R E P O R T

Minneapolis Community Development Agency

600 Crown Roller Mill
105 - 5th Avenue South
Minneapolis, MN 55401

Subsurface Exploration and Geotechnical
Engineering Analysis for the Proposed
Humboldt Greenway in
Minneapolis, Minnesota

Minneapolis Community
Development Agency

Humboldt Greenway
Minneapolis, Minnesota

97836

July 25, 2000

STS Consultants, Ltd.
Solutions through Science & Engineering

July 25, 2000

Mr. Larry Heinz
Minneapolis Community Development Agency
600 Crown Roller Mill
105 - 5th Avenue S.
Minneapolis, MN 55401

Re: Subsurface Exploration and Geotechnical Engineering Analysis for the Proposed Humboldt Greenway in Minneapolis, Minnesota; STS Project 97836

Dear Mr. Heinz:

We have performed a subsurface exploration and geotechnical engineering analysis for the proposed condominium buildings project. The attached report contains the logs of 37 soil borings, an evaluation of the conditions encountered in the borings, and our recommendations for suitable foundation types, allowable soil bearing pressure, and other geotechnical related design and construction considerations.

We appreciate the opportunity to work with you on this project. If you have any questions about our recommendations, please call us at 763/315-6300. To arrange for our testing services during the construction phase of this project, please call me or Mr. Steve Ruesink, P.E., at the same phone number.

Respectfully,

STS CONSULTANTS, LTD.

Stephen S. Weyda
Assistant Project Engineer

Mervyn Mindess, P.E.
Senior Project Engineer

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TABLE OF CONTENTS

Subsurface Exploration and Geotechnical Engineering Analysis
for the Humboldt Greenway Development
in Minneapolis, Minnesota

1.0 PROJECT OVERVIEW

1.1 Project Description

MCDA proposes development of 14 blocks for condominium townhouse residential structures containing 3 to 14 individual units per building, along with the necessary driveways and underground utility lines.

The proposed condominiums will consist of two level, slab-on-grade structures, with wood frame construction for both levels. There will be detached garages associated with each building cluster. We estimate that structural loads on the bearing walls would range from 1.5 to 2.5 kips per lineal foot. Design grades have not been provided, but it is likely that the floor elevations of the buildings will be close to present grade. As part of this development, portions of Humboldt Avenue will be realigned.

The development area is a former single family residential neighborhood. At this time, some of the houses have been removed, and some are still to be demolished. Underground utility lines are currently being installed along Humboldt Avenue.

1.2 Project Scope and Purpose

Our services were performed in accordance with the project scope outlined in our proposal dated June 15, 2000. This work was authorized by Steven Maki on June 19, 2000.

The purposes of this exploration are to:

2.0 EXPLORATION AND TESTING PROCEDURES

2.1 Boring Layout and Soil Sampling Procedures

We mutually agreed on the number of borings. STS recommended the boring depths and locations. An STS engineer staked the borings by measuring from flanking streets, using dimensions obtained from the architect's site plan AO-1. The approximate boring locations are shown on the Soil Boring Location Diagram in the Appendix. The ground surface elevations at the borings are approximate only, and were interpolated from the topographic plan.

We drilled the borings with a truck mounted Diedrich D-50 drill rig, operated by a two person crew. The drill crew advanced the borings using continuous flight hollow stem augers. Detailed descriptions of typical drilling procedures are included in the Appendix. Drilling methods, depths, casing usage, drill rig type, foreman, and other drilling information are indicated on the boring logs.

The drill crew sampled the soil in advance of the auger tip at 2.5 foot intervals of depth to 10 feet and at 5 foot intervals thereafter. They sampled the soil using a split-barrel sampler in accordance with ASTM D-1586, Standard Method of Penetration Test and Split-Barrel Sampling of Soils. An explanation of typical STS drilling and sampling procedures is presented in STS Field and Laboratory Procedures in the Appendix.

Recovered soil samples were described on field logs, containerized, labeled and transported to our laboratory for further examination and testing. The field logs also document sample intervals, test data, observations of drilling resistance, groundwater occurrence and other pertinent conditions.

2.2 Groundwater Measurements and Borehole Abandonment

The drill crew observed the borings for free groundwater while drilling and after completion. These observations and measurements are noted on the lower left corner of the boring logs. The crew then backfilled the borings with soil cuttings to comply with Minnesota Department of Health regulations.

2.3 Laboratory Testing Procedures

The penetration test split-spoon samples were visually examined by a geotechnical engineer to estimate the distribution of grain sizes, plasticity, consistency, moisture condition, color, presence of lenses and seams, and apparent geologic origin. The engineer classified the soils according to type using the Unified Soil Classification System. A chart describing this classification system is included in the Appendix. An explanation of typical laboratory procedures is presented in the Appendix.

We determined the natural moisture content and unconfined compressive strength by calibrated hand penetrometer of a selected number of soil samples from this exploration. These test data are indicated on the boring logs.

2.4 Boring Log Procedures and Qualifications

The results of the field and laboratory observations and tests are printed on final boring logs included in the Appendix. Similar soils were grouped into the strata shown on the boring logs, and the appropriate estimated USCS classification symbols were also added. Note that the stratification depth lines between soil types on the logs are estimated based on the available data. In-situ, the transition between soil types may be distinct or gradual in either the horizontal or vertical directions. The soil conditions have been established at our specific test hole locations only. Variations in the soil stratigraphy may occur between and around the borings, the nature

to medium sand, which was generally medium dense, extending to the termination depths. These boring were mainly within the northerly portion of the site.

The preceding is a generalized description of soil conditions at this site. Variations from the generalized profile exist and should be assessed from the boring logs in the Appendix, the normal geologic character of the deposits, and the soils uncovered during site excavation.

3.3 Groundwater Conditions

We encountered free groundwater in 26 of our 37 borings, at depths of 11 to 15 feet below ground surface, corresponding to approximate elevations 824 to 829 feet.

The site lies within the Shingle Creek watershed, and Shingle Creek crosses Humboldt Avenue approximately at 47th Avenue North. Ryan Lake is about 1.1 miles west of the site, and its average summer water elevation is 851 feet. It drains to Shingle Creek via Ryan Creek. The Mississippi River is about 4,000 to 4,500 feet east of Humboldt Avenue, and has an average summer water elevation of 800 feet abreast of the site.

There is a groundwater gradient along Shingle Creek generally downward in a southeasterly direction, plus a general west to east gradient to the Mississippi River. The groundwater levels we observed in our borings appear to be consistent with this gradient, and probably represent the hydrostatic groundwater level.

Even though there will be seasonal and annual fluctuations of the groundwater level at this site, it is at sufficient depth that it should not affect the proposed construction.

4.0 ANALYSIS AND RECOMMENDATIONS

4.1 Discussion

Based on our interpretation of the soil boring data, it appears that, for most of the building pads, conventional topsoil stripping, grading, and surficial compaction will be sufficient for building development. In building areas where fill or organic soils are encountered to greater depths, a subcut to about 3.5 to 7.5 feet depth to remove loose organic materials will be required. In areas where subcutting is required, fill will be needed to reach design subfloor elevation. On-site sand or silty sand could be used as structural fill. The sand soil is also a good pavement subgrade.

It appears that when the old houses were removed from the site, the basements were broken out and removed, and then the excavation filled with soil; however, there are also no indications that the basement backfill was compacted. Thus it will be important to probe the bases of the new foundations excavations, and to do some local soil correction where loose fill soils are detected.

