Appendix D. Drilled Shaft Report Example

PLEASE NOTE

A sample foundations report is included here for reference. It is provided as an example of content, format, and organization representative of a typical Foundation Investigation and Recommendation Report for a drilled shaft foundation. As site conditions vary widely, the investigation means and methods, and report content (including recommendations), may differ for other projects. Note that the selection and inclusion of this report as a sample does not imply that it is guaranteed to be free of errors. Please contact the Foundations Unit with any questions when interpreting a geotechnical report issued by this office or if you have any questions with respect to preparing geotechnical reports for MnDOT. The information presented here is intended for use as a resource by geotechnical engineering professionals. MnDOT makes no warranty as to the suitability of engineering reports in the style of this sample report, for other geotechnical needs, purposes, clients, or projects.

Minnesota Department of Transportation

Office of Materials & Road Research
Geotechnical Engineering Section
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Date: October 02, 2008

To: D. Dorgan, State Bridge Engineer
Office of Bridges & Structures

From: Hossana Teklyes, Grad Engineer-2
Foundations Unit

Digitally signed by Hossana Teklyes

Concur: Gary Person, Foundations Engineer
Foundations Unit

Digitally signed by Gary Person

Concur: Rich Lamb, Foundations Project Engineer
Foundations Unit

RAL

Subject: S.P. 3902-21 Bridge 39008
TH 11 over Rapid River in Clementson
Preliminary Foundation Investigation and Recommendations

Project Summary

This report provides for a preliminary foundation investigation, analysis and recommendations for replacing Bridge 5557 with Bridge 39008.The old three-span arch Bridge built in 1950, will be replaced with a new three-span structure. The new Bridge (39008) will use 63 inch prestressed concrete beams with a cast in place deck 40 feet wide by 247 feet long. The substructures are to be supported on drilled shaft foundations.

This report is preliminary in nature because of the iterative design process involved with drilled shaft foundations. A final report will be provided once the final structural loads (both axial and lateral) are determined. Load and Resistance Factor Design (LRFD) methods will be used for the analysis and design recommendations.

Field Investigation and Foundation Conditions

Four foundation borings were taken by STS, under a consultant contract for Mn/DOT, in June 2008. A copy of these borings is included with this report.

West Abutment & Pier

At the proposed west Abutment & Pier the foundation soils consist of a 10-15 ft. layer of sandy clay loam soil followed by bedrock. The bedrock at this site is a greenstone generally fresh with slight weathering. Unconfined compression tests were performed on selected representative rock core samples in order to determine the unconfined compressive strength and elastic modulus of the rock. The results of these tests are plotted on the individual boring logs and are shown in Table 1.Groundwater was not encountered during drilling.

East Abutment & Pier

At the proposed east Abutment & Pier the foundation soils consist of a 15-20 ft. layer of sandy loam soil followed by bedrock. The bedrock at this site is a greenstone generally fresh with slight weathering. Unconfined compressive tests were performed on selected representative rock core samples in order to determine the unconfined compressive strength and elastic modulus of the rock. The results of these tests

are plotted on the individual boring logs and are shown in Table 1. Groundwater was not encountered during drilling.

West Abutment Samples

Fig 1: Rock Core from 28.1 ft. to 28.4 ft.

Fig 2: Rock Core from 40 ft. to 40.3 ft

East Abutment Samples

Fig 3: Rock core from 18.2 ft. to 18.5 ft.

Fig 4: Rock core from 26 ft. to 26.8 ft.

Table 1: Results of Lab Tests on Rock Core Samples

Boring	Elevation	Rock Description	q_u psi	elastic modulus, E psi
B-1	1065	Greenstone, slightly weathered	30,000*	3,064,000
B-2	895.3	Greenstone, slightly weathered to generally fresh	30,000*	2,893,100
B-3	897.7	Greenstone, slightly weathered to generally fresh	9,000**	1,825,400
B-4	899.1	Greenstone, slightly weathered to generally fresh	30,000*	3,438,500

* The rock core did not reach unconfined compressive strength
** The rock core did reach unconfined compressive strength

Please refer to the attached boring logs for a detailed description of the foundation soils and rock. Rock core is available for inspection in our lab. Please contact our office if you wish to see the core.

Foundation Analysis

Locations and elevations of existing and proposed substructures were determined from a bridge survey and a preliminary bridge plan provided by the Bridge Office. The existing three- span arch bridge was constructed in 1950 and is supported on spread footing foundations on the shallow bedrock.

