content: 25.7%
Saturation (%): 95.2
Ht.-Diameter Ratio - 1.98
Specific Gravity: 2.65
Load Cell Calibration
Pounds/mVolt 14.55
Dry Density: 96.3 pcf 1542.3 kg/m^3

READING NUMBER	DEFOR-MATION (in.)	TRANS-DUCER READING	LOAD (lbs)	STRAIN (%)	CORRECTED AREA ^(in^2)	AXIAL STRESS (tsf)
0	0.000	0.1	0.0	0.00	1.561	0.00
1	0.010	0.2	2.9	0.36	1.567	0.13
2	0.020	0.3	4.4	0.72	1.573	0.20
3	0.030	0.5	7.3	1.07	1.578	0.33
4	0.040	0.7	10.2	1.43	1.584	0.46
5	0.060	1.0	14.6	2.15	1.596	0.66
6	0.080	1.3	18.9	2.86	1.607	0.85
7	0.100	1.5	21.8	3.58	1.619	0.97
8	0.120	1.7	24.7	4.29	1.631	1.09
9	0.140	1.9	27.6	5.01	1.644	1.21
10	0.160	2.0	29.1	5.72	1.656	1.27
11	0.180	2.1	30.6	6.44	1.669	1.32
12	0.200	2.2	32.0	7.16	1.682	1.37
13	0.220	2.3	33.5	7.87	1.695	1.42
14	0.240	2.4	34.9	8.59	1.708	1.47
15	0.280	2.5	36.4	10.02	1.735	1.51
16	0.300	2.6	37.8	10.73	1.749	1.56
17	0.340	2.7	39.3	12.16	1.778	1.59
18	0.360	2.8	40.7	12.88	1.792	1.64
19	0.380	2.9	42.2	13.60	1.807	1.68
20	0.440	3.1	45.1	15.74	1.853	1.75

Qu = 1.68 tsf 160.98 kPa Strain 15.00%





FAILURE SKETCH

UNCONFINED COMPRESSION STRENGTH

Project: 61st Ave. Widening & Improv.
Client: The HNTB Companies
Date Tested: 12/02/01
Project No.: 016-15159

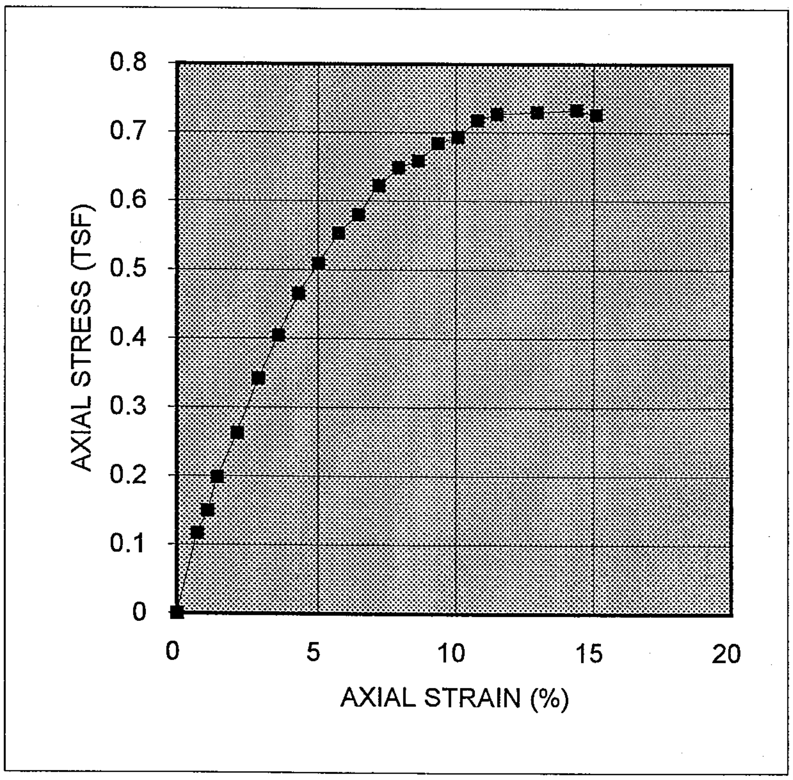
Soil Description: Silty Clay Loam with little organic matter
Tested By: WC
Reviewed By: AJM
Boring #: TB-2 **Sample No.:** 1/ST
Depth (ft): 2 (0.6) meters
LAB NO.: 8402SL
Qp(tsf): 0.5
Wet Weight(g): 965.3

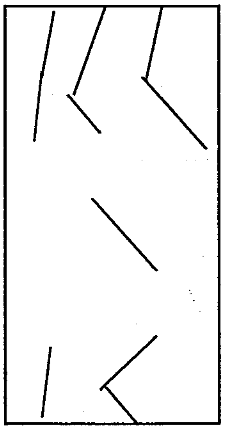
Height: 5.56 inches 141.22 mm
Diameter: 2.82 inches 71.63 mm
Moisture Content: 49.7% **Saturation (%):** 97.8
Ht.-Diameter Ratio - 1.97 **Specific Gravity:** 2.65
Dry Density: 70.7 pcf 1132.4 kg/m^3

Load Cell Calibration
Pounds/mVolt 14.55

READING NUMBER	DEFOR-MATION (in.)	TRANS-DUCER READING	LOAD (lbs)	STRAIN (%)	CORRECTED AREA ^(in^2)	AXIAL STRESS (tsf)
0	0.020	0.4	0.0	0.36	6.268	0.00
1	0.040	0.7	10.2	0.72	6.291	0.12
2	0.060	0.9	13.1	1.08	6.314	0.15
3	0.080	1.2	17.5	1.44	6.337	0.20
4	0.120	1.6	23.3	2.16	6.384	0.26
5	0.160	2.1	30.6	2.88	6.431	0.34
6	0.200	2.5	36.4	3.60	6.479	0.40
7	0.240	2.9	42.2	4.32	6.528	0.47
8	0.280	3.2	46.6	5.04	6.577	0.51
9	0.320	3.5	50.9	5.76	6.627	0.55
10	0.360	3.7	53.8	6.47	6.678	0.58
11	0.400	4.0	58.2	7.19	6.730	0.62
12	0.440	4.2	61.1	7.91	6.783	0.65
13	0.480	4.3	62.6	8.63	6.836	0.66
14	0.520	4.5	65.5	9.35	6.890	0.68
15	0.560	4.6	66.9	10.07	6.945	0.69
16	0.600	4.8	69.8	10.79	7.001	0.72
17	0.640	4.9	71.3	11.51	7.058	0.73
18	0.720	5.0	72.8	12.95	7.175	0.73
19	0.800	5.1	74.2	14.39	7.296	0.73
20	0.840	5.1	74.2	15.11	7.357	0.73

Qu = 0.73 tsf 70.13 kPa Strai 15.00%





FAILURE SKETCH

UNCONFINED COMPRESSION STRENGTH

Project: 61st Ave. Widening & Improv.
Client: The HNTB Companies
Date Tested: 02/02/02
Project No.: 016-15159

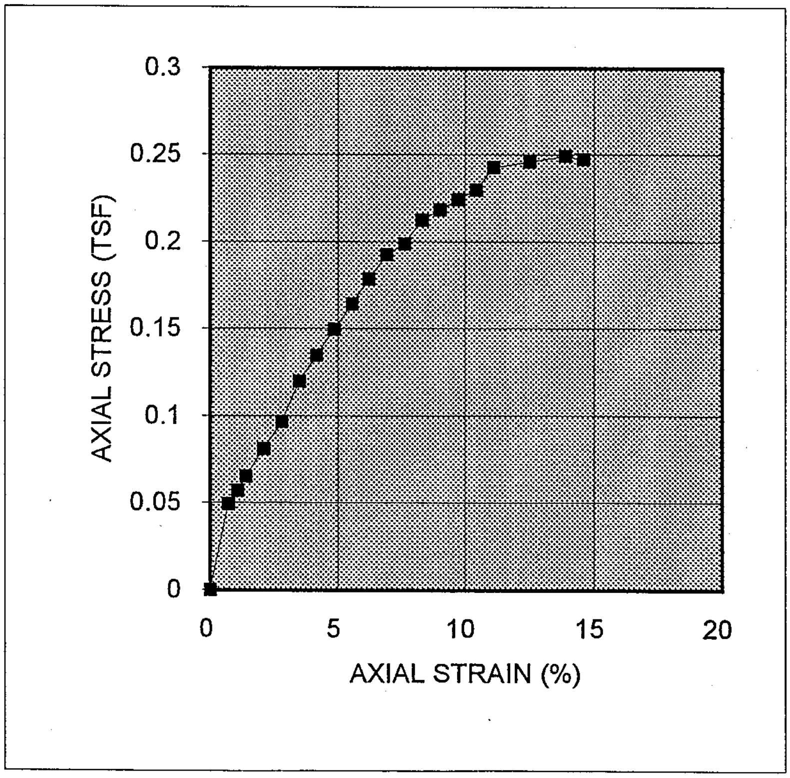
Soil Description: Silty Clay Loam w/ little organic matter & trace marl
Tested By: WC
Reviewed By: PSL
Boring #: TB-2
Sample No.: 2/ST
Depth (ft): 6 (1.8) meters
LAB NO.: 8444SL
Qp(tsf): 0.5
Wet Weight(g): 964.1

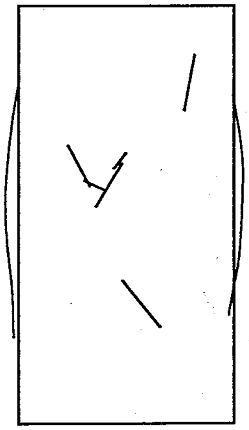
Height: 5.76 inches 146.30 mm
Diameter: 2.73 inches 69.34 mm
Moisture Content: 60.0%
Saturation (%): 110.6
Ht.-Diameter Ratio - 2.11
Specific Gravity: 2.65
Dry Density: 68.0 pcf 1089.5 kg/m^3

Load Cell Calibration
Pounds/mVolt 6.73

READING NUMBER	DEFOR-MATION (in.)	TRANS-DUCER READING	LOAD (lbs)	STRAIN (%)	CORRECTED AREA ^(in^2)	AXIAL STRESS (tsf)
0	0.020	0.5	0.0	0.35	5.874	0.00
1	0.040	0.6	4.0	0.69	5.894	0.05
2	0.060	0.7	4.7	1.04	5.915	0.06
3	0.080	0.8	5.4	1.39	5.936	0.07
4	0.120	1.0	6.7	2.08	5.978	0.08
5	0.160	1.2	8.1	2.78	6.021	0.10
6	0.200	1.5	10.1	3.47	6.064	0.12
7	0.240	1.7	11.4	4.17	6.108	0.13
8	0.280	1.9	12.8	4.86	6.153	0.15
9	0.320	2.1	14.1	5.56	6.198	0.16
10	0.360	2.3	15.5	6.25	6.244	0.18
11	0.400	2.5	16.8	6.94	6.290	0.19
12	0.440	2.6	17.5	7.64	6.338	0.20
13	0.480	2.8	18.8	8.33	6.386	0.21
14	0.520	2.9	19.5	9.03	6.434	0.22
15	0.560	3.0	20.2	9.72	6.484	0.22
16	0.600	3.1	20.9	10.42	6.534	0.23
17	0.640	3.3	22.2	11.11	6.585	0.24
18	0.720	3.4	22.9	12.50	6.690	0.25
19	0.800	3.5	23.6	13.89	6.798	0.25
20	0.840	3.5	23.6	14.58	6.853	0.25

Qu = 0.25 tsf 23.89 kPa Strain 13.89%





FAILURE SKETCH

UNCONFINED COMPRESSION STRENGTH

Project: 61st Ave. Widening & Improv.
Client: The HNTB Companies
Date Tested: 12/02/01
Project No.: 016-15159

Soil Description: Clay Loam with little organic matter
Tested By: WC
Reviewed By: AJM
Boring #: TB-2 **Sample No.:** 3/ST
Depth (ft): 11 (3.4) meters
LAB NO.: 8413SL
Qp(tsf): 0.75
Wet Weight(g): 911.2

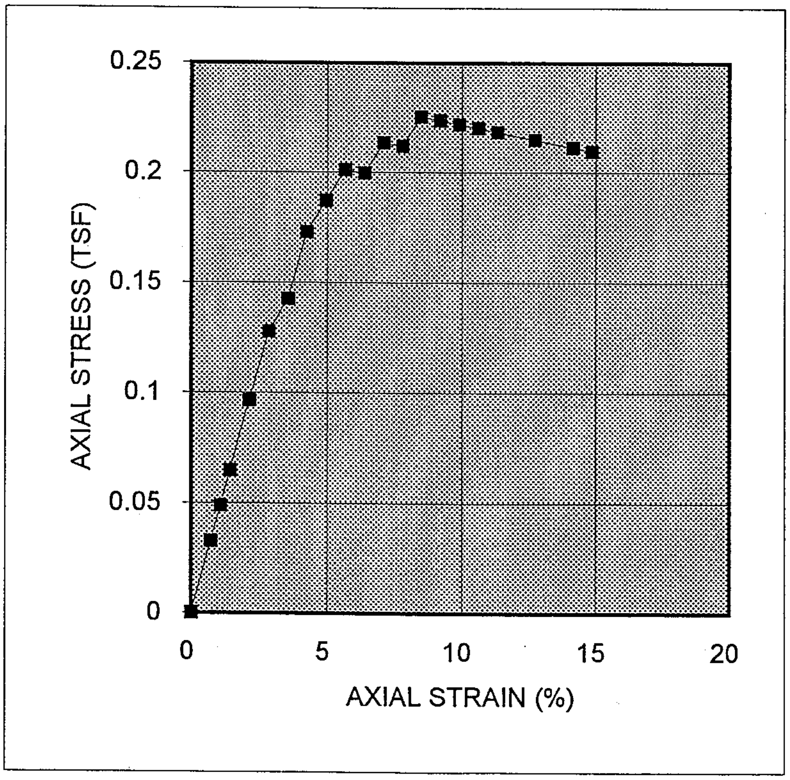
Height:	5.65	inches	143.51	mm	
Diameter:	2.85	inches	72.39	mm	
Moisture Content:	61.7%		**Saturation (%):**	91.5	
Ht.-Diameter Ratio -	1.98		**Specific Gravity:**	2.65	
Dry Density:	59.5	pcf	953.3	kg/m^3	

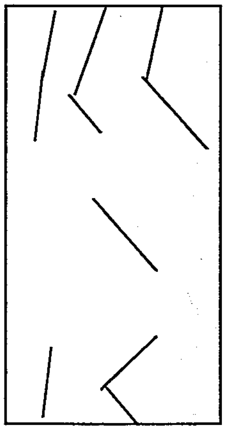
Load Cell Calibration

Pounds/mVolt 14.55

READING NUMBER	DEFOR-MATION (in.)	TRANS-DUCER READING	LOAD (lbs)	STRAIN (%)	CORRECTED AREA ^(in^2)	AXIAL STRESS (tsf)
0	0.020	0.1	0.0	0.35	6.402	0.00
1	0.040	0.2	2.9	0.71	6.425	0.03
2	0.060	0.3	4.4	1.06	6.448	0.05
3	0.080	0.4	5.8	1.42	6.471	0.06
4	0.120	0.6	8.7	2.12	6.518	0.10
5	0.160	0.8	11.6	2.83	6.565	0.13
6	0.200	0.9	13.1	3.54	6.614	0.14
7	0.240	1.1	16.0	4.25	6.662	0.17
8	0.280	1.2	17.5	4.96	6.712	0.19
9	0.320	1.3	18.9	5.66	6.762	0.20
10	0.360	1.3	18.9	6.37	6.814	0.20
11	0.400	1.4	20.4	7.08	6.865	0.21
12	0.440	1.4	20.4	7.79	6.918	0.21
13	0.480	1.5	21.8	8.50	6.972	0.23
14	0.520	1.5	21.8	9.20	7.026	0.22
15	0.560	1.5	21.8	9.91	7.081	0.22
16	0.600	1.5	21.8	10.62	7.137	0.22
17	0.640	1.5	21.8	11.33	7.194	0.22
18	0.720	1.5	21.8	12.74	7.311	0.21
19	0.800	1.5	21.8	14.16	7.432	0.21
20	0.840	1.5	21.8	14.87	7.493	0.21

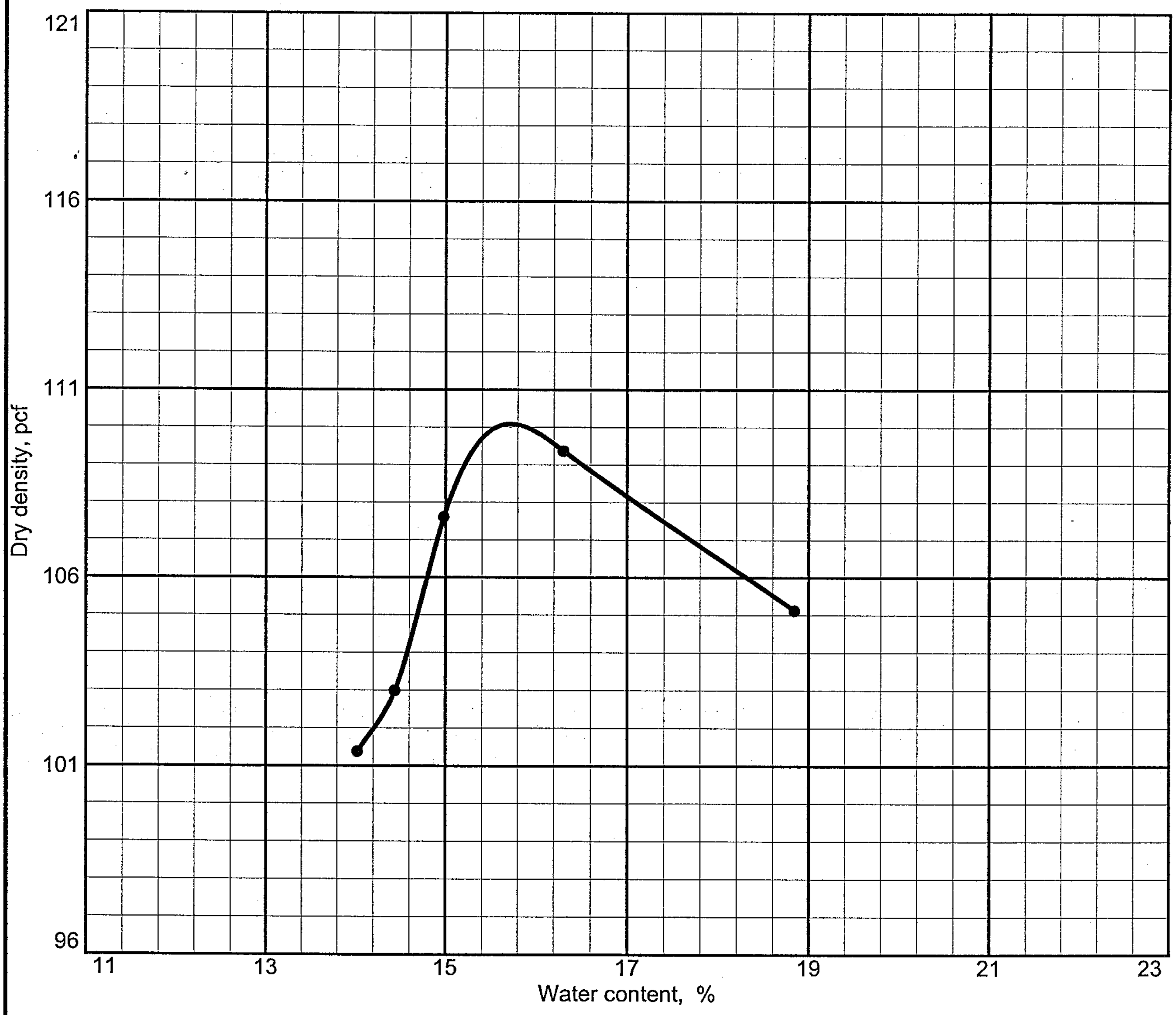
Qu = 0.23 tsf 21.58 kPa Strai 5.66%





FAILURE SKETCH

PROCTOR TEST REPORT



Test specification: AASHTO T 99 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
2'-3'	ML	A-4(7)			34	10	2.1	76.7

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 110.1 pcf Optimum moisture = 15.7 %	Silty Clay Loam

Project No. CM-9945() **Client:** The HNTB Companies

Project: 61st Avenue Widening and Improvements

● **Location:** Station 16+62, 6' Lt., Line "A"

Remarks:

PROCTOR TEST REPORT

PROFESSIONAL SERVICE INDUSTRIES, INC.