4.2 Site Grading and Earthwork

The upper organic soil should be excavated from each building pad plus a 6 foot wide perimeter strip, to expose the underlying sand. Locations, such as former house basement areas, that require subcutting should be backfilled with on-site sand. Sand fill should be placed in 8 to 10 inch lifts, and compacted with a vibratory smooth drum roller to at least 95% of the maximum Standard Proctor dry density, ASTM D-698. We recommend that a geotechnical engineer or engineering technician be on-site during the excavation and placement of the fill material to test for compaction, and to detect loose compacted fill areas.

Procedures to reduce subgrade deterioration and for subgrade improvement when locally unsuitable soils are encountered are discussed in sheets entitled STS Subgrade Stabilization Guideline and STS Subgrade Protection Guideline in the Appendix.

4.3 Foundation Recommendations

We recommend that the condominium buildings be supported by conventional spread footings, bearing on naturally occurring sand, or on compacted sand fill. The footing should be designed for a net allowable soil bearing pressure not to exceed 2,000 psf.

Perimeter footings should be based at least 3 feet 8 inches (3.67 feet) below outside finished grade for frost protection. Unheated garage or deck footings should be based at least 5 feet below grade. Continuous strip footings under bearing walls should be at least 22 inches wide.

The recommended soil bearing pressure provides a theoretical factor of safety against shear or bearing capacity failure in excess of 3. Total and differential settlements corresponding to this loading should be less than 1 inch and 1/2 inch, respectively, provided the bearing soils are not frozen or disturbed at the time of footing installation.

4.4 Ground Supported Floor Slab

The recommended site preparation program will provide adequate support for the garage and interior floor slabs.

If portions of the new residential floor slabs are to have a non-breathable covering such as vinyl tile or linoleum, or if there is to be a room with wood flooring, we recommend that a vapor barrier should be installed below those portions of the slab. If a vapor barrier is used, it should be installed in accordance with the recommendations given in the ACI Manual of Concrete Practice, Part 2, Section 302.2.4.1.

4.5 Foundation Backfill

The foundation wall footings should be backfilled with the excavated non-organic fine to medium sand or sand fill. The backfill should be placed in 6 to 8 inch maximum loose lifts, with each lift uniformly compacted. We recommend the use of manually operated vibratory plate compactors in the zone adjacent to foundation walls. The use of large mechanical equipment within 3 feet of the walls should not be allowed, because this could potentially damage them. The footing backfill should be compacted to at least 92% Standard Proctor dry density.

4.6 Exterior Pavement Areas

Pavement areas for driveways or roadways should be prepared by stripping organic soils completely or at least to 3.5 feet below design pavement grade. The exposed sand subgrade should be surface rolled and compacted. If fill is required to achieve design subgrade elevation, it should be on-site sand compacted to 100% Standard Proctor dry density.

4.7 Utility Trench Backfill

On-site, inorganic sand material could be used as utility trench backfill material. The fill should be placed in 8 to 10 inch lifts and compacted to 95% Standard Proctor dry density when more than 3 feet below pavement grade. The top 3 feet should be compacted to 100% Standard Proctor dry density. We recommend that utility trench backfill materials be tested for adequate compaction during placement.

4.8 Construction Considerations

Good surface drainage should be maintained throughout the work, so that the site is not vulnerable to ponding after or during a rainfall. The excavation for the soil correction to densify loose fill, or for excavation to footing depths, should not encounter groundwater intrusion.

However if water does enter excavations, it should be promptly removed prior to further construction activities. Under no circumstances should fill or concrete be placed into standing water. Trenches for underground utility lines serving the buildings are also expected to be dry.

4.9 Winter Construction

Only unfrozen fill should be used. Placement of fill and/or foundation concrete must not be permitted on frozen soil, and the bearing soils under footings or under the floor slab should not be allowed to freeze after concrete is placed, because excessive post-construction settlement could occur as the frozen soils thaw.

4.10 Construction Safety

All excavations must comply with the requirements of OSHA 29 CFR, Part 1926, Subpart P "Excavations and Trenches". This document states that excavation safety is the responsibility of the contractor. Reference to this OSHA requirement should be included in the job specifications.

The responsibility to provide safe working conditions on this site, for earthwork, building construction, or any associated operations is solely that of the contractor. This responsibility is not borne in any manner by STS Consultants, Ltd.

4.11 Field Observation and Testing

We recommend that the earthwork and footing installations for this project be observed and tested by a geotechnical engineer or qualified engineering technician to determine if the soil and groundwater conditions encountered are consistent with those anticipated based on our exploration. Foundation subgrade should be tested to check for adequate bearing conditions. Subgrades for slabs, pavement and new structural fill should be test rolled and unsuitable areas improved. Fill placement and compaction should be monitored and tested to determine that the

5.0 STANDARD OF CARE

The recommendations and opinions contained in this report are based on our professional judgment. The soil testing and geotechnical engineering services performed for this project have been conducted in a manner consistent with that level of skill and care ordinarily exercised by other members of the profession currently practicing in this area under similar budgetary and time constraints. No other warranty, express or implied, is made.

APPENDIX

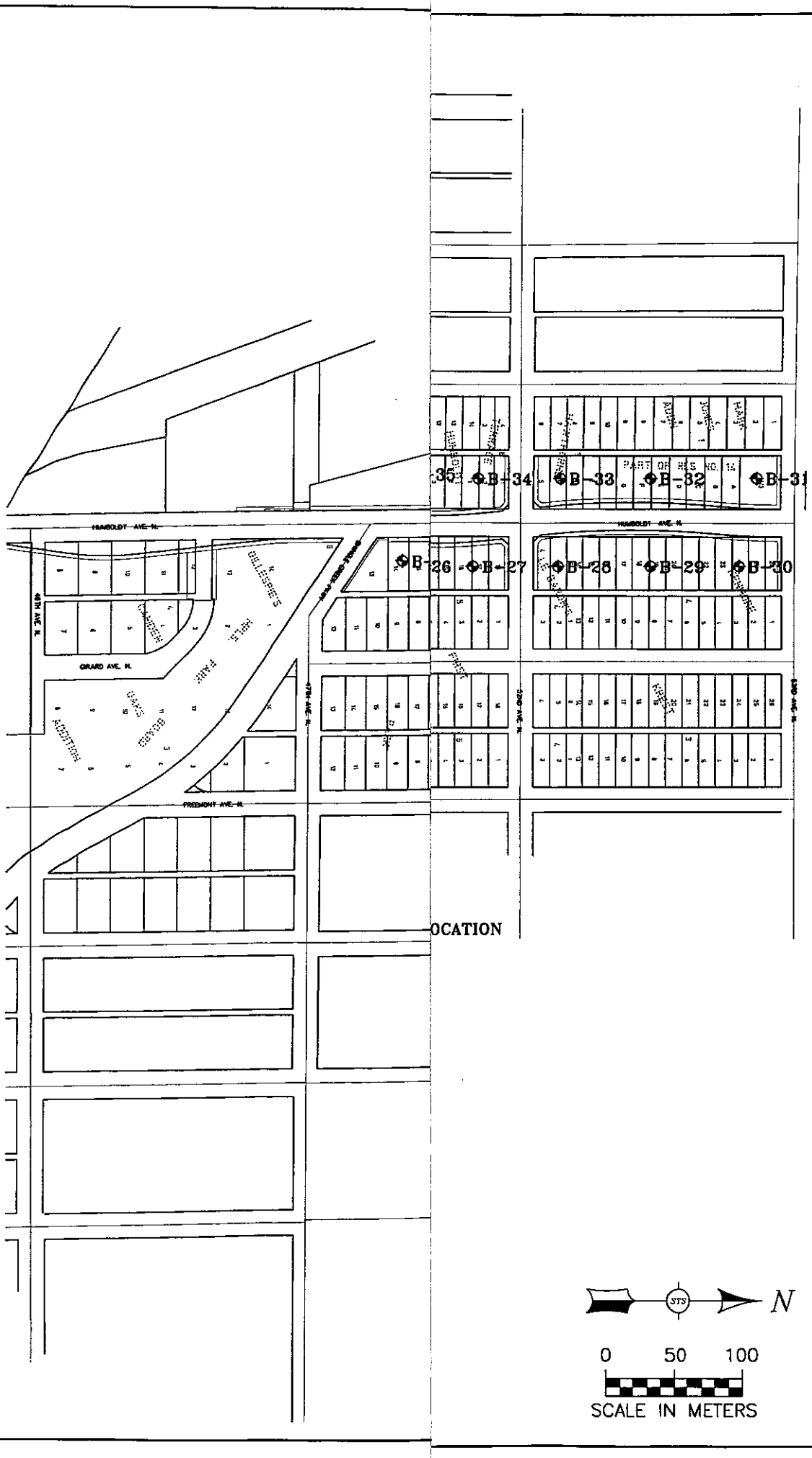
1. STS Changed Condition Clause
2. Boring Location Diagram
3. Boring Logs
4. STS General Boring Log Notes
5. STS Soil Classification System
6. STS Field and Laboratory Procedures
   - Subsurface Exploration Procedures
   - Sampling Procedures
   - Laboratory Index Test Procedures
7. STS Standard Boring Log Procedures
8. ASTM Specification D-1586
9. STS Subgrade Protection Guideline
10. STS Subgrade Stabilization Guideline
11. STS Earthwork Guideline

