STRUCTURE GEOTECHNICAL REPORT

PHASE 1B GEOTECHNICAL REPORT
NEW I-74 BRIDGE OVER MISSISSIPPI RIVER
MOLINE, ILLINOIS TO BETTENDORF, IOWA
RAMP 6TH-D STRUCTURE
SECTION 81-1HVB
ROCK ISLAND COUNTY, ILLINOIS

PROPOSED STRUCTURE NO. 081-0187

PREPARED FOR

IOWA DEPARTMENT OF TRANSPORTATION
AND
ILLINOIS DEPARTMENT OF TRANSPORTATION

PREPARED BY

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Rock Core Photographs
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1.0 PROJECT INFORMATION

Introduction

A study for a new Moline Viaduct, a section of the proposed I-74 crossing of the Mississippi River at the Quad Cities, was conducted by CH2M HILL/JACOBS. The study results are presented in a Technical Memorandum titled "I-74 Iowa-Illinois Corridor Study-Moline Viaduct & Ramps, Proposed Span Arrangement, dated June 21, 2007. Figure 1 shows the structure location. Figure 2, Location Map, shows the overall Quad Cities area and Figure 3, Site Location Map, shows the alignment of both the existing and proposed I-74 Illinois Viaduct and Ramps along with the Ramp 6th-D location. The ramp structure is located in Sections 32 and 33, Township 18N, Range 1 West.

Purpose

This Structural Geotechnical Report (SGR) presents the results of the Phase 1B geotechnical investigation performed for the proposed Ramp 6th-D structure in Moline, Illinois. This report deals only with the Ramp 6th-D substructure units that will be constructed in Moline, Illinois. Five other reports will deal with the recommendations for the piers in the Mississippi River, the land based piers on the Bettendorf, Iowa side of the river, the Moline Main Line Viaduct, the 19th Street Bridge and Ramp 6th-C in Moline, Illinois. The purpose of this investigation was to determine the nature and condition of the subsurface materials, to describe the general site characteristics, and to formulate conclusions and recommendations for the preliminary design and construction of the ramp pier foundations and other subsurface related components of the proposed bridge structures.

Scope

The scope of this investigation includes reviewing available subsurface information for the project area, obtaining the required field and laboratory test data, performing the necessary engineering analyses, and formulating the conclusions and recommendations presented in this report. These conclusions and recommendations have been prepared considering the nature of the proposed project as presently planned and described in this report.

2.0 PROJECT DESCRIPTION

Site Description

The new Moline Viaduct and associated Ramp 6th-D are located in Moline, Illinois, extending from River Drive (Third Avenue) southward to a proposed abutment location just south of 7th Avenue. The alignment continues southward and will encompass a new I-74 overpass of 19th Street. The proposed alignment is located just east (upstream) of the existing I-74 alignment through downtown Moline.

Proposed Ramp 6th-D

The proposed Ramp 6th-D will be an on-ramp from 6th Avenue to WB I-74. Ramp 6th-D will consist of a 3-span structure extending from the abutment which will be located near the intersection of 21st Street and the alley between 4th and 5th Avenues to the existing grassy area between River Drive and the existing on-ramp to WB I-74 (at the east side of the Moline Viaduct Pier No. 2). The ramp will cross over the existing Sivyer Steel Corporation Building located at the end of 21st Street at 4th Avenue. The structure will cross over several existing infrastructure features including 4th Avenue, an existing BNSF railroad track, and existing Ramps 3-N and N-3. Existing Ramps 3-N and N-3 will be removed after construction of the new I-74 Moline Viaduct.

The Ramp 6th-D structure has a total length of approximately 501.2 feet and has span lengths of 159.1 feet (Abutment to Pier 4D), 187.2 feet (Pier 4D to Pier 3D), and 154.9 feet (Pier 3D to Pier 2), respectively. Figure 3 shows a general plan view of the proposed ramp.

The abutment fill height at the abutment backwall at Ramp 6th-D is approximately 24 feet. The abutment will be a typical IDOT stub abutment with traditional spill slopes on the west and north ends and an MSE wall section on the east side. The MSE wall section is addressed in another SGR (see Reference 14).

Preliminary AASHSTO Groups foundation loadings were not available for this ramp.

Potentially Contaminated Site

A Preliminary Environmental Site Assessment (PESA) was completed on the Illinois side of the new I-74 project corridor in August, 2002 by the Illinois State Geological Survey (ISGS). The Ramp 6th-D footprint will cross over the property identified as Riverside Products, 400 21st Street, Moline, IL and be located just east of the Deere & Co. parking lot located between 4th and 5th Avenues and 21st Street to the existing I-74 viaduct. In the final Environmental Impact Statement (FEIS), the Riverside Products property was identified as a site contaminated by VOC's and metals from the machine shop and that any excavation or grading below 6 feet within 50 feet of soil boring 1314-15 would require the management of special waste. The Deere & Co. parking lot was found to be contaminated by VOC's and metals from machine shops and metals from the blacksmith and grinding facilities of a former industrial site and that any excavation or grading will require the management of special waste.

3.0 SUBSURFACE INVESTIGATION

Phase 1A

A subsurface investigation was conducted during Phase 1A of this project from October 2005 through December 2005 to assist in the conceptual study/selection of feasible foundation types. Three borings (PRMPD-01, -02 and -03) were drilled near the proposed footprint of Ramp 6th-D. These boring logs are included in the Appendix as a part of this report.

Phase 1B

Three borings were drilled during the Phase 1B Geotechnical Investigation to determine the nature and condition of the subsurface materials along the proposed Ramp 6th-D alignment. Boring PRMPD-05 was drilled in the corner of the Deere Co. parking lot near the proposed abutment location. Due to overhead wires configurations, the boring location had to be adjusted to the south and west in order to drill safely. Boring PRMPD-06 was drilled in the south lane of 4th Avenue at the proposed Ramp footprint. Boring PRMPD-04 was drilled in a grassy area between existing Ramps 3-N and N-3. The number of borings selected for this preliminary phase was based upon input and approvals from Iowa DOT and CH2M Hill. The locations of the borings are shown on the Boring Location Plan, Figure 3. The borings were located in the field by using a hand held GPS unit and measuring off of existing landmarks. Elevations were interpolated from project .tin files. Datum for the boring locations was the Iowa South State Plane Coordinate System 1402 and NAVD 88.

The borings were drilled during the period September 4-8, 2007 by Terracon Consultants Inc. of Naperville, Illinois as part of the Phase 1B Geotechnical Investigation for the new I-74 Illinois Approach. The borings were drilled using a CME 550 ATV rig owned and operated by Terracon. A Jacobs engineer provided on-site supervision throughout the boring operations, and prepared the boring logs found in the Appendix to this report.

The borings were typically advanced to a depth of 25 feet into bedrock. The total depth of the three borings ranged from approximately 42 to 43 feet below ground surface. The borings were advanced through the overburden soils to top of bedrock using 3-3/4 inch inner diameter hollow stem augers and then extended to the desired depth into bedrock using NQ-wireline rock coring methods. A table summarizing the drilling programs is presented as Table 1.

Standard Penetration Resistance Tests (ASTM D1586) were conducted in the overburden materials of each boring using standard split-spoon samplers and a CME automatic drive hammer. In general, SPT's were conducted at 2.5-foot intervals in the upper 30 feet of boring (or to refusal, whichever occurred first) and at 5-foot intervals thereafter to bedrock or bottom of boring. The samples obtained were placed in plastic bags and delivered to Terracon's laboratory. In addition, relatively undisturbed samples (Shelby tube samples) were obtained of some of the cohesive soil layers, where applicable. Core samples (NQ size) of the underlying bedrock were obtained and placed in wooden boxes for later laboratory testing. The core boxes were removed each day from the site and delivered to Terracon's office in Bettendorf, IA. All recovered rock core samples were photographed each day in order to provide a permanent record. Photographs of the rock cores collected are found in the Appendix.

Samples of cohesive soils encountered in the borings were typically tested for strength using both a pocket penetrometer and a Rimac Spring Tester. Test results are included in the boring logs. The boring logs are attached to this report. We have also included the log for Boring VIAIL-105 which was drilled at Pier 1 of the main viaduct structure.

As part of the test drilling program, Jacobs provided field personnel to operate a photoionization detector (PID) to detect the presence of any volatile organic compounds (VOC's) in soil obtained from the geotechnical borings at levels requiring segregation and drummed storage of auger cuttings pending sampling and analysis or other method to determine appropriate disposition. To that end, a PID was used for headspace analysis of soil during drilling operations; scanning split spoon samples to identify any anomalous zones; sampling the borehole opening between split spoon sampling and coring runs as a general indication of the presence of VOC's; and measuring of VOC concentrations in the breathing zone during drilling/coring operations. In addition, a triple gas meter was used to scan for combustible gases at the top of the auger space during drilling operations.

Table 1 - Summary of Ramp 6th-D Phase 1A and 1B Boring Program

Boring No.	Date Drilled	Ground Elev.	Soil Thickness (ft)	Weathered/Soft Rock Thickness (ft)	Top of Rock Core Depth (ft)	Top of Rock Core Elev. (ft)	Bottom of Hole Depth (ft)	Bottom of Hole Elev (ft)
Phase 1A								
PRMPD-01	10/31/2005	569.9	11.0	5.0	16.0	553.9	18.0	535.9
PRMPD-02	11/01/2005	574.2	13.5	-	13.5	560.7	18.0	542.7
PRMPD-03	11/01/2005	573.5	13.0	15.5	-	-	-	-
Phase 1B								
PRMPD-04	9/4/2007	570.5	13.6	2.2	15.8	554.7	41.8	528.7
PRMPD-05	9/7/2007	575.1	13.5	3.2	16.7	558.4	42.6	532.5
PRMPD-06	9/5/2007	573.4	13.8	2.1	15.9	557.5	42.7	530.7

<u>Laboratory Testing</u>

The laboratory testing program was directed toward establishing the classification and evaluating the general engineering properties of the subsurface materials. The testing was conducted by Terracon Consultants of Bettendorf, IA, and their subsidiary H.C. Nutting Company of Cincinnati, Ohio, in accordance with ASTM specifications. Laboratory tests were performed to determine the physical and engineering characteristics of selected split-spoon and NQ size rock core samples obtained during the subsurface investigation program. The testing program included moisture content determinations, Atterberg limits, dry density, and unconfined compressive strength on soil samples, and uniaxial compression tests, dry density determinations, Moh's Hardness, and moisture content on selected rock core samples.

The results of all laboratory tests have been summarized and are included in the Appendix to this report.

4.0 SUBSURFACE CONDITIONS

Subsurface Materials

A subsurface profile along the proposed Ramp 6th-D structure alignment is presented as Figure 4. In general, all three of the Phase 1B borings encountered about 13 to 14 feet of soil cover overlying bedrock. Borings PRMPD-05 and PRMPD-06 generally had the same depositional sequence except for the soil components. Soils ranged from an upper layer(s) of black silt with rubble at PRMPD-05 to brown sand in PRMPD-06 overlying layers of soft to medium stiff silty clay. Boring PRMPD-05 encountered a nearly 5-foot thick layer of wet fine-grained loose sand at 8.5 to 13.5 feet below ground surface. Boring PRMPD-05 encountered a thin layer of greenish gray severely weathered shale and a 1.3-foot thick layer of sandstone overlying sound limestone, while Boring PRMPD-06 encountered a nearly 2-foot thick layer of weathered limestone overlying sound limestone.

Limestone bedrock was encountered at approximate El. 558.4 ft at Borings PRMPD-05 (Abutment) and at approximate El. 557.5 ft at PRMPD-06 (in 4th Avenue between Piers 4D and 3D) and extended for full depth of boring. The upper limestone layers were typically fine to medium grained, with occasional to some thin green shale partings and seams and some stylolites. The rock was typically hard, thin to medium bedded with predominantly horizontal to very low angle fractures, and fresh to slightly weathered. A second layer of moderately hard, medium to dark gray, fine to coarse grained limestone that was pitted and exhibited “birdseye” texture was encountered in Boring PRMPD-06 at a depth of 29.5 to 40 feet below ground surface (approximate El. 544 to El. 533.5 ft). Rock quality designations (RQD’s) of the limestone ranged from 33 to 100 percent and averaged about 80 percent. Results of two uniaxial compressive strength tests on samples of the upper limestone ranged from 11,000 to 15,000 psi.

Boring PRMPD-04 (at Pier 3D) encountered about 13.5 feet of fine-grained, uniform-sized (well sorted) sandstone extending from approximate El. 554.7 to El. 541.3 overlying limestone. The sandstone was typically soft, moderately well to well cemented, and had non-distinct horizontal fractures at thin to medium bedded spacing. RQD’s of the sandstone ranged from 49 to 78 percent and averaged about 67 percent. One sample of the sandstone core had a uniaxial compressive strength of 4,470 psi but test results from other sandstone core samples obtained from Phase 1B borings indicate the sandstone strength ranges from about 1,500 to 4,250 psi and averaged about 3,090 psi.

Boring PRMPD-01 (near Pier 2) was drilled during the Phase 1A borings and encountered approximately 11 feet of soil including, in descending sequence: clayey silt, clayey sand, and poorly graded sand. An intermediate 5-foot thick layer of shale extended to a depth of about 16 feet below ground surface (approximate El. 554 ft). Bedrock underlying the shale unit consisted of gray, fine to medium grained sandstone for full depth of boring. This sandstone was noted to be slightly to moderately weathered, very weak rock with no apparent bedding (medium to massive).

A graphical plot of Rock Quality Designation (RQD) vs. Elevation for the Ramp 6th-D borings is presented in the Appendix. The plot shows the RQD value at the mid-elevation of each core run drilled in the Ramp 6th-D borings for a given location – i.e. abutment and/or pier location. It is noted that all of the borings show a similar trend of increasing RQD value with depth, with RQD's ranging from 20 to 70 percent in the upper 10 feet of rock (except for at the Pier 1 boring, which had higher values) and then increasing generally to 70 to 100 percent below 10 feet depth into rock.

Areas Requiring Additional Investigations

For final design, it is recommended that a boring be drilled at Pier 4-D once permission to gain access to the property is obtained and the existing building is demolished.

In addition, an Environmental Investigation needs to be performed to determine the extent of contamination at Riverside Products at 400 21st Street near location of Pier 4-D. This investigation should address the quantity of contaminated material to be excavated; disposal methods and available landfills; special handling requirements, certifications and permits; water treatment method from water collected from excavations; site monitoring requirements during construction; and requirements for personnel protection and monitoring.

Groundwater Levels

Groundwater levels were noted from water on drill rods during the course of the Phase 1B drilling operations. In general, water levels noted during drilling in the borings along the proposed ramp alignment ranged from approximate El. 559.5 to El. 564 ft.

During the time of drilling, the Mississippi River level was at approximate El. 561.0 ft. The river levels are controlled by the downstream Mississippi River Lock and Dam No.15 at Rock Island, Illinois. The important water elevations for this project are presented in Table 2 below:

Table 2 - Important Mississippi River Water Elevations

Case	Elevation (NGVD 1912), ft
Normal Pool	561.0
Cessation of Navigation	562.5
2% Flowline	563.5
100-Year Flood	569.6
500-Year Flood	572.2
High Water of Record	569.7

Note: The following conversions apply to the project location:
NGVD 1929 = NGVD 1912 - 0.510 ft
NAVD 88 = NGVD 1912 - 0.727 ft

Groundwater rises when the adjacent Mississippi River rises. Construction of Pier 2 can be influenced by river levels if spread footings are used to support the proposed Ramp 6th-D/Viaduct structure.

Seismicity

Seismic loads will not be considered in preliminary design due to the low seismicity of the project area. For final design, seismic forces will be computed and applied in accordance with AASHTO LRFD for Seismic Performance Zone 1 (per IDOT Seismic Design Guide p. 3.15-82).