Figure Number 14

Information To Build On
Engineering • Consulting • Testing

Summary of CBR Test Results

Boring No.: RB-2
Sample Depth, ft: 1.0'-3.0'
Soil Description: Silty Clay Loam A-4 (0)
Maximum Dry Density, pcf: 110
Optimum Moisture Content, %: 15.5
Surcharge Weight for Soaking, lbs.: 25

Project No.: STP-N 606( )
Project: 61st Ave. Widening and Improvement
Location: Hobart, Indiana

		Average Water Content, %						
SPEC. NO.	BLOWS/ LAYER	AS MOLDED	AFTER SOAKING	INITIAL DRY DENSITY (pcf)	PERCENT MAXIMUM DRY DENSITY	SWELL, %	CBR, % @ 0.1" PEN.	CBR, % @ 0.2" PEN
1	64	15.4	18.5	108.8	98.9	0.96	3.6	4.0
2	64	15.1	19.7	108.0	98.2	1.11	3.3	3.8
3	44	15.9	20.6	104.6	95.1	0.92	2.6	2.7
4	44	15.6	20.9	103.4	94.0	0.92	2.4	2.5
5	20	15.9	23.6	95.0	86.4	0.94	1.2	1.0
6	20	15.7	24.6	94.3	85.7	0.96	1.0	0.8

DRY DENSITY, (pcf)	PERCENT MAXIMUM DRY DENSITY	SELECTED CBR, %
102.3	93	2.2
104.5	95	2.8
106.7	97	3.3

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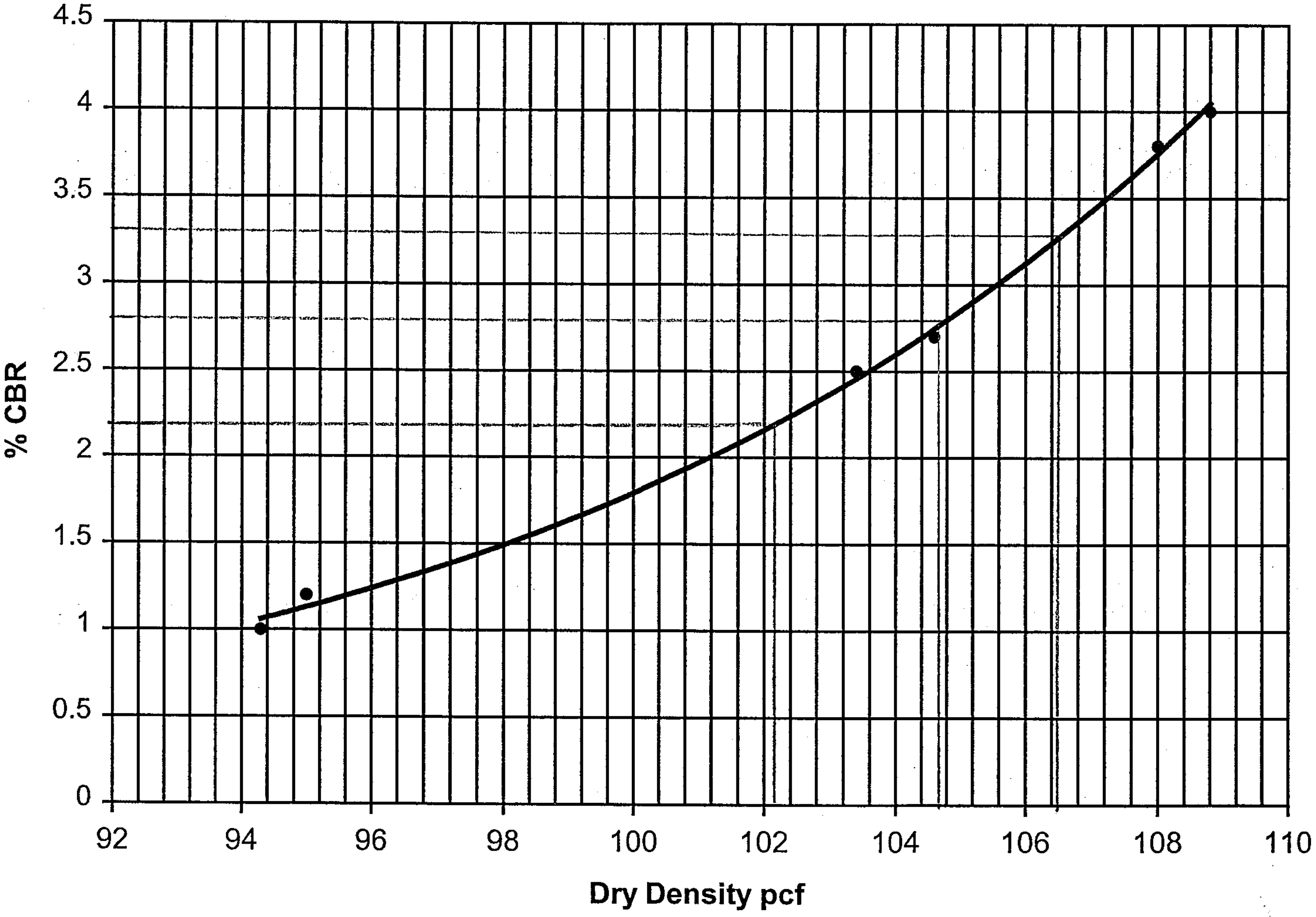
CBR Test Curve

Project No.: 016-15159 Structure No.: County: Lake County Road No.: STP-N606 ( )

Boring No.:	RB-2	Max. Wet Density,: pcf	127.1
Station:	Station 16+62	Max. Dry Density,: pcf	110.0
Offset:	6 ft Lt., Line "A"	Optimum Moisture, %:	15.5
Depth: (ft)	1.0'-3.0'	Liquid Limit:	34
Soil Classification:	Silty Clay Loam A-4 (0)	Plastic Limit:	24
Laboratory No.:	8395SL	Plasticity Index:	10

Sieve Size	Percent Passing				
No. 10	92.8	Gravel, %	7.2	CBR at 97%	3.3
No. 40	88.9	Sand, %	16.1	CBR at 95%	2.8
No. 200	76.7	Silt, %	55.4	CBR at 93%	2.2
		Clay %	21.3		

O CBR at 0.1" Penetration
Δ CBR at 0.2" Penetration



Professional Service Industries, Inc.
7225 Georgetown Road
Indianapolis, Indiana 46268

Figure Number 15

SUBJECT: Settlement Analysis

PROJECT: 61st Ave. Widening & Improv.

PROJECT NO. STP-N606( )/CM-9945( )

CALC. BY: PSL DATE: 2/22/02

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Settlement Analysis @ Station 51+50, Line "A" (Max Fill)

- Existing Ground Elev. = 609 ft.
- Boring used for analysis : TB-2 & TB-1
- Max fill = 14 feet (on the north side)
- Compressible organic soils located from 0' to 12' at TB-2, or about 10' to 22' at TB-1-SG.

<1> Consolidation Parameters for silty clay loam w/little organic matter

$$CR = \frac{C_c}{1+e_o} = 0.202 \qquad C_c = CR \times (1+e_o) = 0.454$$

$$RR = \frac{C_s}{1+e_o} = 0.031 \qquad C_s = RR \times (1+e_o) = 0.0697$$

$$OCR = \frac{P_c}{P_o} = \frac{0.74\ ksf}{0.65\ ksf} = 1.14 \qquad C_s/C_c = 0.157$$

$$\Delta P = 125 \times 14 = 1750\ psf \qquad e_o = 1.249$$

<2> Post-Const. Primary Settlement

$$S_c = RR(H)\log\left(\frac{650 \times 1.14}{650}\right) + CR(H)\log\left(\frac{650+1750}{650 \times 1.14}\right)$$

$$= 0.031(144)\log\left(\frac{740}{650}\right) + 0.202(144)\log\left(\frac{2150}{740}\right)$$

$$= 0.25'' + 13.47'' = 13.72'' \Rightarrow \text{say } 14''$$

SUBJECT: Settlement Analysis

PROJECT: 61st Ave Widening & Improv.

PROJECT NO. STP-N 606( )/CM-9945( )

CALC. BY: PSL DATE: 2/22/02

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<3> Secondary Settlement:

For organic soils, secondary settlement could be significant. Based on the consolidation data,

$C_\alpha = 0.014$, $C_v = 0.0011\ in^2/min$

Required t_{lab} for primary consolidation = 165 min in the lab test under 0.5 tsf (1 ksf)

Therefore, the required time to reach the end of primary consolidation in the field, t_{field} =

$$\frac{t_{lab}}{t_{field}} = \frac{H^2_{dr\,(lab)}}{H^2_{dr\,(field)}} = \frac{\left(\frac{0.748}{2}\right)^2}{\left(\frac{144}{2}\right)^2}$$

$$t_{field} = \frac{(72^2)}{(0.374)^2}\, t_{lab} = 37061.4\ (165\ min)$$

$$= 11.6\ \text{years}$$

$$T_{field} = \frac{C_v \cdot t_{field}}{H_{dr}^2} = \frac{0.0011 \cdot 6115131}{72^2} = 1.298$$

$U\% = 98.3\%$ (Degree of Consol. for primary consol.)

SUBJECT: Settlement Analysis

PROJECT: 61st Ave Widening & Improv.

PROJECT NO. STP-N606( )/CM-9945( )

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<4> Secondary Settlement to 30 years.

$C_\alpha = 0.014$. (secondary compression Index).

$$S_s = \frac{C_\alpha}{1+e_p} \cdot H \cdot \log\left(\frac{t_2}{t_1}\right)$$

where e_p = void ratio at the end of primary consolidation

$= e_o - \Delta e_{primary}$.

$$\Delta e_{primary} = C_s \log\left(\frac{P_c}{P_o}\right) + C_c \log\left(\frac{P_o+\Delta P}{P_c}\right)$$

$$= 0.0697 \log\left(\frac{740}{650}\right) + 0.454 \cdot \log\left(\frac{740+1750}{740}\right)$$

$$= 0.243.$$

Therefore, $e_p = 1.249 - 0.243 = 1.006$

$$S_{s\,(30\,year)} = \frac{0.014}{1+1.006} \cdot 144 \cdot \log\left(\frac{30}{11.6}\right)$$

$$= 0.4''$$

SUBJECT: Settlement Analysis

PROJECT: 61 St Ave Widening & Improv.

PROJECT NO. STP-N606( )/CM-9945( )

CALC. BY: PSL DATE: 2/22/02

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<5> Conclusions:

① primary consolidation settlement = 13.7", say 14"

② It will take about 11.6 years to reach the end of primary consolidation.

③ Secondary settlement is about 0.4" to 30 years

⑤ If say allowable primary settlement is 1",

$$U\% = \frac{13.72 - 1}{13.72} \times 100 = 92.7\ \%$$

The time required to have primary consolidation within 1"

$$T_{93\%} = 0.993.$$

$$t_{93\%} = \frac{T_{93\%}}{C_v} \cdot H_{dr}^2$$

$$= \frac{0.993}{0.0011} \cdot 72^2 = \underline{8.9\ \text{years}}$$

2/26/02

Wick Drain Design

(This analysis is based on Ployfelt TS Design and Practice Technical Manual)

Project Name: **61st Ave. Widening & Improvements**

PSI Project No.: **016-05017**

INDOT Project No.: **STP-N606( )/CM-9945( )**

Designation No.: **9300360**

Client: **HNTB Corporation**

Project Location: **Hobart, Indiana**

Soil Borings: **TB-2 & TB-1-SG**

1. **Units:**

$month \equiv 30 \cdot day$

2. **Design Parameters:**

$H\_surcharge := 14 \cdot ft$	$H_{surcharge}$: Height of surcharge
$WD\_surcharge := 125 \cdot \frac{lb}{ft^3}$	$WD_{surcharge}$: Wet density of the surcharge soil
$q := H\_surcharge \cdot WD\_surcharge$	q: Embankment Surcharge Pressure
$slope := 3.0$	slope: Design slope of surcharge embankment
$a := slope \cdot H\_surcharge$	a: Horizontal distance between the toe and top of slope
$b := 42 \cdot ft$	b: Horizontal distance between crest and centerline
$t := 12 \cdot month$	t: Estimated time to reach 90% consolidation
$D := 2.2 \cdot ft$ $\quad de := 1.05 \cdot D$	D: Design actual distance of wick drains
	d_e: Equivalent drain distance, = 1.05 * D for triangular pattern = 1.13 * D for square pattern

3. **Soil Parameters & Drain Length for Each Layer, l:** (Input)

$i := 1$ $\quad layer := 1$	i: No. of **compressible** soil layers
$h_{layer} := 12 \cdot ft$	h: Thickness of compressible soil layers
$SD_{layer} := 109 \cdot \frac{lb}{ft^3}$	SD: Unit Density of Soils (Wet)
$WD_{layer} := 62.4 \cdot \frac{lb}{ft^3}$	WD: Unit Density of Water
$l_{layer} := 6 \cdot ft$	l = (1/2)*h for drains penetrated into a lower permeable layer = h for drains only drain to the top

4. Influence Factor of Soil Layers: (Based on "Advanced Soil Mechnics" by Das, Fig. 3. 15, p. 188)

$$Z(layer) := h_{layer} - \frac{h_{layer}}{2}$$

Z: Depths to the middle of each layer

$$\alpha 2_{layer} := atan\left(\frac{b}{Z(layer)}\right)$$

$$\alpha 2_{layer} = 1.43$$

$$\alpha 1_{layer} := atan\left(\frac{a+b}{Z(layer)}\right) - \alpha 2_{layer}$$

$$\alpha 1_{layer} = 7.06 \times 10^{-2}$$

$$I_{layer} := \frac{1}{\pi} \cdot \left[\left(\frac{a+b}{a}\right) \cdot (\alpha 1_{layer} + \alpha 2_{layer}) - \frac{b}{a} \cdot \alpha 2_{layer}\right]$$

$$I_{layer} = 0.5$$

5. Overburden Pressure, Horizontal Coefficient of Consolidation, and Horizontal Soil Condictivity in Each Soil Layer:

$$OP(layer) := \left[\sum_{j=1}^{i} (SD_j - WD_j) \cdot h_j \cdot (j \le layer)\right] - (SD_{layer} - WD_{layer}) \cdot \frac{h_{layer}}{2} + (2 \cdot I_{layer}) \cdot q$$

$$OP(1) = 2.03 \times 10^{3} \frac{lb}{ft^2}$$

$$Cv_{layer} := 1.83 \cdot 10^{-5} \cdot \frac{in^2}{sec}$$ (input)

$$Kh_{layer} := 1.0 \cdot 10^{-7} \cdot \frac{cm}{sec}$$ (Input)

K_h: Horizontal soil permeability coefficient

Select C_v for each soil layer according to the overburden pressure in each soil layer and type of soil.

Assumed Horizontal Consolidation Coefficient, C_h, is about 1.2 to 1.5 times of the Vertical Consolidation Coefficient C_v, which is obtained from the consolidation tests.

Assume: $Ch_{layer} := 1.5 \cdot Cv_{layer}$

6. Equivalent Drain Diameter, d_w:

Select Drain Width $b := 4 \cdot in$

$$dw := \frac{b}{2}$$

dw = diameter for round drain or half of the drain width for the flat section

7. Transmissivity q_w: Assume <u>TYPE 2</u> Polyfelt

$$qw_{layer} := 0.01 \cdot \frac{gal}{min}$$ (Input)

The Transmissivity q_w of each soils is a function of the overburden pressure and are taken according to table VD-1 of Polyfelt TS Design & Practice manual

Diameter of the Smear Zone, d_r:

$$dr := 2 \cdot dw$$

Diameter of the smear zone is approximately 1.5 to 3 of Equivalent Drain Diameter

8. Permeability Coefficient of the disturbed soil, K_r:

Assumed $Kr_{layer} := 0.35 \cdot Kh_{layer}$ Generally, $K_h/K_r \sim 2$ to 8

9. Determination of Factor F:

$$F_{layer} := \ln\left(\frac{de}{dr}\right) - 0.75 + 0.64 \cdot \pi \cdot \left(l_{layer}\right)^2 \cdot \left(\frac{Kh_{layer}}{qw_{layer}}\right) + \left(\frac{Kh_{layer}}{Kr_{layer}}\right) \cdot \ln\left(\frac{dr}{dw}\right) \qquad F_{layer} = 3.18$$

10. Degree of Consolidation, U_h:

$$Uh_{layer} := 1 - \exp\left(\frac{-8 \cdot Ch_{layer} \cdot t}{de^2 \cdot F_{layer}}\right) \qquad Uh_{layer} = 0.94$$

11. Average of Consolidation, U_h:

$$Avg\_Uh := \frac{\displaystyle\sum_{layer=1}^{i} Uh_{layer} \cdot h_{layer}}{\displaystyle\sum_{layer=1}^{i} h_{layer}}$$

$Avg\_Uh = 93.9$ % > The minimum required 92.7 % of primary settlement (within 1" of primary settlement)

or 15" spacing for 3 month waiting time.

SUBJECT: Bearing Capacity Analysis for VCC

PROJECT: 61 St. Avenue Widening

PROJECT NO. STP-N 606( )/CM-9945( )

CALC. BY: PSL DATE: 2/28/02

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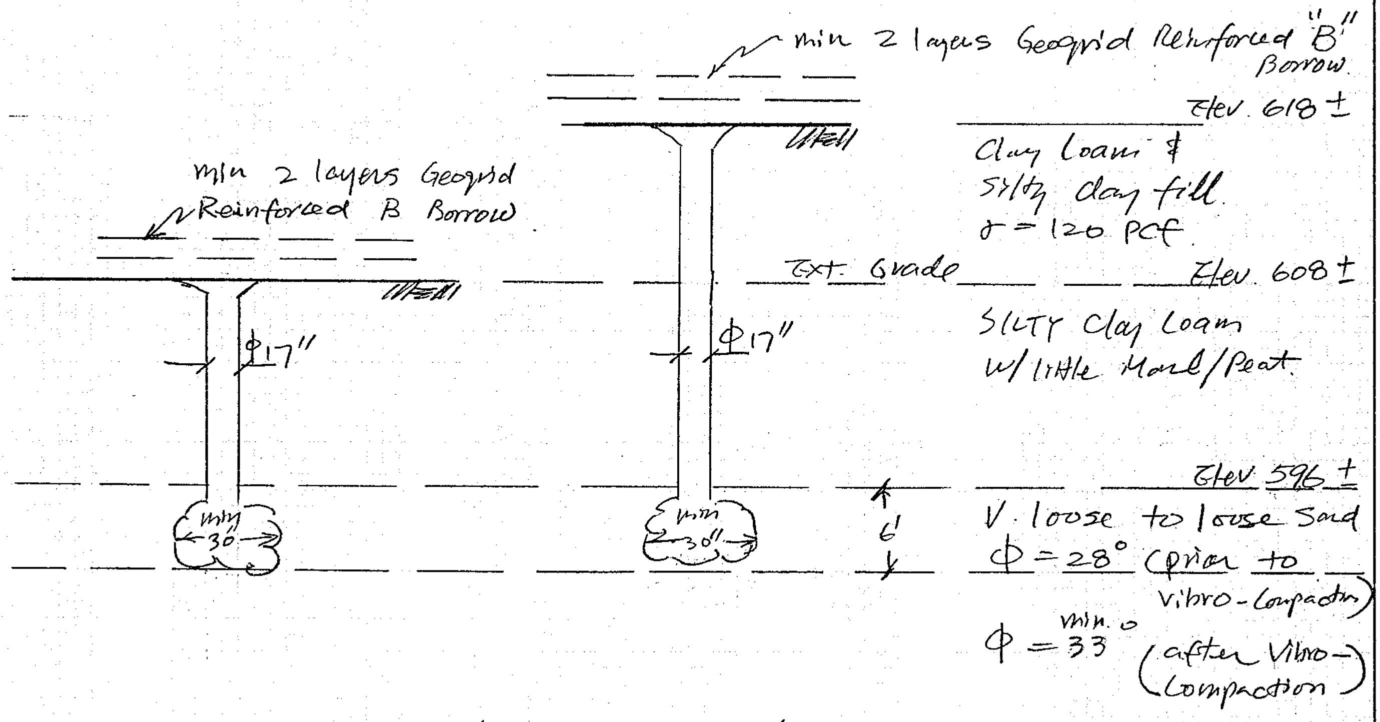
Bearing Capacity Analysis for VCC



① Recommend Using 8' (Transverse) × 6' (Longitudinal) grid.

② Vibrator will densify the underlying Sand to > 80% Dr

③ Based on empirical values for ϕ, Dr, and unit weight of granular soil; We assume $\phi = 34°$ for estimate of allowable bearing pressure.

SUBJECT: Bearing Capacity Analysis for VCC

PROJECT: 61 st. Avenue Widening

PROJECT NO. STP-N606( ) / CM-9945( )

CALC. BY: PSL DATE: 2/28/02

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④ Bearing Capacity (based on $\phi = 34°$)

<1> Terzaghi bearing capacity

$$Q_a = \frac{Q_{ult}}{SF} = \frac{A_p}{3}(L'\gamma N_q + 0.4\gamma B N_\gamma)$$

where

$$A_p = \pi\left(\frac{2.5}{2}\right)^2 = 4.91\ ft^2$$

For shorter VCC (new embankment) → $L' = 18'$ (limit to $15B = 15 \times 1.42 = 21'$)

$\gamma = 120$ pcf (after Vibro-Compaction), $\gamma' = 120-62.4 = 57.6$ pcf

$N_q = 36.5$ ($\phi = 34°$)

$N_\gamma = 36$ ($\phi = 34°$)

Therefore, Allowable VCC Capacity

$$Q_a = \frac{4.91}{3}(18 \times 57.6 \times 36.5 + 0.4 \times 57.6 \times 2.5 \times 36)$$

$$= 65\ kips/VCC$$

$q_{all} = 13,000$ psf at the column tip.

SUBJECT: Bearing Capacity Analysis & VCC Design

PROJECT: 61 St Avenue Widening

PROJECT NO. STP-N 606( )/CM-9945( )

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For 14' of fill + pavement (Assumed avg 125 pcf)

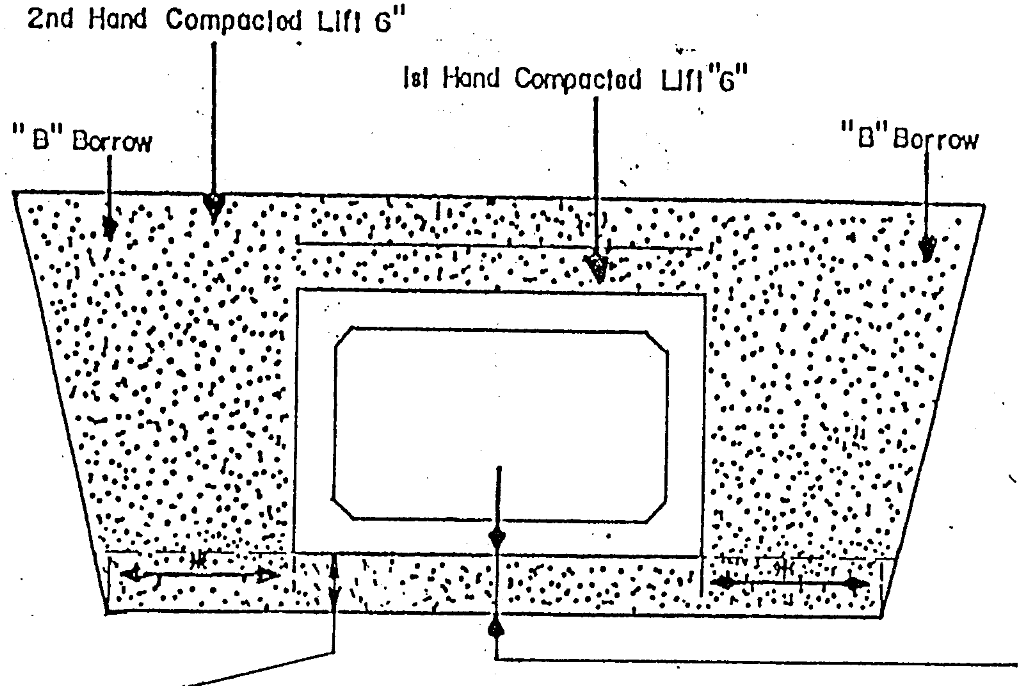
overburden pressure = 120 × 14 = 1680 psf
+ 200 psf (traffic)

Max area/VCC = 65000/1880 = 34.6 ft^2/VCC
⇒ 5.9' spacing use 6'

⇒ use 6' × 6' grid for VCC installation

DRAINAGE STRUCTURE INSTALLATION DETAILS

*The dimensions should be provided in the plans (as per AASHTO Standard Specification for Highway Bridges, sections 11,17,23, and 28)



Not To Scale

Remove all soft materials under the structure

The outer ten feet of this "B" Borrow, under the ends of the Structures, should be enveloped at the top, bottom and outside ends, with a continuous length of permeable Geotextile. This Geotextile should extend the entire width of the excavation.