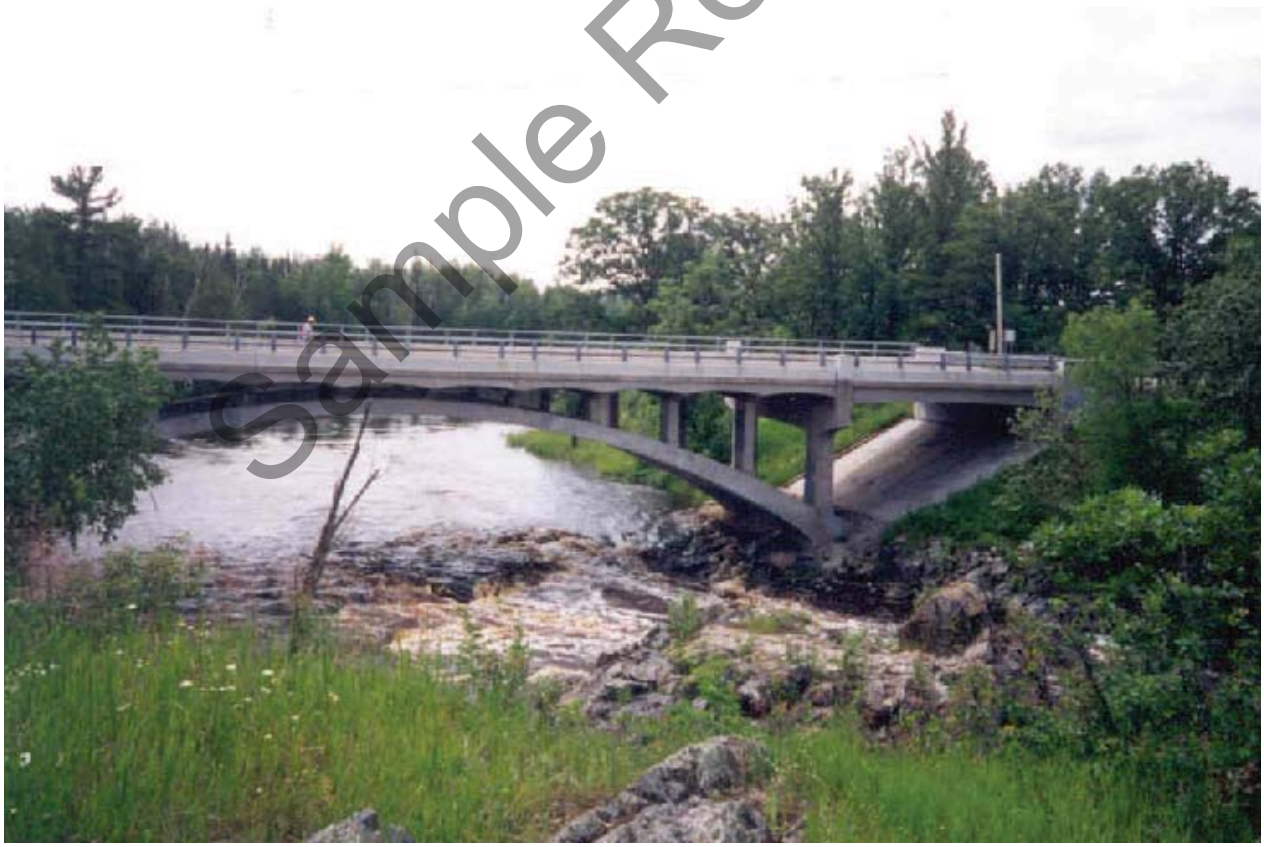


Fig 5.The existing three-span arch Bridge (5557) crossing Rapid River in Clementson

Scour

At this site, no scour depth has been predicted by the Hydraulics Section.

Drilled shaft Settlement

For footings bearing on fair to very good rock, according to the Geomechanics Classification system, as defined in Article 10.4.6.4(AASHTO LRFD Bridge Design Specifications,2008 Interim Revisions), elastic settlements may generally be assumed to be less than 0.5 in.

Lateral loads are not expected to control the drilled shaft design for this project. However, the lateral deflection will be checked once the final structural loads are made available.

The construction method to install the drilled shaft foundations is expected to utilize temporary casing and drilling slurry (water). The casing will first be sealed into competent rock and then the shaft will be drilled out to the design depth. Before placing the rebar cage, the bottom of the shaft will be cleaned out thoroughly.

Abutment & Pier Foundations – Drilled Shaft Axial Capacity

Since bedrock was found at a shallow depth during boring at the abutment and pier locations, drilled shafts foundation were analyzed. Diameters of 36, 42 and 48 in. were assumed for the drilled shaft.

The drilled shaft design follows the guidelines presented in the AASHTO LRFD BRIDGE DESIGN (2008 Interim Revisions). Because of the complexities and unknowns involved with load transfer in stratified rock, a conservative approach was used for design of the axial capacity of the shafts. This design assumes that the axial load will be resisted entirely by side resistance. In actual practice, some of the axial load is transferred to the base of the shaft, however, in lieu of static load testing, it is very difficult to determine how much.

The unit side resistance was first calculated for each material layer using the analysis method of Kulhawy and Phoon (1993).

$$f_{\max i} = 0.65\alpha_E \; p_a \sqrt{\frac{q_{ui}}{p_a}}$$

where p_a = *atmospheric pressure*

q_{ui} = *unconfined compressive strength of rock*

α_E = *reductionfactor to account for jointing in rock*

The total side resistance, R_s, was then computed using the following equation:

$$R_S = \phi_s \; \pi \; B \sum_{i=1}^{n} \Delta z_i \; f_{\max i} \quad \text{where } \phi_s = 0.55$$

Because the final axial and lateral loads are unknown at this time, the factored side resistance is presented as a function of drilled shaft depth and diameter. The Structural Engineer should use this chart to select a preferred shaft diameter and depth and verify that the factored loads, $\eta\Sigma\gamma_i Q_i$, from the most critical design case (strength or extreme event), meet or exceed the factored resistances for the options shown.