The Ramp 6th-D profile is considered Site Class C per AASHTO (2008 Interim Revisions), Section 3.10.3.1, because of the shallow depth to bedrock and due to the fact that all foundations will be supported on bedrock. The acceleration coefficient, A, to be used in the application of AASHTO LRFD criteria is 3.5 percent for a 1,000 year return period according to Figure 3.10.2.1-3 in the AASHTO LRFD (2008 Interim Revisions).

Scour

Scour is not applicable at these structures.

Mining Activity

A review of the Illinois State Geologic Survey (ISGS) maps indicates no past mining activities in the area of the proposed Ramp 6th-D footprint.

5.0 BRIDGE FOUNDATIONS

Limitations

These recommendations have been developed to aid in the preliminary design and construction of the bridge crossing foundations affected by the subsurface materials. These recommendations are limited to the scope of work and understanding of the proposed structures as detailed in this report. Significant changes in the anticipated project scope may invalidate these conclusions and recommendations. If, during construction, subsurface conditions different from those encountered in the borings are observed, or appear to be present beneath excavations, Jacobs should be advised at once so that Jacobs can review these conditions and reconsider these recommendations, when necessary.

Rock Mass Strength

The rock cores obtained from the exploration program were classified using the rock mass rating system (RMR). The RMR classification system is a widely used procedure for determining rock mass quality. This system considers the properties and conditions of the rock/rock mass. The RMR is calculated as the sum of the individual ratings for each of the five parameters minus an adjustment made for joint orientation. In general, the rock classified as Class III, Fair Rock to Class II, Good Rock per Table 10.4.6.4-3 of 2006 AASHTO LRFD.

The shear strength of the fractured rock masses was evaluated using the Hoek and Brown criteria as suggested by 2006 AASHTO LRFD. The estimated range of shear strength parameters for Piers 2, 3D and 4D are presented in Table 3.

Table 3 - Shear Strength Parameters

Material	Friction Angle (degs)	Cohesion (ksf)
Sandstone	48	1.8
Limestone	46.6 – 51.4	3.2-22.2

Rock Mass Deformation

Elastic moduli were determined or estimated from intact modulus of rock core samples, and from the RMR rating per 2006 AASHTO LRFD. Engineering judgment was used to determine which moduli to use in settlement computations. Design parameters selected for Piers 2, 3D and 4D are included in the Appendix. In addition, elastic moduli estimated from the RMR system and unconfined compression tests for all test borings are included in the Appendix.

Abutment 6th-D

Preliminary plans indicate the spill slopes will be constructed at an inclination of 2H:1V. The stability of the abutment was evaluated using SLIDE 5.0. We assumed the compacted embankment material would have an undrained shear strength of 1,000 psf, a value commonly used on IDOT projects. Our analyses indicate the global factor of safeties are 1.50 and 1.39 for the static and seismic cases, respectively.

In CH2M Hill's report titled "Structure Geotechnical Report Ramp 6th-D Retaining Wall, Structure No. 081-6012" dated May, 2008, (Reference 14) the results of global stability and settlement analyses are discussed for the 081-6012 wall alignment, which will be constructed along the east side of the Ramp 6th-D bridge abutment. The results of the analyses are presented below in the sections "Global and External Stability of MSE Wall" and "Settlement".

Global and External Stability of MSE Wall

Stability analyses were performed on models developed using available subsurface data and geometry from proposed cross sections. The analyses involved evaluation of the wall resistance against sliding (safety factor of 1.25), overturning (safety factor of 2.0), global failure (safety factor of 1.3) and bearing failure (safety factor of 2.5) and were performed in accordance with the FHWA manual on MSE walls (Reference 15). Results of global stability analyses are presented in Table 4; the results of external stability analyses (sliding, overturning, bearing) are contained in Table 5.

According to FHWA guidelines the width of the reinforced zone for a MSE wall should be a minimum of 70% of the MSE height, or a length sufficient to satisfy external and global issues. At the "minimum 70%" width, the analyses indicate that the wall will have adequate mass to resist both sliding and overturning.

However, global stability and/or bearing capacity issues still remained on two of the three models analyzed. Subsequent analyses indicate that reinforced zones on the order of 1.0 to 1.3 times the retained height (lengths as great as 32 feet) are necessary, with the required length varying along the alignment, dependant on subsurface conditions and retained height. Any reduction in reinforcement length will require soil strength improvement (staged construction, ground improvement, etc.) and/or a reduction in fill loading (lightweight fill, wall height reduction).

TABLE 4 - GLOBAL STABILITY ANALYSES RESULTS FOR MSE WALL SECTIONS

Location of Slope Analyzed	Loading Case	Failure Mode	FS with Recommended Shear Strength & Full MSE Section	B_{MSE} [B] (ft)	B_{MSE}/H_{MSE} [C] (%)
Station 438+00	Undrained	Circular	1.37	29	104
		Block	1.30	29	104
	Drained	Circular	1.71	29	104
		Block	1.75	29	104
Station 439+50	Undrained	Circular	1.42	32[A]	133
		Block	1.40	32[A]	133
	Drained	Circular	1.98	32[A]	133
		Block	2.04	32[A]	133
Station 440+50	Undrained	Circular	1.89	12	70
		Block	1.54	12	70
	Drained	Circular	1.89	12	70
		Block	1.54	12	70

[A] Length controlled by External Stability Analysis

[B] B_{MSE} = Width of Reinforced Zone

[C] H_{MSE} = Height of MSE Wall Section (Including Embedment)

TABLE 5 - EXTERNAL STABILITY ANALYSES RESULTS FOR MSE WALL SECTIONS

Wall Station Analyzed	Height (ft)	Embed -ment (ft)	H_{MSE} (ft)	B_{MSE} (ft)	B_{MSE}/H_{MSE} (%)	Bearing F.S.	Sliding F.S.	Overturning F.S.
438+00	24	4	28	29[B]	104	3.4	2.7	8.1
439+50	20	4	24	32	133	2.5	1.3	12.9
440+50	13	4	17	12	70	3.5	1.8	3.3

[B] Length controlled by global stability analyses.

In addition to the above-described calculations, walls bearing on cohesive soils were also examined for local shear (lateral squeeze) failure. Cohesive soils encountered in the borings drilled on the northern portion of the wall alignment were commonly weak, and often WOH. Given the amount of fill to be retained, these soils, in their current state, have inadequate resistance against local shear. Consequently, the soils in these areas will need to be improved by one of the construction alternatives presented in Section 5.1 of Reference 14. Conversely, weak cohesive soils were not encountered at the southern portion of the alignment, therefore similar local shear issues did not exist.

If staged construction, ground improvement, and/or lightweight fill are not suitable, and the wall height cannot be reduced, the MSE wall selection should be re-evaluated and compared with a CIP wall supported on a deep-foundation system. A deep-foundation-supported CIP wall may be a more suitable system at this location. However, settlement of the considerable fill behind the CIP wall footing/heel will not be supported by the CIP deep foundations and, hence, staged construction, ground improvement, and/or lightweight fill of the embankment will still be required."

Settlement

According to Reference 14, "the most compressible soils appear to exist at the north end of the alignment, where coincidentally the highest proposed embankment/walls will be placed. Our analyses estimate settlements on the order of 7 inches at the face of the wall at the northern end of the alignment and with settlements on the order of 15 inches occurring within 10 feet (behind the wall face). Settlement magnitudes are anticipated to decrease to the south, given the presence of less-compressible soils and lesser fill heights. Differential settlements (for both north and south) may approach total settlements.

If these settlements are not acceptable, it is recommended that a multi-stage construction program be pursued, as discussed in Section 5.1 of Reference 14. Staged construction will result in considerably lower settlement magnitudes. The construction involves fill placement in several lifts. Extensive monitoring, discussed in Section 5, will be required during and after placement of each fill lift to ensure that the underlying soils do not become unstable and that settlement has been completed prior to placement of the next lift. Assuming staged construction, it is estimated that the settlement incurred will be on the order of 2 to 4 inches.

While a majority of settlement will likely occur during construction, settlement may continue after fill placement, with almost all settlement occurring within 4 months of construction. The magnitude and rate of settlement is a major factor in the selection, design, and construction of the retaining wall. Although the sub-soils can be improved by a variety of methods, it is recommended that the selection of a MSE wall, accompanied by appropriate construction sequencing and methods, may provide adequate performance with a reasonable risk to the owner."

When settlement is greater than 0.4 inches, it must be accounted for as downdrag or negative skin friction for pile foundations. The downdrag geotechnical loss will account for the loss of maximum factored resistance available as well as the additional soil load.

Driven Piles

Piers 3-D and 4-D and the abutment are recommended to be founded on driven H-piles bearing on the underlying bedrock. Driven piling (8BP36, 10BP42 and 10BP57) was used on several bents of the existing viaduct where the depth to bedrock was greater than 15 feet.

For preliminary design, the initial pile layout should be based upon using the IDOT Pile Data Guidelines for 2007 Standard Specifications dated November 17, 2006. Steel HP piles (AASHTO M270 Grade 50) driven to refusal should be used. Metal Shell Piles, Precast Concrete Piles and Timber Piles would not be considered viable options due to the damage potential during driving as bedrock approaches. Pile shoes should be used to protect the piles when driving into the weathered rock zone. Typical pile capacities for ASD and LRFD design are shown in Table 6.

Table 6 - Pile Capacities

Pile Section	Pile Area (sq. in.)	Maximum Nominal Required Bearing (Kips)	Allowable Resistance Available (Kips)	Maximum Factored Resistance Available (Kips)
HP10X42	12.4	335	112	167
HP10X57	16.8	454	151	227
HP 12X53	15.5	419	139	209
HP12X63	18.4	497	165	248
HP 12X74	21.8	589	196	294
HP12X84	24.6	664	221	332
HP 14X73	21.4	578	192	289
HP 14X89	26.1	705	235	352

For pile foundations which specify a Nominal Required Bearing above 600 kips, in lieu of hammer selection criteria and use of the FHWA Modified Gates formula specified in Section 512 of the Standard Specifications, the contractor is required to conduct a wave equation analysis to establish driving criteria. However, since the piles are so short and the driving time is minimal, the use of HP14X89 piles or larger is not cost effective to warrant a wave equation analysis.

The maximum nominal required bearing (NRB) and factored resistance available (FRA) were determined as per IDOT LRFD Pile Design Guides.

$$NRB = 0.54xF_YA_S$$

$$FRA = NRB\ (\phi_G) - (DD+Scour+Liq.)x(\phi_G)x(\lambda_G) - DDx(\gamma_p)$$

Maximum Factored Resistance Available (FRA) for abutment should be reduced for downdrag force. The downdrag force is determined by multiplying the values given in the table below by the perimeter of the corresponding pile. The Load factor γ_p applied to the downdrag force shall be as recommended by IDOT or as per AASHTO (Table 3.4.1-2).

Table 7 – Downdrag Force for Abutment

Depth El., ft	Downdrag Force, kips/ft
*587 to 575	11.0
575 to 567	10.0

The downdrag force is significant and will reduce the maximum FRA. As discussed under the SGR for the MSE wall on the east side of the abutment, staged construction, ground improvement, and/or lightweight fill of the embankment will be required to minimize settlements and improve the stability of the abutment MSE wall. During final design it should be determined if there is sufficient FRA and the number of piles at the abutment are reasonable prior to determining if improvements in coordination with the design of the MSE wall needs to be made to the underlying soils to limit the settlement to less than 0.4 inches.

Anticipated pile tip elevations are:

Table 8 - Pile Tip Elevations

Pier No.	Tip Elev.(ft)	Foundation Material
3D	554.7	Sandstone
4D	557.5	Limestone
Abutment	558.4	Sandstone

For final design, point bearing piles on rock should be designed according to the 2006 LRFD Section 10.7.3.2.

Preliminary lateral analysis at Pier 3D and 4D was performed using LPILE 5.0 (computer program developed by Ensoft Inc,). The LPILE results for Pier 3D indicate the embedment of 10.5 ft will not provide adequate embedment to develop fixity. We recommend the piles should be set in rock as specified in Bridge Manual Section 3.10.1.10 or driven on a batter. The results of the piles at Pier 4D indicate the embedment of 10.5 ft is adequate for maximum lateral load of 4 kips per pile. The LPile results are attached for reference. During final design, a more detailed soil-structure analysis should be performed.

Drilled Shafts

As an alternate to driven piles and spread footings, drilled shafts can be considered at Piers 3D and 4D. AASHTO specifies that drilled shafts be designed to have adequate axial and structural resistances, tolerable settlements, and tolerable lateral displacements.

A single, two and four shaft layout under each column should be evaluated during final design. Where fixed piers are used resulting in high moments due to thermal movements, two to four shafts may be needed to resist the applied loadings. If a single shaft is used beneath the planned oblong pier column, a shaft diameter on the order of 9 feet may be required. For a two shaft supported column, drilled shafts on the order of 4 to 6 foot diameter are expected. A four shaft supported column would have shafts on the order of 3 to 4 foot diameter. Rock socket lengths would typically be on the order of 2 to 3 times the shaft diameter.

A mono column/drilled shaft substructure presents some benefits, namely:

a. Minimal contaminated soil and water disposal as compared to spread footings and driven pile groups.
b. No sheeting or shoring is required.
c. No pile caps or large footing is required.
d. Minimizes or eliminates conflicts with existing foundations.
e. Required limited space and provides maximum flexibility for construction staging.
f. No intensive handwork as required by spread footings.
g. Reduced uncertainty - final depth to quality rock determined during construction, quantity of manual preparation of rock surface, quantity of contaminated soil, groundwater level, dewatering, time for construction, etc.

Axial resistances of drilled shafts socketed into bedrock were evaluated using the methodology presented in 2006 AASHTO LRFD for determining side and tip resistance (Equations 10.8.3.5.4b-1, 10.8.3.5.4c-a, and 10.8.3.5.4c-2). The following ultimate side and tip resistances were calculated and are presented in Table 9 for several pier locations.

Table 9 - Drilled Shaft Unit Side and Unit Tip Resistance

Pier	Material Type	qs (psi)	qp (psi)
2/3D/4D	Sandstone	150	350

Note: qs – ultimate skin resistance
qp – ultimate tip resistance

If drilled shafts are preferred, a cost analysis should be conducted for comparison with spread footings and driven piles. Horizontal movements and stresses induced by lateral loads and applied moments should be evaluated using the methods in GROUP 6.0/7.0

or FB MultiPier software packages. Determination of whether a rock socket is necessary should be evaluated in final design. The effects of group interaction should be accounted for when analyzing the drilled shaft group horizontal response. Hyperbolic p-y curves can be developed for the rock formations using criterion proposed by Ke Yang (Reference 4) that uses theoretical derivations and numerical analysis results.

Abutment Earth Pressures

The proposed Abutment will be restrained at the top with MSE wall straps. However, the stub abutments will probably develop active pressure. The following parameters should be used to determine the static earth pressure on the abutment wall:

Table 10 - Abutment Earth Pressure Parameters

Parameter	Recommended Value
Unit Weight	125 pcf
Angle of Internal Friction, φ	34
Angle of Wall Friction, δ	17

Backfill behind the walls should be granular fill according to the latest Illinois DOT standard details.

Conclusions and Recommendations

Based on the analyses and subsurface conditions, conclusions and recommendations are summarized as follows:

- Parameters are provided for the analyses and design of spread footings and driven piles.
- Downdrag forces will develop on the abutment piles and will impact the maximum FRA.

6.0 CONSTRUCTION CONSIDERATIONS

Foundation Construction

The foundation types and bearing elevations closely match the foundations employed when constructing the existing viaduct. In general, the foundation construction and excavation and backfill should follow the plans and Illinois DOT Standard Specifications/Supplemental Specifications.