Note: Riprap and Permeable Geotextile Filter Fabric should be used at the ends of the Drainage Structure to protect the exposed "B" Borrow backfill above the existing ground.

Figure 16

SPECIAL PROVISION FOR VIBRO-COMPACTED CONCRETE COLUMNS

1.0 Introduction

1.1 Vibro-compacted concrete columns are to be constructed using Vibro Compaction equipment. Vibro Compaction is a technique utilizing specially developed depth vibrators to direct compactive energy to the required improvement depth. This compactive energy results from electrically driven eccentric weight assemblies to apply a radial energy in the horizontal plane to the surrounding soil materials. Improvement is achieved by increasing the mass in-situ density, increasing the mass shear strength and reinforcing the subsurface materials with a prepared backfill. When concrete is used for the prepared backfill a compacted concrete column is produced. This item is explicitly associated with Alternate (a) for the 61st Avenue Improvements project.

1.2 The installation sequence initially inserting the probe to the required depth using a combination of water jetting, vibration and the dead weight of the equipment followed by repeated cycles of raising and lowering the probe while concrete is pumped into the hole created by the probe. The initial insertion of the probe causes particle re-arrangement and densification in the soil within 2.0 to 4.0 feet of the probe. Concrete is pumped out the bottom of the probe while it is withdrawn. Periodically the probe is re-penetrated to densify the concrete and expand it outward. The resulting concrete column is about 17.0 inches in diameter surround by a zone of highly compact soil.

2.0 Scope of Work

2.1 Specialty contractor shall provide all supervision, labor, material, equipment and related services necessary to perform all concrete column installation and soil improvement by the Vibro-concrete technique as indicated on the drawings or specified herein.

2.1.1 Alternates or exceptions to the plans or specification should only be considered when submitted in writing. All acceptances of alternates or exceptions will be provided in writing. In the absence of written response no acceptance should be assumed.

2.2 The work includes subsurface soil improvement by Vibro-Compaction and delivery and placement of all concrete as necessary to the improvement process.

2.3 Soil improvement by the Vibro-compacted concrete column method is specified for the roads, culvert, and sewer structures, and retaining wall subgrades.

2.4 The owner or owner's representative shall locate and stake all concrete column locations by providing a piling location at the centerline of the roadway. The Contractor will be responsible for locating the remainder of the piling based on the location of the piling at the centerline.

2.5 Specialty contractor shall contact IUPPS at 1-800-382-5544 three business days prior to the start of work and meet with utility representatives (particularly from NIPSCO for the existing gas main) as necessary to determine the location of utilities.

2.6 Specialty contractor shall install all concrete columns and perform compaction at the locations and to the elevations indicated on the plans.

2.7 Specialty contractor shall maintain the grades at the scheduled top of concrete column elevation. B-Borrow shall be placed over the site as needed to recover the soil volume lost due to compaction.

2.8 Specialty contractor shall cooperate and provide material to the Owner's representatives as necessary for them to complete inspection and testing requirements.

2.9 The Contractor shall hand dig all existing utilities to ensure that piling are not installed directly through existing utilities. The Contractor shall be responsible for the repair of other utilities that are damaged by the piling operations.

2.10 Top of column elevations shall be adjusted at locations where proposed utilities are to be installed and there is a conflict between the two. Top of column elevation shall be reduced so that there is a 18' to 24' separation between the outside diameter of the proposed utility and the top of the columns.

2.11 The Contractor shall ensure a firm base on which heavy equipment can be operated without platform maintenance. The Contractor will be responsible for water diversion and containment.

3.0 Owners Responsibilities

3.1 The owner shall provide access and egress into the site for the Specialty Contractors' equipment, work force, and delivery of material.

3.2 The general contractor at the owners direction shall perform additional densification with a vibratory roller at the top of column grade after the installation of columns is complete. This compaction may be necessary due to the large vibration produced by the Vibro-Compaction equipment and the absence of confinement at the surface. This compaction in no way relieves the specialty contractor of any responsibilities or requirements for compaction of the existing soft or placement of columns.

3.3 The owner shall supply a source of water at the existing fire hydrants for the contractor's use. The volumes required will vary with technique, and could range from several thousand g.p.h to in excess of 5,000 g.p.h.

4.0 Applicable Documents

4.1 All Vibro-concrete columns bid work should be based upon the following: plans, specifications and geotechnical report.

4.2 The subsurface conditions are described in PSI Geotechnical Report, dated March 18, 2002.

4.3 The following documents are referenced elsewhere in this specification.

4.3.1 ASTM D 1586 "Penetration Test and Split Barrel Sampling of Soil"

4.3.2 ASTM D 3441 "Deep, Quasi-Static, Cone & Friction-Cone Penetration Tests of Soil"

4.4.3 ASTM D 1143 "Axial Static Load Testing of Piles"

4.4 The following documents may be referenced for design and analysis:

4.4.1 Aboshi, H.; lehimoto, E; Harada, K.; and Enoki, M; "the composer, a Method to Improve Characteristics of soft clays by Inclusion of Large Diameter Sand Columns. It's design and practical applications," International Conference on Soil Reinforcement, Paris, March 20-22, 1979

4.4.2 Barksdale, R.D.; and Bachus, R.C.; "Design and Construction of Stone Column - Volume 1", Federal Highway Administration Report No; FHWAIRD-831026, February 1983

4.4.3 Bell, F.G. (editor) 1975 Method of Treatment of Unstable Ground, Chapter II, Vibro Floatation; Rational for design and Practices. London, Awnes-Butterworths, pp. 189 - 209

4.4.4 DiMaggio, J.A., "Stone Columns for Highway Construction", Report No.: FHWA-DP-46-1, Department of Transportation, Federal Highway Administration, June 1978.

4.4.5 Greenwood, D.A., "Mechanical Improvement of Soils Below Ground Surface," Proceedings of Conference on Ground Engineering, ICE, London, 1970.

4.4.6 Greenwood, D.A., and Kirsch, K., "Specialist Ground Treatment by Vibratory and Dynamic Methods,: Piling and Ground Treatment for Foundations", Thomas Telford, London, 1983.

4.4.7 Mitchell, J.K. and Huber, J.R., "Performance of a stone column foundation", ASCE Journal of Geotechnical Engineering, Vol. 111, NO. 2, February 1985.

5.0 Qualifications

5.1 The Specialty Contractor performing the Vibro-Compacted Concrete columns shall be one who can provide a minimum of five (5) years of experience record documenting five (5) recent successful projects completed with specific application to these site conditions and improvement criteria. References asserting this documentation shall be provided upon request.

6.0 Vibro-Compaction Requirements

6.1 The Specialty Contractor shall use a down hole vibratory capable of providing at least 80 hp and 15 tons of force. The minimum diameter of the probe tip excluding guides shall be 16.0 inches.

6.2 After penetration to the specified column tip elevation the vibrator should slowly retrieved in 12 to 18 inch increments to allow concrete placement.

6.3 The vibrator should be re-driven through each increment into the recently placed concrete. Amperage buildup shall be noted.

6.4 Amperage buildup and concrete quantities shall be established based on the type of vibratory, concrete slump, soil conditions required to meet the requirements in this section. The established amperage buildup shall be maintained throughout the project.

6.5 The concrete shall have a twenty-eight day strength of 3,000 psf. The concrete shall be placed at a slump of 1.0 inches or less.

6.6 The concrete should be tested at the rate of one test per half day of production. Each test should consist of one set of three test cylinders 6.0 inches in diameter. One cylinder should be tested at seven days and two cylinders should be tested at twenty-eight days. The cost of the testing to be by the owner.

6.7 One column shall be load tested in accordance with ASTM D 1883. The column shall be loaded using the "Quick Load' procedure. The column shaft be loaded to a capacity of 40 tons (80 kips). The column shall be considered acceptable of the settlement at a load of 20 tons (40 kips) is less than 0.5 inches and is less than 2.0 inches at a load of 40 tons (80 kips). A production column may be used for the column load test. The project/ geotechnical engineer shall specify the test column location.

7.0 <u>Tolerances and Acceptance Criteria</u>

7.1 Columns shall be located with an accuracy of 3.0 inches of the scheduled location. Piles shall be constructed within 1.5 degrees of vertical.

7.2 The concrete column shall be a continuous column of concrete between the top and tip elevations without voids or soil inclusions. The minimum diameter of each column shall be 17.0 inches. The concrete volume shall exceed 115 percent of the theoretical volume of an 18.0 inch diameter column of the specified length.

7.3 The zone of soil within 2.0 feet of the face of the concrete column shall be compacted to the following criteria:

'N" Value	10 blows/foot or greater
CPT Resistance	50 t.s.f. or greater
Relative Density	55 percent or greater

7.3.1 Should the minimum "N" values, CPT Resistance or Relative Density not be met, the Vibro contractor will place additional probes to attain the soil improvement criteria at no <u>additional cost to the owner.</u>

8.0 Restrictions

8.1 The Specialty Contractor shall obtain all state and municipal permits and conform to all state and local regulations.

8.2 Presently no known restrictions exist on handling of the soil at this site. However, Protection Level D should be assumed due to the known industrial nature of the existing **fill.**

8.3 Utility restrictions should be determined by contacting IUPPS and individual utilities as required.

8.4 The Contractor shall provide a detailed copy of it's equipment performance specifications for review **prior to award of Contract.**

9.0 Quality Assurance / Testing and Inspection

9.1 All testing to determine specification compliance will be provided by an independent testing agency and will consist of standard penetration testing per ASTM D 1586, static cone penetration testing per ASTM D 3441 and pile load tests per ASTM D 1883.

9.2 Five to ten locations will be established by the geotechnical engineer within the treatment area. CPT and SPT test locations should be located to provide an average of the subsurface improvement.

9.3 The geotechnical engineer will provide site inspection to insure performance of the Vibro-Compacted Concrete Column Installation. The inspection may include any specialty Contractor's procedures, recording of concrete quantities and recording of ammeter information.

10.0 Documentation

10.1 A daily log shall be submitted to the owner by the Specialty Contractor to include: recording of probe number, start/finished time of probe, depth of treatment, approximate concrete quantities and indication of relative ammeter increases.

10.2 Any change in the predetermined vibro program necessitated by a change in the subsurface conditions will be immediately reported and submitted to the engineers.

11.0 Measurement & Payment

11.1 Specialty contractor shall provide a lump sum price which shall include all costs for mobilization, demobilization, concrete column layout, concrete column installation and materials, fill incidental to maintaining grade and one concrete column load test.

11.2 Unit price for additional concrete columns of specified length.

11.3 Unit price for increasing length of scheduled concrete columns.

11.4 Unit price for decreasing length of scheduled concrete columns.

11.5 Unit price for deletion of scheduled concrete columns.

11.6 Unit price for additional load tests.

11.7 Unit price for piling reinforcement.

11.8 Concrete columns damaged due to negligence of specialty contractor shall be replaced at no cost to owner.

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December 4, 2003

Mr. Chad A. Modesitt, P.E.
Project Manager
The HNTB Companies
111 Monument Circle
Indianapolis, IN 46204-5178

Re: MSE Wall Recommendations
INDOT Project No.: STP-N606( )
Des. No.: 0088390
61st Avenue Widening and Improvements
Hobart, Lake County, Indiana
PSI Project No. 016-15159

Dear Mr. Modesitt:

We have completed the analysis and recommendations for 61st Avenue widening and improvements project. The purpose of the study was to evaluate the external stability and develop recommendations to aid in design of the proposed MSE walls over the VCC reinforced soils. This report presents our MSE wall analysis and construction considerations.

Based on the preliminary Road Plans prepared by HNTB, the proposed profile indicates significant embankment fills, up to about 14 feet (4.3 m) in thickness, will be required for the roadway widening at the existing culvert structure. To reduce the excessive settlement due to the presence of underlying organic soils, to uniformly support the proposed precast 4-sided reinforced concrete box culvert and sewers, and to limit the risk of overstressing the existing gas pressure main, HNTB has elected Vibro Concrete Column (VCC) from a list of alternatives provided by PSI in the geotechnical report, dated March 27, 2002, for soil remediation.

We understand VCC installed at a 6 feet by 6 feet grid will be required. The VCC grid should be adjusted or additional VCC elements added to provide concentric support along the box culvert, storm sewer alignments, and MSE walls. Also, to uniformly support the proposed embankment fill, precast 4-sided reinforced concrete box culvert, and sewer over VCC, we recommend two layers of biaxial geogrid reinforced crushed aggregate (one foot for each layer) be placed over the installed VCC underneath the precast box culvert and sewer, and three layers of geogrid reinforced crushed aggregate underneath the proposed MSE walls and embankment fills. For further construction considerations for VCC, please refer to PSI geotechnical report, dated March 27, 2002.

Due to the limited space for the roadway widening and embankment slope construction near the proposed culvert structure, south and north MSE walls are planned between Station 50+01 and 51+65, and between Station 50+55 and 52+40, Line "A", respectively.

We have selected a most critical cross section at Station 51+50, Line "A", for the MSE wall analysis. MSE wall design involves the use of controlled soil backfill and thin metallic strips, mesh, or geosynthetic reinforcement mesh (geogrids) to form a gravity mass capable of supporting or restraining large imposed loads. We recommend that the MSE walls be designed by a contractor/manufacturer based on their knowledge and experience in the practice of MSE walls construction of this type.

The MSE walls must be designed for internal and external stability. The design of MSE walls for internal stability is typically the contractor/manufacturer's responsibility. For external stability, a vertical MSE wall must satisfy the same external design criteria as a conventional retaining wall. That is, it must resist forces that can cause sliding as a rigid body at or below the base, overturning, bearing capacity failure, and rotation slip-surface failure (i.e., an unsafe failure surface around the entire embankment). PSI has evaluated sliding, overturning, bearing capacity and rotational failure for the MSE walls supported on VCC. The contractor/manufacturer should be required to submit shop drawings and detailed calculations for final review by INDOT, HNTB, and PSI.

The vertical MSE walls must be designed to resist lateral earth pressures and surcharge pressures transferred from the roadway. The design of this type of system requires that the skin friction between reinforcements should resist the soil pressure from the backfill layer, that the reinforcement length be great enough to support the skin friction and provide a stable mass, and that the reinforcement be strong enough to resist the tension applied. For overall stability, a minimum top width of 0.7 times the overall height of MSE walls is recommended. The length of reinforcements must be extended beyond the zone of Rankine failure. We recommend granular "B" Borrow be used behind the vertical MSE walls and must be compacted to at least 95 percent of the maximum dry density as determined by AASHTO T-99.

The following values are recommended for the design parameters for the MSE retaining walls:

(1). Granular "B" Borrow in MSE fill

$\gamma_s = 125$ pcf
$\phi = 34°$

(2). Retained Compacted Granular Engineered Fill ("B" Borrow)

$\phi = 32°$
$K_a = 0.31$
$K_p = 3.26$
$\gamma_s = 125$ pcf

(3). Foundation Soils

1. Natural Soft to Very Soft Silty Clay Loam
   K_p = 1.0
   c = 200 psf
   γ_s = 100 pcf
   ϕ = 0°
2. Vibro Concrete Column (VCC)
   K_p = 1.0
   c = 5,000 psf (assumed hard soils throughout)
   γ_s = 150 pcf
   ϕ = 0°

Allowable bearing pressure = 3,500 psf on the biaxial geogrid reinforced crushed aggregate be placed over the VCC.

The stability analysis was performed by using STABL for WINDOWS two-dimensional, limit equilibrium slope stability program, originally developed at Purdue University. The factor of safety was determined using the modified Bishop method for circular shaped failure surfaces. The minimum factor of safety for overall stability, under the short term (undrained) condition, must meet or exceed the recommendation of 1.5 for external slope stability, static loading recommended for MSE walls in Reinforced Soil Structures, Volume I, Design and Construction Guidelines, Publication No. FHWA-RD-89-043, dated November 1990. The calculated factor of safety for overall stability was 2.0 for the MSE wall. The analyses are reported and summarized in the Appendix.

A minimum factor of safety of 1.5 is recommended for a MSE wall against sliding. The factor of safety against sliding with a 250 psf surcharge was calculated as 2.1 for the MSE wall.

A minimum factor of safety of 2.0 is recommended for a MSE wall against overturning. The factor of safety against overturning with a 250 psf surcharge was calculated as 2.7 for the MSE wall.

A minimum factor of safety of 2.5 is recommended for a MSE wall against bearing failure. Bearing capacity failure governs the VCC spacing design. The VCC spacing of 6 feet was selected to provide a factor of safety of 2.6 against bearing failure with a 250 psf surcharge. However, due to the stress concentration near the face of MSE walls, we recommend a maximum spacing of 5 feet be used between the first and second VCC from the face of MSE walls.

A summary of calculated factors of safety against sliding, bearing failure, overturning, and overall stability (or rotation slip-surface) failure is presented below.

Failure Mode ①②	**Sliding**	**Overturning**	**Bearing**	**Overall Stability**
Minimum Required Factor of Safety	1.5	2.0	2.5	1.5
MSE Wall Station 51+50, Line "A" (TB-2)	2.1	2.7	2.6	1.9

① Analysis for the proposed MSE walls, with 250 psf surcharge.

② Assumed length of horizontal reinforcements extended about 0.7 time the height of the proposed MSE walls.

We appreciate the opportunity to provide geotechnical engineering services for this project. If there are any questions regarding the information contained in this report, please contact us at (317) 216-7131.

Respectfully,

PROFESSIONAL SERVICE INDUSTRIES, INC.

Peter Lee

Peter S. Lee, Ph.D., P.E.
Senior Engineer

Elizabeth Dwyre

Elizabeth M. Dwyre, P.E.
Regional Engineer

PETER S. LEE
REGISTERED
No. 19700241
STATE OF INDIANA
PROFESSIONAL ENGINEER

Attachment: MSE wall analysis

SUBJECT: MSE Wall Analysis

PROJECT: 61st Ave Reconstruction

PROJECT NO. STP - N 606 ( ), Des.