DIFFERING SITE CONDITIONS

The following is a suggested standard clause for unanticipated subsurface conditions:

The owner had a subsurface exploration and testing program performed by a geotechnical consultant. The results of this program are contained in the consultant's report. The consultant's report presents conclusions on the subsurface conditions based on their interpretation of the data obtained in the exploration. The contractor acknowledges that they have reviewed the consultant's report and any addenda thereto, and that their bid for earthwork operations is based on the subsurface conditions, as described in that report. The contract parties recognize that a subsurface exploration does not disclose all conditions as they actually exist and further, conditions may change, particularly groundwater conditions, between the time of subsurface exploration and the time of subsurface construction operations. In recognition of these facts, this clause is made part of the contract and provides a means of equitable additional compensation to the contractor if adverse unanticipated conditions are encountered and found to be materially different than reasonably expected as represented in the contract documents.

If at any time during earthwork, paving, foundation, and underground construction operations, the contractor encounters conditions that they consider to be materially different than those anticipated by the geotechnical consultant's report, contractor shall promptly and before such conditions are disturbed notify the owner's representative in writing of the condition and shall explain: (1) how subsurface or latent physical conditions at the site differ materially from those indicated in the contract, or, (2) what unknown physical conditions were encountered that are of an unusual nature and differ materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in this contract. The owner's representative will promptly initiate an investigation of the alleged differing site conditions. The contractor will provide access to the conditions and fully cooperate with the investigation. Upon completion, the owner's representative will issue a findings report with a recommendation on merit. Conversely, if owner's representative observes subsurface conditions which are different than those anticipated by the foundation consultant's report, he will also promptly notify the contractor. If a differing site condition claim has been found to have merit, negotiations will commence between the owner and the contractor to arrive at an equitable change in contract price for the necessary additional work or for reduction in work because of the unanticipated conditions. The contractor agrees that unit prices listed in the bid are applicable in computing equitable adjustments for additional or reduced work under the contract. For changed conditions for which unit prices are not listed, the additional work will be paid for on a time and material basis.



REVISIONS	BY:	DATE:
TEXT	BY:	DATE

DRAWN BY: TAK | DATE: 7/21/00
CHECKED BY: SSW | DATE:
APPROVED BY: JHQ | DATE:
CADFILE NAME: X:\97836\G636001.DWG

BORING LOCATION DIAGRAM
HUMBOLDT GREENWAY
FOR: MCDA
MINNEAPOLIS, MINNESOTA

STS Consultants Ltd.
Consulting Engineers

STS PROJECT NO.
97836

STS PROJECT FILE
G636001.DWG

SCALE
AS SHOWN

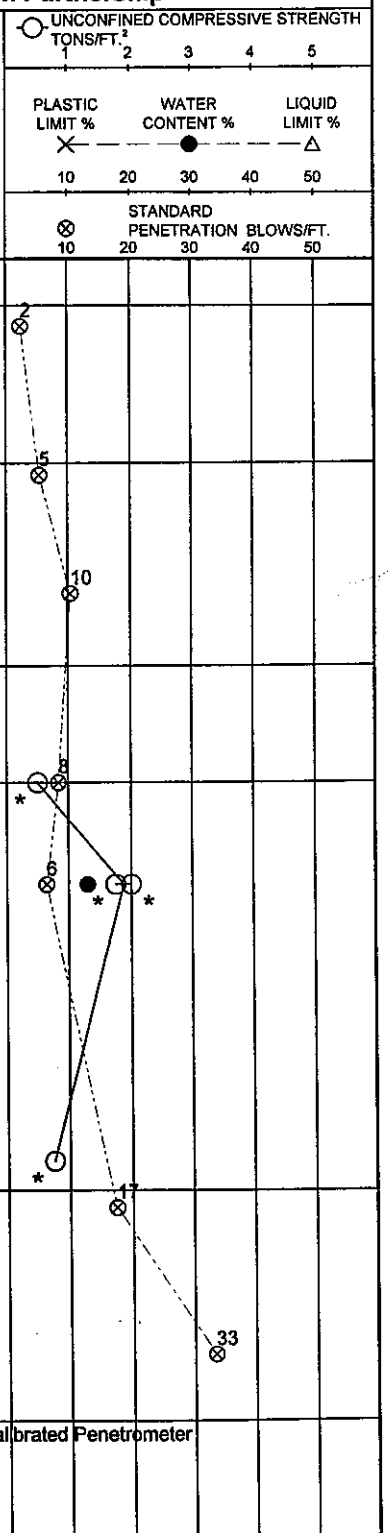
FIGURE NO.
1

STS Consultants Ltd.

OWNER: **MCDA**	LOG OF BORING NUMBER: **B-01**
PROJECT NAME: **Humboldt Greenway**	ARCHITECT-ENGINEER: **Nelson Termain Partnership**

SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
					SURFACE ELEVATION Approx. 841.7 NGVD	
	1	SS			TOPSOIL: ORGANIC SILTY fine to medium SAND, trace gravel - black - moist - very loose - (SM-OL)	
0.8	1A	SS			FILL: Fine to medium SAND, trace gravel - brown - damp - loose - (SM)	
2.5		HS				
	2	SS				
3.5	2A	SS			FILL: fine to coarse SAND, little gravel - tan - humid - loose to medium dense - random concrete rubble from 5 to 7 ' - (SW)	
5.0		HS				
	3	SS				
7.0		HS			Fine to coarse SAND, trace gravel - brown - damp - medium dense - (SW)	
7.5	4	SS				
9.0	4A	SS			SANDY CLAY, trace gravel - gray - firm - (CL)	
10.0		HS				
	5	SS				
12.5		HS				
15.0	6	SS				
16.0	6A	SS			Fine to coarse SAND, little gravel - brown - saturated - medium dense to dense - (SW)	
17.5		HS				
	7	SS				
20.0					End of boring at 20.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 15 ' WS	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL 12 ' BCR	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: **MCDA**	LOG OF BORING NUMBER: **B-02**
PROJECT NAME: **Humboldt Greenway**	ARCHITECT-ENGINEER: **Nelson Termain Partnership**