It is anticipated that the soils at the site can be excavated using conventional excavation equipment. For all temporary excavations, space permitting, slopes in soil should be excavated to an inclination no steeper than 2 Horizontal : 1 Vertical. Temporary slopes may experience some sloughing and the Contractor should take caution and follow the appropriate OSHA regulations. Where space is limited, shoring will need to be installed.

At Pier 2, River Drive could be impacted if an open cut excavation with side slopes is made.

Further environmental investigations should be conducted to determine whether the materials excavated in the areas identified in the FEIS will need to be disposed in special landfills.

Driven Pile Construction

As stated in 2006 AASHTO LRFD, care should be taken in driving piles to hard rock to avoid tip damage. The piles on this project will be relatively short. Piles should have a minimum yield strength of 50 ksi. Pile tips should be protected using a cast steel tip.

Since the piles are so short, dynamic testing is not recommended. Piles should be driven in accordance with the Illinois Department of Transportation Standard Specifications. The specifications specify the use of the FHWA Modified Gates formula.

Test Piles should be driven at the abutment and each bent where piles are specified.

Drilled Pier Construction

The performance of drilled shafts is sensitive to the installation methods. Drilled shaft construction should follow the applicable sections of the Illinois DOT Standard Specifications for Concrete Drilled Shafts (SS-01032). The following are issues to be considered during final design in preparing the specifications and contract documents should drilled shafts be selected:

- Editing the Standard Specification for drilled shaft construction may be required.
- All drilled shafts should have Crosshole Sonic Logging (CSL) tubes installed in them.
- All CSL tubes should be filled with water within two hours of concrete placement, in order to prevent debonding between the CSL tubes and the surrounding concrete. CSL tubes should be covered after being filled with water to keep debris from blocking the tubes.
- Either the State or Contractor should hire a qualified CSL testing company to perform and interpret the results of the CSL testing.
- It is anticipated that the shafts would be installed using soil augers and rock core barrels/rock augers. Temporary casing will need to be installed in the soil overburden. Water infiltration into the shaft excavation should be anticipated.

Drilled Shaft Testing

CSL testing is the preferred testing method during construction to ensure the shaft concrete is free of defects and the bottom of the shaft is sound.

7.0 FINAL DESIGN CONSIDERATIONS

Final design will be performed using 2006 AASHTO LRFD specifications. The information presented in this report can easily be incorporated into LRFD for strength and service limits. Resistance factors for design of shallow and drilled shaft foundations should be selected from AASHTO LRFD Tables 10.5.5.2.2-1 and 10.5.5.2.4-1. For driven piles, References 10 and 11 provide guidance.

As recommended elsewhere in this report, an additional boring at Pier 4-D should be drilled.

Environmental investigations will be required at the contaminated areas (Riverside Products) identified in this report and in other areas identified in the FEIS. Contaminated areas may have a major impact on project construction, cost and schedule. Disposal methods, material quantities, permitting, treatment and disposal of water from excavations, site monitoring activities and personnel protection will need to be evaluated during final design.

A detailed constructability comparison of the three foundation system alternatives should be conducted during final design to ensure the selected foundation system is compatible with the proposed staging phases. This comparison should include but not be limited to construction time, traffic impacts, safety, and risk/uncertainty.

8.0 REFERENCES

1. Technical Memorandum, I-74 Iowa-Illinois Corridor Study – Moline Viaduct & Ramps, Proposed Span Arrangements, dated June 21, 2007.

2. AASHTO LRFD Bridge Design Specifications, 2006 Interim Revisions, Third Edition.

3. AASHTO LRFD Bridge Design Specifications, 2008 Interim Revisions, 4th Edition, 2007.

4. AASHTO Standard Specifications for Highway Bridges, 17th Edition, 2002

5. Analysis of Laterally Loaded Drilled Shafts in Rock, A Dissertation Presented to The Graduate Faculty of The University of Akron, In Partial Fulfillment for the Degree Doctor of Philosophy, by Ke Yang, May 2006.

6. JACOBS Technical Memorandum, I-74 Iowa-Illinois Corridor Study, Bridge Design Criteria, dated November 14, 2005.

7. GROUP 6.0/7.0 for Windows, Analysis of a Group of Piles Subjected to Axial and Lateral Loading, Ensoft, Inc., February 2003/February 2006.

8. LPILE 5.0 for Windows, a Program for the Analysis of Piles and Drilled Shafts Under Lateral Loads, July 2004.

9. FB-MultiPier, Bridge Software Institute.

10. 2007 Illinois DOT Standard Specifications for Roadway and Bridge Construction.

11. IDOT Pile Data Guidelines for 2007 Standard Specifications, Bridge Memorandum 06.2, November 17, 2006.

12. IDOT Bridge Manual, May 2008.

13. Interstate 74 Quad Cities Corridor Study, Scott County, Iowa and Rock Island County, Illinois, Final Environmental Impact Statement and Statement 4(f).

14. CH2M Hill, Structure Geotechnical Report, Ramp 6th-D Retaining Wall, Structure Number 081-6012, I-74 Iowa to Illinois Corridor Study, FAI Route 74, Section 81-1HVB, Ramp 6th-D Station 437+55.99 to 442+49.70, Rock Island County, Illinois, P-92-032-01, May 2008. Prepared for Illinois Department of Transportation.

15. "Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Design and Construction Guidelines," FHWA-NH-00-043, March, 2001.

Appendix

Figures

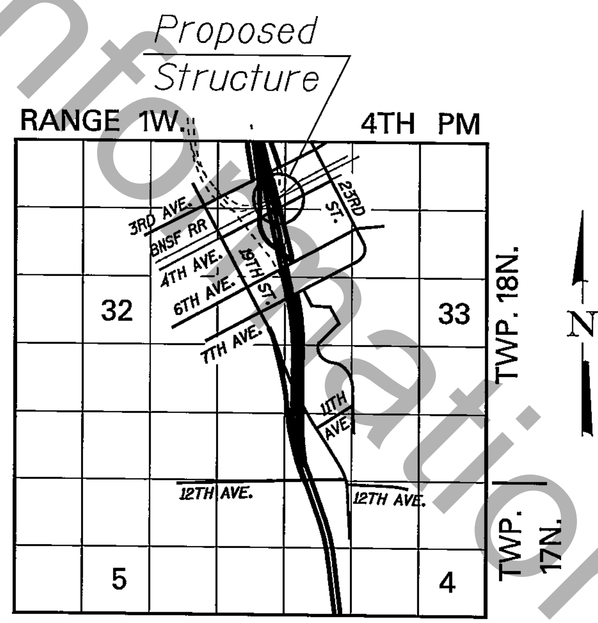


Figure 1
Ramp 6th D Structure Location Map
I-74 Iowa-Illinois Corridor Study
Map of Township 18N, Range 1W
Section 32 & 33

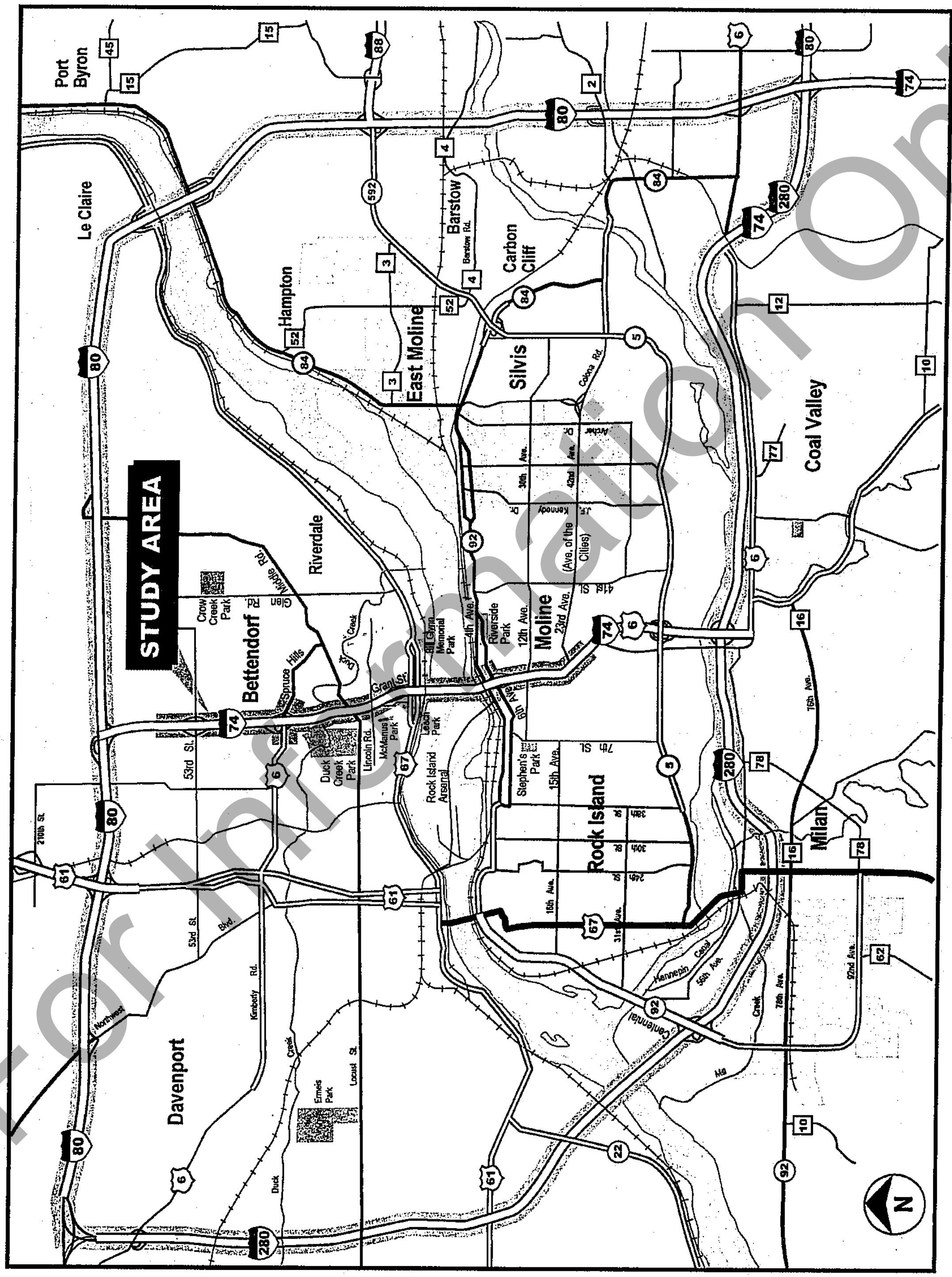
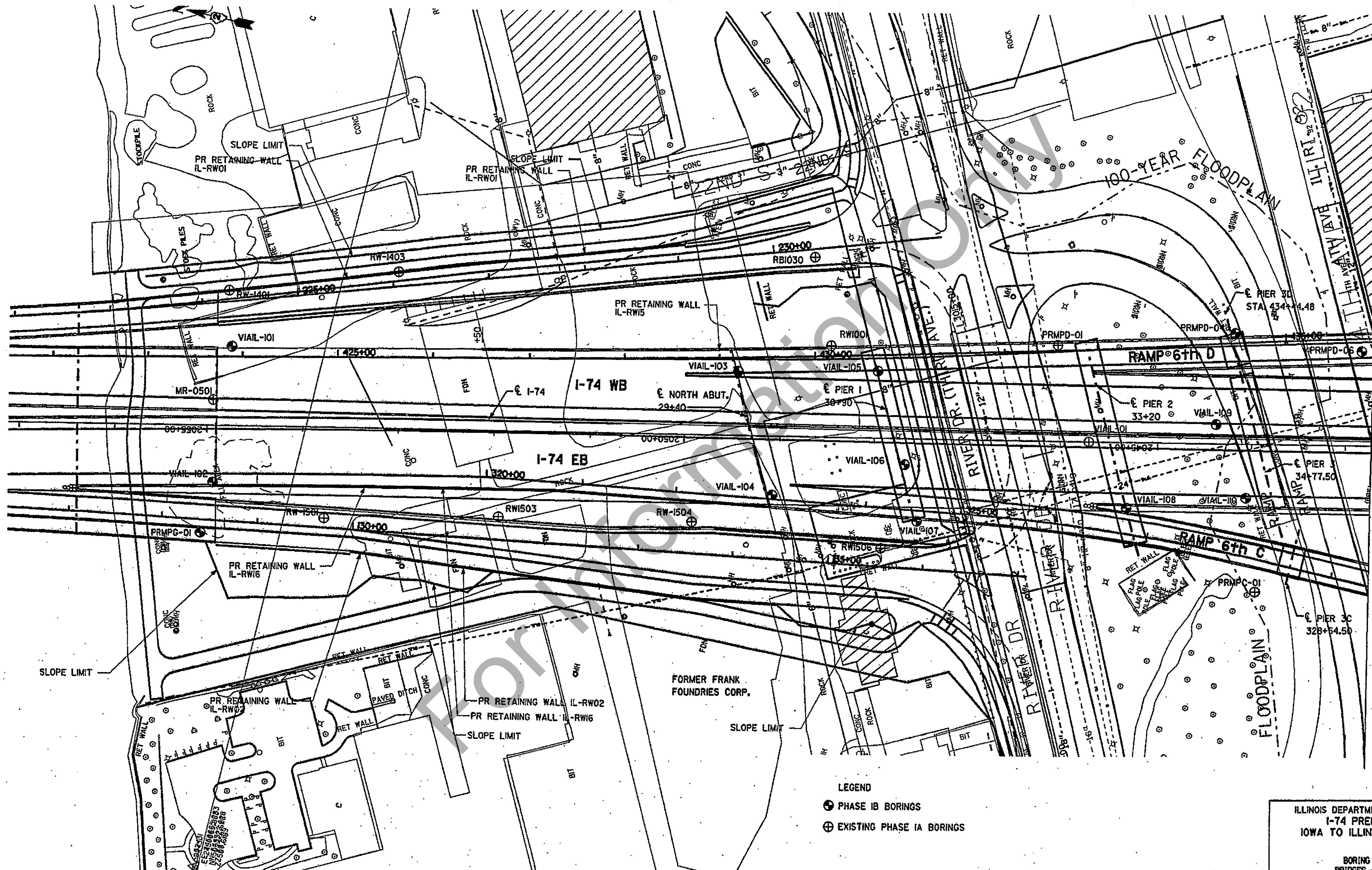


Figure 2
I-74 Iowa - Illinois Corridor Study
Location Map

T158835.AA.ES.06 Fig 3-2(Loc_Map) 3-19-03 lg

Figure 1 I-74 Iowa-Illinois Corridor Study
Location Map

F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
74		ROCK ISLAND		
STA.		TO STA.		
FED. ROAD DIST. NO. 2	ILLINOIS	FED. AID PROJECT		