CALC. BY: PSL DATE: 11/19/03

CHECKED. BY: FMP DATE: 11/30/03

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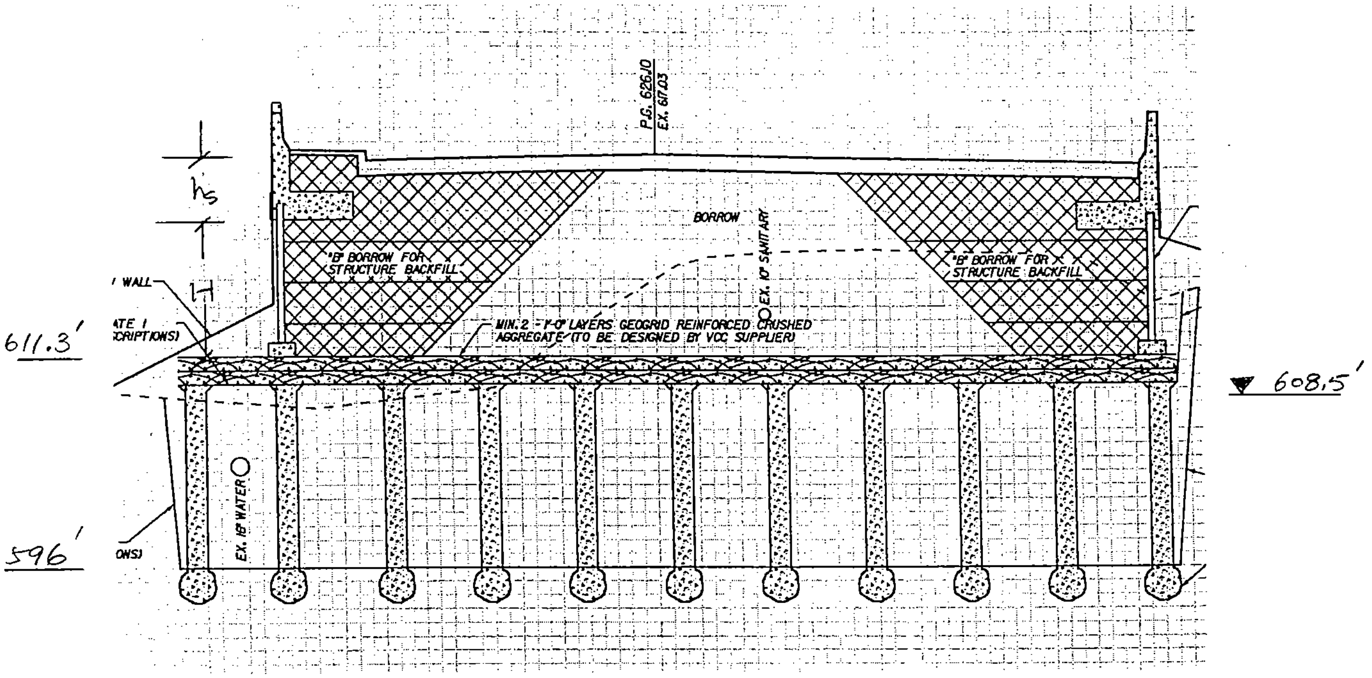
MSE WALL ANALYSIS @ Station 51+50, Line "A"

— Height of MSE Wall (from top of geogrid to bottom of Coping):



— Existing Ground Surface Elev. = 608.7'

— Top of Geogrid = 611.3'

— Bottom of Coping: 621.3'

— Top of pavement: 626.0'

— Thickness of geogrid = 2'

— Height of Coping, $h_s = (626' - 621.3') + \underline{\underline{2'}} = 6.7'$ (w/Traffic load of 250 psf)

— Height of MSE Wall = 621.3' − 611.3' = 10'

A-300-9 (Indy)

Subject: *MSE Wall External Stabilty Analysis*

Project: *61st Avenue Widening, Culvert @ Station 50+95, Line "A"*

Project No.: *STP-N 606( )* **Designation No.:** *0088390*

Calculated by: *PSL* **Date:** *11/17/03*

Checked by: *Emd* **Date:** *11/20/03* **Page** *2* **of** 6

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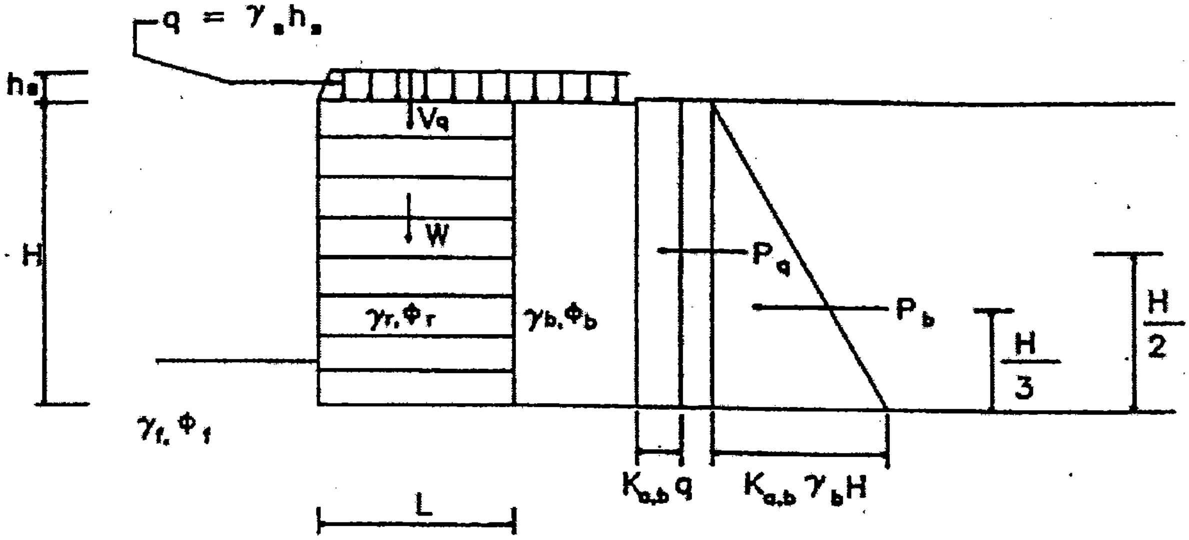
Units

$\text{kip} := 1000 \cdot \text{lb}$ $\text{plf} := \frac{\text{lb}}{\text{ft}}$ $\text{psf} := \frac{\text{lb}}{\text{ft}^2}$ $\text{pcf} := \frac{\text{lb}}{\text{ft}^3}$ $\text{ksi} := \frac{\text{kip}}{\text{in}^2}$

$\text{klf} := \frac{\text{kip}}{\text{ft}}$ $\text{ksf} := \frac{\text{kip}}{\text{ft}^2}$ $\text{kcf} := \frac{\text{kip}}{\text{ft}^3}$

Typical Cross Section of MSE Wall (Top of Levelling Pad Elev. = 610.3")



(I). Soil and MSE Wall Properties at TB-1-SG & TB-2

$B := 240 \cdot \text{ft}$ B: Length of MSE Wall

$\gamma s := 125 \cdot \text{pcf}$ γ_s: Unit Weight of Surcharge Soil $hs := 6.7 \cdot \text{ft}$ h_s: Weight of Surcharge (soil+Traffic)

$\gamma r := 125 \cdot \text{pcf}$ γ_r: Unit Weight of Reinforced Soil $\phi r := 34 \cdot \text{deg}$ ϕ_r: Friction Angle of Reinforced Soil

$\gamma f := 125 \cdot \text{pcf}$ γ_f: Unit Weight of Foundation Soil $\phi f := 34 \cdot \text{deg}$ ϕ_f: Friction Angle of Foundation Soil

$cf := 0 \cdot \text{psf}$ c_f: Cohesion of Foundation Soil $Df := 3.5 \cdot \text{ft}$ D_f: Depth of MSE Wall Leveling Pad

$Kp := \frac{1 + \sin(\phi f)}{1 - \sin(\phi f)}$ K_p: Coefficient of Passive Earth Pressure $Kp = 3.537$

$\gamma b := 125 \cdot \text{pcf}$ γ_b: Unit Weight of Backfill $\phi b := 32 \cdot \text{deg}$ ϕ_b: Friction Angle of Backfill

$H := 11.0 \cdot \text{ft}$ H: Height of MSE Wall $L := 0.7 \cdot H$ L: Width of MSE Wall

$\mu := \tan(\phi b)$ μ = (Select) Minimum of $\tan\phi_r$, $\tan\phi_f$, or $\tan\phi_b$ $\mu = 0.625$

Subject: ***MSE Wall External Stabilty Analysis***

Project: ***61st Avenue Widening, Culvert @ Station 50+95, Line "A"***

Project No.: *STP-N 606( )* *Designation No.:* *0088390*

Calculated by: *PSL* *Date:* *11/17/03*

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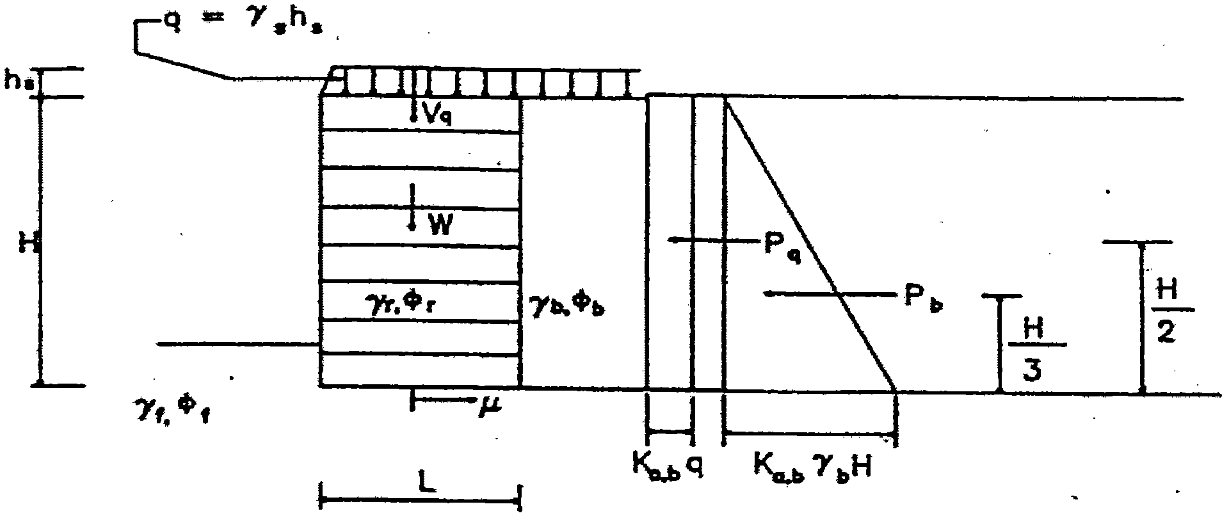
(II). Factor of Safety against Sliding



$Vq := \gamma s \cdot hs \cdot L$

$W := \gamma r \cdot H \cdot L$

$Kab := \tan\left(\frac{\pi}{4} - \frac{\phi b}{2}\right)^2$

$Pb := 0.5 \cdot Kab \cdot \gamma b \cdot H^2$

$Pq := Kab \cdot \gamma s \cdot hs \cdot H$

$$FS\_sliding := \frac{(Vq + W) \cdot \mu}{Pb + Pq}$$

$FS\_sliding = 2.1$ >1.5, O.K.

Subject: *MSE Wall External Stabilty Analysis*

Project: *61st Avenue Widening, Culvert @ Station 50+95, Line "A"*

Project No.: *STP-N 606( )* **Designation No.:** *0088390*

Calculated by: *PSL* **Date:** *11/17/03*

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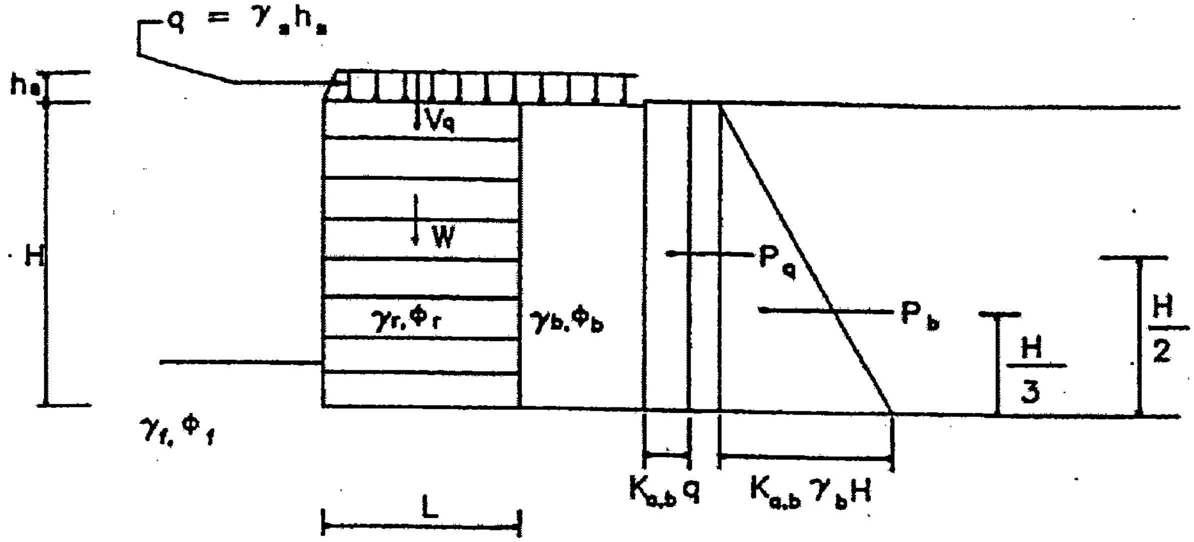
(III). Factor of Safety against Overturning



$$Vq := \gamma s \cdot hs \cdot L$$

$$W := \gamma r \cdot H \cdot L$$

$$Kab := \tan\left(\frac{\pi}{4} - \frac{\phi b}{2}\right)^2$$

$$Pb := 0.5 \cdot Kab \cdot \gamma b \cdot H^2$$

$$Pq := Kab \cdot \gamma s \cdot hs \cdot H$$

$$FS\_overturning := \frac{(Vq + W)\cdot\left(\frac{L}{2}\right)}{Pb\cdot\left(\frac{H}{3}\right) + Pq\cdot\left(\frac{H}{2}\right)}$$

FS_overturning = 2.7 >=2.0, O.K.

Subject: MSE Wall External Stabilty Analysis

Project: 61st Avenue Widening, Culvert @ Station 50+95, Line "A"

Project No.: STP-N 606( ) **Designation No.:** 0088390

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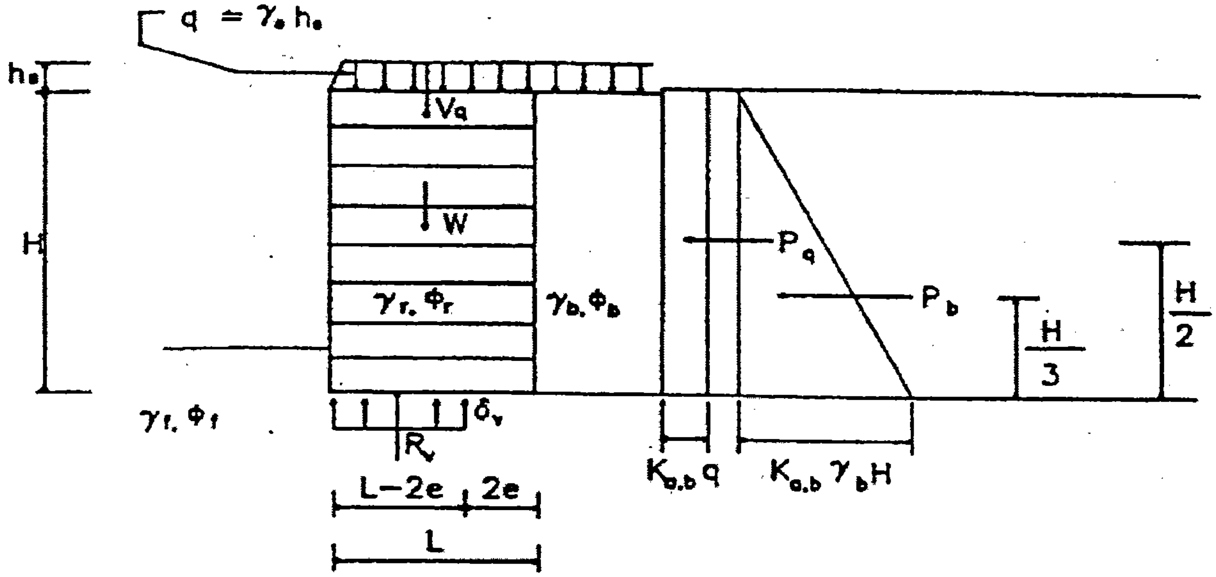
Checked by: Emd **Date:** 11/20/03

(IV). Factor of Safety against Bearing Failure



(1). The Eccentricity, e, of the resultant loads:

$$e := \frac{Pb\cdot\left(\frac{H}{3}\right) + Pq\cdot\left(\frac{H}{2}\right)}{W + Vq} \qquad e = 1.4\,\text{ft} \quad <= \quad emax := \frac{L}{6} \qquad emax = 1.3\,\text{ft} \qquad \text{O.K.}$$

(2). The magnitude of the Vertical Stress, σ_{vmax}: $\sigma vmax := \frac{(Vq + W)}{L - 2\cdot e}$ $\sigma vmax = 3497\,\text{psf}$

(3) soils below the base of Vibro Concrete Column (VCC) are indicated to be loose to very loose Sand, w/N = 3~7 bpf, $\phi = 28°$

(4) Base Diameter of VCC = 2.5′ = 30″ (provided by Contractor)

(5) Unit Wt. of overlying silty clay loam with organics

γ_s = 109 pcf
γ_d = 72 pcf } based on Cosolidation data

(6) Allowable bearing capacity at base of VCC

$$Q_{p_{ult}} = A_p\, q_p = A_p \cdot q'\, N_q^* = 4.9 \times (125\times2 + 109 \times 2.8 + (109 - 62.4) \times 12.5) \times 40 = 4.9 \times 1138 \times 40 = 223 \text{ kips.}$$

$$Q_{p_{all}} = 223/2.5 = 89 \text{ Kips}$$

SUBJECT: MSE Wall Analysis

PROJECT: 61st Ave Reconstruction

PROJECT NO. STP - N 606 ( )

CALC. BY: PSL DATE: 11/19/03

CHECKED. BY: BMD DATE: 11/30/03

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(7) For VCC pattern of 6'×6'

Max Load on each VCC

$= (h_s + 11 + \text{geogrid reinforced mat}) \times 125 \times 6 \times 6$

$= (6.7 + 10 + 2) \times 125 \times 6 \times 6 = 84 \text{ kips} < Q_{pall} = 89 \text{ kips}$

General VCC pattern of 6'×6' is considered appropriate except in the area near MSE face where maximum stress is concentrated.

(8) Max spacing under MSE wall.

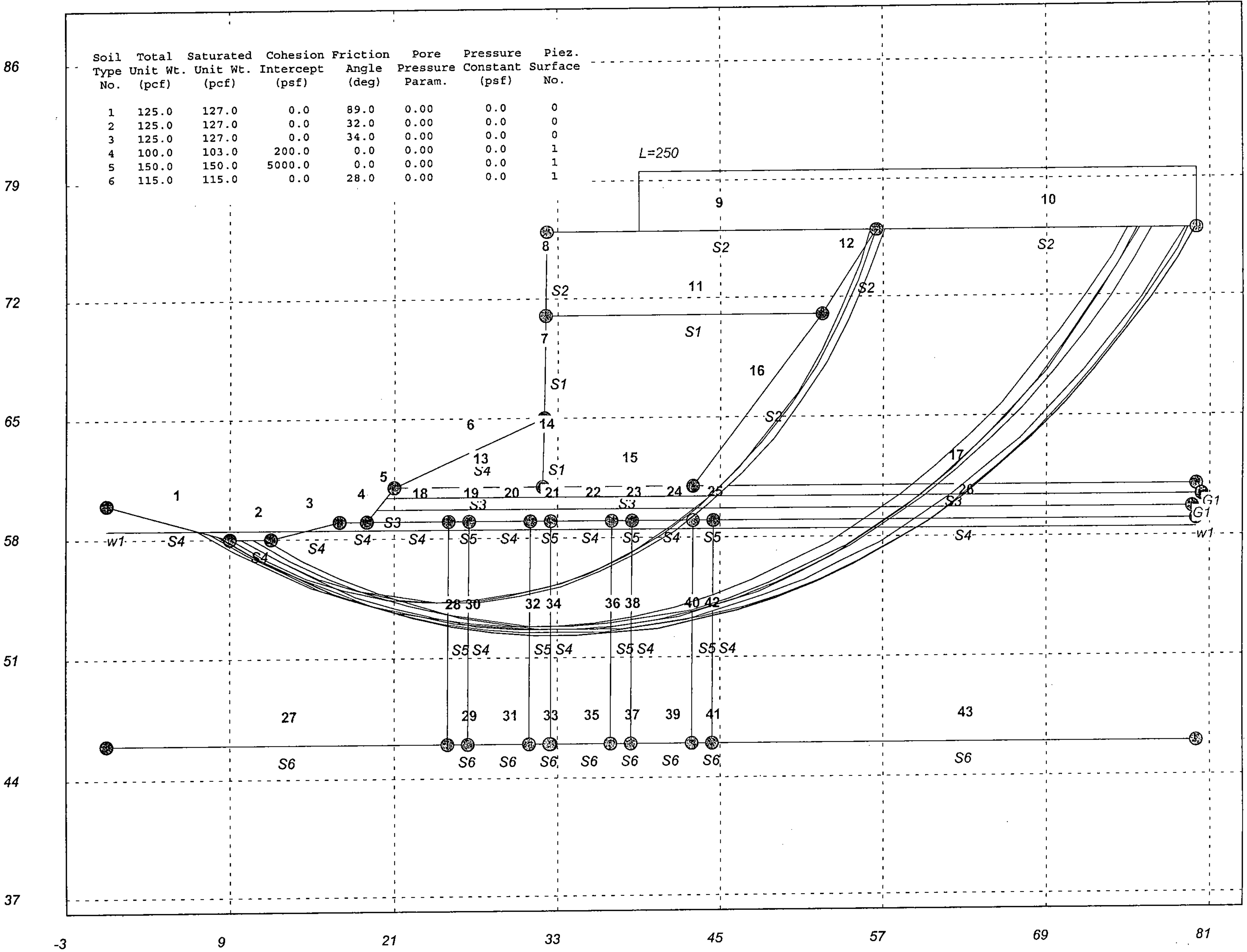
$$S_{max} = \sqrt{\frac{Q_{p\,all}}{\sigma_{v\,max}}} = \sqrt{\frac{89}{3.5}} = 5.0'$$

Therefore, the spacing between the first and second VCC from the face of MSE wall should be 5' max.

(V) Global Stability Failure

See the attached slope stability analysis using the composite soil parameters after VCC improvements

61st Avenue Widening - STP-N606( ) - FS Min = 1.888



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	125.0	127.0	0.0	89.0	0.00	0.0	0
2	125.0	127.0	0.0	32.0	0.00	0.0	0
3	125.0	127.0	0.0	34.0	0.00	0.0	0
4	100.0	103.0	200.0	0.0	0.00	0.0	1
5	150.0	150.0	5000.0	0.0	0.00	0.0	1
6	115.0	115.0	0.0	28.0	0.00	0.0	1

K&S ENGINEERS, INC.
9715 KENNEDY AVENUE • HIGHLAND, INDIANA 46322
(219) 924-5231 • (773) 734-5900 • FAX (219) 924-5271
www.kandsengineers.com • ksengineers@sbcglobal.net

July 25, 2006

HNTB Corporation
111 Monument Circle
Suite 1200
Indianapolis, IN 46204-5178

Attn: David W. McDougall, P.E.,
Structures Department Manager

RE: Designation No.0088390
Project No. STP-N606()
Subsurface Conditions for MSE Wall Design
61st Avenue Widening and Improvements
Hobart, Lake County, Indiana
K & S Project No. 7998

Dear Mr. McDougall:

We are herewith submitting for your review and approval a draft copy of a report for the Subsurface Conditions for MSE Wall Design, 61st Avenue Widening and Improvements, Hobart, Lake County, Indiana. This report presents the field and laboratory data obtained, together with our conclusions and recommendations concerning the influence of the subsurface conditions on the proposed design and construction.

We are looking forward to receiving your comments. If you have any questions or need additional information, please do not hesitate to call us at (219) 924-5231.

Very truly yours,
K & S Engineers, Inc.