Figure 1: Estimated Factored Geotechnical Side Resistance vs. Depth

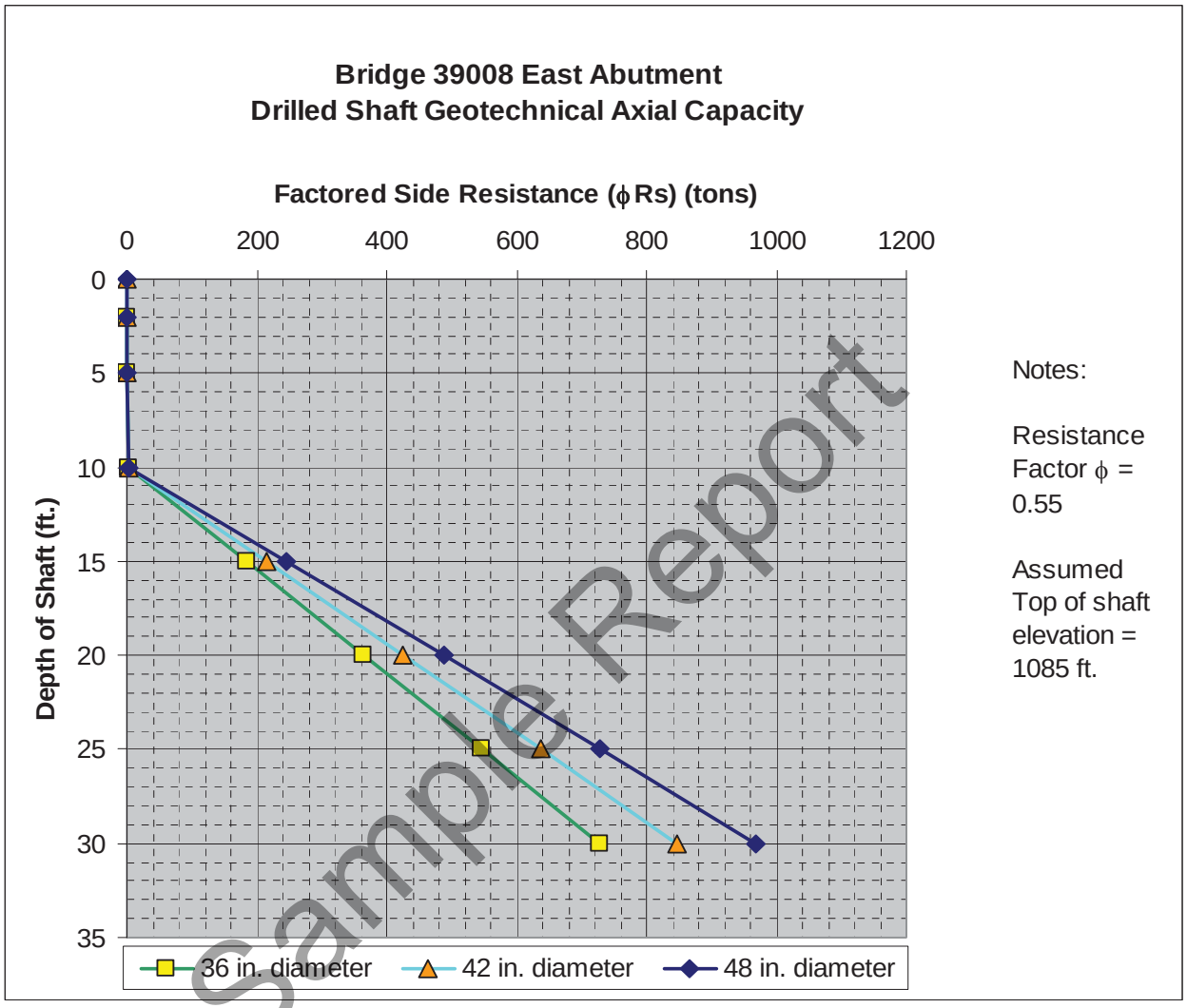


Figure 2: Estimated Factored Geotechnical Side Resistance vs. Depth

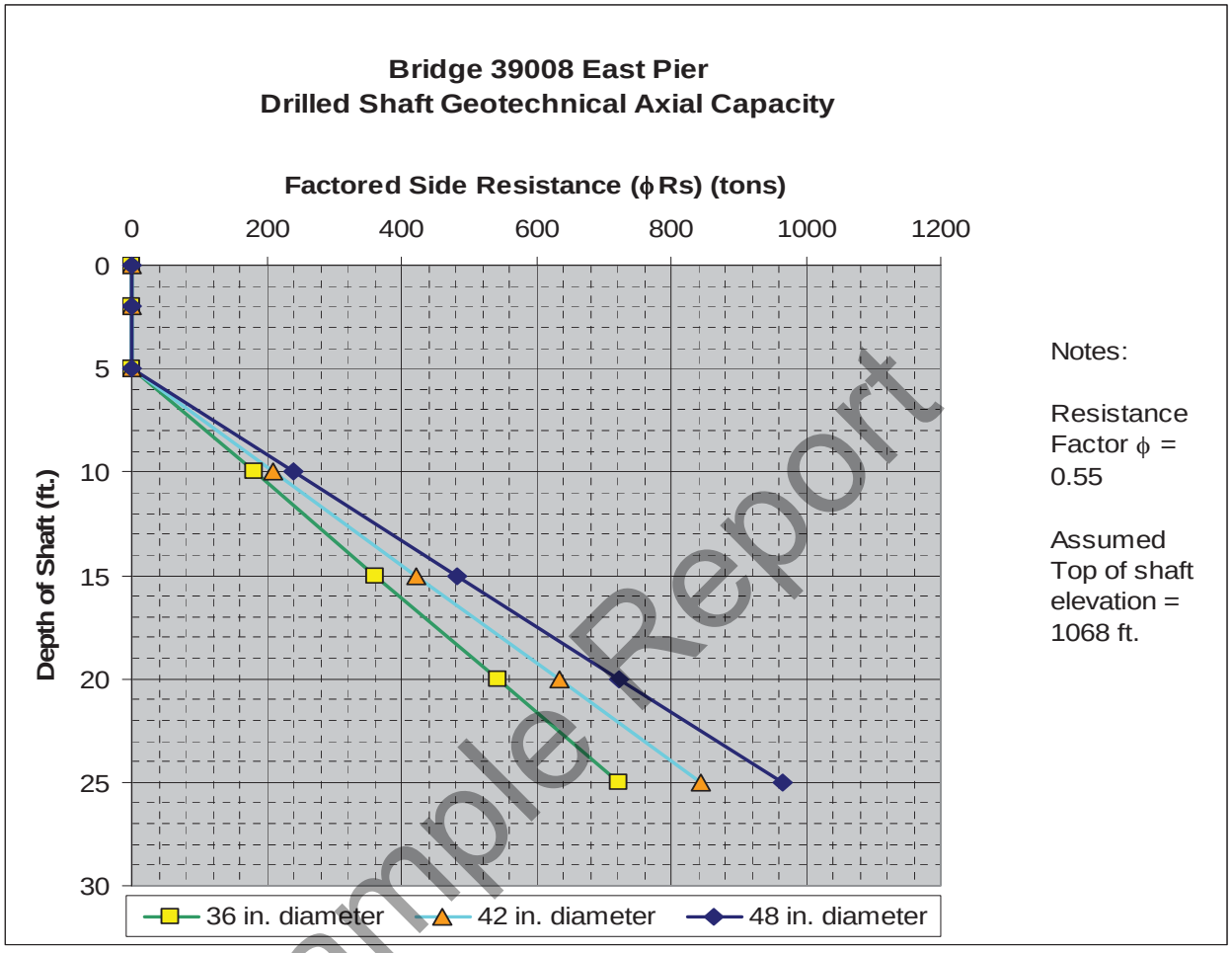


Figure 3: Estimated Factored Geotechnical Side Resistance vs. Depth