LEGEND

⊕ PHASE IB BORINGS

⊕ EXISTING PHASE IA BORINGS

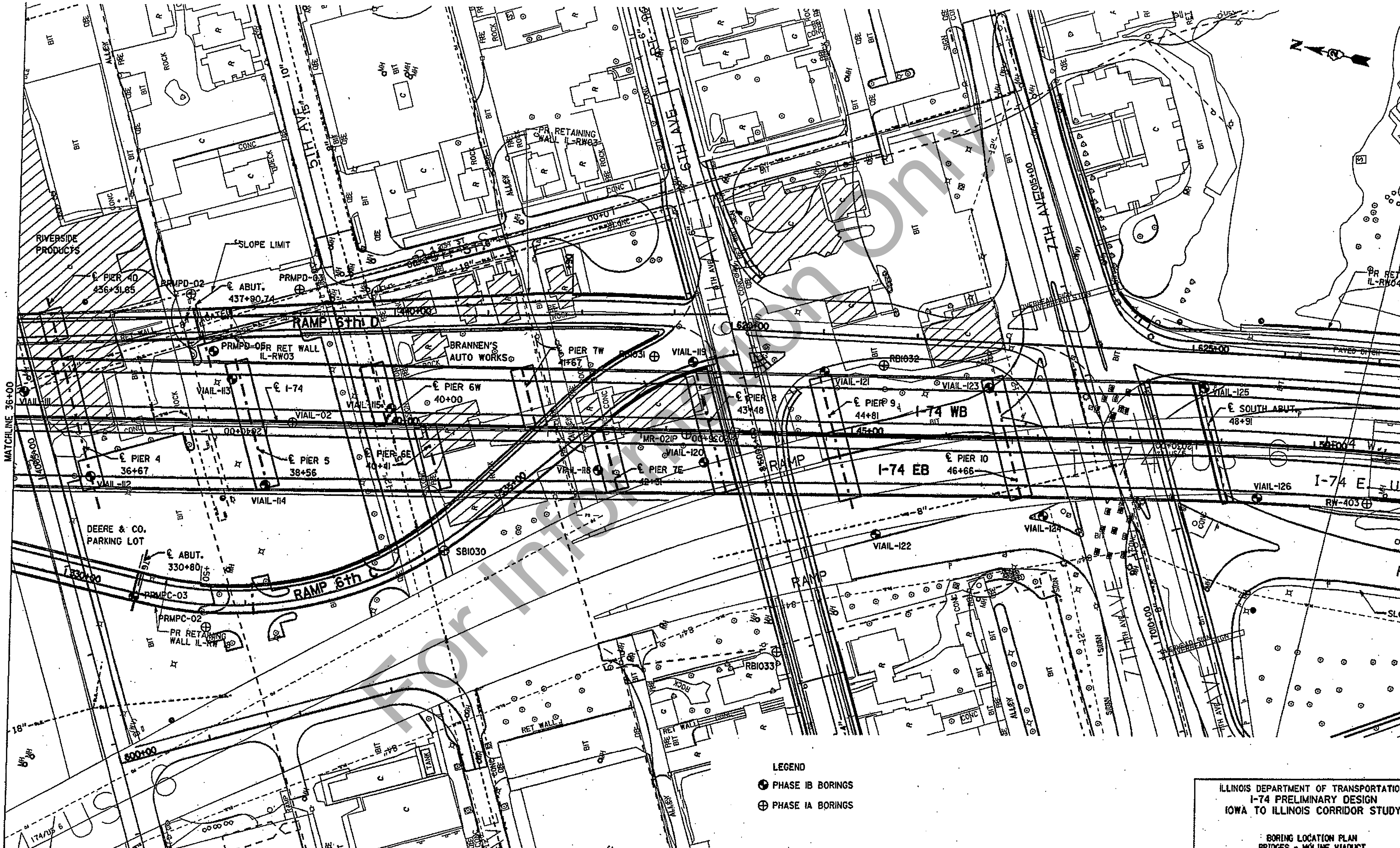
ILLINOIS DEPARTMENT OF TRANSPORTATION
I-74 PRELIMINARY DESIGN
IOWA TO ILLINOIS CORRIDOR STUDY

BORING LOCATION PLAN
BRIDGES - MOLINE VIADUCT
FIGURE 3

DRAWN BY
DATE 1 OF 2
CHECKED BY

PLOT DATE = 06-FEB-2008 PLOT SCALE = 100.000000:1.000000 FILE NAME = bor01.dgn

F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
74		ROCK ISLAND		
STA.		TO STA.		
FED. ROAD DIST. NO. 2	ILLINOIS	FED. AID PROJECT		



LEGEND

PHASE IB BORINGS

PHASE IA BORINGS

ILLINOIS DEPARTMENT OF TRANSPORTATION
I-74 PRELIMINARY DESIGN
IOWA TO ILLINOIS CORRIDOR STUDY

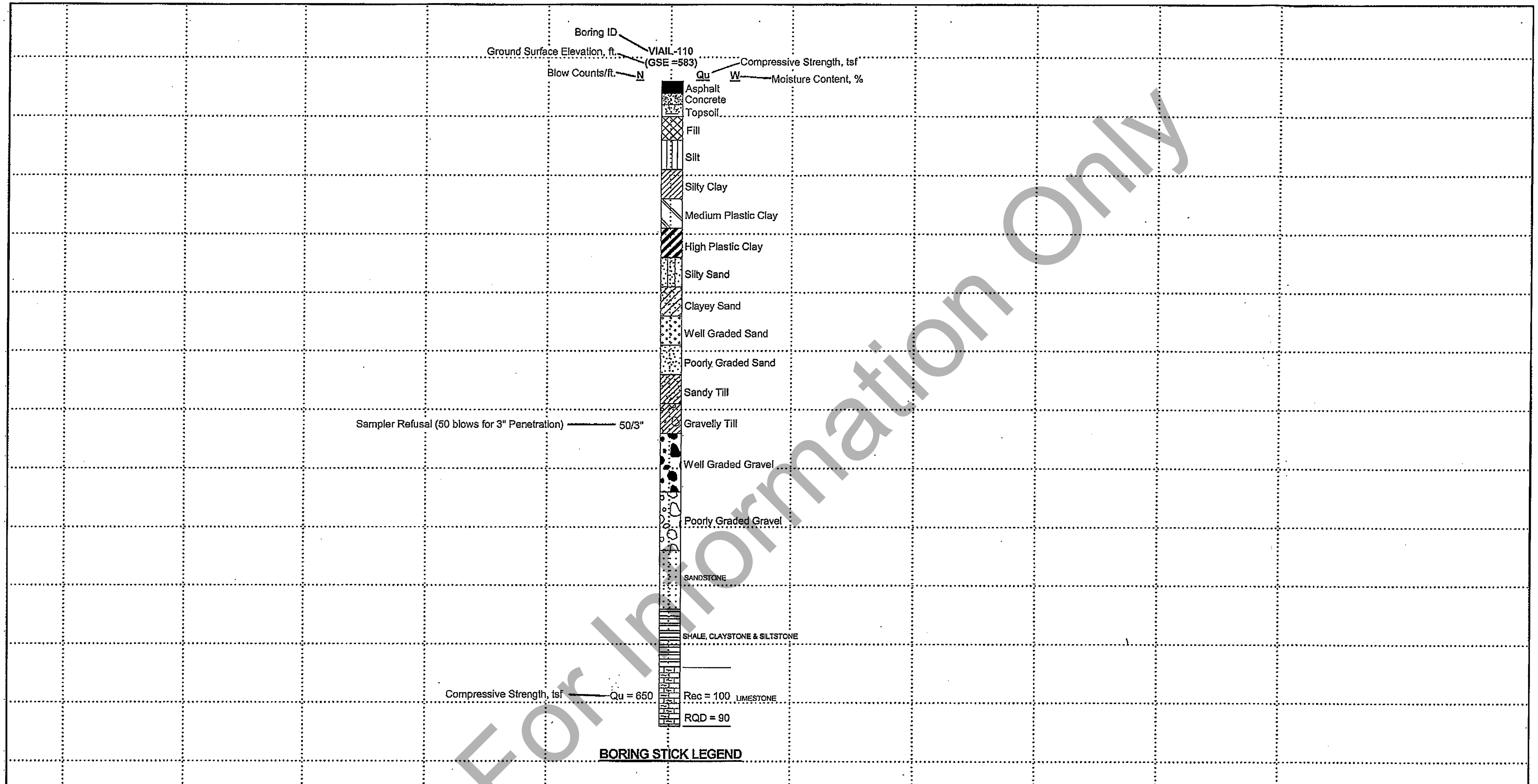
BORING LOCATION PLAN
BRIDGES - MOLINE VIADUCT
FIGURE 3

DRAWN BY

DATE 2 OF 2

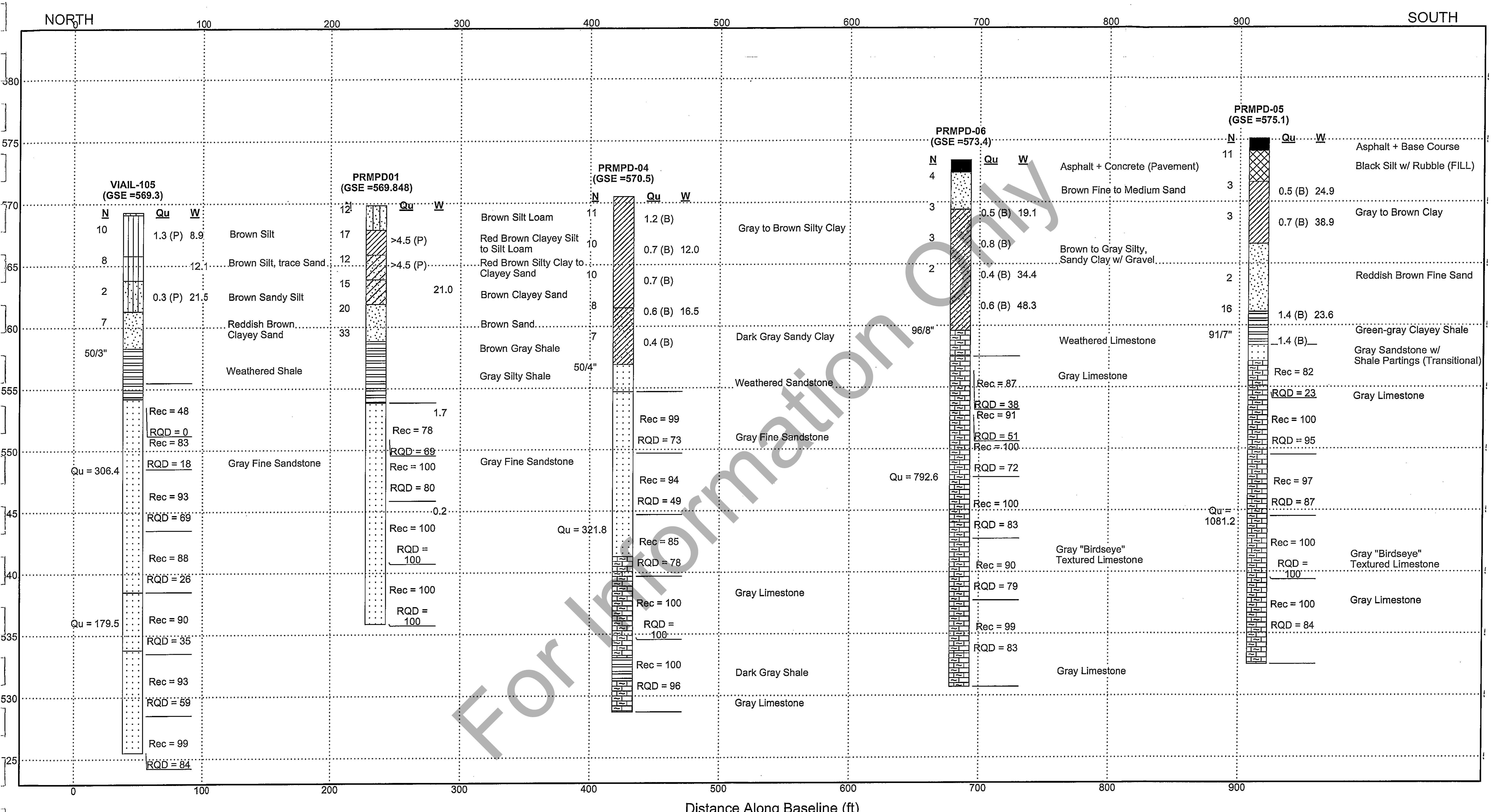
CHECKED BY

PLOT DATE = 06-FEB-2008 PLOT SCALE = 100.000000:1.000000 FILE NAME = bor18.dgn



SUBSURFACE PROFILE: BORING STICK LEGEND

FIGURE 4: Sheet 1 of 2



SUBSURFACE PROFILE: RAMP D

FIGURE 4: Sheet 2 of 2

BORING LOGS

GRAIN SIZE IDENTIFICATION

Name	Size Limits	U.S. Sieve Size
BOULDERS	12" or greater	
COBBLES	3" to 12"	
GRAVEL		
COARSE	3/4" to 3"	3/4" to 3"
FINE	3/16" to 3/4"	No. 4 to 3/4"
SAND		
COARSE	2.00 mm to 4.75 mm	No. 10 to No. 4
MEDIUM	0.42 mm to 2.00 mm	No. 40 to No. 10
FINE	0.07 mm to 0.42 mm	No. 200 to No. 40
SILT	0.002 mm to 0.07 mm	
CLAY	less than 0.002 mm	

RELATIVE PROPORTIONS OF SECONDARY COMPONENTS

Trace	0% to 10%
Little	10% to 20%
Some	20% to 35%
And	35% to 50%

PLASTICITY

Term	PI
Non–plastic	0–3
Slightly plastic	4–15
Medium plastic	16–30
Highly plastic	>30

RELATIVE DENSITY OF GRANULAR SOILS

SPT N–value (blows/ft)	Relative Density
0–4	Very loose
5–10	Loose
11–30	Medium dense
31–50	Dense
>50	Very dense

STRENGTH AND CONSISTENCY OF COHESIVE SOILS

SPT N–value (blows/ft)	Unconfined Compressive Strength (tons/ft^2)	Consistency
0–2	0.00–0.25	Very soft
3–4	0.25–0.50	Soft
5–8	0.50–1.00	Medium stiff
9–15	1.00–2.00	Stiff
16–30	2.00–4.00	Very stiff
>30	>4.00	Hard

Soil classifications shown on boring logs are determined by visual inspection of samples and from laboratory tests where available.

Split spoon samples are obtained by driving a 2" O.D. sampler 18" with a 140–pound hammer free–falling 30".
(Standard penetration test or "SPT", ASTM 1586)

Numbers shown next to split spoon symbol represent the number of hammer blows for the corresponding penetration (blows/inches).

LEGEND FOR BORING LOGS AND SOIL CLASSIFICATION SYSTEM

JE JACOBS

PHYSICAL PROPERTIES OF ROCK

Texture	· dense · fine · medium · coarse · crystalline	
		Spacing
Bedding Characteristics	· very thin · thin · medium · thick · massive	less than 2 in. 2 in. to 1 ft. 1 ft. to 3 ft. 3 ft. to 10 ft. greater than 10 ft.
		Compressive Strength (tsf)
Hardness	· very soft · soft · hard · very hard · extremely hard	10 – 250 250 – 500 500 – 1,000 1,000 – 2,000 > 2,000
		Description
Degree of Weathering	· fresh · very slight · slight · moderate · moderately severe · severe · very severe · complete	unweathered rock fresh, joints stained rock fresh, discoloration may extend 1 in. into rock significant portions show discoloration all rock except quartz discolored rock fabric clear but reduced to soil strength rock fabric discernible but mass reduced to soil rock reduced to soil, fabric not discernible
Lithologic Charactheristics	· clayey · shaly · calcareous · siliceous · sandy · silty	
Structure	Bedding Orientation · gently dipping bedding · steeply dipping bedding Fractures · scattered fractures · closely spaced fractures · cemented fractures · tight fractures · open fractures · brecciated (fragmented) Joints · very close · close · moderately close · wide · very wide Miscellaneous · slickensided	**Spacing** less than 2 in. 2 in. to 1 ft. 1 ft. to 3 ft. 3 ft. to 10 ft. greater than 10 ft.
Solution and Void Conditions	· vuggy (pitted) · vesicular (igneous) · porous · cavities · cavernous	
Miscellaneous	· swelling · slaking	

ROCK CORE PROPERTIES

Recovery (REC) is defined as the length of rock core recovered divided by the length of the core run (in percent).

Rock Quality Designator (RQD) is defined as the total length of rock core pieces greater than 4 in. long divided by the length of the core run (in percent).