Dibakar Sundi, P.E..
Senior Engineer

Padmakar Srivastava, Ph.D., P.E.
Project Engineer

DATE RECEIVED
HNTB INDIANAPOLIS
JOB NO. ________
FILE ________
JUL 31 2006
ROUTE-TO:

Attachment: One draft copy of the geotechnical report

DS:PS/dp

• Geotechnical and Environmental Consultants •

REPORT

SUBSURFACE CONDITIONS FOR MSE WALL DESIGN
PROJECT NO. STP-N606()
DESIGNATION NO. 0088390
61st AVENUE WIDENING AND IMPROVEMENTS
HOBART, LAKE COUNTY, INDIANA
K & S PROJECT NO. 7998

HNTB Corporation
111 Monument Circle
Suite 1200
Indianapolis, IN 46204-5178

Attn: David W. McDougall, P.E.
Structures Department Manager

K&S

Subsurface Conditions for MSE Wall Design
Project No. STP-N606( ); Des. No. 0088390
61st Avenue Widening and Improvements
Hobart, Lake County, Indiana
K & S Project No. 7998

EXECUTIVE SUMMARY

A summary of the conclusions and recommendations of this report is given below.

Project Description: City of Hobart, Lake County, Indiana is planning widening and improvements of 61st Avenue from approximately 200 feet east of Marcella Boulevard to approximately 750 east of Colorado Street. The eastern portion of the project, where the roadway would be supported on a MSE wall, is identified as Project No. STP-N606( ) with Designation No. 0088390.

It is reported that compressible organic materials are present underlying the 61st Avenue from approximately Station 50+00 to 52+50, a distance of approximately 250 feet. It was proposed to improve the ground by using Vibro Concrete Columns. Later, based on the unsatisfactory performance of the Vibro Concrete Column system on some projects, it was decided not to use such system on the present project.

It is proposed to install sheeting along the limits of the proposed roadway, excavate the unsuitable material between the sheet piles down to suitable foundation material and construct MSE walls within the excavation up to the proposed roadway profile.

The purpose of the present geotechnical exploration was to establish a subsurface profile and delineate the organic materials along 61st Avenue between the proposed limits.

Subsurface Conditions: Underlying approximately 0.8-foot to 3.5-foot-thick layer of asphalt and crushed stone at the surface, the borings encountered silty clay loam and silty clay extending to depths ranging from 9 feet in Boring RB-4 to 18.5 feet in Borings RB-1 and RB-6 through RB-8.

Very soft to soft organic materials and peat were observed in Borings RB-4 (extending from a depth of 9 feet to 16 feet) and RB-5 (extending from a depth of 13.5 feet to 23.5 feet).

Organic materials were not observed in Borings RB-1 through RB-3 and RB-6 through RB-8.

Underlying the organic materials in Borings RB-4 and RB-5 and below silty clay loam/silty clay in the remainder borings, stratum of loose to medium dense sand was observed.

The borings were terminated in the stratum of loose to medium dense sand at depths ranging from 20 feet to 30 feet.

Groundwater levels were observed at depths ranging from 6 feet to 16 feet after 24 hours of completion of the boreholes.

Do not consider this summary separate from the entire text of this report, with all the conclusions and qualifications mentioned herein. Details of our analysis and recommendations are discussed in the following sections and in the Appendix of this report.

Subsurface Conditions for MSE Wall Design
Project No. STP-N606( ); Des. No. 0088390
61st Avenue Widening and Improvements
Hobart, Lake County, Indiana
K & S Project No. 7998

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Subsurface Conditions for MSE Wall Design
Project No. STP-N606( ); Des. No. 0088390
61st Avenue Widening and Improvements
Hobart, Lake County, Indiana
K & S Project No. 7998

1. INTRODUCTION

1.1 Project Identification and Description

We understand that the City of Hobart, Lake County, Indiana is planning widening and improvements of 61st Avenue from approximately 200 feet east of Marcella Boulevard to approximately 750 east of Colorado Street. The eastern portion of the project, where the roadway would be supported on a MSE wall, is identified as Project No. STP-N606( ) with Designation No. 0088390.

A geotechnical exploration was performed and report was submitted by PSI of Indianapolis, Indiana on March 27, 2002. It was observed that compressible organic materials are present underlying the 61st Avenue from approximately Station 50+00 to 52+50, a distance of approximately 250 feet. The depth of the organic materials is as much as 22 feet. It was proposed to improve the ground by using Vibro Concrete Columns. Later, based on the unsatisfactory performance of the Vibro Concrete Column system on some projects, it was decided not to use such system on the present project.

It is proposed to install sheeting along the limits of the proposed roadway, excavate the unsuitable material between the sheet piles down to suitable foundation material and construct MSE walls within the excavation up to the proposed roadway profile. Therefore, a better understanding of the limits of the unsuitable material is required.

The purpose of the present geotechnical exploration was to establish a subsurface profile and delineate the organic materials along 61st Avenue between proposed limits.

1.2 Scope of Service and Procedures

The general purpose of the geotechnical exploration was to develop recommendations with regard to the soil and groundwater conditions to aid in the design of the MSE wall. The scope of our services for this project was as follows:

1. A review of available geologic information for the project area.

2. A section beginning from Station 48+75 to 53+50 along 61st Avenue was considered.

3. Perform a total of 8 borings, ranging in depth from 20 feet to 30 feet. The Roadway Borings are referred to with a Prefix 'RB.' Obtain soil samples according to INDOT specifications.

4. Observe groundwater level during and 24 hr after drilling.

5. Perform appropriate laboratory tests and visual classification according to current INDOT specifications.

6. Prepare a report which provides our recommendations with regard to cut and fill requirements and pavement design as well as potential groundwater problems.

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air on or below, or around this site. Any statement in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for the informational purposes.

2. GENERAL SITE CONDITIONS

2.1 General Geology

Soils within the project area are characterized as unconsolidated glacial deposits overlying sedimentary bedrock sequences. The unconsolidated sediments were deposited during the Late Wisconsian Age as lake-bottom and near shore deposits of glacial Lake Chicago. As fluctuations in lake levels occurred, cycles of sand, gravel and lake bottom deposits of silt and clay occurred as the lake shore line receded northward. The northward movement of the shore line resulted in the deposition interstratified lake and terrestrial (surface erosion deposition of sand dune) deposits which are indistinguishable from one another.

Within the project area the unconsolidated deposits are classified as belonging to the dune or lacustrine facies of the Atherton Formation of northwestern Indiana and form the Calumet Lacustrine Plain. The Calumet Lacustrine Plain forms the principal shallow groundwater aquifer or the Calumet Aquifer. The Calumet Aquifer is a water-bearing unconfined aquifer ranging from about 5 to 75 feet (1.5 to 23 meters) in thickness. Beneath the aquifer is a relatively impermeable clay till overlying the sedimentary bedrock sequences. The estimated depth to the sedimentary bedrock sequences within the project area is approximately 100 to 150 feet (30 to 46 meters) below the ground surface. Bedrock within the site consist of limestone and dolomite deposits of Silurian age.

3. INVESTIGATION PROCEDURES

3.1 Field Investigation

A K & S field engineer/senior foreman was on site during drilling operations to assist in logging the boring. Traffic control was observed to provide a safe working environment for our field crews during our field operations. Upon completion of drilling, the borings were either covered with cones, or a screened PVC pipe was installed for observing 24-hour water level readings. The borings were backfilled subsequently.

The borings included split-spoon sampling in general accordance with ASTM Standard D 1586/AASHTO T-206. Results of the boring data showing the materials encountered, natural moisture content of cohesive soils, groundwater level readings and other pertinent observations made during the drilling operations are included on the boring logs in the Appendix.

3.2 Laboratory Testing

The purpose of the laboratory investigation was to determine the classification and physical properties of the soils encountered on the project. The classification tests included grain-size analyses, Atterberg Limit and Loss on Ignition tests. In addition to these tests, natural moisture content tests were performed on all cohesive soil samples. A summary of the classification tests is presented in Table 1 and the results of all laboratory tests are presented in Table 2 in the appendix.

4. RESULTS OF FIELD INVESTIGATION

4.1 General Subsurface Conditions

At the surface approximately 0.8-foot to 3.5-foot-thick layer of asphalt and crushed stone was observed.

Underlying asphalt and crushed stone at the surface, the borings encountered silty clay loam and silty clay extending to depths ranging from 9 feet in Boring RB-4 to 18.5 feet in Borings RB-1 and RB-6 through RB-8. The standard penetration resistance (SPR) N-values in silty clay loam and silty clay ranged from approximately 3 blows per foot (bpf) to 24 bpf.

Very soft to soft organic materials and peat were observed in Borings RB-4 (extending from a depth of 9 feet to 16 feet) and RB-5 (extending from a depth of 13.5 feet to 23.5 feet). The SPR values in the organic materials ranged from 2 bpf to 4 bpf with pocket penetrometer resistance (PPR) values ranging from 0 tons per square foot (tsf) to 1.25 tsf. The moisture content in the organic materials ranged from 19 percent to 163 percent, with organic content ranging from 3 percent to 74 percent.

Organic materials were not observed in Borings RB-1 through RB-3 and RB-6 through RB-8.

Underlying the organic materials in Borings RB-4 and RB-5 and below silty clay loam/silty clay in the remainder borings, stratum of sand was observed. The SPR values in the stratum of sand ranged from approximately 7 bpf tp 29 bpf, indicating a loose to medium dense consistency.

The borings were terminated in the stratum of loose to medium dense sand at depths ranging from 20 feet to 30 feet.

4.2 Groundwater Conditions

Groundwater levels were observed at depths ranging from 6 feet to 16 feet after 24 hours of completion of the boreholes. It should be noted that the groundwater levels are subject to seasonal and long-term variations in response to climatic conditions and man-made influences.

5. ANALYSES AND RECOMMENDATIONS

5.1 MSE Wall Design

It is understood that the design of the sheet-pile and MSE walls would be performed by others. The MSE wall should analyzed for the external stability, including: Sliding, Overturning, Bearing Capacity and Global stability. It is believed that the internal stability would be performed by the MSE Wall manufacturer.

Following Factors of Safety (FOS) are recommended for the analysis.

Sliding	≥ 1.5	
Overturning	≥ 2.0	
Bearing	≥ 2.5	
Slope Stability	≥ 1.5	(Static conditions)

A 2 feet of surcharge should also used to reflect FHWA HS 20 loading.

For estimating bearing capacity, factor of safety for sliding, overturning and global stability, following parameters are recommended:

Specified Backfill: (Reinforced Soil Zone)	$c = 0$ $\phi = 32°$ $\gamma = 120$ pcf
In-situ Foundation Soils (Sand)	$c = 0$ $\phi = 32°$ to $34°$ $\gamma = 120$ pcf

6. CONSTRUCTION CONSIDERATIONS

6.1 Fill Placement and Compaction

Engineered fill used on this project should be approved, environmentally clean material, free of lumps, frozen soil, wood, roots, topsoil, or other deleterious material. The engineered fill should meet the requirement of borrow as specified in Section 203.08, INDOT 1999 Standard Specifications. On-site materials such as silty clay loam are not expected to meet the requirement for "B" borrow material. Depending on the time of construction, some aeration, or moisture conditioning of the fill material may be required.

Fill materials should be placed in lift thicknesses (loose) not to exceed 8 inches (20 centimeters), and compacted to the required density as specified in the latest INDOT Standard Specifications. A vibratory roller should be used to compact the granular soils.

6.2 Excavations

The Contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of all the excavations as required to maintain the stability of the excavation sides and bottom. All excavations should comply with applicable local, state and federal regulations including the current OSHA Excavation and Trench Safety Standards. Construction site safety generally is the sole responsibility of the Contractor, who shall also be responsible for the means, methods and sequencing of construction operations. We are providing this information solely as a service to our client. Under no circumstances should the information provided herein be interpreted to mean that K & S Engineers, Inc., is assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

In no case should slope height, slope inclination or excavation depth, including utility trench excavation depth exceed those specified in local, state and federal safety regulations. Specifically, the current OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926 should be followed. We understand these regulations are being strictly enforced and if they are not closely followed, the Owner and Contractor could be liable for substantial penalties.

7. LIMITATIONS

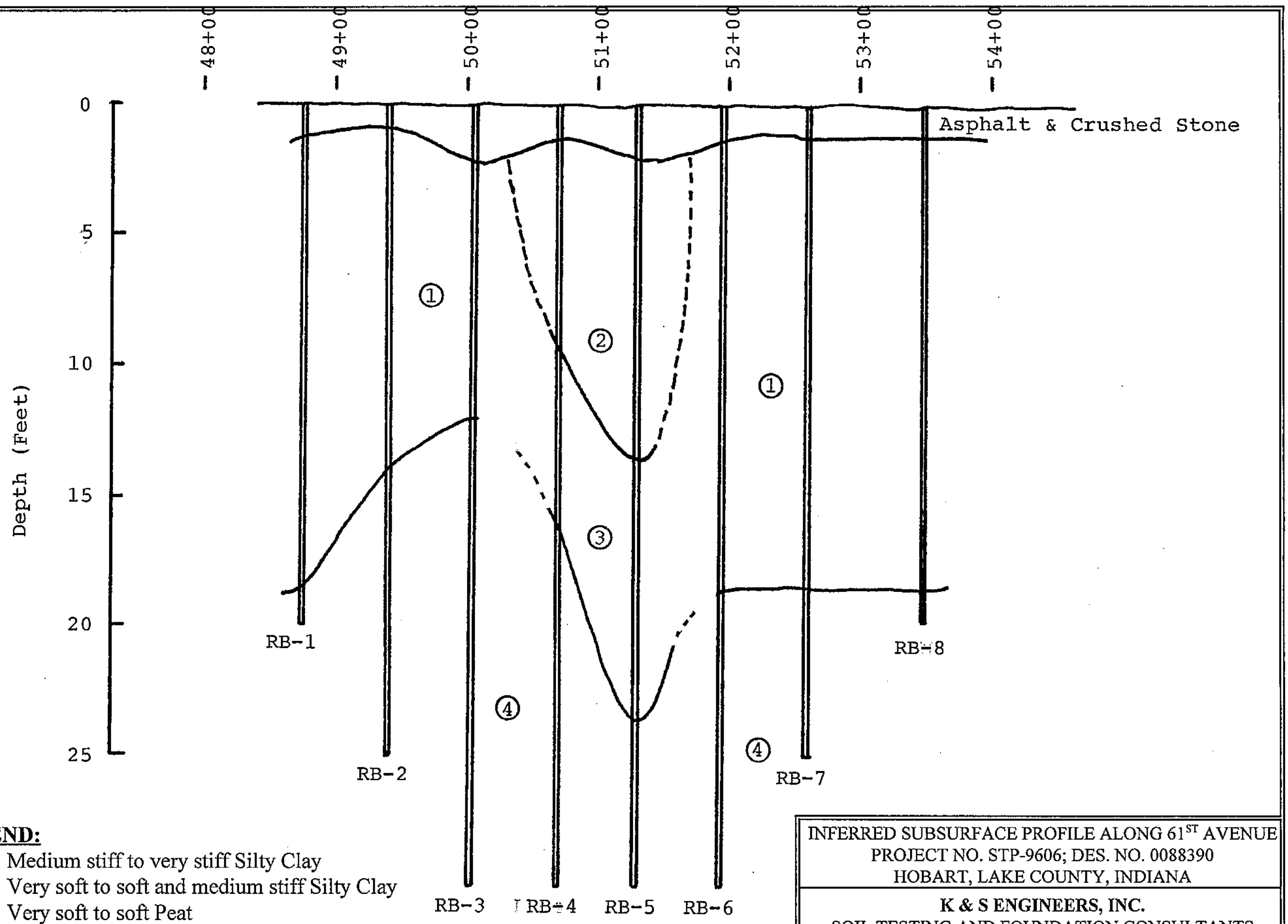
The conclusions and recommendations presented in this report are based upon the assumption that the subsurface conditions do not deviate appreciably from those disclosed by the borings. These conclusions and recommendations are also based upon the premise of competent field engineering, monitoring and testing during construction.

If, during construction, subsurface conditions different from those encountered in the exploratory borings are observed or appear to be present beneath excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary.

This report was prepared for the exclusive use of the owner, architect, and engineer for evaluating the design of the project as it relates to the geotechnical aspects discussed herein.

APPENDIX

1. Exhibit 1: Inferred Subsurface Profile
2. Exhibits 2 through 9: Boring Logs
3. Summary of Classification Test Results
4. Summary of Special Laboratory Test Results
5. Figures 1 through 5, Grain Size Distribution Curves



LEGEND:

- ① Medium stiff to very stiff Silty Clay
- ② Very soft to soft and medium stiff Silty Clay
- ③ Very soft to soft Peat
- ④ Loose to medium dense Sand

INFERRED SUBSURFACE PROFILE ALONG 61ST AVENUE
PROJECT NO. STP-9606; DES. NO. 0088390
HOBART, LAKE COUNTY, INDIANA

K & S ENGINEERS, INC.
SOIL TESTING AND FOUNDATION CONSULTANTS

Scale (feet)
As Shown

Date: 07/24/2006
File No. 7998

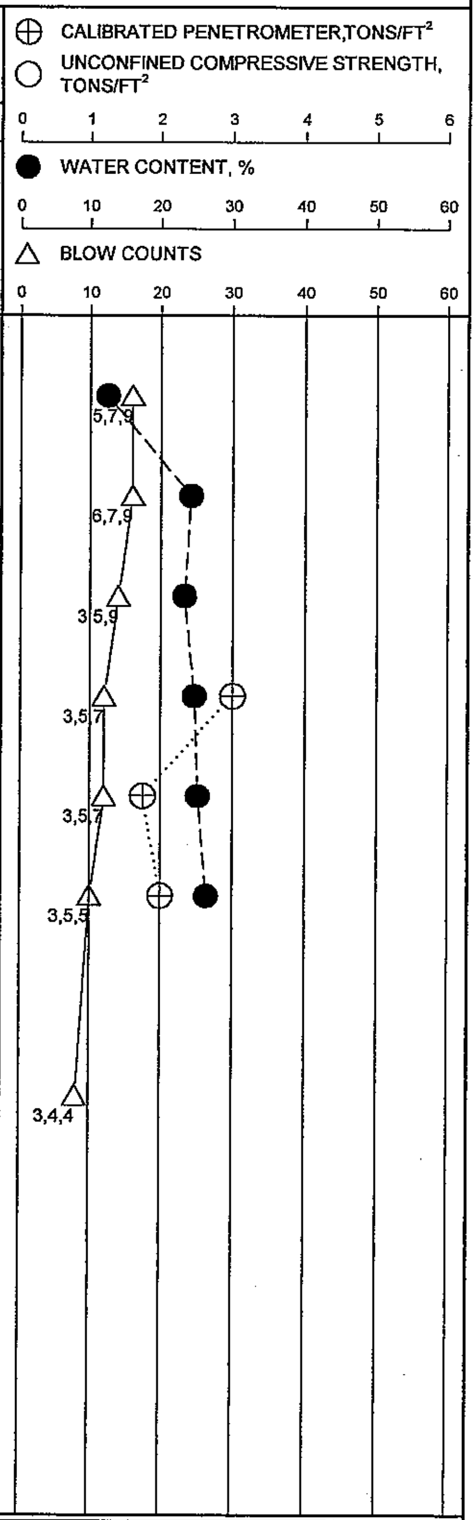
EXHIBIT 1

EXHIBIT 2
Sheet 1 of 1

CLIENT	**The HNTB Companies**	LOG OF BORING NUMBER **RB-1**	DES. NO.
PROJECT NAME	**61st Avenue Widening & Improvement**		PROJECT NO.
SITE LOCATION	**61st Avenue, Hobart, Indiana**	STRUCTURE NUMBER	STATION **48+75, Line A** OFFSET **10' Rt**
BORING STARTED	**1-31-06**	RIG **Diedrich D-50**	FILE NUMBER **7998**
BORING COMPLETED	**1-31-06**	FOREMAN **Ruben Perez**	

SURFACE ELEVATION ft (m) USC & GS

STRATA DEPTH (METERS) (FEET)	TEXTURAL CLASSIFICATION	DESCRIPTION OF MATERIAL	DEPTH (FEET)	SAMPLE TYPE	RECOVERY	NUMBER	DRY UNIT WEIGHT pcf (kg/m³)
1.3		Asphalt, 13 inches over 2 inches of crushed stone, visual					
8.5		Brown, damp, very stiff to stiff, Silty Clay LOAM, Lab No. 7998-1, A-6(9)	2.5	╱		1	
			5.0	╱		2	
			7.5	╱		3	
18.5		Gray, damp, medium stiff, Silty Clay, Lab. No. 7998-2, A-6(13)	10.0	╱		4	
			12.5	╱		5	
			15.0	╱		6	
			17.5				
20.0		Brown, wet, loose, Sand, Lab. No. 7998-3, A-3(0)	20.0	╱		7	
		END OF BORING @ 20.0 FEET					



▽ WATER LEVEL WHILE DRILLING 18.5 FEET
▼ WATER LEVEL 16.0 FEET 24 HOURS AFTER COMPLETION

REMARKS

╱ SPLIT SPOON ■ SHELBY TUBE A AUGER ▨ ROCK CORE
+ PL - PLASTIC LIMIT + LL - LIQUID LIMIT γ_d - UNIT DRY WEIGHT

K & S ENGINEERS, INC.