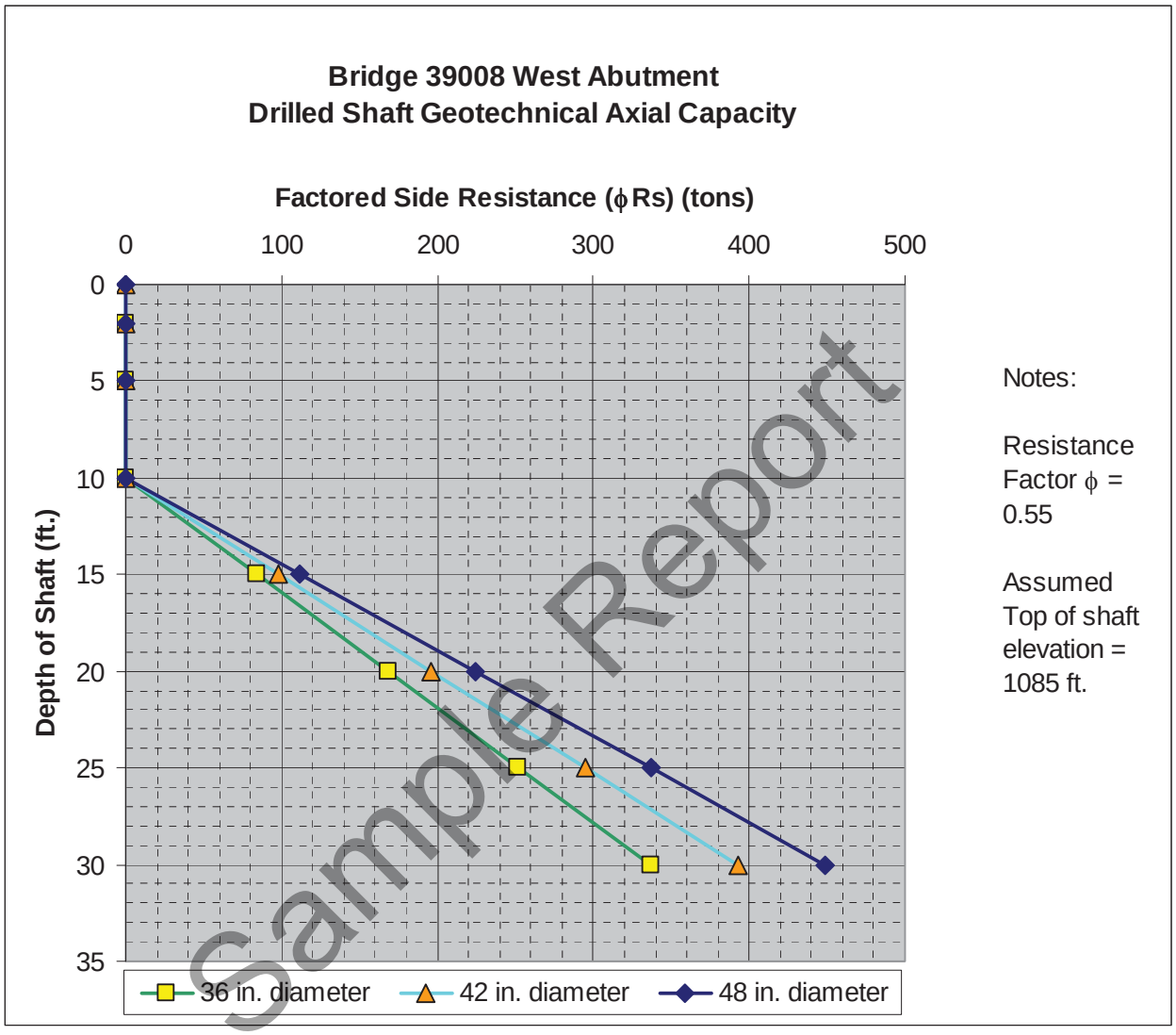
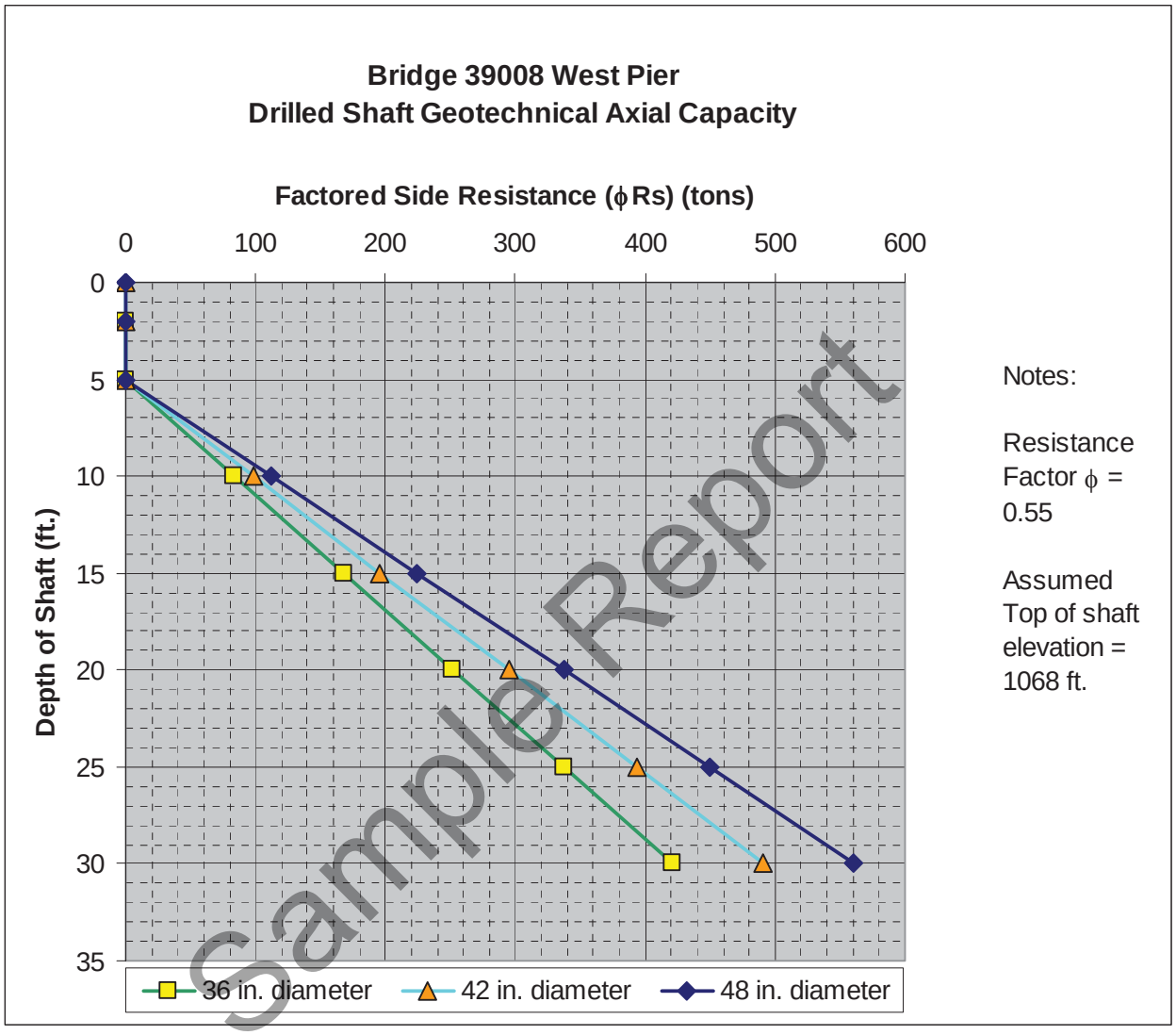


Figure 3: Estimated Factored Geotechnical Side Resistance vs. Depth



Preliminary Foundation Recommendations

Based on the existing conditions along with an analysis of the project soils, we recommend that;