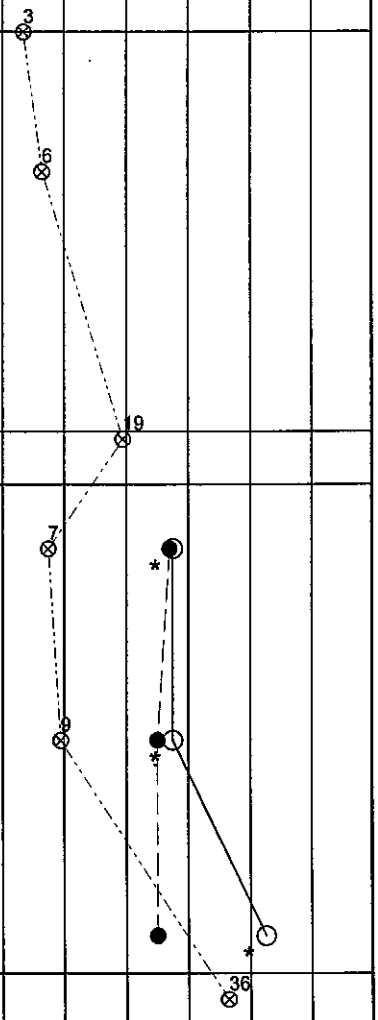
SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
						SURFACE ELEVATION Approx. 842.5 NGVD	
		1	SS			TOPSOIL: ORGANIC SILTY fine to medium SAND, trace gravel and roots - black - moist - very loose - (SM-OL)	
					1.5		
		1A	SS			SILTY fine to medium SAND, trace gravel - brown - damp - loose - (SM)	
2.5			HS				
		2	SS				
5.0			HS				
		3	SS				
					6.8		
		3A	SS			Fine to coarse SAND, with GRAVEL - tan - humid to damp - medium dense - (SW-GP)	
7.5			HS		7.5		
		4	SS			SANDY CLAY, trace gravel - red-brown - firm - (CL)	
10.0			HS				
		5	SS				
12.5			HS				
		6	SS				
					14.0		
		6A	SS			Fine to coarse SAND, trace gravel - brown - wet to saturated - dense - (SW)	
15.0					15.0		
						End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 14 ' WS	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL 13.8 ' BCR	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: MCDA

LOG OF BORING NUMBER: B-03

PROJECT NAME: Humboldt Greenway

ARCHITECT-ENGINEER: Nelson Termain Partnership

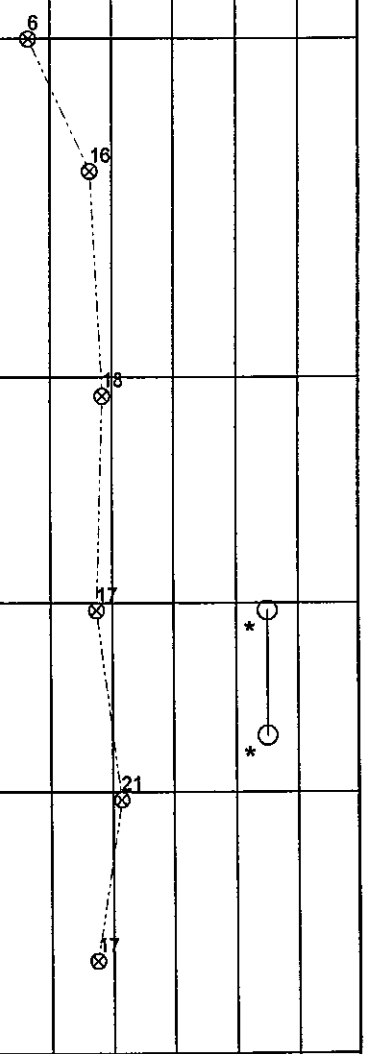
SITE LOCATION: Humboldt Greenway, Minneapolis, MN

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2} (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE / RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
				SURFACE ELEVATION Approx. 842.8 NGVD	
	1	SS		TOPSOIL: ORGANIC SILTY fine to medium SAND, with roots - black - moist - loose - (SM-OL)	
				1.5	
	1A	SS		SILTY fine to medium SAND, trace gravel - brown - damp - moist - loose to medium dense - (SM)	
2.5		HS			
	2	SS			
5.0		HS			
	3	SS			
				6.0	
	3A	SS		Fine to coarse SAND, little gravel - tan - humid - medium dense - (SW)	
7.5		HS			
	4	SS			
				9.0	
	4A	SS		SANDY CLAY - trace gravel - red-brown - firm to stiff - (CL)	
10.0		HS			
	5	SS			
				11.5	
	5A	SS		Fine to coarse SAND, trace gravel - brown - wet to saturated - medium dense - (SW)	
12.5		HS			
	6	SS			
15.0				15.0	
				End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 13 ' WS	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL 11.8 ' BCR	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: **MCDA**	LOG OF BORING NUMBER: **B-04**
PROJECT NAME: **Humboldt Greenway**	ARCHITECT-ENGINEER: **Nelson Termain Partnership**

SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE / RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³	Penetration (BLOWS/FT.)
				SURFACE ELEVATION Approx. 842.5 NGVD		
	1	SS		TOPSOIL: ORGANIC SILTY fine to medium SAND, trace gravel - brown-black - damp - loose - (SM-OL)		5
	1A	SS		1.8 SILTY fine to medium SAND - brown - damp - loose - (SM)		
2.5		HS				
	2	SS				6
5.0		HS				
	3	SS		6.5		23
	3A	SS		Fine to medium SAND, little gravel - tan - humid - medium dense - (SP)		
7.5		HS		7.5 SILTY mostly fine SAND, trace to a little SAND - damp - dense - random cobbles to 15.5 ' - (SM)		
	4	SS				37
10.0		HS				
	5	SS		11.5		35
	5A	SS		CLAYEY GRAVEL - brown to red-brown - dense - (GC)		
12.5		HS		14.0		
		HS		Fine GRAVEL, with sand - brown to dark brown - wet to saturated - dense - (GP)		
15.0	6	SS				28
17.5		HS				
	7	SS		19.0		28
				SANDY CLAY, little gravel - brown-gray - very stiff - (CL)		○ *
20.0				20.0 End of boring at 20.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings		

*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 15 ' WS	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL 11.5 ' BCR	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: MCDA	LOG OF BORING NUMBER: B-05
PROJECT NAME: Humboldt Greenway	ARCHITECT-ENGINEER: Nelson Termain Partnership

SITE LOCATION: Humboldt Greenway, Minneapolis, MN

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE / RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
				SURFACE ELEVATION Approx. 843.7 NGVD	
	1	SS		FILL: Fine to medium SAND, trace silt, roots and organics - brown to black damp - loose - (SP)	
				1.5	
	1A	SS		FILL: SILTY fine to medium SAND, mildy organic - dark brown to black - moist - very loose - (SM)	
2.5		HS			
	2	SS			
5.0		HS		5.0	
	3	SS		SILTY fine to coarse SAND, little gravel - dark brown to black - damp - very loose - probable - (SM)	
7.5		HS		7.4	
	4	SS		SILTY fine to medium SAND, little gravel - dark brown - damp - medium dense - (SM)	
				9.0	
	4A	SS		Fine to coarse SAND, little to some gravel - brown - damp to saturated - medium dense - (SW)	
10.0		HS			
	5	SS			
12.5		HS			
	6	SS			
15.0				15.0	
				End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 13 ' WS	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL 11.8 ' BCR	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: MCDA	LOG OF BORING NUMBER: B-06
PROJECT NAME: Humboldt Greenway	ARCHITECT-ENGINEER: Nelson Termain Partnership