BORING LOG 7998.GPJ 7-25-06

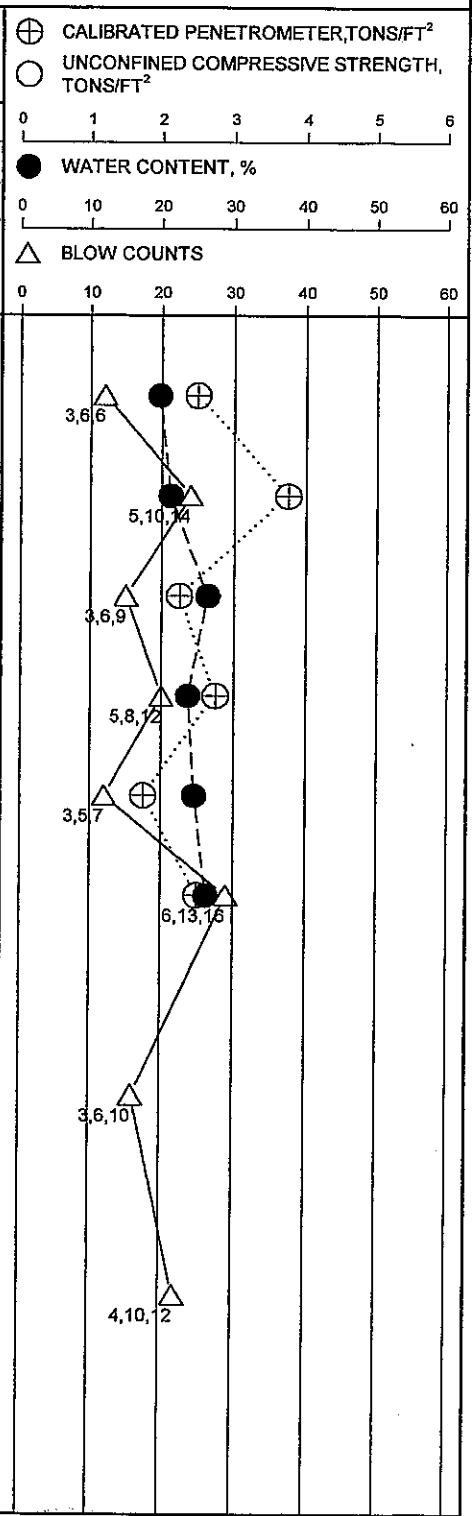
EXHIBIT 3
Sheet 1 of 1

CLIENT	**The HNTB Companies**	LOG OF BORING NUMBER **RB-2**	DES. NO.
PROJECT NAME	**61st Avenue Widening & Improvement**		PROJECT NO.
SITE LOCATION	**61st Avenue, Hobart, Indiana**	STRUCTURE NUMBER	STATION **49+40, Line A** OFFSET **10' Lt**
BORING STARTED	**1-18-06**	RIG **Diedrich D-120**	FILE NUMBER
BORING COMPLETED	**1-18-06**	FOREMAN **Carlos Santana**	**7998**

SURFACE ELEVATION **ft (m) USC & GS**

STRATA DEPTH (FEET)	DESCRIPTION OF MATERIAL
0.8	Asphalt, 6 inches over 4 inches of crushed stone, visual
14.0	Brown to gray, moist, stiff to very stiff, Silty Clay LOAM, Lab. No. 7998-4, A-6(9)
25.0	Brown, wet, medium dense, Sand, Lab. No. 7998-3, A-3
	END OF BORING @ 25.0 FEET

SAMPLE NUMBER	TYPE
1	▨
2	▨
3	▨
4	▨
5	▨
6	▨
7	▨
8	▨



▽ WATER LEVEL WHILE DRILLING 14.0 FEET
▼ WATER LEVEL 13.0 FEET 24 HOURS AFTER COMPLETION

REMARKS

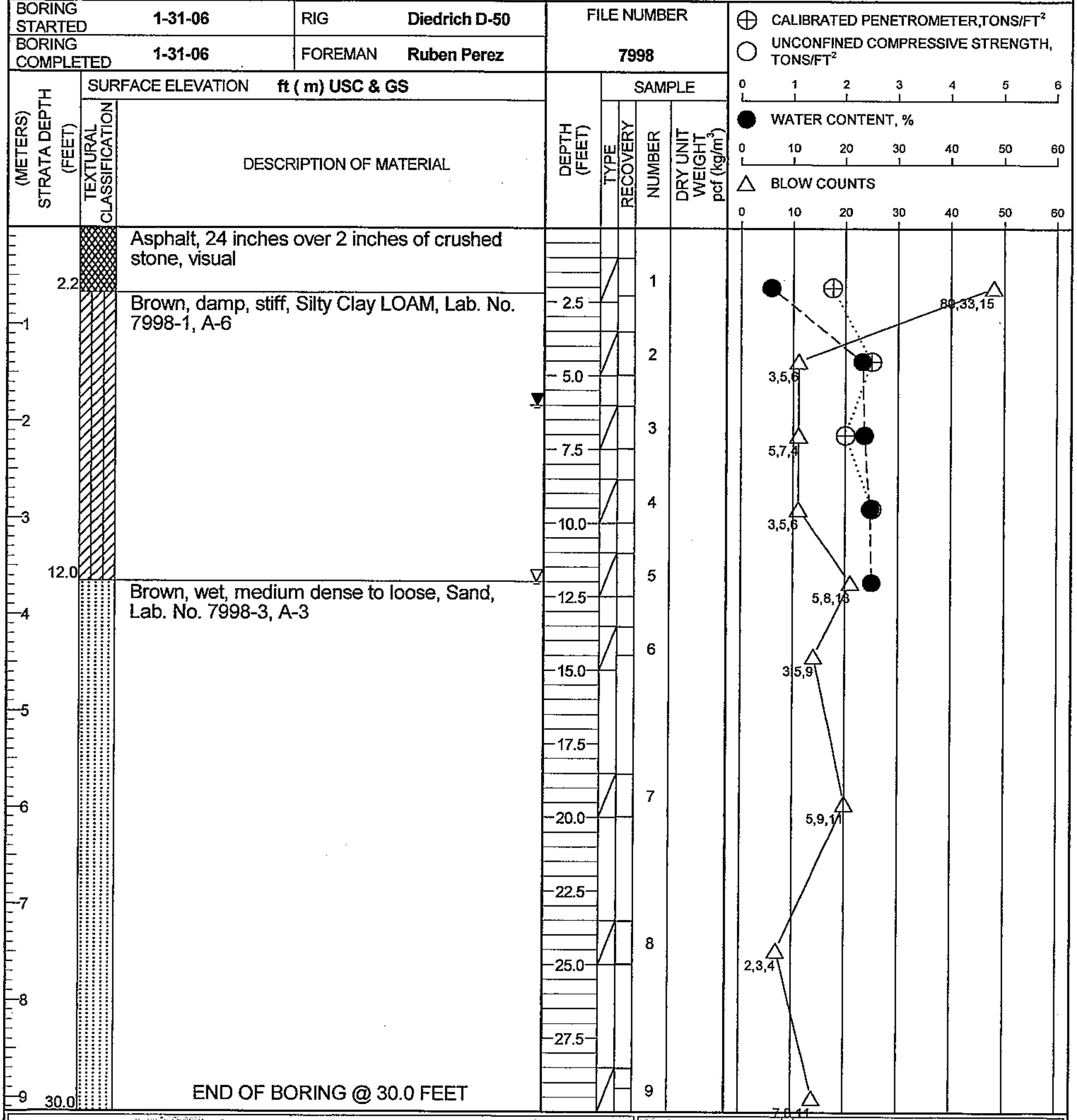
▨ SPLIT SPOON ■ SHELBY TUBE A AUGER ▨ ROCK CORE
+ PL - PLASTIC LIMIT + LL - LIQUID LIMIT γ_d - UNIT DRY WEIGHT

K & S ENGINEERS, INC.

EXHIBIT 4
Sheet 1 of 1

CLIENT	**The HNTB Companies**	LOG OF BORING NUMBER **RB-3**	DES. NO.
PROJECT NAME	**61st Avenue Widening & Improvement**		PROJECT NO.
SITE LOCATION	**61st Avenue, Hobart, Indiana**	STRUCTURE NUMBER	STATION **50+04, Line A** OFFSET **10' Rt**
BORING STARTED	**1-31-06**	RIG **Diedrich D-50**	FILE NUMBER
BORING COMPLETED	**1-31-06**	FOREMAN **Ruben Perez**	**7998**

SURFACE ELEVATION **ft (m) USC & GS**



STRATA DEPTH (FEET)	DESCRIPTION OF MATERIAL
2.2	Asphalt, 24 inches over 2 inches of crushed stone, visual
12.0	Brown, damp, stiff, Silty Clay LOAM, Lab. No. 7998-1, A-6
30.0	Brown, wet, medium dense to loose, Sand, Lab. No. 7998-3, A-3

END OF BORING @ 30.0 FEET

▽ WATER LEVEL WHILE DRILLING 12.0 FEET

▼ WATER LEVEL 6.0 FEET 24 HOURS AFTER COMPLETION

REMARKS

▱ SPLIT SPOON ■ SHELBY TUBE A AUGER ▨ ROCK CORE

+ PL - PLASTIC LIMIT + LL - LIQUID LIMIT γ_d - UNIT DRY WEIGHT

K & S ENGINEERS, INC.

EXHIBIT 5
Sheet 1 of 1

CLIENT **The HNTB Companies**

PROJECT NAME **61st Avenue Widening & Improvement**

SITE LOCATION **61st Avenue, Hobart, Indiana**

LOG OF BORING NUMBER **RB-4**

DES. NO.

PROJECT NO.

STRUCTURE NUMBER

STATION **50+68, Line A**

OFFSET **10' Lt**

BORING STARTED **1-18-06**

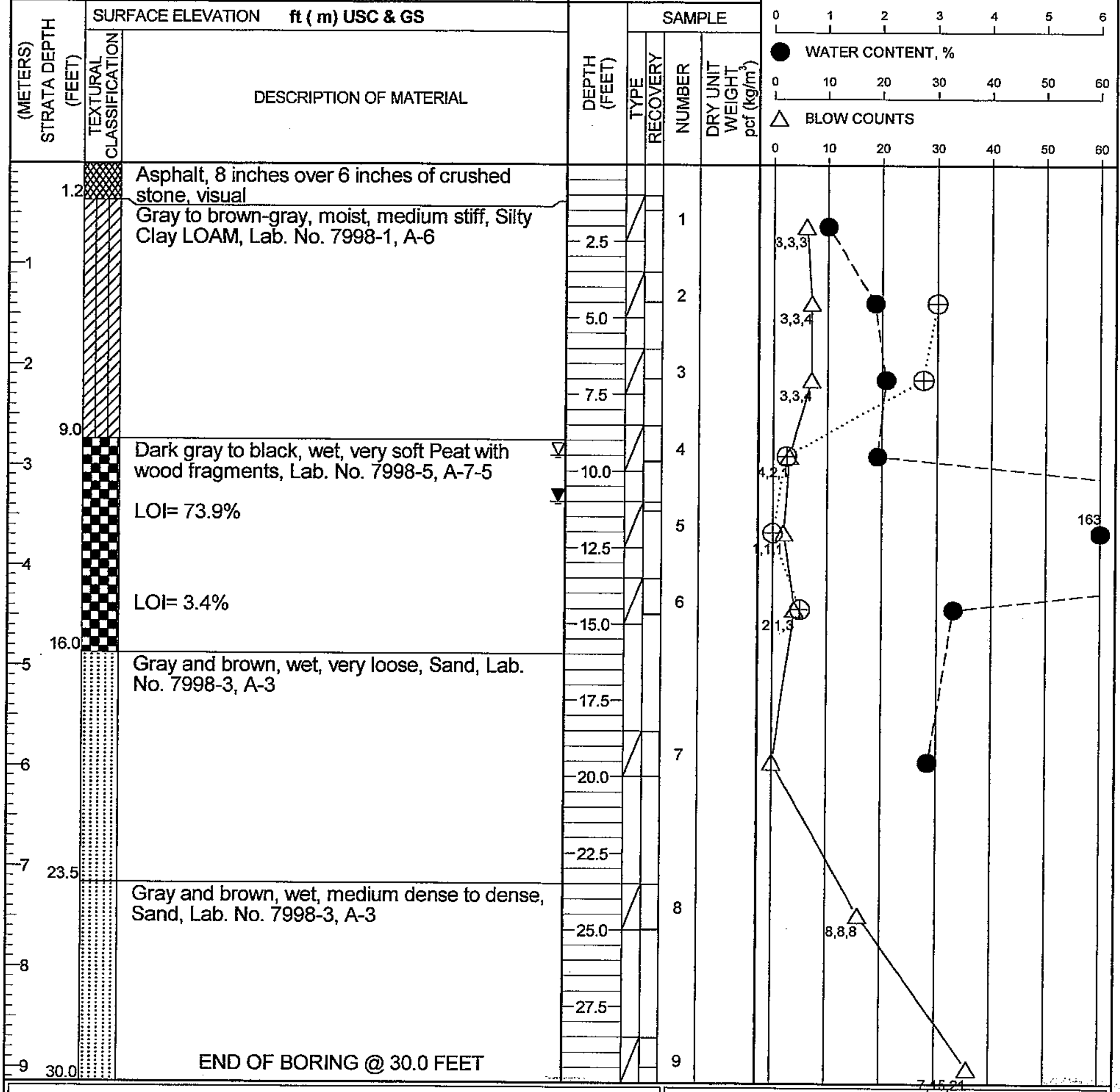
RIG **Diedrich D-120**

BORING COMPLETED **1-18-06**

FOREMAN **Carlos Santana**

FILE NUMBER **7998**

SURFACE ELEVATION **ft (m) USC & GS**



STRATA DEPTH (FEET)	DESCRIPTION OF MATERIAL
1.2	Asphalt, 8 inches over 6 inches of crushed stone, visual
9.0	Gray to brown-gray, moist, medium stiff, Silty Clay LOAM, Lab. No. 7998-1, A-6
16.0	Dark gray to black, wet, very soft Peat with wood fragments, Lab. No. 7998-5, A-7-5 LOI= 73.9% LOI= 3.4%
23.5	Gray and brown, wet, very loose, Sand, Lab. No. 7998-3, A-3
30.0	Gray and brown, wet, medium dense to dense, Sand, Lab. No. 7998-3, A-3

END OF BORING @ 30.0 FEET

∇ WATER LEVEL WHILE DRILLING 9.5 FEET

▼ WATER LEVEL 8.0 FEET 24 HOURS AFTER COMPLETION

REMARKS

▨ SPLIT SPOON ■ SHELBY TUBE Ⓐ AUGER ▨ ROCK CORE

+ PL - PLASTIC LIMIT + LL - LIQUID LIMIT γ_d - UNIT DRY WEIGHT

K & S ENGINEERS, INC.

EXHIBIT 6
Sheet 1 of 1

CLIENT **The HNTB Companies**

PROJECT NAME **61st Avenue Widening & Improvement**

SITE LOCATION **61st Avenue, Hobart, Indiana**

LOG OF BORING NUMBER **RB-5**

DES. NO.

PROJECT NO.

STRUCTURE NUMBER

STATION **51+32, Line A**

OFFSET **10' Rt**

BORING STARTED **1-31-06**

RIG **Diedrich D-50**

BORING COMPLETED **1-1-06**

FOREMAN **Ruben Perez**

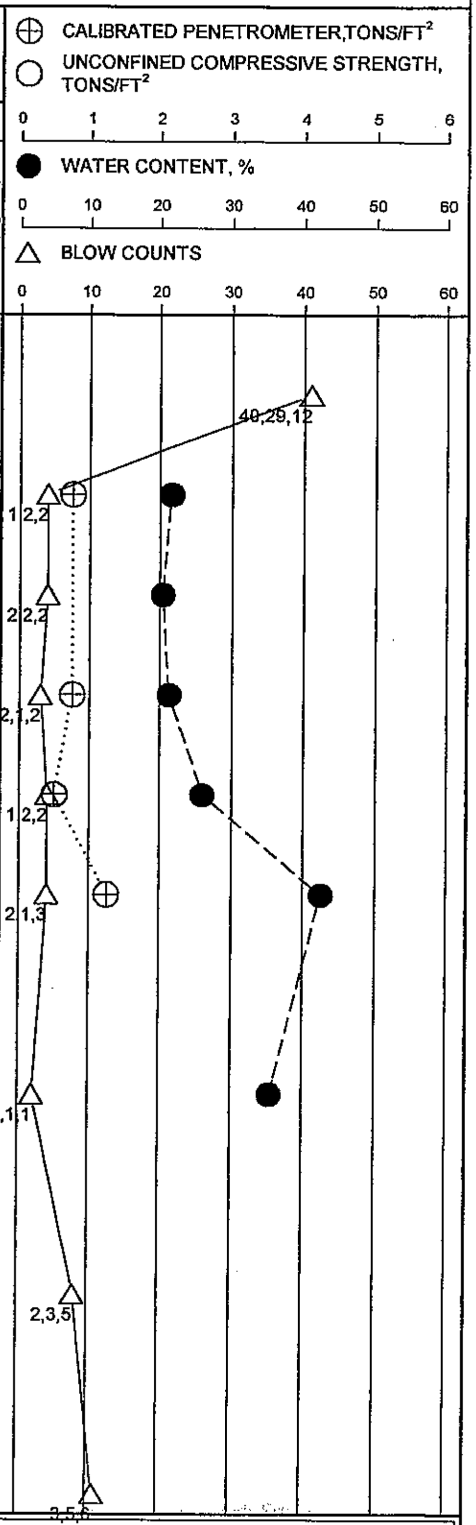
FILE NUMBER **7998**

SURFACE ELEVATION **ft (m) USC & GS**

STRATA DEPTH (METERS)	STRATA DEPTH (FEET)	DESCRIPTION OF MATERIAL
	2.1	Asphalt, 21 inches over 4 inches of crushed stone, visual
1 2 3 4	13.5	Brown-gray, moist to damp, very soft to soft, Silty Clay LOAM, Lab. No. 7998-1,A-6
5 6 7	23.5	Black, moist to wet, very soft to soft, Peat, Lab. No. 7998-5, A-7-5(19) LOI = 9.6% LOI = 3.0%
8 9	30.0	Gray-brown, wet, loose to medium dense, Sand, Lab. No. 7998-3, A-3 END OF BORING @ 30.0 FEET

DEPTH (FEET)	SAMPLE NUMBER
2.5	1
5.0	2
7.5	3
10.0	4
12.5	5
15.0	6
17.5	
20.0	7
22.5	
25.0	8
27.5	
	9

TYPE RECOVERY | DRY UNIT WEIGHT pcf (kg/m³)



▽ WATER LEVEL WHILE DRILLING 18.5 FEET

▼ WATER LEVEL 9.0 FEET 24 HOURS AFTER COMPLETION

REMARKS

▨ SPLIT SPOON ■ SHELBY TUBE [A] AUGER ▨ ROCK CORE

+ PL - PLASTIC LIMIT + LL - LIQUID LIMIT γ_d - UNIT DRY WEIGHT

K & S ENGINEERS, INC.

EXHIBIT 7
Sheet 1 of 1

CLIENT	**The HNTB Companies**	LOG OF BORING NUMBER **RB-6**	DES. NO.
PROJECT NAME	**61st Avenue Widening & Improvement**		PROJECT NO.
SITE LOCATION	**61st Avenue, Hobart, Indiana**	STRUCTURE NUMBER	STATION **51+96, Line A** OFFSET **10' Lt**

BORING STARTED	**1-18-06**	RIG	**Diedrich D-120**	FILE NUMBER
BORING COMPLETED	**1-18-06**	FOREMAN	**Carlos Santana**	**7998**

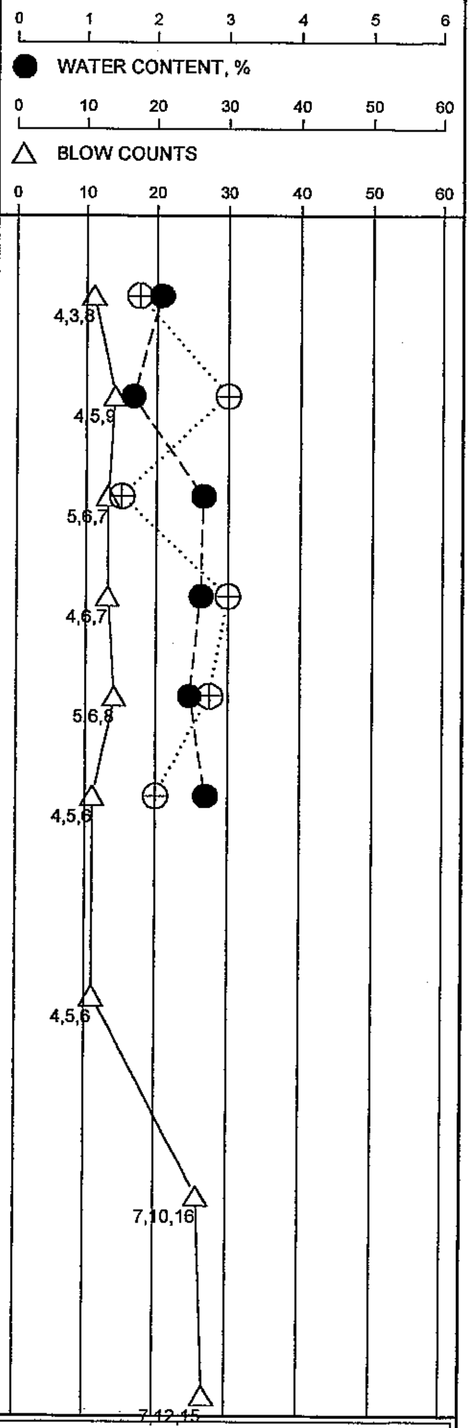
SURFACE ELEVATION ft (m) USC & GS

⊕ CALIBRATED PENETROMETER,TONS/FT²
○ UNCONFINED COMPRESSIVE STRENGTH, TONS/FT²
● WATER CONTENT, %
△ BLOW COUNTS

STRATA DEPTH (METERS)	STRATA DEPTH (FEET)	DESCRIPTION OF MATERIAL
	1.3	Asphalt, 11 inches over 4 inches of crushed stone, visual
	18.5	Gray-brown to gray, moist, stiff, Silty Clay LOAM, Lab. No. 7998-1, A-6
	30.0	Gray-brown, wet, medium dense, Sand, Lab. No. 7998-3, A-3
9	30.0	END OF BORING @ 30.0 FEET

Meters scale: 1, 2, 3, 4, 5, 6, 7, 8, 9

DEPTH (FEET)	TYPE	SAMPLE NUMBER	BLOW COUNTS
2.5	▨	1	4,3,8
5.0	▨	2	4,5,9
7.5	▨	3	5,6,7
10.0	▨	4	4,6,7
12.5	▨	5	5,6,8
15.0	▨	6	4,5,6
17.5			
20.0	▨	7	4,5,6
22.5			
25.0	▨	8	7,10,16
27.5			
	▨	9	7,12,15



▽ WATER LEVEL WHILE DRILLING 18.5 FEET
▼ WATER LEVEL 11.0 FEET 24 HOURS AFTER COMPLETION

REMARKS

▨ SPLIT SPOON ■ SHELBY TUBE A AUGER ▨ ROCK CORE
+ PL - PLASTIC LIMIT + LL - LIQUID LIMIT γ_d - UNIT DRY WEIGHT

K & S ENGINEERS, INC.