RQD (%)	Diagnostic Description
90 – 100	Excellent
75 – 90	Good
50 – 75	Fair
25 – 50	Poor
0 – 25	Very Poor

LEGEND FOR BORING LOGS AND ROCK CLASSIFICATION SYSTEM

JACOBS

Boring Logs
Phase 1 B

Illinois Department of Transportation
Division of Highways
JCI

SOIL BORING LOG

Date 8/28/07

ROUTE I-74 DESCRIPTION New I-74 Bridge Over Mississippi River - Illinois Approach LOGGED BY KJB

SECTION ______ LOCATION (N=564749.647, E=2459344.727), SEC. 32, TWP. 18N, RNG. 1W, 4th PM

COUNTY Rock Island DRILLING METHOD HSA, CME 55 HAMMER TYPE CME AUTOMATIC

STRUCT. NO. ______
Station 30+90

BORING NO. VIAIL-105
Station ______
Offset ______
Ground Surface Elev. 569.30 ft

Surface Water Elev. ______ ft
Stream Bed Elev. ______ ft

Groundwater Elev.:
First Encounter 560.8 ft ▼
Upon Completion ______ ft
After ______ Hrs. ______ ft

Description	Elev. (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
TOPSOIL - 2-inch thick, roots.	569.10				
SILT - brown, trace sand, trace to little clay, slightly plastic, stiff, moist.			4		
			6	1.3	8.9
			4	P	
	565.80				
SILT - brown, trace to little fine sand, grading downwards to some fine sand, trace clay, crumbly, moist.			3		
			3		12.1
		-5	5		
	563.80				
SILT - brown, sandy, little to some sand, trace clay, very soft to loose, wet.			2		
			1	0.3	21.5
[Sample at 6'-7.5' had free water in soil but outside of spoon was not wet until sample at 8.5'-10.0']			1	P	
	561.30	▼			
SAND - reddish brown, clayey, fine to medium sand with gravel, loose, saturated.			2		
			2		
		-10	5		
	558.30				
WEATHERED SHALE - augered through			50/3"		
	555.50				
Borehole continued with rock coring.		-15			
		-20			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
JCI

ROCK CORE LOG

Date 8/28/07

ROUTE I-74 DESCRIPTION New I-74 Bridge Over Mississippi River - Illinois Approach LOGGED BY KJB

SECTION ____ LOCATION (N=564749.647, E=2459344.727), SEC. 32, TWP. 18N, RNG. 1W, 4th PM

COUNTY Rock Island CORING METHOD NQ Core

STRUCT. NO. ____
Station 30+90

CORING BARREL TYPE & SIZE NQ Wireline

Core Diameter 1.8 in
Top of Rock Elev. 558.30 ft
Begin Core Elev. 555.50 ft

BORING NO. VIAIL-105
Station ____
Offset ____
Ground Surface Elev. 569.30 ft

Description	Elev.	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
SHALE - medium gray, sandy, laminated chips, rock-like to clay-shale, hard clay to very soft rock, dry. [Drilling produced alternating light gray (sandstone) and dark gray (shale or coal) drill water return.]	555.50		Run 1	48	0	1.5	
	554.20	-15					
SANDSTONE - light brownish gray to gray, fine grained, uniform, well sorted, well rounded, soft, porous, moderately well to moderately cemented, generally not friable when wet, with black banding, non-distinct horizontal planar sandy rough fractures at thin to medium bedding spacing, no high angle fractures encountered, slightly to locally moderately weathered.			Run 2	83	18		
							306.4
- 8" thick layer of friable, iron-stained sandstone at 17.1' to 17.8'.							
		-20					
			Run 3	93	69	0.6	
		-25					
- a series of thin (1/8" to 1/2" thick) interporous black or brown staining within the sandstone at 22.5', 23.6', 24.4'-24.7', and 27.8'.							
[Inexplicable core loss (typically 4" to 6") in Run 3 to Run 6. Drilled steadily throughout. No seams noted, no change in drill water return color; must have been poorly cemented and washed away or ground up]			Run 4	88	26	0.8	
		-30					
	538.50						179.5
SANDSTONE - light gray, fine to medium grained, trace coarse grained, soft, moderately well cemented, few thin black bands, non-distinct bedding at thin bedded spacing, fresh.			Run 5	90	35	1.2	

Color pictures of the cores Yes
Cores will be stored for examination until ____
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

Illinois Department of Transportation
Division of Highways
JCI

ROCK CORE LOG

Date 8/28/07

ROUTE I-74 DESCRIPTION New I-74 Bridge Over Mississippi River - Illinois Approach LOGGED BY KJB

SECTION ______ LOCATION (N=564749.647, E=2459344.727), SEC. 32, TWP. 18N, RNG. 1W, 4th PM

COUNTY Rock Island CORING METHOD NQ Core

STRUCT. NO. ______
Station 30+90

BORING NO. VIAIL-105
Station ______
Offset ______
Ground Surface Elev. 569.30 ft

CORING BARREL TYPE & SIZE NQ Wireline
Core Diameter 1.8 in
Top of Rock Elev. 558.30 ft
Begin Core Elev. 555.50 ft

Description	Elev.	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
SANDSTONE - light gray, fine to medium grained, trace coarse grained, soft, moderately well cemented, few thin black bands, non-distinct bedding at thin bedded spacing, fresh. *(continued)*	533.80	-35					
SANDSTONE - light gray, fine grained, trace black banding, trace gray shale pods, porous, soft, slightly friable, moderately cemented, horizontal non-distinct planar sandy rough fractures at thin to medium bedded spacing, fresh.			Run 6	93	59	0.8	
		-40	Run 7	99	84	0.7	
	525.50						
End of Boring		-45					
		-50					

Color pictures of the cores Yes
Cores will be stored for examination until ______
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

BBS, form 138 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
JCI

SOIL BORING LOG

Date 9/4/07

ROUTE I-74 DESCRIPTION New I-74 Bridge Over Mississippi River - Illinois Approach LOGGED BY SL

SECTION ______ LOCATION (N=564389.584, E=2459470.273), SEC. 32, TWP. 18N, RNG. 1W, 4th PM

COUNTY Rock Island DRILLING METHOD HSA, CME 550X HAMMER TYPE CME AUTOMATIC

STRUCT. NO. ______
Station 434+44.5

BORING NO. PRMPD-04
Station ______
Offset ______
Ground Surface Elev. 570.50 ft

Surface Water Elev. ______ ft
Stream Bed Elev. ______ ft

Groundwater Elev.:
First Encounter 559.5 ft ▼
Upon Completion ______ ft
After ______ Hrs. ______ ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
CLAY - greenish gray to orange brown, some silt, some sand/gravel in matrix, slightly to medium plastic, medium stiff to stiff, moist		4 4 7	1.2 B	
- very stiff to stiff layer between 1'-5'	-5	4 4 6	0.7 B	12.0
		4 5 5	0.7 B	
561.50				
CLAY - medium to dark gray, some sand, trace gravel, slightly to medium plastic, soft to medium stiff, moist	-10	3 3 5	0.6 B	16.5
	▼	2 2 5	0.4 B	
556.90				
WEATHERED SANDSTONE		50/4"		
	-15			
554.70				
Borehole continued with rock coring.				
	-20			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
JCI

ROCK CORE LOG

Date 9/4/07

ROUTE I-74 DESCRIPTION New I-74 Bridge Over Mississippi River - Illinois Approach LOGGED BY SL

SECTION ______ LOCATION (N=564389.584, E=2459470.273), SEC. 32, TWP. 18N, RNG. 1W, 4th PM

COUNTY Rock Island CORING METHOD NQ Core

STRUCT. NO. ______
Station 434+44.5

CORING BARREL TYPE & SIZE NQ Wireline

Core Diameter 1.8 in
Top of Rock Elev. 556.90 ft
Begin Core Elev. 554.70 ft

BORING NO. PRMPD-04
Station ______
Offset ______
Ground Surface Elev. 570.50 ft

Description	Elev.	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
SANDSTONE - light gray to light brownish gray, fine grained, with occasional to minor black banding, soft, moderately well to well cemented, thin to medium bedded, horizontal to very low angle planar to slightly irregular sandy rough fractures, fresh to slightly weathered -shale parting at 17.3' with smooth planar fracture	554.70		Run 1	99	73	0.8	
		-20					
-clay-like shale seam at 21.5' with planar horizontal fracture at the seam, closely spaced black banding from 21.5' to 22.8', occasional rock-like shale clasts			Run 2	94	49	0.8	321.8
		-25					
-clay-like partings/seams with smooth planar fractures at 26.5' and 29.2'			Run 3	85	78	1	
	541.30						
LIMESTONE - gray, fine to medium grained, hard, thin to medium bedded, occasional styolites, minor pittings, some green shale clasts, partings and infilling, predominantly clay-like (possibly some healed to partially healed); fractures along shale partings are smooth and slightly irregular; limestone fractures are slightly irregular to irregular and jagged, slightly weathered to fresh except at vugs		-30					
-vuggy with open and partially filled voids at 31.5'-32.4'			Run 4	100	100	0.8	
		-35					

Color pictures of the cores Yes
Cores will be stored for examination until______
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

Illinois Department of Transportation
Division of Highways
JCI

ROCK CORE LOG

Date 9/4/07

ROUTE I-74 DESCRIPTION New I-74 Bridge Over Mississippi River - Illinois Approach LOGGED BY SL

SECTION ______ LOCATION (N=564389.584, E=2459470.273), SEC. 32, TWP. 18N, RNG. 1W, 4th PM

COUNTY Rock Island CORING METHOD NQ Core

STRUCT. NO. ______
Station 434+44.5

CORING BARREL TYPE & SIZE NQ Wireline

Core Diameter 1.8 in
Top of Rock Elev. 556.90 ft
Begin Core Elev. 554.70 ft

BORING NO. PRMPD-04
Station ______
Offset ______
Ground Surface Elev. 570.50 ft

Description	Elev.	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
	533.10		Run 5	100	96	2.5	
SHALE - medium to dark gray, soft, rock-like, thin bedded to laminated, smooth planar fractures at low to medium angles, with large limestone clasts	531.20						
LIMESTONE - medium to dark gray, fine to coarse grained, clastic calcarenite at 39.3'-41.6', dense fine limestone at 41.6'-41.8', hard, thin bedded, fresh	528.70	-40					
End of Boring		-45					
		-50					
		-55					

Color pictures of the cores Yes
Cores will be stored for examination until ______
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

Illinois Department of Transportation
Division of Highways
JCI

SOIL BORING LOG

Date 9/7/07

ROUTE I-74 DESCRIPTION New I-74 Bridge Over Mississippi River - Illinois Approach LOGGED BY SL

SECTION ______ LOCATION (N=564029.213, E=2459513.152), SEC. 32, TWP. 18N, RNG. 1W, 4th PM

COUNTY Rock Island DRILLING METHOD HSA, CME 550X HAMMER TYPE CME AUTOMATIC

STRUCT. NO. ______
Station 437+80.7

BORING NO. PRMPD-05
Station ______
Offset ______
Ground Surface Elev. 575.10 ft

Surface Water Elev. ______ ft
Stream Bed Elev. ______ ft

Groundwater Elev.:
First Encounter 564.1 ft ▼
Upon Completion ______ ft
After ____ Hrs. ______ ft

Description	Elev. (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
PAVEMENT - asphalt and base course	574.10				
SILT - black, with rubble (FILL)			4		
			6		
			5		
	571.60				
CLAY - medium gray to orange brown, slightly to medium plastic, medium stiff, moist			2		
			1	0.5	24.9
		-5	2	B	
			1		
			2	0.7	38.9
			1	B	
[Attempted Shelby tube at 8.5'-10.5'; no recovery]	566.60				
SAND - red brown, fine grained, loose, wet					
		-10			
[Attempted Shelby tube at 11'-13'; no recovery; followed up with SPT]		▼	1		
			1		
			1		
	561.10		1		
SHALE - green gray, clayey, severely weathered			3	1.4	23.6
		-15	13	B	
			12		
			41	1.4	
	558.40		50/1"	B	
Borehole continued with rock coring.					
		-20			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
JCI

ROCK CORE LOG

Date 9/7/07

ROUTE I-74 DESCRIPTION New I-74 Bridge Over Mississippi River - Illinois Approach LOGGED BY SL

SECTION ______ LOCATION (N=564029.213, E=2459513.152), SEC. 32, TWP. 18N, RNG. 1W, 4th PM

COUNTY Rock Island CORING METHOD NQ Core

STRUCT. NO. ______
Station 437+80.7

CORING BARREL TYPE & SIZE NQ Wireline
Core Diameter 1.8 in
Top of Rock Elev. 561.60 ft
Begin Core Elev. 558.40 ft

BORING NO. PRMPD-05
Station ______
Offset ______
Ground Surface Elev. 575.10 ft

Description	Elev.	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
SANDSTONE - medium gray, very fine grained, silt in matrix, abundant shale partings, conglomeratic at 17.5'-18.1' (TRANSITIONAL)	558.40		Run 1	82	23	1	
	557.10						
LIMESTONE - gray, fine grained, with occasional to some thin green shale partings and seams, locally stylolitic, hard, thin to medium bedded, predominantly horizontal to very low angle fractures, planar to slightly irregular, smooth to slightly rough, fresh		-20					
			Run 2	100	95	1.2	
		-25					
			Run 3	97	87	1	1081.2
-slightly rough fractures across stylolites at 28.3'-30.6'		-30					
-thick bedded, occasional stylolites at 30.6'-35.6'			Run 4	100	100	2.6	
-minor pitting with some "birdseye" texture from 32.1' to 35.6'		-35					
			Run 5	100	84	1.3	

Color pictures of the cores Yes
Cores will be stored for examination until ______
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

Illinois Department of Transportation
Division of Highways
JCI

ROCK CORE LOG

Date 9/7/07

ROUTE I-74 **DESCRIPTION** New I-74 Bridge Over Mississippi River - Illinois Approach **LOGGED BY** SL

SECTION ______ **LOCATION** (N=564029.213, E=2459513.152), **SEC.** 32, **TWP.** 18N, **RNG.** 1W, 4th **PM**

COUNTY Rock Island **CORING METHOD** NQ Core

STRUCT. NO. ______
Station 437+80.7

BORING NO. PRMPD-05
Station ______
Offset ______
Ground Surface Elev. 575.10 ft

CORING BARREL TYPE & SIZE NQ Wireline
Core Diameter 1.8 in
Top of Rock Elev. 561.60 ft
Begin Core Elev. 558.40 ft

Description	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
LIMESTONE - gray, fine grained, with occasional to some thin green shale partings and seams, locally stylolitic, hard, thin to medium bedded, predominantly horizontal to very low angle fractures, planar to slightly irregular, smooth to slightly rough, fresh *(continued)* -occasional soft rock-like green shale partings and clasts in limestone with fractures along shale, occasional pitting, at 38.9'-40.3' -green rock-like shale seam with 85° fracture at 40.3'-40.8' -medium gray, fine to medium grained, occasional shale partings 532.50	-40					
End of Boring	-45 -50 -55					

Color pictures of the cores Yes
Cores will be stored for examination until ______
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

Illinois Department of Transportation
Division of Highways
JCI

SOIL BORING LOG

Date 9/5/07

ROUTE I-74 DESCRIPTION New I-74 Bridge Over Mississippi River - Illinois Approach LOGGED BY SL