1. Topsoil and other organic material should be removed from areas where fill is to be placed.

2. The side slopes and end slopes be same as existing or flatter for stability.

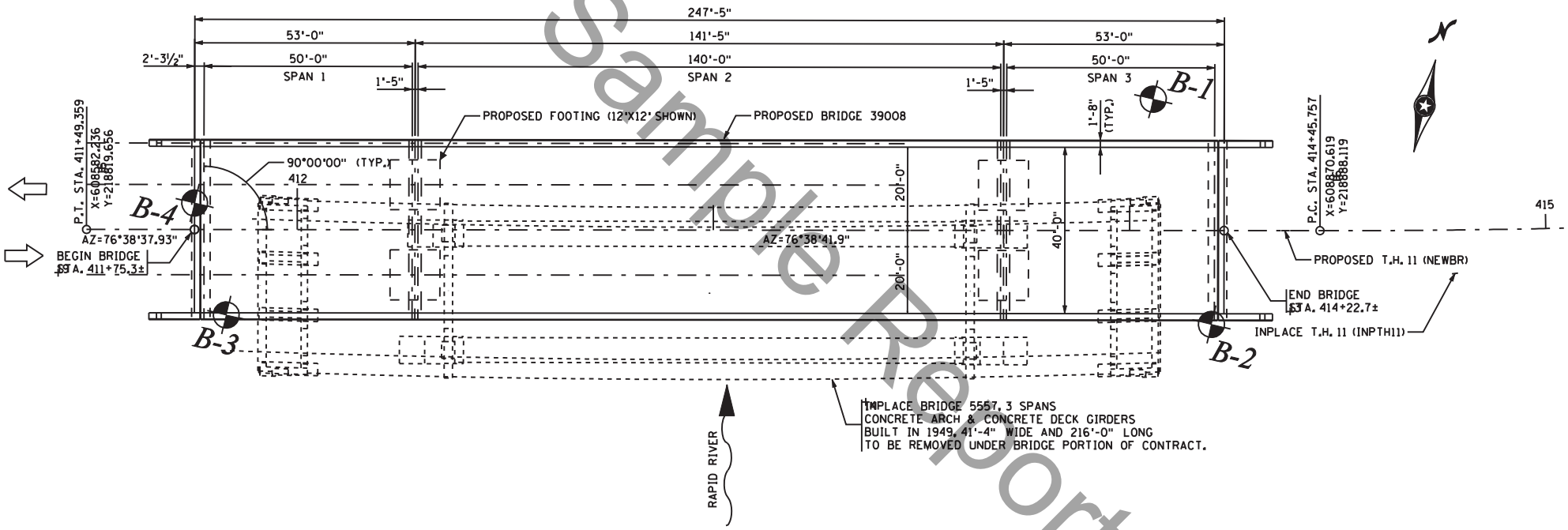
3. The bridge abutments and piers should be supported with drilled shaft foundations. The drilled shaft diameter and depth will be finalized in the final Foundation Recommendation Report after the final structural loads are made available. Please provide the following loading values to our office when they become available:

a. Axial design load per column for most critical design case (strength or extreme event)
b. Lateral design load per column for most critical design case (strength or extreme event)

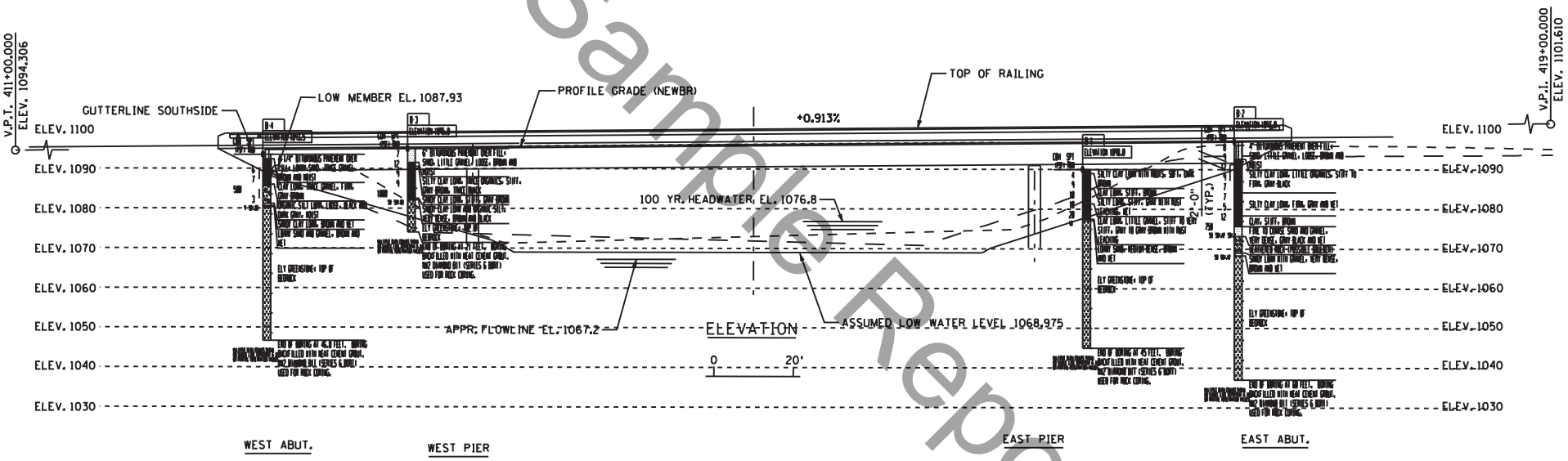
Attachments: Boring Logs B-1 – B-4 (Unique #70658-70661)
Boring Plan
Boring Profile

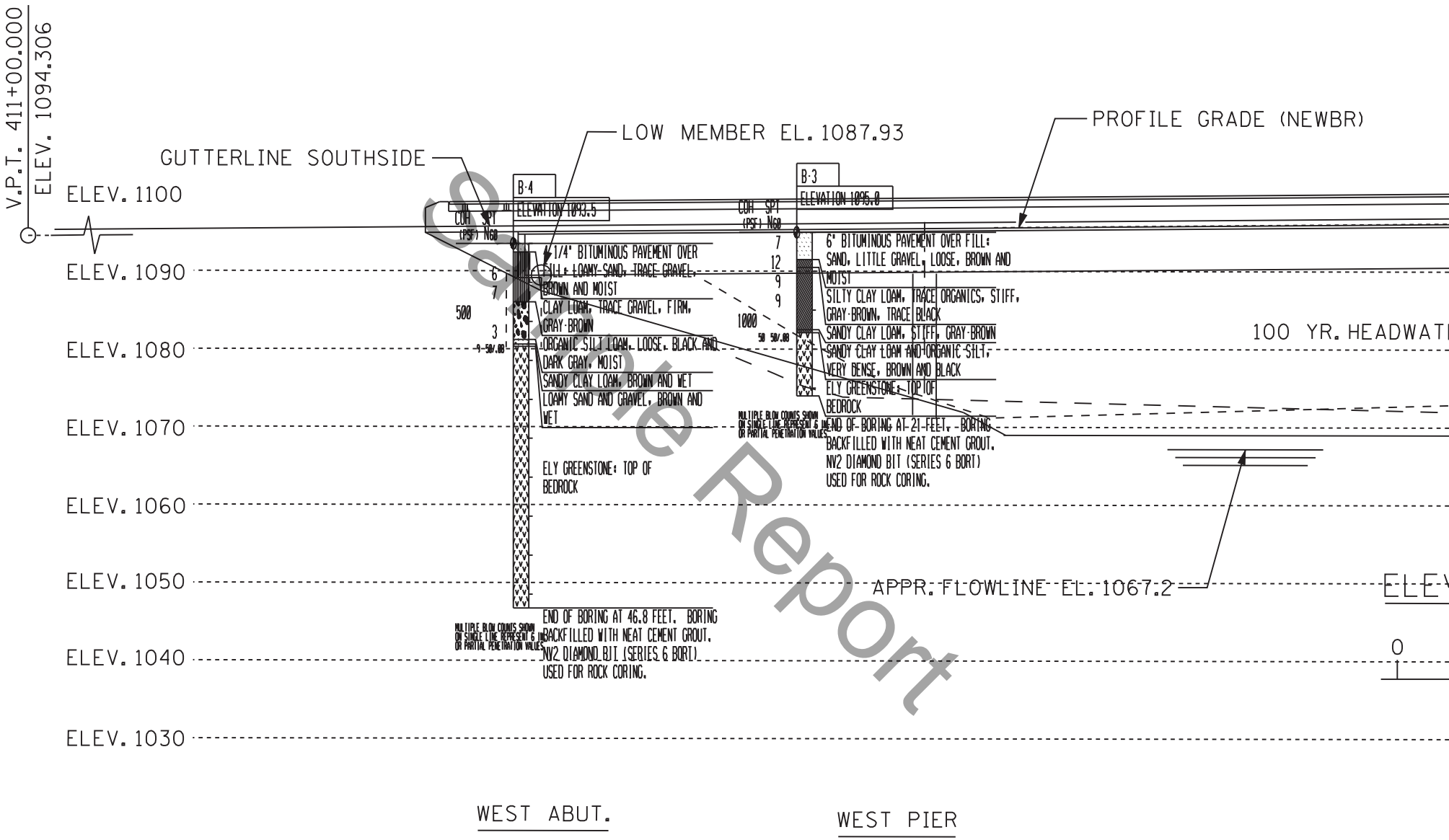
cc: G. Engstrom
D. Dorgan
T. Styrbicki
A. Staples
D. Robertson
J. Bittman