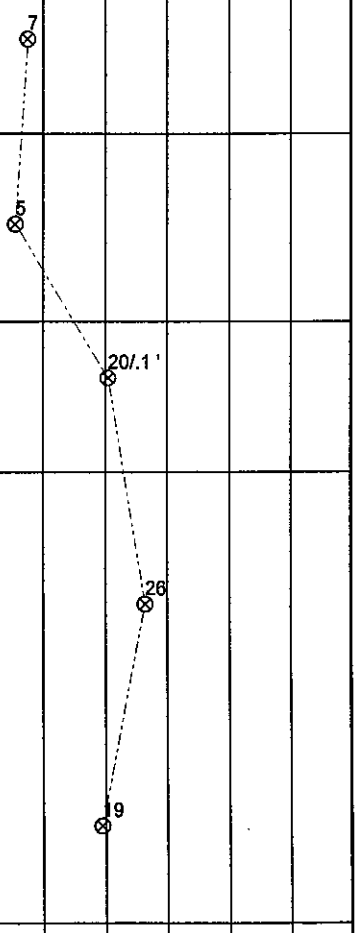
SITE LOCATION: Humboldt Greenway, Minneapolis, MN

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
						SURFACE ELEVATION Approx. 843.5 NGVD	
		1	AS		1.5	TOPSOIL: ORGANIC SILTY fine to medium SAND, trace roots and gravel - brown to black - damp - very loose - (SM-OL)	
		1A	AS			Mostly fine SAND, trace roots - light brown to brown - moist - loose - (SP)	
2.5			HS				
		2	SS		4.5		
5.0			HS			SILTY fine to medium SAND, trace gravel - light brown - moist - loose - (SM)	
		3	SS		7.0		
7.5			HS			Fine to coarse SAND, little gravel - brown - damp - medium dense - (SW)	
		4	SS		9.0		
		4A	SS			SILTY and GRAVELLY SAND, trace clay - dark brown - wet to saturated - medium dense - (SM-GP)	
10.0			HS				
		5	SS				
12.5			HS				
		6	SS		15.0		
15.0						End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 14 ' WS	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL 12.3 ' BCR	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: **MCDA**	LOG OF BORING NUMBER: **B-07**
PROJECT NAME: **Humboldt Greenway**	ARCHITECT-ENGINEER: **Nelson Termain Partnership**

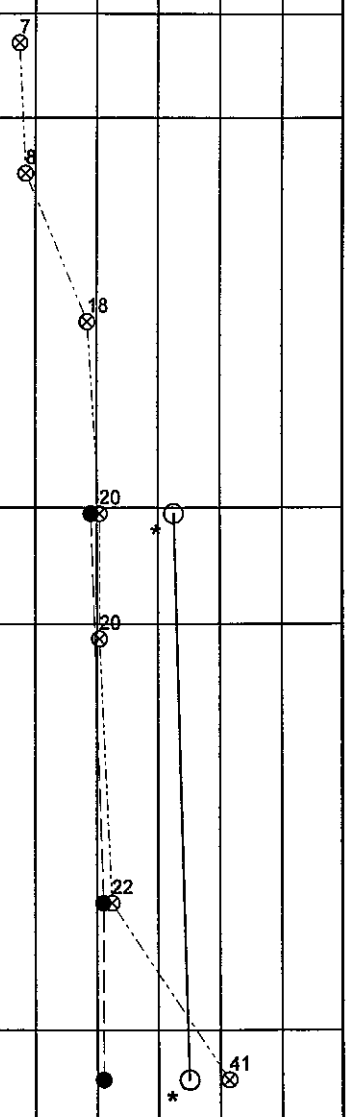
SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
						SURFACE ELEVATION Approx. 843.8 NGVD	
		1	SS		0.5	TOPSOIL: ORGANIC SILTY mostly fine SAND - black - damp - loose - (SM-OL)	
		1A	SS			SILTY mostly fine SAND - light brown - damp - loose - (SM)	
2.5			HS		2.3		
		2	SS			Fine to coarse SAND, trace to little gravel - brown - damp - medium dense - random cobbles from 6.5 to 9.0 ' depth - (SW)	
5.0			HS				
		3	SS				
7.5			HS				
		4	SS		9.0		
		4A	SS			SANDY CLAY, trace gravel - red-brown - very stiff - (CL)	
10.0			HS				
		5	SS		11.0		
		5A	SS			CLAYEY fine to coarse SAND, little gravel - brown - saturated - medium dense - (SC)	
12.5			HS				
15.0		6	SS				
17.5			HS		18.0		
		7	SS			SANDY CLAY, trace gravel - red-brown - hard - (CL)	
20.0					20.0		
						End of boring at 20.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 11.0 ' WD	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: MCDA	LOG OF BORING NUMBER: B-08
PROJECT NAME: Humboldt Greenway	ARCHITECT-ENGINEER: Nelson Termain Partnership

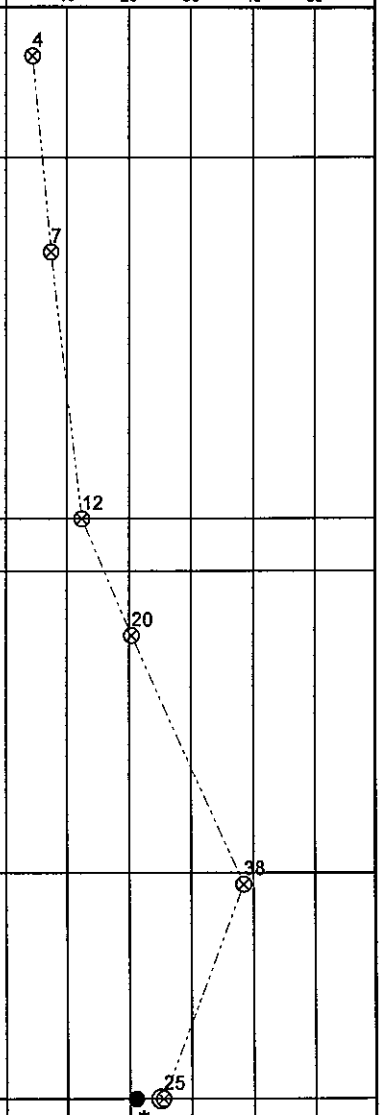
SITE LOCATION: Humboldt Greenway, Minneapolis, MN

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
						SURFACE ELEVATION Approx. 843.5 NGVD	
		1	SS			Fine to medium SAND, little gravel - brown - damp - loose - (SP)	
						2.0	
2.5			HS			SILTY fine to medium SAND, trace gravel - brown - moist - loose - (SM)	
		2	SS				
5.0			HS				
		3	SS				
						6.8	
		3A	SS			Mostly fine SAND, trace to a little gravel - brown to dark brown - moist - medium dense - (SP)	
7.5			HS			7.5	
		4	SS			Fine to medium SAND, trace gravel - brown - moist - medium dense - (SP)	
10.0			HS				
		5	SS				
						11.5	
		5A	SS			Fine to coarse SAND, with GRAVEL - brown - moist - dense - (SW-GP)	
12.5			HS				
		6	SS				
						14.5	
15.0		6A	SS			SANDY CLAY - trace gravel - red-brown - very stiff - (CL)	
						15.0	
						End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL Dry	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: **MCDA**