SECTION ______ LOCATION (N=564254.16, E=2459482.275), SEC. 32, TWP. 18N, RNG. 1W, 4th PM

COUNTY Rock Island DRILLING METHOD HSA, CME 550X HAMMER TYPE CME AUTOMATIC

STRUCT. NO. ______
Station 436+31.6

BORING NO. PRMPD-06
Station ______
Offset ______
Ground Surface Elev. 573.40 ft

Surface Water Elev. ______ ft
Stream Bed Elev. ______ ft

Groundwater Elev.:
First Encounter 559.9 ft ▼
Upon Completion ______ ft
After ____ Hrs. ______ ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
PAVEMENT - asphalt, concrete, and base course (12" thick)	572.40				
SAND - light to medium brown, fine to medium grained, loose, moist			3		
			2		
			2		
	569.40		2		
CLAY - orange brown to greenish gray, some sand and gravel, some silt, medium plastic, medium stiff, moist			1	0.5	19.1
		-5	2	B	
			WOH		
			2	0.8	
			1	B	
			WOH		
-soft			1	0.4	34.4
		-10	1	B	
- [Dry unit weight = 69.6 pcf]					
				0.6	48.3
				B	
- medium brown, fine grained sand, some clay, some silt, at 12.7'	559.60 ▼		12		
WEATHERED LIMESTONE - augered through			46		
		-15	50/2"		
	557.50				
Borehole continued with rock coring.					
		-20			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
JCI

ROCK CORE LOG

Date 9/5/07

ROUTE I-74 DESCRIPTION New I-74 Bridge Over Mississippi River - Illinois Approach LOGGED BY SL

SECTION ______ LOCATION (N=564254.16, E=2459482.275), SEC. 32, TWP. 18N, RNG. 1W, 4th PM

COUNTY Rock Island CORING METHOD NQ Core

STRUCT. NO. ______
Station 436+31.6

CORING BARREL TYPE & SIZE NQ Wireline

Core Diameter 1.8 in
Top of Rock Elev. 559.60 ft
Begin Core Elev. 557.50 ft

BORING NO. PRMPD-06
Station ______
Offset ______
Ground Surface Elev. 573.40 ft

Description	Elev.	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
LIMESTONE - gray, fine to medium grained, occasional to some stylolites, hard, pitted below 16', thin bedded, horizontal to low angle fractures, primarily planar to slightly irregular, smooth to slightly rough with occasional rough fractures, fresh	557.50		Run 1	87	38	5.8	
- "birdseye" texture at 18.2'-19.0'			Run 2	91	51	1.9	
-pitted, locally vuggy, few stylolites at 19'-20.7'		-20					
			Run 3	100	72	2	792.6
		-25					
			Run 4	100	83	2	
	544.00						
LIMESTONE - medium gray, fine to coarse, pitted, "birdseye" texture, stylolitic, thin to medium bedded, irregular rough/jagged horizontal to very low angle fractures, occasional rock-like shale clasts to 2" elongated, locally large clay-like to soft rock-like shale clasts, partings, and seams, fresh		-30					
			Run 5	90	79	1	
		-35					

Color pictures of the cores Yes
Cores will be stored for examination until______
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

Illinois Department of Transportation
Division of Highways
JCI

ROCK CORE LOG

Date 9/5/07

ROUTE I-74 DESCRIPTION New I-74 Bridge Over Mississippi River - Illinois Approach LOGGED BY SL

SECTION LOCATION (N=564254.16, E=2459482.275), **SEC.** 32, **TWP.** 18N, **RNG.** 1W, 4th **PM**

COUNTY Rock Island CORING METHOD NQ Core

STRUCT. NO.
Station 436+31.6

BORING NO. PRMPD-06
Station
Offset
Ground Surface Elev. 573.40 ft

CORING BARREL TYPE & SIZE NQ Wireline
Core Diameter 1.8 in
Top of Rock Elev. 559.60 ft
Begin Core Elev. 557.50 ft

Description	Elev.	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
LIMESTONE - medium gray, fine to coarse, pitted, "birdseye" texture, stylolitic, thin to medium bedded, irregular rough/jagged horizontal to very low angle fractures, occasional rock-like shale clasts to 2" elongated, locally large clay-like to soft rock-like shale clasts, partings, and seams, fresh *(continued)* -abundant shale and sandstone clasts and occasional shale partings, localized deep angular pitting, locally vuggy	533.40	-40	Run 6	99	83	0.7	
LIMESTONE -gray, fine to medium grained, abundant green soft rock-like to clay-like shale partings and matrix infilling; fractures horizontal to 20° angle, fractures along shale partings is slight to moderately irregular, slightly rough -40.4' to 41.4' has brecciated appearance -41.4' to 42.7' appears to be shale partings deformed by limestone clasts	530.70						
End of Boring		-45 -50 -55					

Color pictures of the cores Yes
Cores will be stored for examination until
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

Boring Logs
Phase 1A

Illinois Department of Transportation
Division of Highways
JCI

SOIL BORING LOG

Date 10/31/05

ROUTE I-74 **DESCRIPTION** **LOGGED BY** L. Hunt

SECTION **LOCATION** VIADUCT, RAMP 6TH-D, **SEC.**, **TWP.**, **RNG.**

COUNTY Rock Island **DRILLING METHOD** CME-550 Hollow Stem Auger **HAMMER TYPE**

STRUCT. NO.
Station

BORING NO. PRMPD01
Station
Offset
Ground Surface Elev. 569.85 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 561.8 ft ▼
Upon Completion ft
After Hrs. ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Silt Loam (SM) Silt Loam, trace gravel, dark brown to red brown, dry to moist, stratified.			5		
			6		
			6		
	567.85		6		
Clayey Silt to Silt Loam (CL-SM) Clayey Silt to Silt Loam, red brown, dry to moist, stratified.			5		
			7	>4.5	
			10	P	
	565.85		9		
Silty Clay to Clayey Sand (CL-SC) Silty Clay to Clayey Sand, red brown, dry to moist, stratified.			6		
		-5	5	>4.5	
			7	P	
	563.85		8		
Clayey Sand (SC) Clayey Sand, medium grained, well sorted, well rounded, brown, mottled gray brown and dark brown, moist to wet, stratified.			6		
			7		21.0
			8		
	561.85 ▼		10		
Poorly Graded Sand (SP) Sand, trace gravel, trace clay, brown, wet, homogeneous. Water at 8' while drilling			6		
			7		
			13		
		-10	11		
			4		
	558.85		10		
Shale Brown gray			23		
	557.85		36		
Silty Shale Silty Shale, gray, moist, laminated beds, very broken up.			30		
			50/3		
			50/5		
		-15			
	553.85				
Borehole continued with rock coring.					
		-20			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
JCI

ROCK CORE LOG

Date 10/31/05

ROUTE I-74 DESCRIPTION LOGGED BY L. Hunt

SECTION LOCATION VIADUCT, RAMP 6TH-D, SEC., TWP., RNG.

COUNTY Rock Island CORING METHOD NQ DOUBLE BARREL DIAMOND TIP

STRUCT. NO.
Station

BORING NO. PRMPD01
Station
Offset
Ground Surface Elev. 569.85 ft

CORING BARREL TYPE & SIZE
Core Diameter in
Top of Rock Elev. 553.85 ft
Begin Core Elev. 553.85 ft

Description	Elev.	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Sandstone Sandstone, gray, fine to medium grained, slightly to moderately weathered, very weak rock, poorly to well sorted, well rounded, laminated to thin beds. Bottom of Borehole at 16'; begin rock coring at 16' at 10:26 Horizontal fractures, extremely fractured to sound, extremely close to moderate discontinuity, smooth to rough (planar) joints, tightly healed to very stiff clay mineral coatings in joints with >1/4" thick rock wall separation.	553.85		R1	78	69		
Sandstone, gray, fine to medium grained, slightly to moderately weathered, very weak rock, laminated to medium beds, poorly to well sorted, well rounded. Horizontal fractures, extremely fractured to sound, extremely close to moderate discontinuity, smooth to rough (planar) joints, slightly altered to highly altered with very stiff clay mineral coatings in joints with >1/4" thick rock wall separation.		-20	R2	100	80		
Sandstone, gray, fine to medium grained, slightly to moderately weathered, very weak rock, no apparent bedding (medium to massive), poorly to well sorted, well rounded. Possible limestone at 25.5ft Horizontal fractures, extremely fractured to sound, extremely close to moderate discontinuity, smooth to rough (planar) joints, unaltered joints.		-25	R3	100	100		
Sandstone, gray, fine to medium grained, slightly to moderately weathered, very weak rock, no apparent bedding (medium to massive), poorly to well sorted, well rounded.	535.85	-30	R4	100	100		
End of rock coring at 34'. End of Boring		-35					

Color pictures of the cores
Cores will be stored for examination until
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

Illinois Department of Transportation
Division of Highways
JCI

SOIL BORING LOG

Date 11/1/05

ROUTE I-74 DESCRIPTION LOGGED BY L. Hunt

SECTION LOCATION VIADUCT, RAMP 6TH-D, **SEC., TWP., RNG.**

COUNTY Rock Island DRILLING METHOD CME-550 Hollow Stem Auger HAMMER TYPE

STRUCT. NO.
Station

BORING NO. PRMPD02
Station
Offset
Ground Surface Elev. 574.20 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter ft
Upon Completion ft
After Hrs. ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Clay (CL) Clay, few gravel, trace sand, dark brown, dry to moist, homogeneous.		6		
		4	1.3	
		4	P	
		4		
Clay, few gravel and sand, dark brown, dry to moist, homogeneous.		WOH		
		1	0.9	
		1	P	
	-5	2		
Clay, trace sand and gravel, dark brown, dry to moist, homogeneous.		1		
		1	0.6	13.0
		1	P	
		2		
No Sample.		WOH		
		WOH		
		8		
565.20		16		
Silty Clay(CL) Silty Clay, trace sand and gravel, gray mottled orange brown and dark brown, moist, homogeneous. Shelby tube sample T-1 from 9'-11' from adjacent location having mc: 28%, dry density: 84.5pcf and UC: 920psi		WOH		
	-10	WOH	0.3	37.0
		WOH	P	
		1		
		WOH		
		50/3	0.8	
			P	
Silty Clay, trace sand and gravel, gray mottled orange brown and dark brown, moist, homogeneous. 560.70		50/2		
Borehole continued with rock coring.				
	-15			
	-20			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
JCI

ROCK CORE LOG

Date 11/1/05

ROUTE I-74 **DESCRIPTION** ____ **LOGGED BY** L. Hunt

SECTION ____ **LOCATION** VIADUCT, RAMP 6TH-D, **SEC., TWP., RNG.**

COUNTY Rock Island **CORING METHOD** NQ DOUBLE BARREL DIAMOND TIP

STRUCT. NO. ____
Station ____

BORING NO. PRMPD02
Station ____
Offset ____
Ground Surface Elev. 574.20 ft

CORING BARREL TYPE & SIZE ____
Core Diameter ____ in
Top of Rock Elev. 560.70 ft
Begin Core Elev. 560.70 ft

Description	Elev.	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Limestone Limestone, gray, fine to coarse grained, moderately weathered, weak rock, laminated to thin beds, vugs present. Auger refusal at 13.5'; begin rock core at 13.5' at 10:27 Horizontal and vertical fractures, extrememly fractured to slightly fractured, extremely close to close discontinuity, rough to smooth (undulating and planar) joints, tightly healed to sandy particles in joints with no rock wall separation, stylolites present. Coring rate smooth, slow in the beginning, but overall fast; no rod drops.	560.70	-15	R1	82	13		524.0
Limestone, gray, fine to coarse grained, moderately weathered, strong to very strong rock, laminated to thin beds, vugs present. Horizontal fractures, extrememly fractured to slightly fractured, extremely close to close discontinuity, rough to smooth (undulating and planar) joints, tightly healed to slightly altered with sandy particles in joints, stylolites present.		-20	R2	100	58		
Limestone, gray, fine to medium grained, slightly weathered, medium strength, thin to medium beds, vugs present. At 23.5' changed bit to one for limestone coring Horizontal fractures, sound, moderate to wide discontinuity, rough to smooth (planar) joints, tightly healed to unaltered joints with hard dark mineral on joints walls, stylolites present.		-25	R3	100	100		249.0
Limestone, gray, fine to medium grained, slightly weathered, medium strength, medium beds. Ran out of water; stopped at 18' of tock core. Horizontal fractures, sound, moderate discontinuity, rough undulating joints, slightly altered joints with sandy particles and <1/4" thick rock wall separation, stylolites present.	542.70	-30	R4	97	97		
End of rock coring at 31.5'. End of Boring							

Color pictures of the cores ____
Cores will be stored for examination until ____
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

Illinois Department of Transportation
Division of Highways
JCI

SOIL BORING LOG

Date 11/1/05

ROUTE I-74 DESCRIPTION LOGGED BY L. Hunt

SECTION LOCATION RAMP 6TH-D, SEC., TWP., RNG.

COUNTY Rock Island DRILLING METHOD CME-550 Solid Stem 4" Auger HAMMER TYPE

STRUCT. NO.
Station

BORING NO. PRMPD03
Station
Offset
Ground Surface Elev. 573.45 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 561.4 ft
Upon Completion ft
After Hrs. ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Clay (CL) Clay, trace gravel, sand, and brick, dark brown, dry to moist, homogeneous. 1' of concrete, pavement, and gravel on top of sediment.		5		
		6	1.5	
		6	P	
		4		
Clay, few silt, trace sand, dark brown, dry to moist, homogeneous.		2		
		2	1.6	
		3	P	
	-5	4		
Clay, few silt, dark brown to gray brown, mottled orange brown and dark brown, dry to moist, homogeneous.		1		
		2	1.0	
		3	P	
566.45		3		
Silty Clay(CL) Silty Clay, gray brown, mottled orange brown and dark brown, dry to moist, homogeneous.		WOH		
		2	0.6	
		2	P	
564.45		3		
Clay (CL) Clay, some silt, trace sand, gray brown, mottled orange brown, dry to moist, homogeneous.		1		
	-10	1	0.4	
		2	P	
562.45		3		
Sandy Clay to Sand(CL-SW) Sandy Clay to Sand, gray, wet, stratified. Water at 12' while drilling		1		
		2		
		13		
560.45		10		
Siltstone Siltstone, little sand, gray, moist, homogeneous.		7		
		9		
		16		
	-15	30		
554.45				
Shale Shale, gray, moist, homogeneous.		50/4		
	-20			
Shale Shale, gray, moist, homogeneous. *(continued)*				
No Sample.		50/0		
	-25			
547.45				
544.95				
Auger refusal at 28.5'; end of borehole. End of Boring				
	-30			
	-35			
	-40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, from 137 (Rev. 8-99)

Laboratory Test Results

SUMMARY OF LABORATORY TEST RESULTS FOR SOIL

PROJECT NO: C1X13500
PROJECT: I-74 River Crossing, Bettendorf-Moline
Illinois Land Based Borings

Boring	Sample No.	Depth From	Depth To		Moisture Content %	Dry Unit Weight pcf	Atterberg Limits LL %	Atterberg Limits PL %	Atterberg Limits PI %	Grain Size Passing 4 %	Grain Size Passing 10 %	Grain Size Passing 40 %	Grain Size Passing 200 %	Compressive Strength tsf
PRMPD-04	SS-2	3.5	5.0		12.0									
	SS-4	8.5	10.0		16.5		27	15	12					
PRMPD-05	SS-2	3.5	5.0		24.9									
	SS-5	6.0	7.5		38.9									
	SS-6	13.5	15.0		23.6									
PRMPD-06	SS-2	3.5	5.0		19.1									
	SS-4	8.5	10.0		34.4									
	ST-1	11.0	12.7		48.3	70								0.63