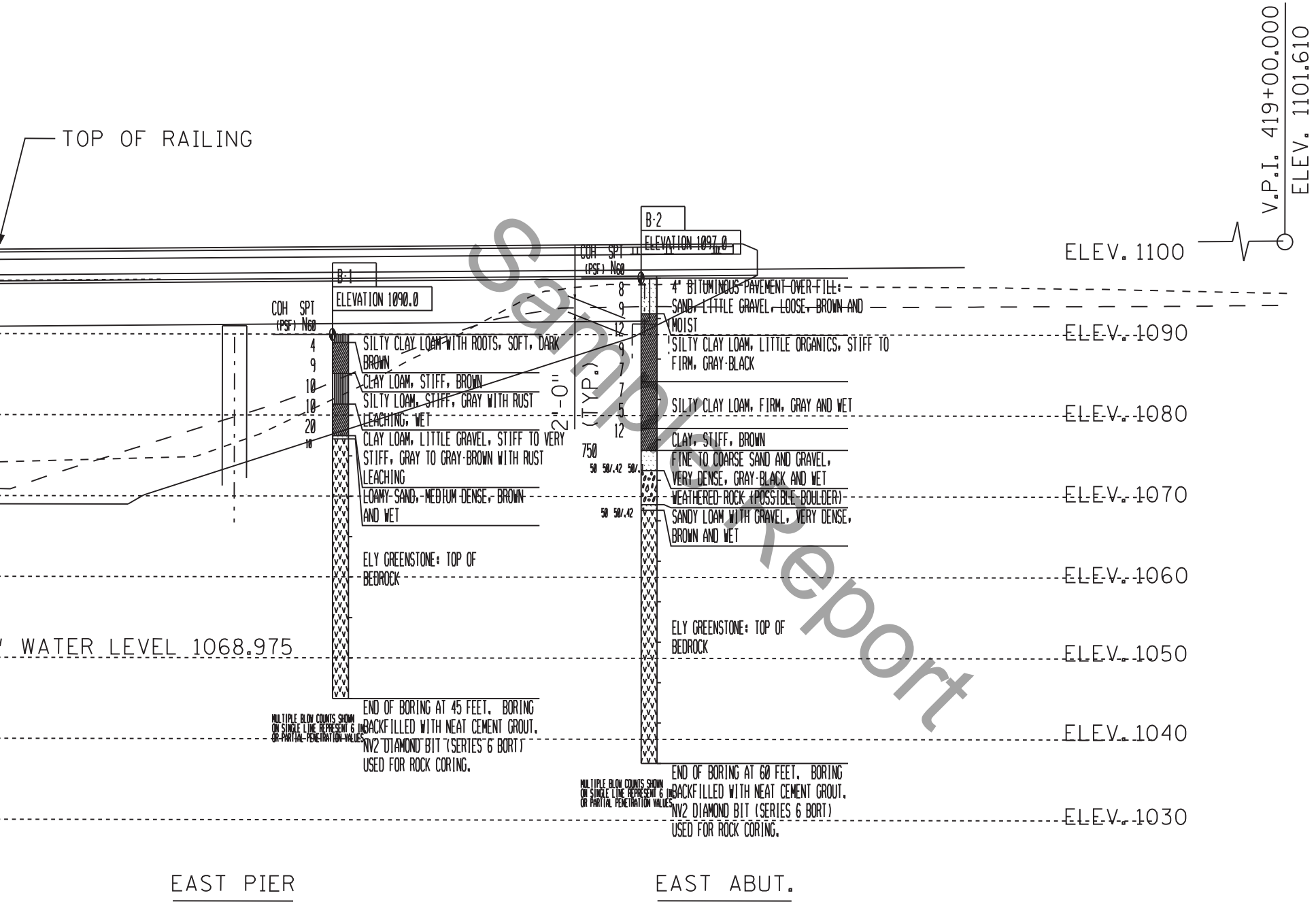
File



GENERAL PLAN

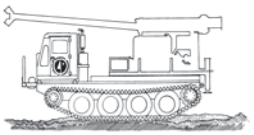






Minnesota Department of Transportation Geotechnical Section

Boring Log Descriptive Terminology (English Units)



USER NOTES, ABBREVIATIONS AND DEFINITIONS - Additional information available in Geotechnical Manual.

This boring was made by ordinary and conventional methods and with care deemed adequate for the Department's design purposes. Since this boring was not taken to gather information relating to the construction of the project, the data noted in the field and recorded may not necessarily be the same as that which a contractor would desire. While the Department believes that the information as to the conditions and materials reported is accurate, it does not warrant that the information is necessarily complete. This information has been edited or abridged and may not reveal all the information which might be useful or of interest to the contractor. Consequently, the Department will make available at its offices, the field logs relating to this boring.

Since subsurface conditions outside each borehole are unknown, and soil, rock and water conditions cannot be relied upon to be consistent or uniform, no warrant is made that conditions adjacent to this boring will necessarily be the same as or similar to those shown on this log. Furthermore, the Department will not be responsible for any interpretations, assumptions, projections or interpolations made by contractors, or other users of this log.

Water levels recorded on this log should be used with discretion since the use of drilling fluids in borings may seriously distort the true field conditions. Also, water levels in cohesive soils often take extended periods of time to reach equilibrium and thus reflect their true field level. Water levels can be expected to vary both seasonally and yearly. The absence of notations on this log regarding water does not necessarily mean that this boring was dry or that the contractor will not encounter subsurface water during the course of construction.