LOG OF BORING NUMBER: **B-09**

PROJECT NAME: **Humboldt Greenway**

ARCHITECT-ENGINEER: **Nelson Termain Partnership**

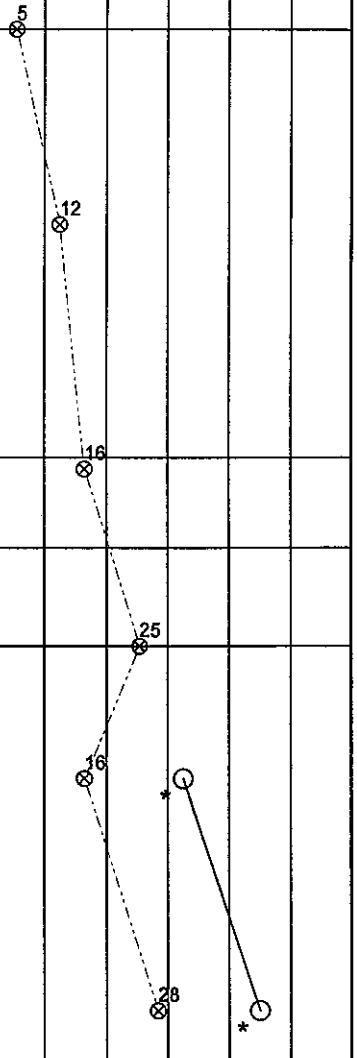
SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
					SURFACE ELEVATION Approx. 843.9 NGVD	
	1	SS			TOPSOIL: ORGANIC SILTY fine to medium SAND, trace roots - black - damp - loose - (SM-OL)	
				0.8		
	1A	SS			Mostly fine SAND - brown - damp - medium dense - (SP)	
2.5		HS				
	2	SS				
5.0		HS				
	3	SS				
				6.5		
	3A	SS			Fine to medium SAND, trace gravel - tan - damp - medium dense - (SP)	
7.5		HS				
	4	SS		7.7		
	4A	SS			CLAYEY SAND, trace gravel - dark brown - moist - medium dense - (SC)	
				9.0		
	4B	SS			SANDY CLAY, trace gravel - red-brown - stiff to hard - (CL)	
10.0		HS				
	5	SS				
12.5		HS				
	6	SS				
15.0				15.0		
					End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)



*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL Dry	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: MCDA	LOG OF BORING NUMBER: B-10
PROJECT NAME: Humboldt Greenway	ARCHITECT-ENGINEER: Nelson Termain Partnership

SITE LOCATION: Humboldt Greenway, Minneapolis, MN

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE / RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³	UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5) / PLASTIC LIMIT % / WATER CONTENT % / LIQUID LIMIT % (10 20 30 40 50) / STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)
				SURFACE ELEVATION Approx. 843.3 NGVD		
	1	SS		TOPSOIL: ORGANIC SILTY mostly fine SAND, trace roots - black - damp - loose - (SM-OL)		4
		HS		2.3		
2.5		HS		Mostly fine SAND, trace gravel - light brown - damp - loose to medium dense - (SP)		
	2	SS				9
5.0		HS		5.0		
	3	SS		Fine to medium SAND - brown - damp - medium dense - (SP)		13
7.5		HS				
	4	SS		8.5		30
9.3	4A	SS		Fine to coarse SAND, with coarse GRAVEL - brown - moist - dense - random cobbles from 8.5 to 9.5 ' depth - (SW-GP) 9.3		
				End of boring at 9.3 feet due to auger refusal on cobbles. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings		

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL: Dry	BORING STARTED: 7/5/00	STS OFFICE: Minneapolis Area - 06	
WL	BORING COMPLETED: 7/5/00	ENTERED BY: SSW	SHEET NO.: 1 OF 1
WL	RIG/FOREMAN: D-50/D.Z.	APP'D BY	STS JOB NO.: 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

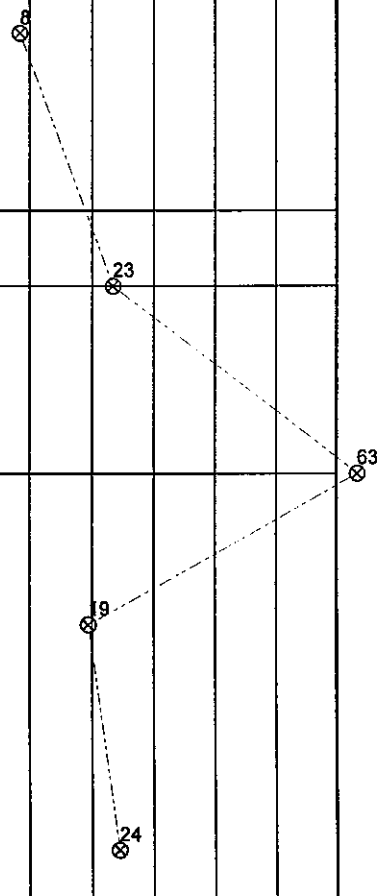
OWNER: MCDA	LOG OF BORING NUMBER: B-11
PROJECT NAME: Humboldt Greenway	ARCHITECT-ENGINEER: Nelson Termain Partnership
SITE LOCATION: Humboldt Greenway, Minneapolis, MN	

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
				SURFACE ELEVATION Approx. 843.8 NGVD	
	1	AS		TOPSOIL: ORGANIC SILTY mostly fine SAND, trace gravel and roots - black - damp - (SM-OL)	
				2.0	
2.5		HS		Mostly fine SAND, trace gravel - light brown - damp - loose - (SP)	
	2	SS			
5.0		HS			
	3	SS		5.5	
	3A	SS		Fine to medium SAND, little gravel - brown - moist - medium dense - random cobbles from 6.5 to 8 ' depth - (SP)	
				6.5	
	3B	SS		Fine to coarse SAND, with GRAVEL - brown - moist - dense to very dense - (SW-GP)	
7.5		HS			
	4	SS			
				9.0	
	4A	SS		SANDY CLAY, trace gravel - red-brown - very stiff - (CL)	
10.0		HS			
	5	SS			
12.5		HS			
	6	SS			
15.0				15.0	
				End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL Dry	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: MCDA	LOG OF BORING NUMBER: B-12
PROJECT NAME: Humboldt Greenway	ARCHITECT-ENGINEER: Nelson Termain Partnership

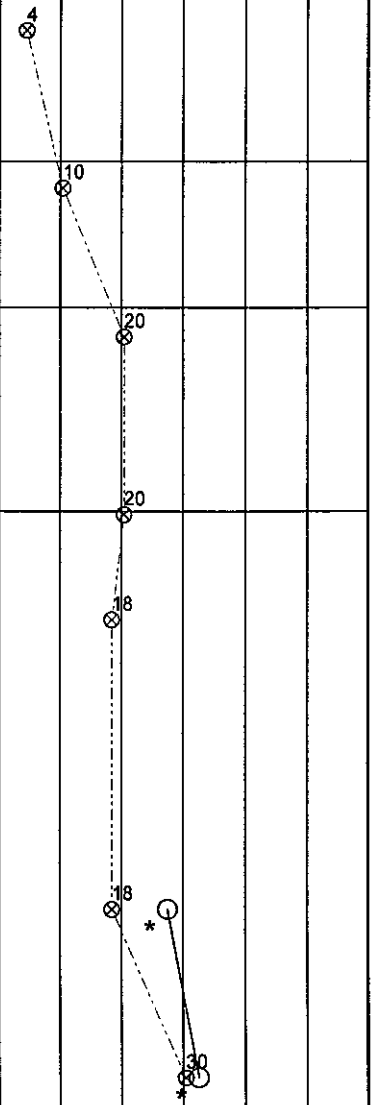
SITE LOCATION: Humboldt Greenway, Minneapolis, MN