H.C. Nutting Company
611 Lunken Park Dr.
Cincinnati, Ohio 45226

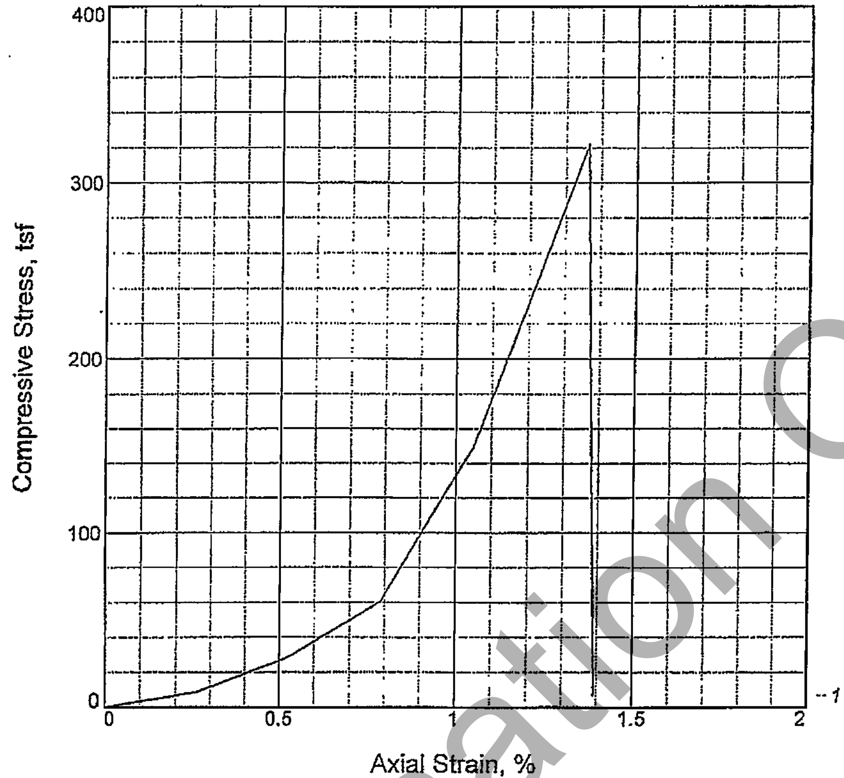
Terracon
I-74 Crossing-Bettendorf-Moline (Job #07045052)
Baettendorf, Iowa
HCN W.O. #19636.040

TABLE II: TABULATION OF UNDISTURBED DATA

Lab No.	Boring No.	Sample No.	Depth (ft.)	Unconfined Strength (tsf)	Material Description	Moh's Hardness	Failure Strain (%)	Dry Density (pcf)	Water Content (%)	Remarks
10167	RW165-02	T3	17-19	---	Sandy lean clay (bott)			87.0	34.1	Cv
10168	RW165-04	T2	7-9	---	Silty clay			107.0	18.7	Cv
10163	SC1002A	T1	11-13	---	Silty clay with sand			104.6	23.8	Cv
10164	SC1009	T2	11-13	---	Silty clay			106.5	25.6	Cv
10165	SC1001	T1	5-7		Sandy lean clay tr/gravel			111.4	18.0	Cv
10166	SC1008	T4	19-21	---	Cilty clay			103.5	23.7	Cv
10292	VIAIL-111	Run 3	26-27	251.7	Limestone	7	1.1	159.7	1.6	Unc
10293	VIAIL-112	Run 2	21-22	256.0	Sandstone	4	1.2	119.3	7.1	Unc
10294	VIAIL-113	Run 2	19-20	516.8	Limestone	6	1.3	161.4	0.0	Unc
10295	VIAIL-114	Run 2	24-25	712.5	Limestone	7	1.5	161.6	0.1	Unc
10296	VIAIL-115	Run 3	27-28	813.1	Limestone	7	1.8	164.9	0.0	Unc
10298	VIAIL-118	Run 1	18-20	647.8	Limestone	7	1.2	164.7	0.4	Unc
~~10297~~	~~VIAIL-120~~	~~Run 2~~	~~29-30~~	~~264.2~~	~~Sandstone~~	~~4~~	~~1.2~~	~~148.7~~	~~1.5~~	~~Unc~~
10299	PRMPD-04	Run 2	23-24	321.8	Sandstone	2	1.4	119.4	0.1	Unc
10300	PRMPD-05	Run 3	26-27	1081.2	Limestone	8	1.2	166.2	0.0	Unc
10301	PRMPD-06	Run 3	22-23	792.6	Limestone	7	1.3	163.4	0.1	Unc

2tb 9-21-07

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	321.8457			
Undrained shear strength, tsf	160.9228			
Failure strain,	1.4			
Strain rate, in./min.	0.500			
Water content, %	0.1			
Wet density, pcf	119.5			
Dry density, pcf	119.4			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	1.860			
Specimen height, in.	3.810			
Height/diameter ratio	2.05			

Description: SANDSTONE (MOH'S - 2)

LL =	PL =	PI =	GS=	Type: Sandstone

Project No.: 19636.040
Date: 9-21-07
Remarks:
Lab No. 10299

Figure ________

Client: TERRACON (#07045052)

Project: I-74 CROSSING-BETTENDORF-MOLINE

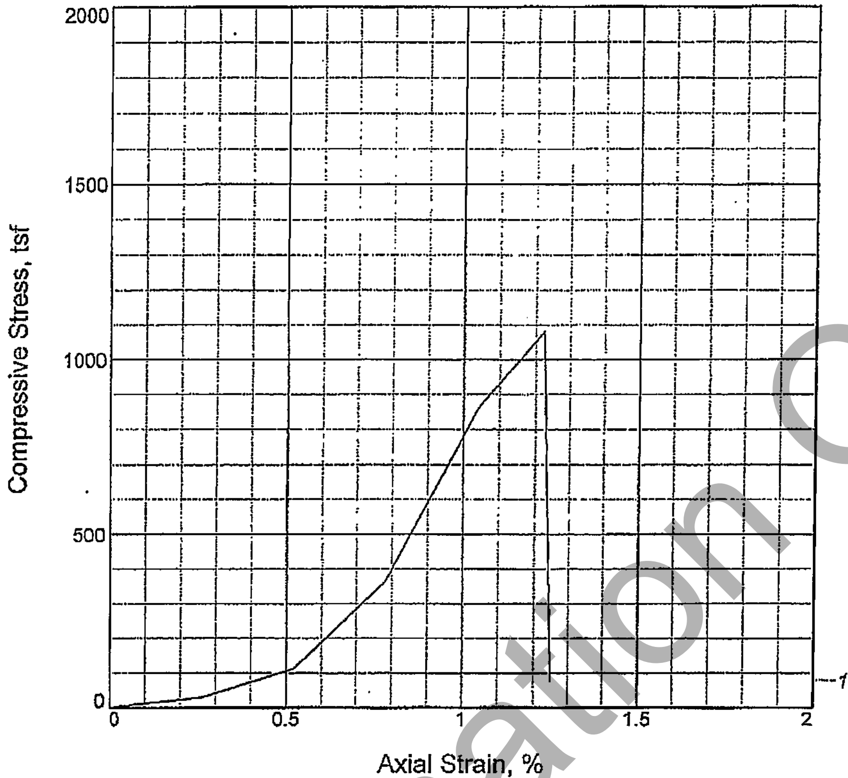
Source of Sample: PRMPD-04 **Depth:** 23.8-24.8'
Sample Number: RUN-2

UNCONFINED COMPRESSION TEST

H. C. NUTTING COMPANY

Tested By: SV **Checked By:** GS

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1081.2436			
Undrained shear strength, tsf	540.6218			
Failure strain,	1.2			
Strain rate, in./min.	0.500			
Water content, %	0.0			
Wet density, pcf	166.2			
Dry density, pcf	166.2			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	1.850			
Specimen height, in.	3.840			
Height/diameter ratio	2.08			

Description: WHITE LIMESTONE (MOH'S - 8)

LL =	PL =	PI =	GS=	Type: Limestone

Project No.: 19636.040
Date: 9-21-07
Remarks:
Lab No. 10300

Figure ________

Client: TERRACON (#07045052)

Project: I-74 CROSSING-BETTENDORF-MOLINE

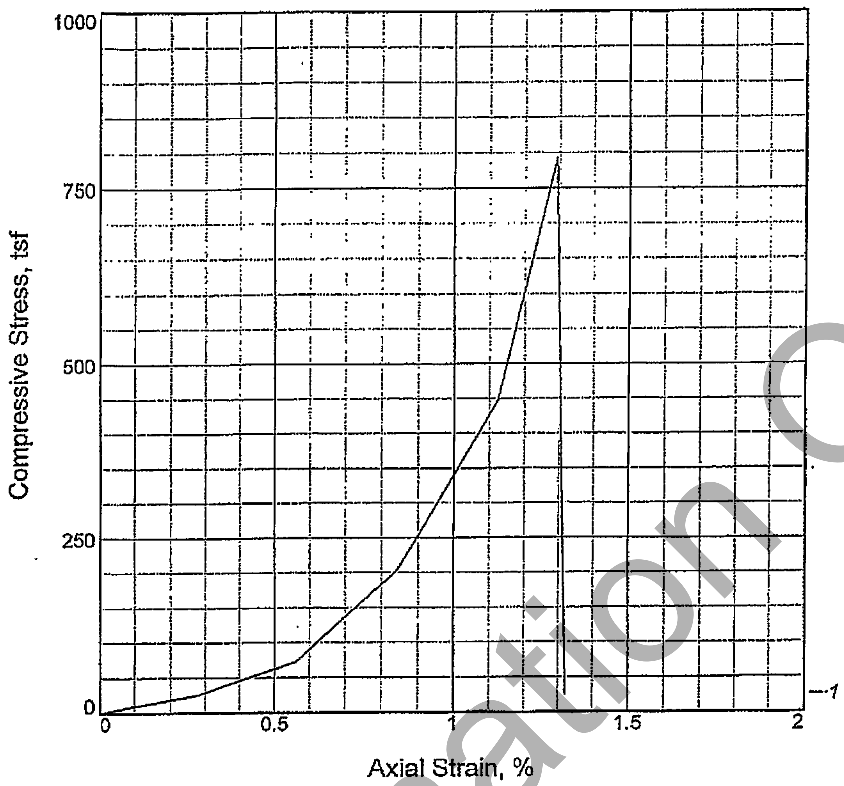
Source of Sample: PRMPD-05 **Depth:** 27-27.9'
Sample Number: RUN-3

UNCONFINED COMPRESSION TEST

H. C. NUTTING COMPANY

Tested By: SV **Checked By:** GS

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	792.6262			
Undrained shear strength, tsf	396.3131			
Failure strain,	1.3			
Strain rate, in./min.	0.500			
Water content, %	0.1			
Wet density, pcf	163.5			
Dry density, pcf	163.4			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	1.860			
Specimen height, in.	3.560			
Height/diameter ratio	1.91			

Description: LIMESTONE (MOH'S - 7)

LL =	**PL =**	**PI =**	**GS=**	**Type:** Limestone

Project No.: 19636.040
Date: 9-21-07
Remarks:
Lab No. 10301

Figure ________

Client: TERRACON (#07045052)

Project: I-74 CROSSING-BETTENDORF-MOLINE

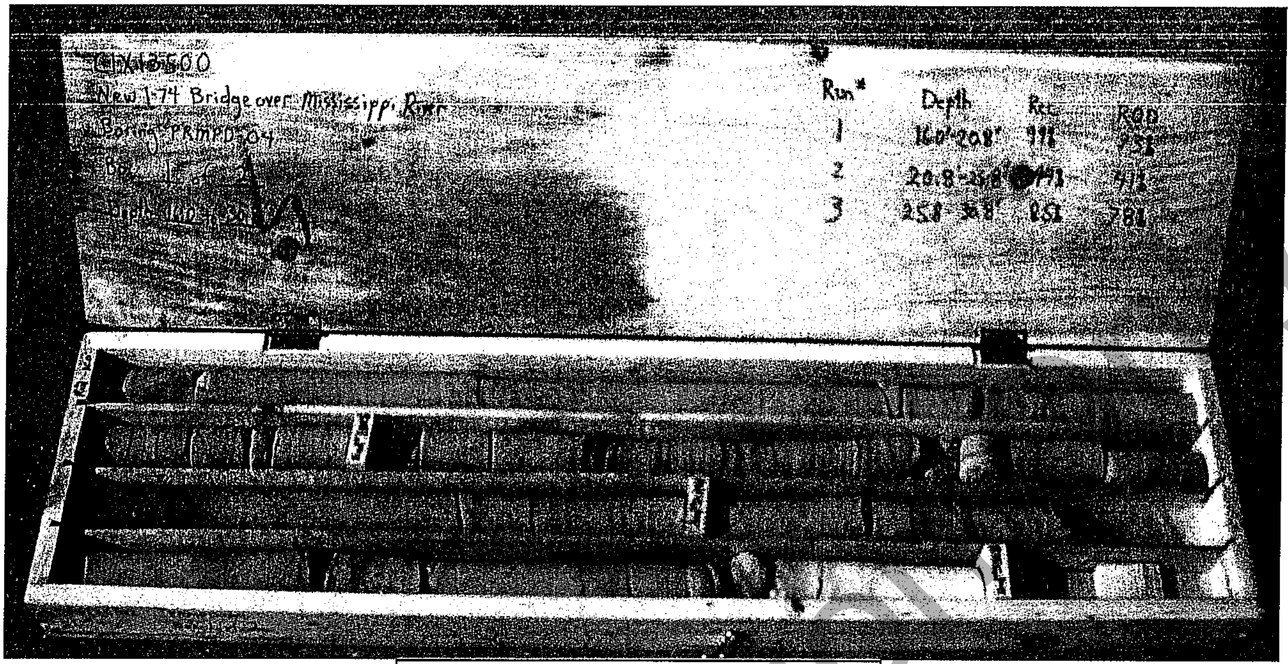
Source of Sample: PRMPD-06 **Depth:** 22.8-23.4'
Sample Number: RUN-3