WH ..... Weight of Hammer
WR ..... Weight of Rod
Mud..... Drilling Fluids in Sample
CS ..... Continuous Sample

SOIL/CORE TESTS

SPT N_{60} ..... ASTM D1586 Modified Blows per foot with 140 lb. hammer and a standard energy of 210 ft-lbs. This energy represents 60% of the potential energy of the system and is the average energy provided by a Rope & Cathead system.
MC..... Moisture Content
COH ..... Cohesion
γ ..... Sample Density
LL..... Liquid Limit
PI..... Plasticity Index
Φ ..... Phi Angle
REC..... Percent Core Recovered
RQD ..... Rock Quality Description (Percent of total core interval consisting of unbroken pieces 4 inches or longer)
ACL..... Average Core Length (Average length of core that is greater than 4 inches long)
Core Breaks .... Number of natural core breaks per 2-foot interval.

DISCONTINUITY SPACING

Fractures	Distance	Bedding
Very Close	<2 inches	Very Thin
Close	2-12 inches	Thin
Mod. Close	12-36 inches	Medium
Wide	>36 inches	Thick

Consistency - Cohesive Soils	BPF
very soft	0-1
soft	2-4
firm	5-8
stiff	9-15
very stiff	16-30
hard	31-60
very hard	> 60

COLOR

blk..... Black
grn ..... Green
orng ..... Orange
dk..... Dark
IOS..... Iron Oxide Stained
wht .....White
brn.....Brown
yel.....Yellow
lt .....Light

GRAIN SIZE /PLASTICITY

VF..... Very Fine
F..... Fine
Cr..... Coarse
pl .....Plastic
slpl .....Slightly Plastic

SOIL/ROCK TERMS

C..... Clay
L..... Loam
S..... Sand
Si..... Silt
G ..... Gravel (No. 10 Sieve to 3 inches)
Bldr..... Boulder (over 3 inches)
T..... till (unsorted, nonstratified glacial deposits)
Lmst.....Limestone
Sst.....Sandstone
Dolo.....Dolostone
wx.....weathered

WATER MEASUREMENT

AB ..... After Bailing
AC ..... After Completion
AF..... After Flushing
w/C..... with Casing
w/M ..... with Mud
WSD..... While Sampling/Drilling
w/AUG..... with Hollow Stem Auger

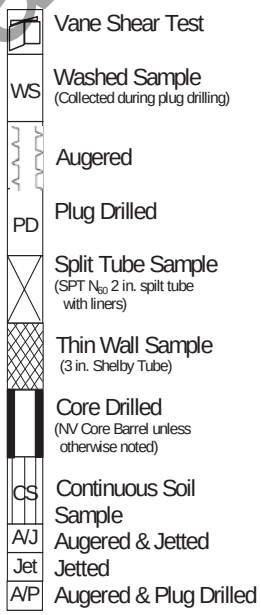
MISCELLANEOUS

NA ..... Not Applicable
w/ ..... with
w/o ..... with out
sat ..... saturated

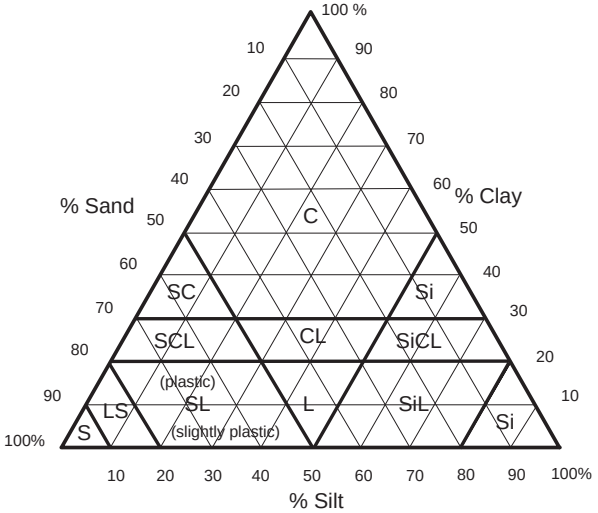
DRILLING OPERATIONS

AUG ..... Augered
CD ..... Core Drilled
DBD..... Disturbed by Drilling
DBJ ..... Disturbed by Jetting
PD ..... Plug Drilled
ST..... Split Tube (SPT test)
TW..... Thinwall (Shelby Tube)
WS..... Wash Sample
NSR..... No Sample Retrieved

DRILLING SYMBOLS



Mn/DOT Triangular Textural Soil Classification System



RELATIVE DENSITY

Compactness - Granular Soils	BPF
very loose	0-4
loose	5-10
medium dense	11-24
dense	25-50
very dense	>50

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 70658

This boring was taken by STS Limited, Inc. under a consultant contract for Mn/DOT

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
3902-21	5557	MN Trunk Highway 11	B-1	1090.0 (DTM)

Location , , ft. LT

Lake of the Woods/North Zone Co. Coordinate: X=608824 Y=2189(ft)

Latitude (North)= Longitude (West)=

Drill Machine CME-750

Hammer CME Automatic

SHEET 1 of 2

Drilling Completed 5/30/08

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60	MC (%)	COH (psf)	γ (pcf)	Soil / Rock	Other Tests Or Remarks / Formation or Member
	1.0 / 1089.0		Silty clay loam with roots, soft, dark brown		4	21				
			Clay loam, stiff, brown		9	23				SPT hammer cal. to 68%, 2005
5	4.8 / 1085.2		Silty loam, stiff, gray with rust leaching, wet		10	22				Groundwater not observed or measured while drilling
	8.6 / 1081.4		Clay loam, little gravel, stiff to very stiff, gray to gray-brown with rust leaching		10	21				
10					20	21				
	12.5 / 1077.5		Loamy sand, medium dense, brown and wet	PD	10	20				
	12.9 / 1077.1			PD						
15					100	83				ELY GREENSTONE Fine-grained, gray-green, unweathered
20					100	74				8 min./ foot
			ELY GREENSTONE: Top of Bedrock							
25					100	38				11 min./ foot
										Drill bit jammed at 27.3 feet
										Water loss approximately 35 gallons
30					100	81				10 min./ foot
35										

Index Sheet Code 3.0

(Continued Next Page)

Soil Class:MM Rock Class: DH Edit: Date: 9/30/08

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MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 70658

This boring was taken by STS Limited, Inc. under a consultant contract for Mn/DOT

U.S. Customary Units

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS *SHEET 2 of 2*

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
3902-21	**5557**	**MN Trunk Highway 11**	**B-1**	**1090.0** *(DTM)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} (%)	MC (%)	COH (psf)	γ (pcf)	Soil / Rock	Other Tests Or Remarks / Formation or Member
					REC (%)	RQD (%)	ACL (ft)	Core Breaks		
40			ELY GREENSTONE: Top of Bedrock *(continued)*		100	89				10 min./ foot
					100	100				
45	45.0 / 1045.0		End of boring at 45 feet. Boring backfilled with neat cement grout.							

NV2 diamond bit (Series 6 Bort) used for rock coring.