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
						SURFACE ELEVATION Approx. 844.0 NGVD	
		1	SS			TOPSOIL: ORGANIC SILTY mostly fine SAND - black - damp - loose - (SM-OL)	
2.5			HS				
		2	SS		3.0		
		2A	SS			FILL: CLAYEY SAND, trace gravel - brown - moist - medium dense - (CL)	
5.0			HS				
		3	SS		5.5		
		3A	SS			Fine to coarse SAND, little gravel - brown - damp - random cobbles from 5.5 to 8.0 ' depth - (SW)	
7.5			HS				
		4	SS		9.0		
		4A	SS			SANDY CLAY, trace gravel - red-brown - very stiff - hard - sand lenses from 18 to 20 ' depth - (CL, Lenses SP)	
10.0			HS				
		5	SS				
12.5			HS				
15.0		6	SS				
17.5			HS				
		7	SS				
20.0					20.0		
						End of boring at 20.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL Dry	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: **MCDA**

LOG OF BORING NUMBER: **B-13**

PROJECT NAME: **Humboldt Greenway**

ARCHITECT-ENGINEER: **Nelson Termain Partnership**

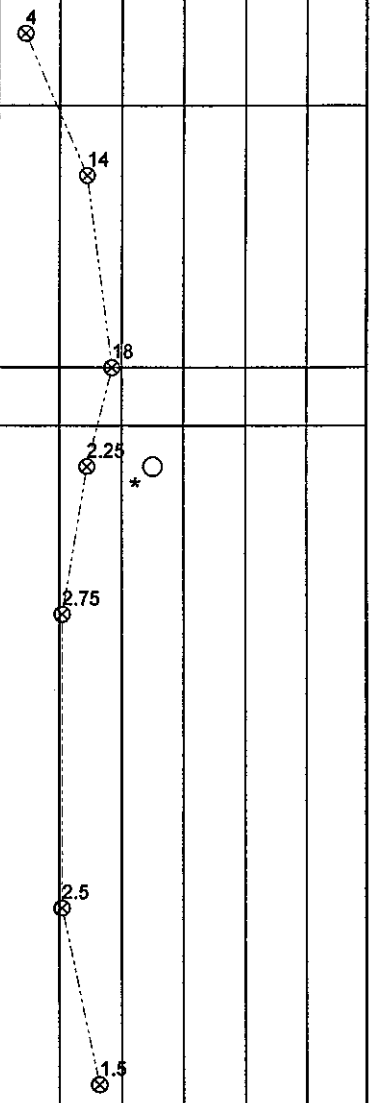
SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
					SURFACE ELEVATION Approx. 843.5 NGVD	
	1	SS			TOPSOIL: ORGANIC SILTY mostly fine SAND, trace roots - black - loose - (SM-OL)	
2.0						
2.5		HS			Fine to coarse SAND, trace gravel - light brown - humid - medium dense - (SW)	
	2	SS				
5.0		HS				
	3	SS				
6.5						
	3A	SS			Fine to medium SAND, little gravel - dark brown - damp - medium dense - (SP)	
7.5		HS				
	4	SS			SANDY CLAY, trace gravel - dark brown - stiff to very stiff - (CL)	
10.0		HS				
	5	SS				
12.5		HS				
15.0						
	6	SS				
17.5		HS				
	7	SS				
20.0						
					End of boring at 20.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % / WATER CONTENT % / LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)



*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL Dry	BORING STARTED 7/7/00	STS OFFICE Minneapolis Area - 06	
WL	BORING COMPLETED 7/7/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: **MCDA**

LOG OF BORING NUMBER: **B-14**

PROJECT NAME: **Humboldt Greenway**

ARCHITECT-ENGINEER: **Nelson Termain Partnership**

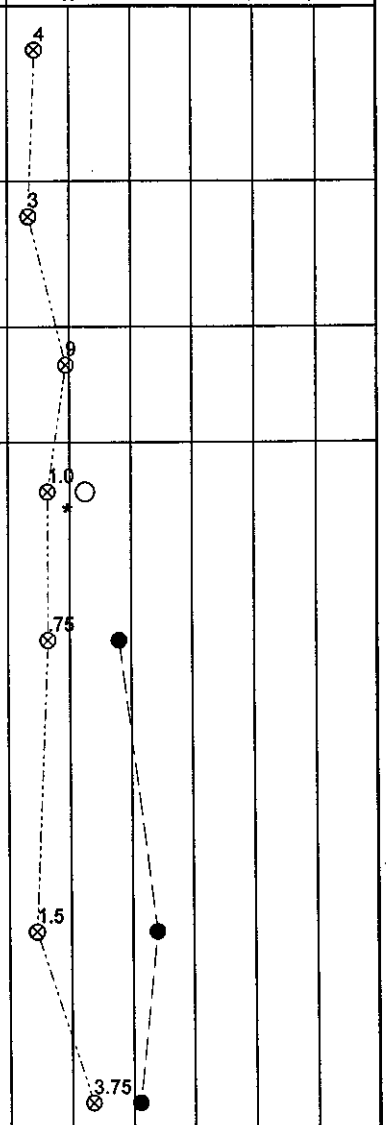
SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
						SURFACE ELEVATION Approx. 843.3 NGVD	
		1	SS			SILTY mostly fine SAND, trace roots and organics - dark brown to black - damp - loose - (SM)	
2.5			HS				
		2	SS			3.0	
		2A	SS			Mostly fine SAND, with SILT - brown - damp - very loose - (SP-SM)	
5.0			HS				
		3	SS			5.5	
		3A	SS			Fine to medium SAND, trace gravel - brown - damp to moist - loose to medium dense - (SP)	
7.5			HS			7.5	
		4	SS			SANDY CLAY, trace gravel - gray - firm to stiff - (CL)	
10.0			HS				
		5	SS				
12.5			HS				
15.0		6	SS				
17.5			HS				
		7	SS				
20.0						20.0	
						End of boring at 20.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)



*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL Dry	BORING STARTED 7/7/00	STS OFFICE Minneapolis Area - 06	
WL	BORING COMPLETED 7/7/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: MCDA	LOG OF BORING NUMBER: B-15
PROJECT NAME: Humboldt Greenway	ARCHITECT-ENGINEER: Nelson Termain Partnership

SITE LOCATION: Humboldt Greenway, Minneapolis, MN

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
						SURFACE ELEVATION Approx. 843.8 NGVD	
		1	SS		2.0	TOPSOIL: ORGANIC SILTY fine to medium SAND, trace roots - black - damp - loose - (SM-OL)	
2.5			HS			Mostly fine SAND, trace gravel - brown to dark brown - damp - loose to medium dense - (SP)	
		2	SS				
5.0			HS				
		3	SS				
7.5			HS				
		4	SS		8.5		
		4A	SS			Fine to coarse SAND, little gravel - brown - moist - loose to medium dense - (SW)	
10.0			HS				
		5	SS		10.5		
		5A	SS			SANDY CLAY, trace gravel - gray - firm - (CL)	
12.5			HS				
		6	SS				
15.0					15.0		
						End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	

*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL Dry	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: **MCDA**	LOG OF BORING NUMBER: **B-16**
PROJECT NAME: **Humboldt Greenway**	ARCHITECT-ENGINEER: **Nelson Termain Partnership**