UNCONFINED COMPRESSION TEST

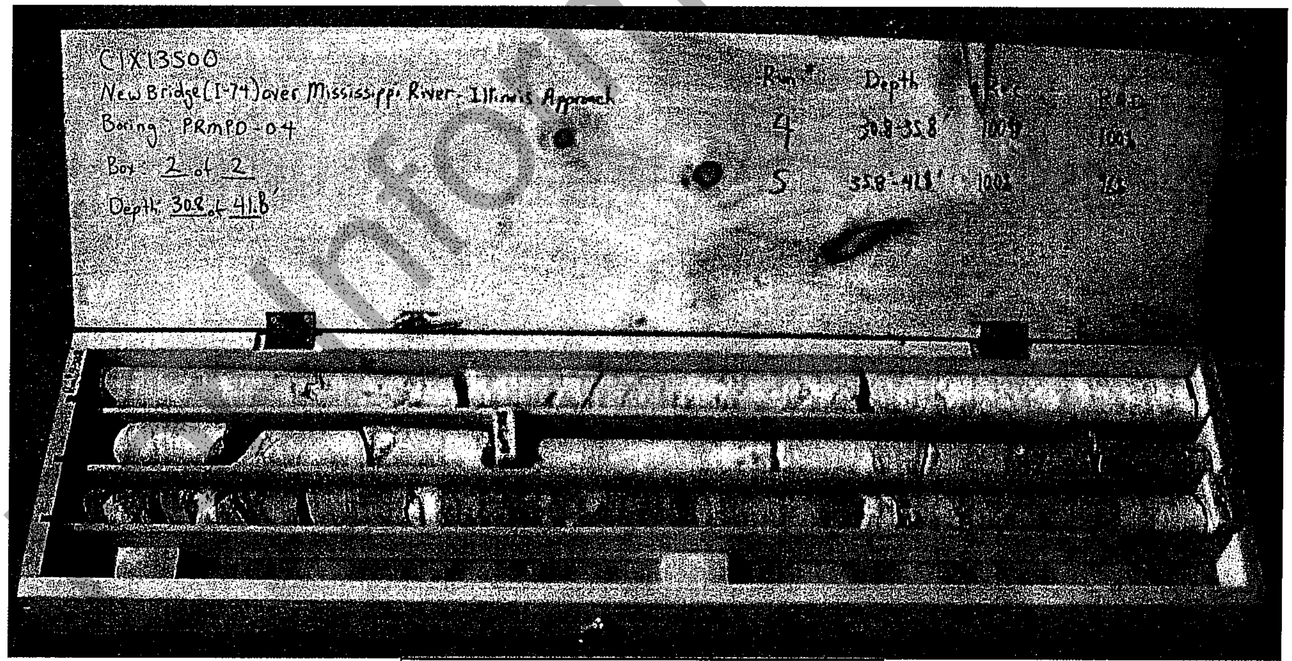
H. C. NUTTING COMPANY

Tested By: SV **Checked By:** GS

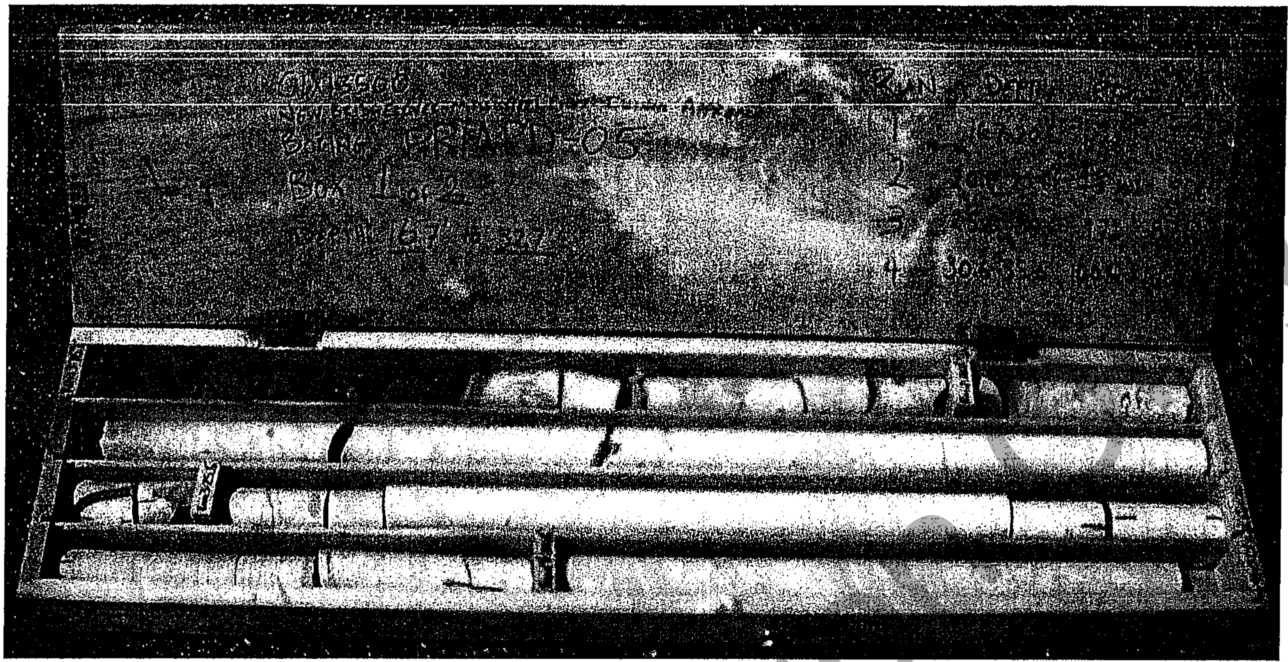
ROCK CORE PHOTOGRAPHS



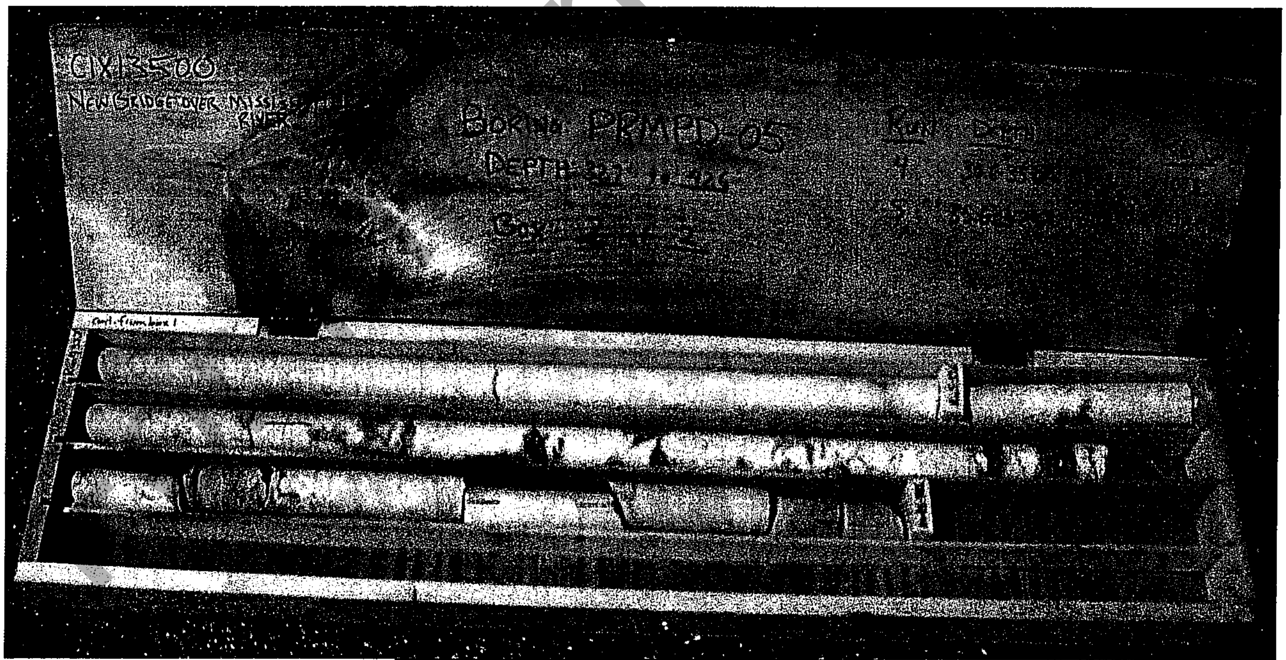
Boring PRMPD-04			
Run	Depth (ft)	REC (%)	RQD (%)
1	15.8 – 20.8	99	73
2	20.8 – 25.8	94	49
3	25.8 – 30.8	85	78



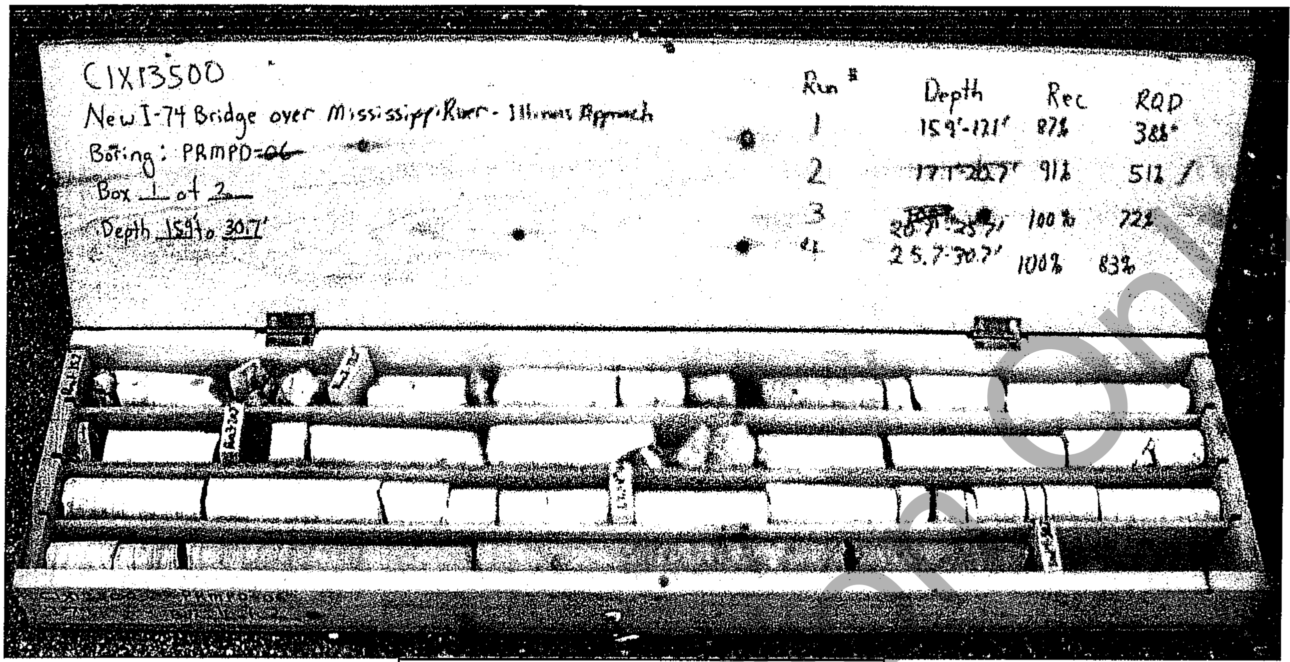
Boring PRMPD-04			
Run	Depth (ft)	REC (%)	RQD (%)
4	30.8 – 35.8	100	100
5	35.8 – 41.8	100	96



Boring PRMPD-05			
Run	Depth (ft)	REC (%)	RQD (%)
1	16.7 – 20.6	82	23
2	20.6 – 25.6	100	95
3	25.6 – 30.6	97	87
4	30.6 – 35.6	100	100



Boring PRMPD-05			
Run	Depth (ft)	REC (%)	RQD (%)
5	35.6 – 42.6	100	84



Boring PRMPD-06			
Run	Depth (ft)	REC (%)	RQD (%)
1	15.9 – 17.1	87	38
2	17.1 – 20.7	91	51
3	20.7 – 25.7	100	72
4	25.7 – 30.7	100	83

Boring PRMPD-06			
Run	Depth (ft)	REC (%)	RQD (%)
5	30.7 – 35.7	90	79
6	35.7 – 42.7	99	83

Summary of RMR and Elastic Moduli

SUMMARY OF ROCK MASS RATING (RMR) AND ELASTIC MODULI

Pier	Boring No.	Run No.	REC (%)	RQD (%)	RMR (Lower)	RMR (Upper)	RMR (Ave.)	Em (ksi)	Ei (ksi)
34+77.50 Pier 3	PRMPD-04	1	99	73	51	57	54	1825.4	
		2	94	49	46	53	50	1408.9	612
		3	85	78	50	58	54	1825.4	
		4	100	100	60	66	63	3064.6	
		5	100	96	60	64	62	2893.1	
36+67 Pier 4	PRMPD-06	1	87	33			0	81.5	
		2	91	51	48	56	52	1626.9	
		3	100	72	53	59	56	2048.2	1357
		4	100	83	58	62	60	2578.5	
		5	90	79	55	63	59	2434.3	
		6	99	83	56	62	59	2434.3	
38+56 Pier 5	PRMPD-05	1	82	23	38	48	43	969.1	
		2	100	95	58	68	63	3064.6	
		3	97	87	58	66	62	2893.1	1917
		4	100	100	74	74	74	5772.6	
		5	100	84	56	65	61	2653.8	

Em: Elastic Modulus of Rock Mass
Ei: Elastic Modulus of Intact Rock from Test

Illinois Department of Transportation

Structure Geotechnical Report Responsibility Checklist

Structure Number: 081-0187 (prop.) ______ (exist.) Contract Number: ______ Date: 6/26/2008

Route: I-74 Section: Ramp 6th - D County: Rock Island

TSL plans by: Jacobs

Structure Geotechnical Report and Checklist by: Jacobs

IDOT Structure Geotechnical Report Approval Responsibility : ☒ Qualified District Geotechnical Personnel ☐ BBS Central Geotechnical Unit

Geotechnical Data, Subsurface Exploration and Testing	Yes	No	N/A
All pertinent existing boring data, pile driving data, site inspection information included in the report?	☒	☐	☐
Are the preliminary substructure locations, foundation needs, and project scope discussions between Geotechnical Engineer and Structure Planner included in the report?	☒	☐	☐
All ground and surface water elevations shown on all soil borings and discussed in the report?	☒	☐	☐
Has all existing and new exploration and test data been presented on a subsurface data profile?	☒	☐	☐
Is the exploration and testing in accordance with the IDOT Geotechnical Manual policy?	☐	☒	☐
Are the number, locations, depths, sampling, testing, and subsurface data adequate for design?	☒	☐	☐

Geotechnical Evaluations	Yes	No	N/A
Have structure or embankment settlement amounts and times been discussed in report?	☒	☐	☐
Does the report provide recommendations/treatments to address settlement concerns?	☒	☐	☐
Has the critical factor of safety against slope instability been identified and discussed in the report?	☒	☐	☐
Does the report provide recommendations/treatments to address stability concerns?	☒	☐	☐
Is the seismic design data (PGA, amplification, category, etc.) noted in the report?	☒	☐	☐
Have the vertical and horizontal limits of any liquefiable layers been identified and discussed?	☐	☐	☒
Has seismic stability been discussed and have any slope deformation estimates been provided?	☐	☐	☒
Has the report discussed the proximity of ISGS mapped mines or known subsidence events?	☒	☐	☐
Has scour been discussed, any Hydraulics Report depths reported & soil type reductions made?	☐	☐	☒
Do the Factors of Safety meet AASHTO and IDOT policy requirements?	☒	☐	☐

Geotechnical Analyses and Design Recommendations	Yes	No	N/A
When spread footings are recommended, has a bearing capacity and footing elevation been provided for each substructure or footing region?	☒	☐	☐
Has footing sliding capacity been discussed?	☒	☐	☐
When piles are recommended, does the report include a table indicating estimated pile lengths vs. a range of feasible required bearings and design capacities for each pile type recommended?	☒	☐	☐
Have any downdrag, scour, and liquefaction reductions in pile capacity been addressed?	☒	☐	☐
Will piles have sufficient embedment to achieve fixity and lateral capacity?	☐	☒	☐
Have the diameters & elevations of any pile pre-coring been specified (when recommended)?	☐	☒	☐
Has the need for test piles been discussed and the locations specified (when recommended)?	☒	☐	☐
Has the need for metal shoes been discussed and specified (when recommended)?	☒	☐	☐
When drilled shafts are recommended, have side friction and/or end-bearing values been provided?	☒	☐	☐
Has the feasibility of using belled shafts been discussed when terminating above rock, or have estimated top of rock elevations been provided when extending into rock?	☐	☒	☐
Have shaft fixity, lateral capacity, and min. embedment been discussed?	☒	☐	☐
When retaining walls are required, has feasibility and relative costs for various wall types been discussed?	☐	☒	☐
Have lateral earth pressures and backfill drainage recommendations been discussed?	☒	☐	☐
Has ground modification been discussed as a way to use a less expensive foundation or address feasibility concerns?	☒	☐	☐
Have any deviations from IDOT Geotechnical Manual or Bridge Manual policy been recommended?	☒	☐	☐

Construction Considerations	Yes	No	N/A
Has the need for cofferdams, seal coat, or underwater structure excavation protection been discussed?	☐	☐	☒
Has stability of temporary construction slopes vs. the need for temporary walls been discussed?	☒	☐	☐
Has the feasibility of cantilevered sheeting vs. a temporary soil retention system been discussed?	☐	☐	☒
Has the feasibility of using a geotextile wall vs. a temp. MSE for any temp fill retention been noted?	☐	☒	☐

"In order to aid in determining the level of departmental review, please attach additional documentation or reference specific portions of the SGR to clarify any checklist responses that reflect deviation from IDOT policy/practice."

I-74 Ramp 6th-D Structure Geotechnical Report Responsibility Checklist Notes:

1. Soil classification based upon Jacobs Soil and Rock classification System per previous agreement with Iowa DOT and CH2M Hill.

2. Lateral capacities using GROUP 7.0 or Florida Multi Pier should be performed during final design once the pile/drilled shaft layouts are made and group reduction factors can be applied. The vertical shallow piles may not provide the required fixity. Piles may need to be driven on a batter or set in rock.