BORING LOG 7998.GPJ 7-25-06

EXHIBIT 8
Sheet 1 of 1

CLIENT **The HNTB Companies**

PROJECT NAME **61st Avenue Widening & Improvement**

SITE LOCATION **61st Avenue, Hobart, Indiana**

LOG OF BORING NUMBER **RB-7**

DES. NO.

PROJECT NO.

STRUCTURE NUMBER

STATION **52+60, Line A**

OFFSET **10' Rt**

BORING STARTED **1-31-06**

BORING COMPLETED **1-31-06**

RIG **Diedrich D-50**

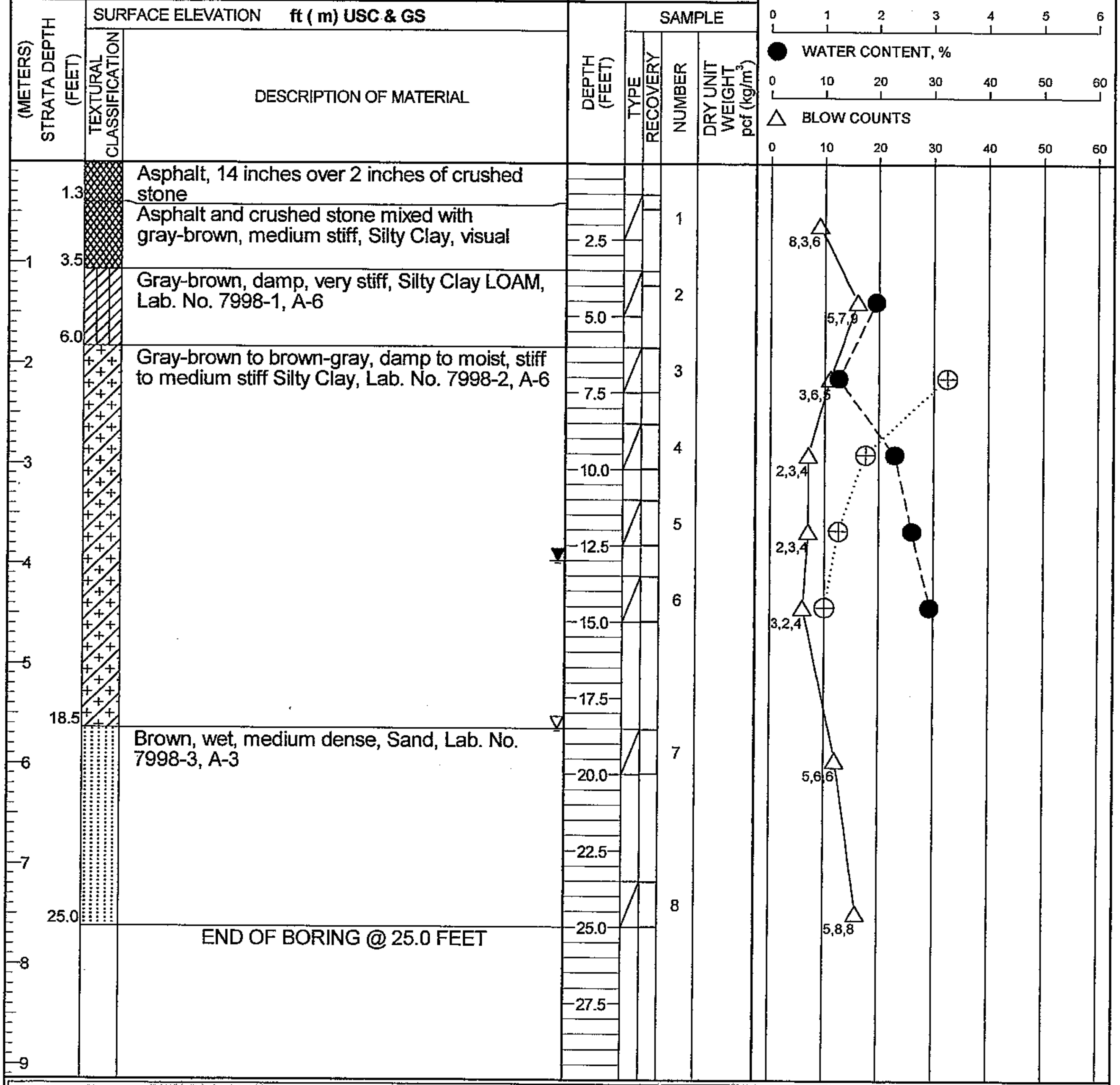
FOREMAN **Ruben Perez**

FILE NUMBER **7998**

SURFACE ELEVATION **ft (m) USC & GS**

STRATA DEPTH (FEET)	DESCRIPTION OF MATERIAL
1.3	Asphalt, 14 inches over 2 inches of crushed stone
3.5	Asphalt and crushed stone mixed with gray-brown, medium stiff, Silty Clay, visual
6.0	Gray-brown, damp, very stiff, Silty Clay LOAM, Lab. No. 7998-1, A-6
18.5	Gray-brown to brown-gray, damp to moist, stiff to medium stiff Silty Clay, Lab. No. 7998-2, A-6
25.0	Brown, wet, medium dense, Sand, Lab. No. 7998-3, A-3

END OF BORING @ 25.0 FEET



▽ WATER LEVEL WHILE DRILLING 18.5 FEET

▼ WATER LEVEL 13.0 FEET 24 HOURS AFTER COMPLETION

REMARKS

▱ SPLIT SPOON ■ SHELBY TUBE Ⓐ AUGER ▨ ROCK CORE

+ PL - PLASTIC LIMIT + LL - LIQUID LIMIT γ_d - UNIT DRY WEIGHT

K & S ENGINEERS, INC.

BORING LOG 7998.GPJ 7-25-06

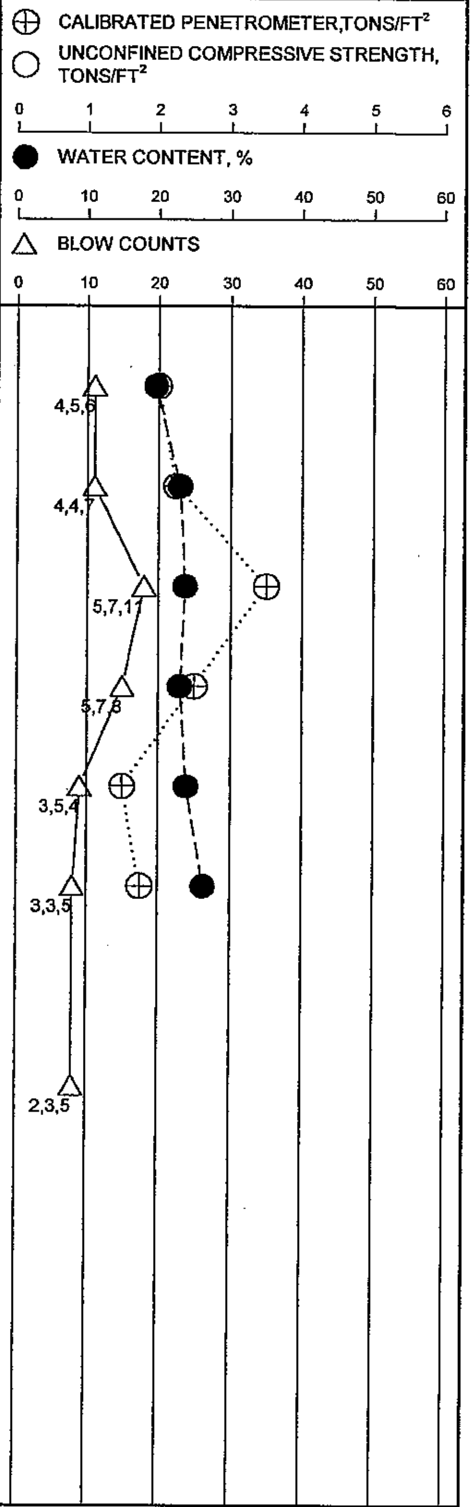
EXHIBIT 9
Sheet 1 of 1

CLIENT	**The HNTB Companies**	LOG OF BORING NUMBER **RB-8**	DES. NO.
PROJECT NAME	**61st Avenue Widening & Improvement**		PROJECT NO.
SITE LOCATION	**61st Avenue, Hobart, Indiana**	STRUCTURE NUMBER	STATION **53+50, Line A** OFFSET **10'Lt**
BORING STARTED	**1-18-06**	RIG **Diedrich D-120**	FILE NUMBER **7998**
BORING COMPLETED	**1-18-06**	FOREMAN **Carlos Santana**	

SURFACE ELEVATION **ft (m) USC & GS**

STRATA DEPTH (METERS) (FEET)	TEXTURAL CLASSIFICATION	DESCRIPTION OF MATERIAL
1.2	▩	Asphalt, 10 inches over 4 inches of crushed stone, visual
11.0	▨	Brown, moist, stiff to very stiff, Silty Clay LOAM, Lab No. 7998-1, A-6
18.5	▨	Gray-brown, moist, medium stiff, Silty Clay, Lab No. 7998-2, A-6
20.0	░	Brown, wet, loose, Sand, Lab. No. 7998-3, A-3
		END OF BORING @ 20.0 FEET

DEPTH (FEET)	TYPE	RECOVERY	NUMBER	DRY UNIT WEIGHT pcf (kg/m³)
2.5	/		1	
5.0	/		2	
7.5	/		3	
10.0	/		4	
12.5	/		5	
15.0	/		6	
17.5				
20.0	/		7	



▽ WATER LEVEL WHILE DRILLING 18.5 FEET
▼ WATER LEVEL 14.0 FEET 24 HOURS AFTER COMPLETION

REMARKS

/ SPLIT SPOON ■ SHELBY TUBE A AUGER ▨ ROCK CORE
+ PL - PLASTIC LIMIT + LL - LIQUID LIMIT γ_d - UNIT DRY WEIGHT

K & S ENGINEERS, INC.

Subsurface Conditions for MSE Wall Design
Project No. STP-N606( ); Des. No. 0088390
61st Avenue Widening and Improvements
Hobart, Lake County, Indiana
K & S Project No. 7998

TABLE 1. SUMMARY OF CLASSIFICATION TEST RESULTS

Lab. No.	Boring No. Sample No.	Station	Offset	Depth (Ft)	Classification	% Passing			% Gravel	% Sand	% Silt	% Clay	Atterberg Limits		
						No. 10	No. 40	No. 200					LL	PL	PI
7998-1	RB-1; SS-2	48+75	10 ft Rt., Line A	3.5-5.0	Silty Clay Loam A-6 (9)	81.7	79.3	73.0	18.3	8.7	50.1	22.8	31	15	16
7998-2	RB-1; SS-4	48+75	10 ft Rt., Line A	8.5-10.0	Silty Clay A-6 (13)	96.3	93.4	90.2	3.7	6.1	57.9	32.3	32	16	16
7998-3	RB-1; SS-7	48+75	10 ft Rt., Line A	18.5-20.0	Sand A-3 (0)	98.6	95.9	0.08	1.4	98.5	0.1		NP	NP	NP
7998-4	RB-2; SS-1	49+40	10 ft Lt., Line A	1.0-2.5	Silty Clay Loam A-6 (9)	99.5	98.8	97.2	0.5	2.3	71.3	25.9	26	15	11
7998-5	RB-5; SS-6	51+32	10 ft Rt., Line A	13.5-15.0	Peat (Organic Silty Loam) A-7-5 (19)	99.5	97.0	74.1	0.5	25.4	64.8	9.3	54	30	24

Subsurface Conditions for MSE Wall Design
Project No. STP-N606( ); Des. No. 0088390
61st Avenue Widening and Improvements
Hobart, Lake County, Indiana
K & S Project No. 7998

TABLE 2. SUMMARY OF LABORATORY TEST RESULTS

Lab No.	SUMMARY OF LABORATORY TEST RESULTS								
	Boring No. Sample No.	Depth (Ft)	NATURAL WATER CONTENT (%)	Uncon Comp Strength (tsf)	pH	ORGANIC CONTENT (%)	UNIT DRY WEIGHT pcf	STANDARD PROCTOR RESULTS	
								Opt. Moisture	Max Dry Density
	RB-1								
7998-RB1S1	SS-1	1.0-2.5	12.5						
7998-1	SS-2	3.5-5.0	24.2						
7998-RB1S3	SS-3	6.0-7.5	23.3						
7998-2	SS-4	8.5-1.0	24.7						
7998-RB1S5	SS-5	11.0-12.5	25.2						
7998-RB1S6	SS-6	13.5-15.0	26.4						
	RB-2								
7998-4	SS-1	1.0-2.5	19.7						
7998-RB2S2	SS-2	3.5-5.0	21.2						
7998-RB2S3	SS-3	6.0-7.5	26.4						
7998-RB2S4	SS-4	8.5-10.0	23.7						
7998-RB2S5	SS-5	11.5-12.5	24.6						
7998-RB2S6	SS-6	13.5-15.0	26.3						
	RB-3								
7998-RB3S1	SS-1	1.0-2.5	5.8						
7998-RB3S2	SS-2	3.5-5.0	23.2						
7998-RB3S3	SS-3	6.0-7.5	23.6						
7998-RB3S4	SS-4	8.5-10.0	24.7						
7998-RB3S5	SS-5	11.5-12.5	25.0						
	RB-4								
7998-RB4S1	SS-1	1.0-2.5	10.0						

Subsurface Conditions for MSE Wall Design
Project No. STP-N606( ); Des. No. 0088390
61st Avenue Widening and Improvements
Hobart, Lake County, Indiana
K & S Project No. 7998

SUMMARY OF LABORATORY TEST RESULTS

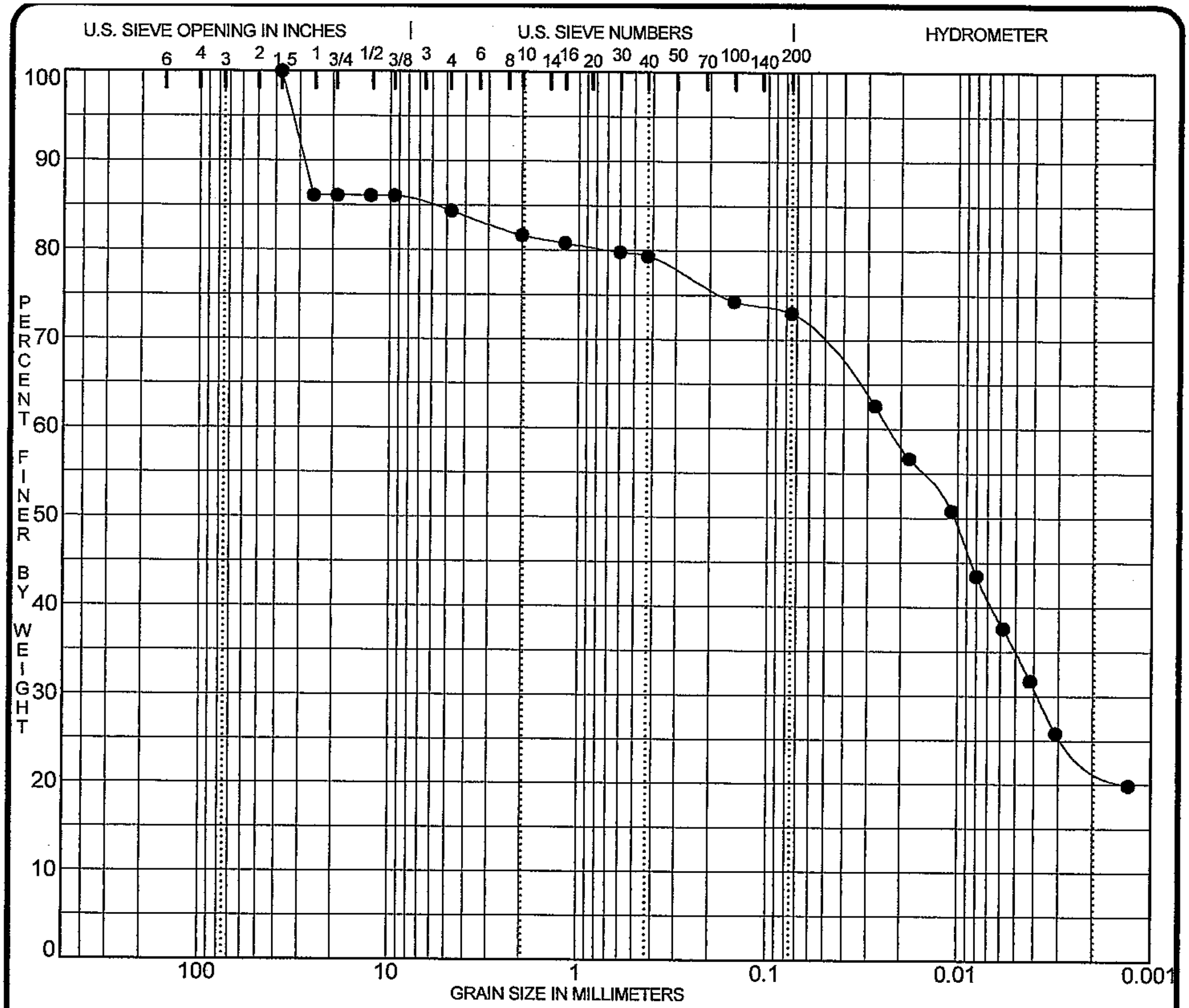
Lab No.	Boring No. Sample No.	Depth (Ft)	NATURAL WATER CONTENT (%)	Uncon Comp Strength (tsf)	pH	ORGANIC CONTENT (%)	UNIT DRY WEIGHT pcf	STANDARD PROCTOR RESULTS	
								Opt. Moisture	Max Dry Density
7998-RB4S2	SS-2	3.5-5.0	18.7						
7998-RB4S3	SS-3	6.0-7.5	20.7						
7998-RB4S4	SS-4	8.5-10.0	19.2						
7998-RB4S5	SS-5	11.5-12.5	162.5			73.9			
7998-RB4S6	SS-6	13.5-15.0	33.1			3.4			
	RB-5								
7998-RB5S2	SS-2	3.5-5.0	21.6						
7998-RB5S3	SS-3	6.0-7.5	20.4						
7998-RB5S4	SS-4	8.5-10.0	21.3						
7998-RB5S5	SS-5	11.5-12.5	26.0						
7998-5	SS-6	13.5-15.0	42.5			9.6			
7998-RB5S7	SS-7	18.5-20.0	35.5			3.0			
	RB-6								
7998-RB6S1	SS-1	1.0-2.5	20.7						
7998-RB6S2	SS-2	3.5-5.0	16.6						
7998-RB6S3	SS-3	6.0-7.5	26.6						
7998-RB6S4	SS-4	8.5-10.0	26.3						
7998-RB6S5	SS-5	11.5-12.5	24.7						
7998-RB6S6	SS-6	13.5-15.0	27.0						
	RB-7								
7998-RB7S2	SS-2	3.5-5.0	19.4						
7998-RB7S3	SS-3	6.0-7.5	12.5						
7998-RB7S4	SS-4	8.5-10.0	22.9						
7998-RB7S5	SS-5	11.5-12.5	26.1						

Subsurface Conditions for MSE Wall Design
Project No. STP-N606( ); Des. No. 0088390
61st Avenue Widening and Improvements
Hobart, Lake County, Indiana
K & S Project No. 7998

SUMMARY OF LABORATORY TEST RESULTS

Lab No.	Boring No. Sample No.	Depth (Ft)	NATURAL WATER CONTENT (%)	Uncon Comp Strength (tsf)	pH	ORGANIC CONTENT (%)	UNIT DRY WEIGHT pcf	STANDARD PROCTOR RESULTS	
								Opt. Moisture	Max Dry Density
7998-RB7S6	SS-6	13.5-15.0	29.3						
	RB-8								
7998-RB8S1	SS-1	1.0-2.5	19.6						
7998-RB8S2	SS-2	3.5-5.0	23.0						
7998-RB8S3	SS-3	6.0-7.5	23.7						
7998-RB8S4	SS-4	8.5-10.0	23.0						
7998-RB8S5	SS-5	11.5-12.5	23.9						
7998-RB8S6	SS-6	13.5-15.0	26.3						

* Please see grain-size distribution curves



COBBLES	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	RB-1	5.0	**Silty Clay LOAM A-6 (9) A-6 (10)**		31	15	16		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	RB-1	5.0	37.50	0.02	0.004		18.3	8.7	50.1	22.8

PROJECT **61st Avenue Widening & Improvement - 61st Avenue, Hobart, Indiana**

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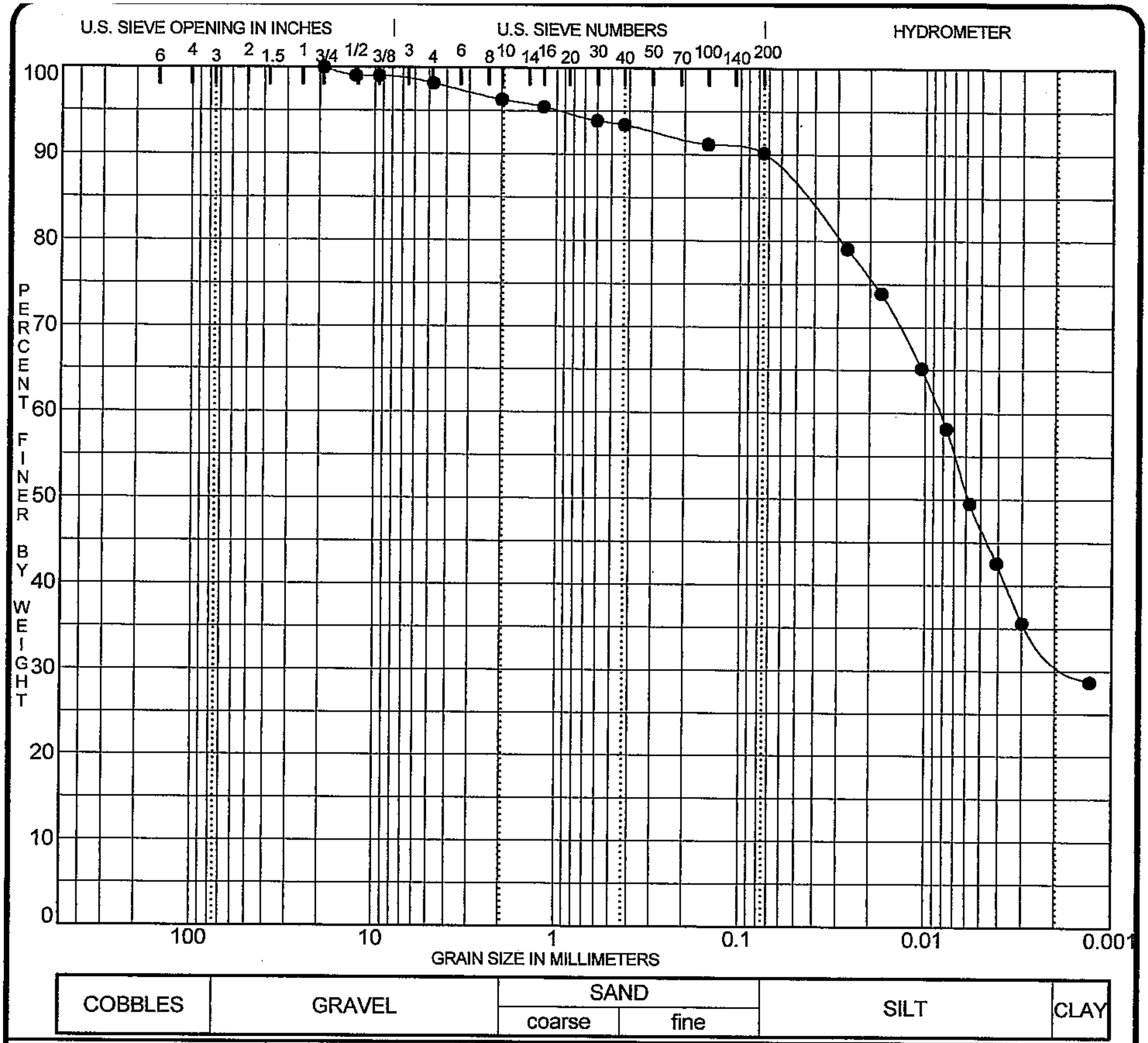
GRADATION CURVES

K & S ENGINEERS, INC.