Soil Class:MM Rock Class: DH Edit: Date: 9/30/08

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MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 70659

This boring was taken by STS Limited, Inc. under a consultant contract for Mn/DOT

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
3902-21	5557	MN Trunk Highway 11	B-2	1097.0 (DTM)

Location , , ft. LT

Lake of the Woods/North Zone Co. Coordinate: X=608850 Y=2188600

Latitude (North)= Longitude (West)=

Drill Machine CME-750

Hammer CME Automatic

SHEET 1 of 2

Drilling Completed 6/3/08

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
0			4" Bituminous pavement over FILL: sand, little gravel, loose, brown and moist		8	5				SPT hammer cal. to 68%, 2005
					9	7				
	4.4 / 1092.6									Groundwater not observed or measured while drilling
5			Silty clay loam, little organics, stiff to firm, gray-black		12	24				
					9	24				
10				PD	7	29				
	12.8 / 1084.2			PD						
			Silty clay loam, firm, gray and wet		7	6				
15				PD	5	26				
				PD	12	23				
	18.6 / 1078.4		Clay, stiff, brown	PD			750	127		
20	21.3 / 1075.7		Fine to coarse sand and gravel, very dense, gray-black and wet	PD	50 / 50/.42 / 50/.1	33				No recovery at 22.5 to 23.5 feet
	23.8 / 1073.2		Weathered rock (possible boulder)	PD						Set NX casing to 23.4 feet
25										Pulled NX, reamed hole with 3 7/8", reset NX to 28.7 feet
	28.0 / 1069.0		Sandy loam with gravel, very dense, brown and wet		50 / 50/.42	7				
	28.7 / 1068.3			PD						ELY GREENSTONE, fine-grained, gray-green, unweathered
30			ELY GREENSTONE: Top of Bedrock		100	83				6 min./ foot
										No voids, no water loss
35										

Soil Class:MM Rock Class: DH Edit: Date: 9/30/08

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MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 70659

This boring was taken by STS Limited, Inc. under a consultant contract for Mn/DOT

U.S. Customary Units

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS *SHEET 2 of 2*

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
3902-21	**5557**	**MN Trunk Highway 11**	**B-2**	**1097.0** *(DTM)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} (%)	MC (%)	COH (psf)	γ (pcf)	Soil / Rock	Other Tests Or Remarks / Formation or Member
					REC (%)	RQD (%)	ACL (ft)	Core Breaks		
40					100	89				5 min./ foot
45			ELY GREENSTONE: Top of Bedrock *(continued)*		90	56				5 min./ foot
										6 min./ foot
					100	68				No water loss, no voids
50										5 min./ foot
					100	74				No water loss, no voids
55										5 min./ foot
					100	87				No water loss, no voids
60	60.0 / 1037.0		End of boring at 60 feet. Boring backfilled with neat cement grout.							

NV2 diamond bit (Series 6 Bort) used for rock coring.

Soil Class:MM Rock Class: DH Edit: Date: 9/30/08

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MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 70660

This boring was taken by STS Limited, Inc. under a consultant contract for Mn/DOT

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
3902-21	5557	MN Trunk Highway 11	B-3	1095.0 (DTM)

Location , , ft. LT

Lake of the Woods/North Zone Co. Coordinate: X=608620 Y=2188077.

Latitude (North)= Longitude (West)=

Drill Machine CME-750

Hammer CME Automatic

SHEET 1 of 1

Drilling Completed 6/4/08

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			6" Bituminous pavement over FILL: Sand, little gravel, loose, brown and moist		7	6				SPT hammer cal. to 68%, 2005
	3.5 / 1091.5		Silty clay loam, trace organics, stiff, gray-brown, trace black		12	20				
5	4.5 / 1090.5				9	14				Groundwater not observed or measured while drilling
			Sandy clay loam, stiff, gray-brown		9	17				Set 4" casing to 9.0 feet- mud rotary
10				PD		29	1000	129		
	12.5 / 1082.5		Sandy clay loam and organic silt, very dense, brown and black	PD	50 / 50/.08					
	12.9 / 1082.1			PD	100	67				ELY GREENSTONE, fine-grained, gray-green, unweathered
15			ELY GREENSTONE: Top of Bedrock		100	68				Set NX casing to 13.5 feet- rock bit to 14.0 feet
										No water loss, 6 min./ foot
										No water loss, 6 min./ foot
					100	84				No water loss, 7 min./ foot
20	21.0 / 1074.0		End of boring at 21 feet. Boring backfilled with neat cement grout.							Core barrel locked in boring- broke off core barrel

NV2 diamond bit (Series 6 Bort) used for rock coring.

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 70661

This boring was taken by STS Limited, Inc. under a consultant contract for Mn/DOT

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
3902-21	5557	MN Trunk Highway 11	B-4	1093.5 (Auto Level)

Location , , ft. LT

Lake of the Woods/North Zone Co. Coordinate: X=608606 Y=2188[illegible]2)

Latitude (North)= Longitude (West)=

Drill Machine CME-750

Hammer CME Automatic

SHEET 1 of 2

Drilling Completed 6/10/08

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	1.1 1092.4		4 1/4" bituminous pavement over FILL: loamy sand, trace gravel, brown and moist			8				
			Clay loam, trace gravel, firm, gray-brown		6	21				SPT hammer cal. to 68%, 2005
5					7	24				Groundwater not observed or measured while drilling
	7.5 1086.0						500	130		
10			Organic silt loam, loose, black and dark gray, moist		3	44				
	12.3 1081.2		Sandy clay loam, brown and wet	PD	9	28				
	12.9 1080.6		Loamy sand and gravel, brown and wet		50/.08					
15	13.2 1080.3				100	67				ELY GREENSTONE, fine-grained, gray-green, unweathered 10 min./ foot, no water loss
					100	69				3 min./ foot, no water loss
20					100	65				4 min./ foot, no water loss
			ELY GREENSTONE: Top of Bedrock		100	42				4 min./ foot, 15% water loss
25					100	97				4 min./ foot, 15% water loss
30					100	83				4 min./ foot, 16% water loss
					100	90				4 min./ foot, no water loss
35										

Index Sheet Code 3.0

(Continued Next Page)

Soil Class:MM Rock Class: DH Edit: Date: 9/30/08

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MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 70661

This boring was taken by STS Limited, Inc. under a consultant contract for Mn/DOT

U.S. Customary Units

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS *SHEET 2 of 2*

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
3902-21	**5557**	**MN Trunk Highway 11**	**B-4**	**1093.5** *(Auto Level)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} (%) REC	MC (%) RQD	COH (psf) ACL	γ (pcf) Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
40			ELY GREENSTONE: Top of Bedrock *(continued)*		100	77				5 min./ foot, no water loss
					100	100				5 min./ foot, no water loss
45					100	88				5 min./ foot, no water loss
	46.8 / 1046.7		End of boring at 46.8 feet. Boring backfilled with neat cement grout.							

NV2 diamond bit (Series 6 Bort) used for rock coring.

Soil Class:MM Rock Class: DH Edit: Date: 9/30/08

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