Figure 1



Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● **RB-1 10.0**	**Silty CLAY A-6 (13) A-6 (10)**		**32**	**16**	**16**		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **RB-1 10.0**	**19.00**	**0.01**	**0.002**		**3.7**	**6.1**	**57.9**	**32.3**

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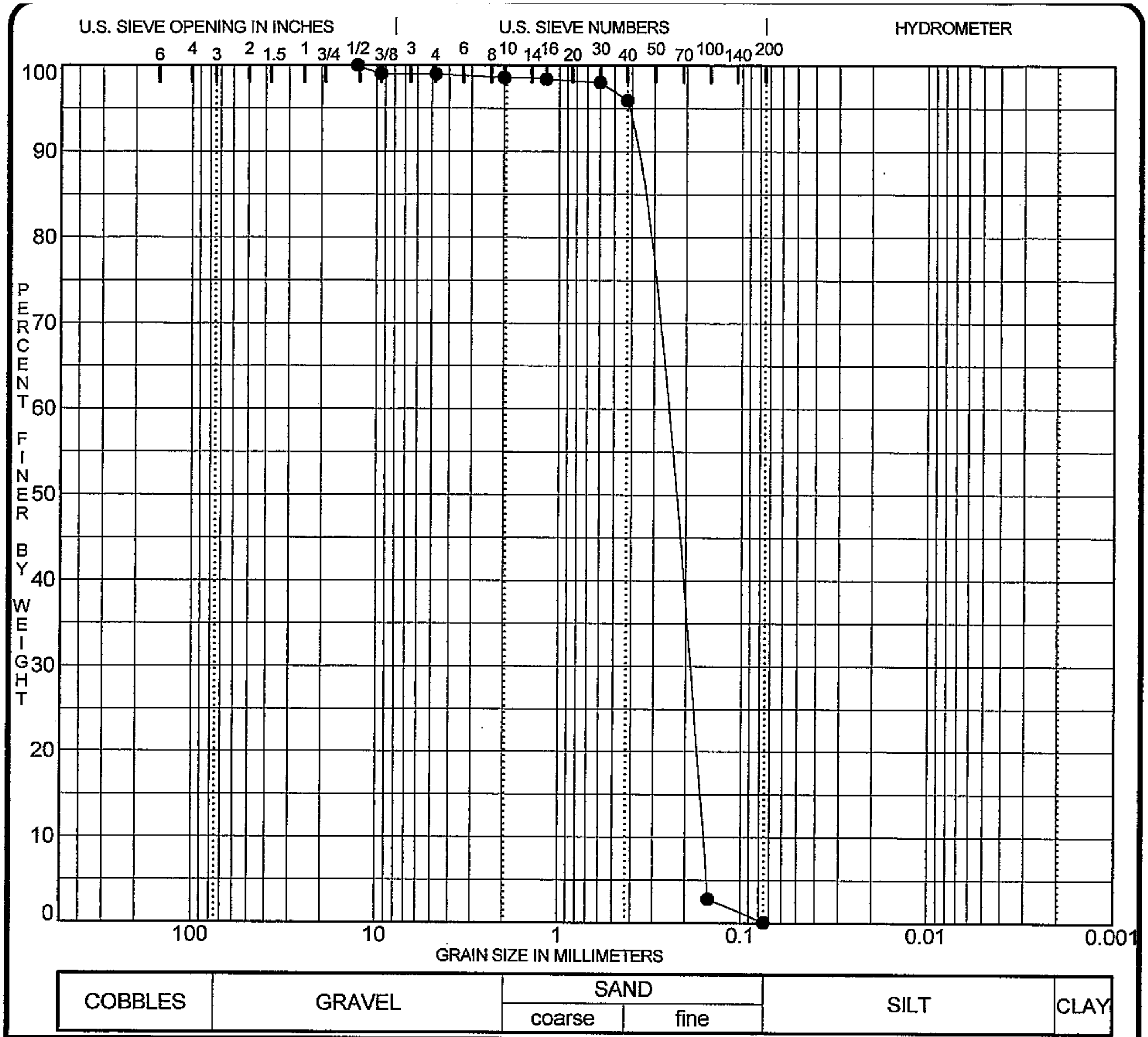
GRADATION CURVES

K & S ENGINEERS, INC.

Figure 2



	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	RB-1	20.0	SAND A-3 (0)		NP	NP	NP	0.89	1.7

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	RB-1	20.0	12.70	0.28	0.203	0.1625	1.4	98.5	0.1	

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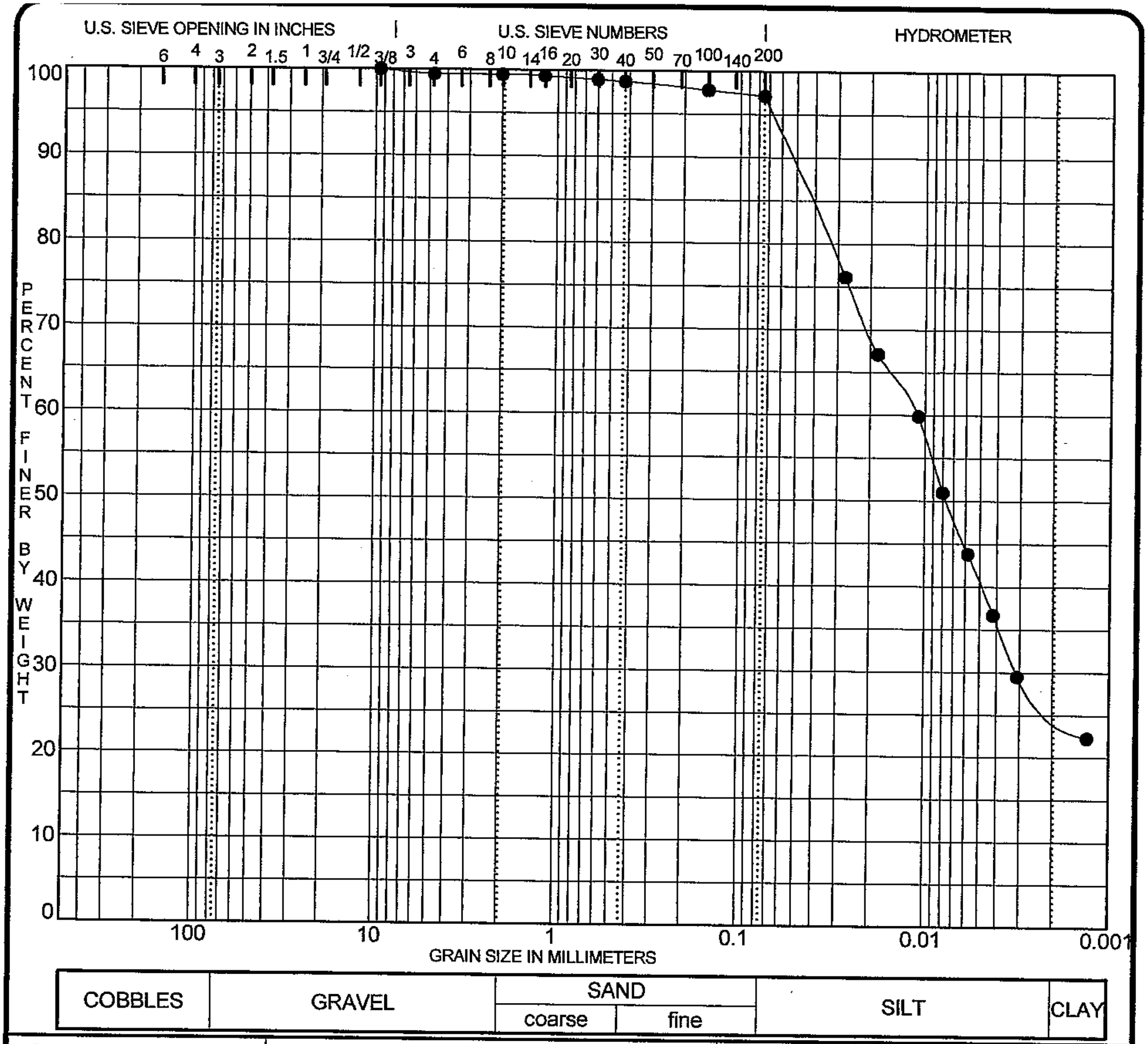
GRADATION CURVES

K & S ENGINEERS, INC.

Figure 3



Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	RB-2	2.5	Silty Clay LOAM A-6 (9) A-6 (8)		26	15	11		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	RB-2	2.5	9.50	0.01	0.003		0.5	2.3	71.3	25.9

PROJECT **61st Avenue Widening & Improvement - 61st Avenue, Hobart, Indiana**

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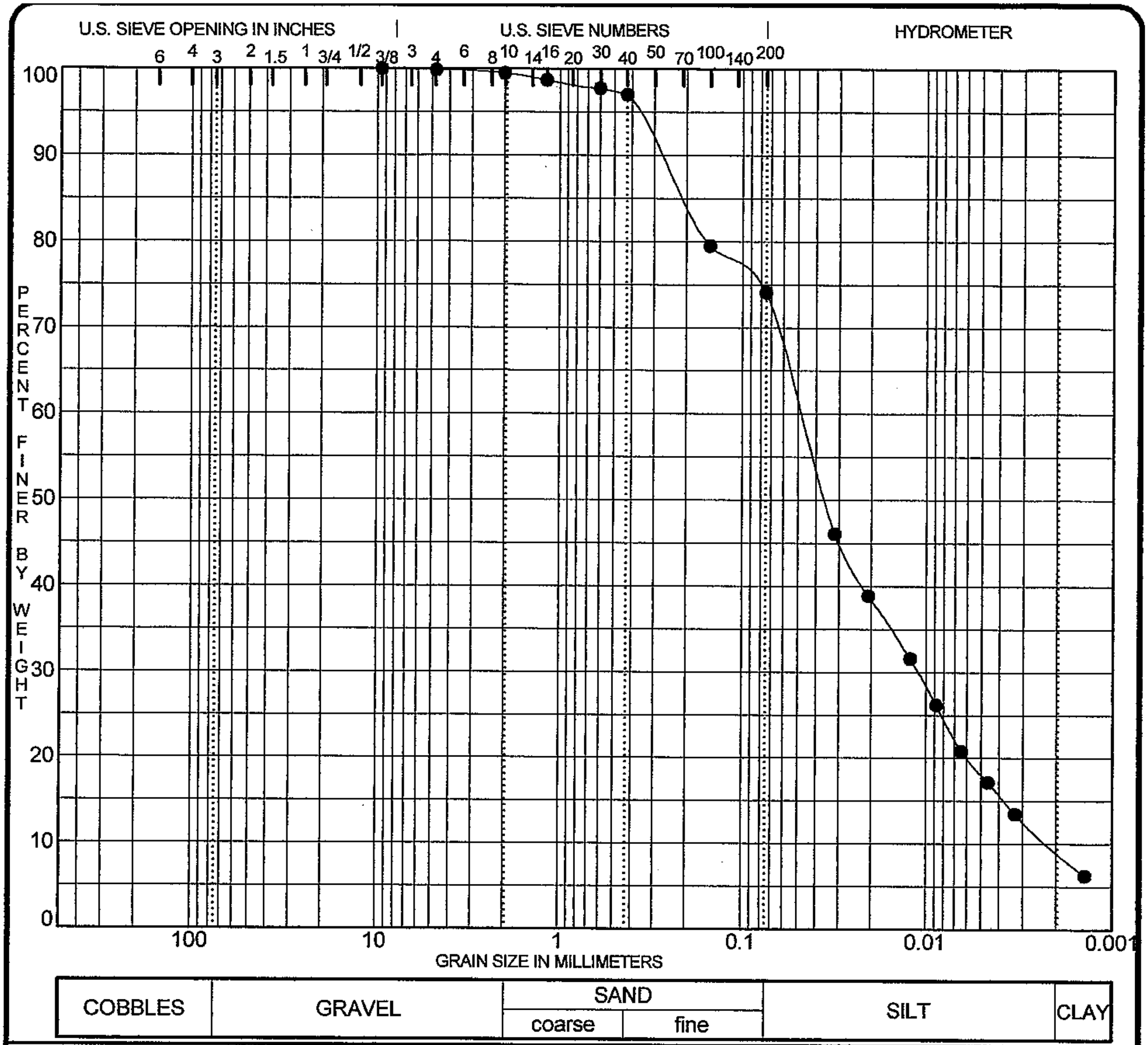
GRADATION CURVES

K & S ENGINEERS, INC.

Figure 4



	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	RB-5	15.0	Peat A-7-5 (19) A-7-5 (16)		54	30	24	1.16	22.4

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	RB-5	15.0	9.50	0.05	0.011	0.0022	0.5	25.4	64.8	9.3

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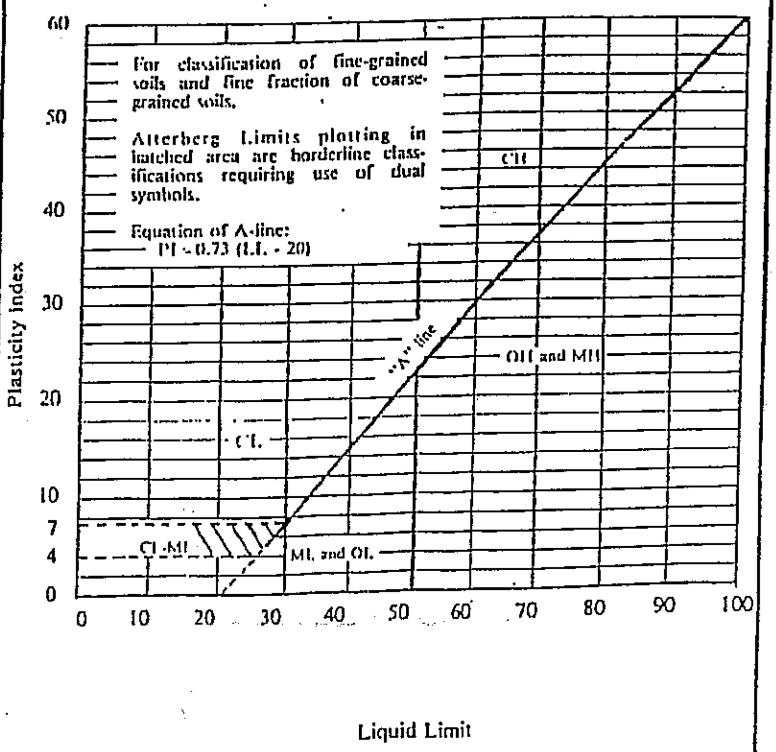
GRADATION CURVES

K & S ENGINEERS, INC.

Figure 5

UNIFIED SOIL CLASSIFICATION

K&S

Major Divisions			Group symbols		Typical names	Laboratory classification criteria		
Coarse-grained soils (More than half of material is *larger* than No. 200 sieve size)	Gravels (More than half of coarse fraction larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-grades gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 per cent........ GW, GP, SW, SP More than 12 per cent........ GM, GC, SM, SC 5 to 12 per cent........ *Borderline* cases requiring dual symbols	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM	d	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM	d	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half of material is *smaller* than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity			
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly organic soils		Pt		Peat and other highly organic soils			

Plasticity Chart

GENERAL QUALIFICATIONS

- This report has been prepared in order to aid in the evaluation of this property and to assist the architect and/or engineer in the design of this project. The scope is limited to the specific project and location described herein. In the event that any changes in the design or location of the building as outlined in this report are planned, we should be informed so that changes can be reviewed and the conclusions of this report modified as necessary. We recommend that we be authorized to review the project plans and specifications within our scope of work to confirm that the recommendations contained in this report have been interpreted in accordance with our intent. Without this review, we will not be responsible for misinterpretation of our data, our analysis, and/or our recommendations, nor how these are incorporated into the final design.

- The analysis and recommendations submitted in this report are based upon the data obtained from the soil borings performed at the locations indicated on the location diagram and from any other information discussed in this report. This report does not reflect any variations which may occur between these borings. In the performance of subsurface explorations, specific information is obtained at specific locations at specific times. However, it is a well-known fact that variations in soil and rock conditions exist on most sites between boring locations and also such situations as groundwater levels vary from time to time. The nature and extent of variations may not become evident until the course of construction. If variations then appear evident, it will be necessary for a re-evaluation of the recommendations of this report after performing on-site observations during construction period and noting the characteristics of any variations.

K & S Testing and Engineering Inc.
9715 Kennedy Ave. Highland, Indiana Phone: (219) 924-5231

GENERAL NOTES

IN ORDER TO PROVIDE UNIFORMITY THROUGHOUT OUR PROJECTS, THE FOLLOWING SYSTEM HAS BEEN ADOPTED TO DESCRIBE EACH SOIL SAMPLE. ROCK, SHALE AND OTHER MATERIALS WILL BE DESCRIBED IN DETAIL AS ENCOUNTERED.

CONSISTENCY OF COHESIVE SOILS

UNCONFINED COMPRESSIVE STRENGTH, Qu, TSF	CONSISTENCY
< 0.25	VERY SOFT
0.25 - 0.49	SOFT
0.50 - 0.99	MEDIUM
1.00 - 1.99	STIFF
2.00 - 3.99	VERY STIFF
4.00 - >	HARD

RELATIVE DENSITY OF GRANULAR SOILS

"N" VALUE *	RELATIVE DENSITY
0 - 3	VERY LOOSE
4 - 9	LOOSE
10 - 29	MEDIUM
30 - 49	DENSE
50 - >	VERY DENSE

*NUMBER OF BLOWS PER FOOT REQUIRED TO DRIVE A 2" O.D. SPLIT-SPOON SAMPLER USING A 140 LB. WEIGHT FALLING FREE FOR 30".

COLOR - AS DETERMINED ON THE FRESH MOIST SAMPLES

PREDOMINATE COLORS		SHADES	MODIFYING ADJECTIVES
BLACK	YELLOW	LIGHT	VARI-COLORED
BROWN	RED	DARK	STREAKED
GRAY	BLUE		MOTTLED

SOIL IDENTIFICATION TERMINOLOGY

GRANULAR SOILS

COMPONENTS	SIZE RANGE
BOULDERS	OVER 8 INCHES
COBBLES	8 INCHES TO 3 INCHES
GRAVEL	3 IN. TO #4 SIEVE (4.75 mm)
SAND	#4 SIEVE TO #200 SIEVE (0.075 mm)
SILT	PASSING #200 SIEVE (0.075 mm)

COHESIVE SOILS

DESCRIPTIVE TERM	PLASTICITY INDEX
CLAY OR ORGANIC CLAY	30
SILTY CLAY OR ORGANIC SILTY CLAY	8 - 30
INTERMEDIATE SOILS	
CLAYEY SILT	4 - 7
SILT	0 - 3

ESTIMATED PROPORTIONS OF MATERIAL SIZE BY WEIGHT IN PERCENT

TRACE	1 - 10
LITTLE	10 - 20
SOME	20 - 35
AND	35 - 50

WATER LEVELS ARE THOSE OBSERVED WHEN BORINGS WERE MADE, OR AS NOTED. POROSITY OF THE SOIL STRATA, VARIATIONS OF RAINFALL, SITE TOPOGRAPHY, ETC., MAY CAUSE CHANGES IN THESE LEVELS.