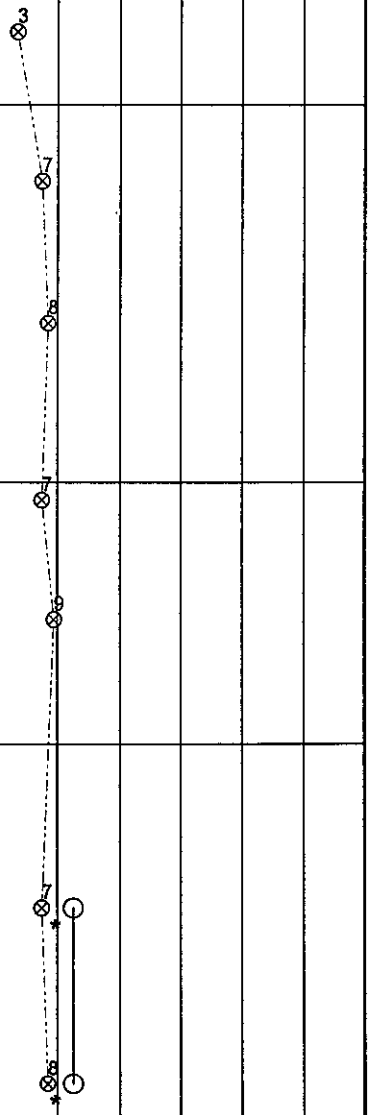
SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
						SURFACE ELEVATION Approx. 843.7 NGVD	
		1	SS			TOPSOIL: ORGANIC SILTY mostly fine SAND, trace roots - black - damp - very loose - (SM-OL)	
					2.0		
2.5			HS			Fine to medium SAND, trace silt and gravel - light brown - damp - loose - (SP)	
		2	SS				
5.0			HS				
		3	SS				
7.5			HS				
		4	SS		8.5		
		4A	SS			Fine to coarse SAND, little to some gravel - brown - moist to saturated - loose - (SW)	
10.0			HS				
		5	SS				
12.5			HS		13.0		
			HS			SANDY CLAY, trace gravel - gray - firm - (CL)	
15.0		6	SS				
17.5			HS				
		7	SS				
20.0					20.0		
						End of boring at 20.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)



*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 11.0 ' WS	BORING STARTED 7/7/00	STS OFFICE Minneapolis Area - 06	
WL	BORING COMPLETED 7/7/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: MCDA

LOG OF BORING NUMBER: B-17

PROJECT NAME: Humboldt Greenway

ARCHITECT-ENGINEER: Nelson Termain Partnership

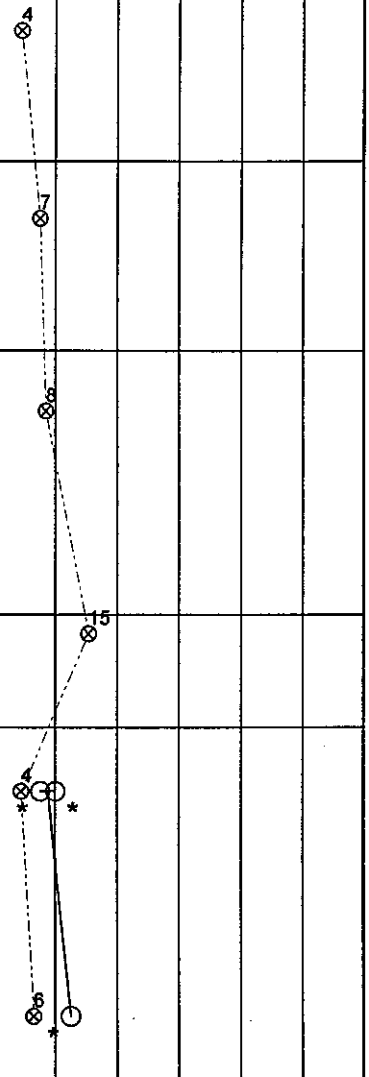
SITE LOCATION: Humboldt Greenway, Minneapolis, MN

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
					SURFACE ELEVATION Approx. 843.5 NGVD	
	1	SS			TOPSOIL: ORGANIC SILTY fine to medium SAND, trace roots - black - damp - loose - (SM-OL)	
2.5		HS		2.5		
	2	SS			Mostly fine SAND - red-brown - damp - loose - (SP)	
5.0		HS		5.0		
	3	SS			Fine to medium SAND, trace gravel - brown - damp to moist - loose - (SP)	
7.5		HS				
	4	SS		8.5		
	4A	SS			Fine to coarse SAND, trace gravel - brown - moist to wet - medium dense - (SW)	
10.0		HS		10.0		
	5	SS			SANDY CLAY, trace gravel - gray - soft to firm - (CL)	
12.5		HS				
	6	SS				
15.0				15.0		
					End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL Dry	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: MCDA	LOG OF BORING NUMBER: B-19
PROJECT NAME: Humboldt Greenway	ARCHITECT-ENGINEER: Nelson Termain Partnership

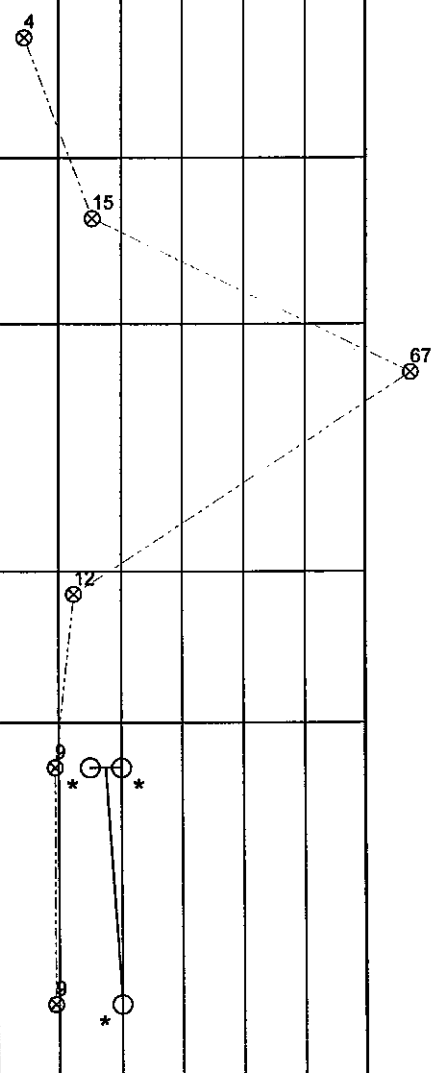
SITE LOCATION: Humboldt Greenway, Minneapolis, MN

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
					SURFACE ELEVATION Approx. 843.6 NGVD	
	1	SS			TOPSOIL: ORGANIC SILTY mostly fine SAND - black - damp - loose - (SM-OL)	
2.5		HS		2.5		
	2	SS			Fine to medium SAND, trace gravel - light brown - humid - medium dense - (SP)	
		HS		4.7		
5.0		HS			Fine to medium SAND, with GRAVEL - brown - humid - medium dense - (SP-GP)	
	3	SS				
7.5		HS				
	4	SS		8.0		
	4A	SS			Fine to medium SAND, trace gravel - brown - moist - medium dense - (SP)	
10.0		HS		10.0		
	5	SS			SANDY CLAY, trace gravel - dark brown - stiff - sand lenses from 12.5 to 14.2 ' depth - (CL, Lenses SP)	
12.5		HS				
	6	SS				
15.0				15.0		
					End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 12 ' WS	BORING STARTED 7/7/00	STS OFFICE Minneapolis Area - 06	
WL 12.6 ' BCR	BORING COMPLETED 7/7/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: MCDA

LOG OF BORING NUMBER: B-20

PROJECT NAME: Humboldt Greenway

ARCHITECT-ENGINEER: Nelson Termain Partnership

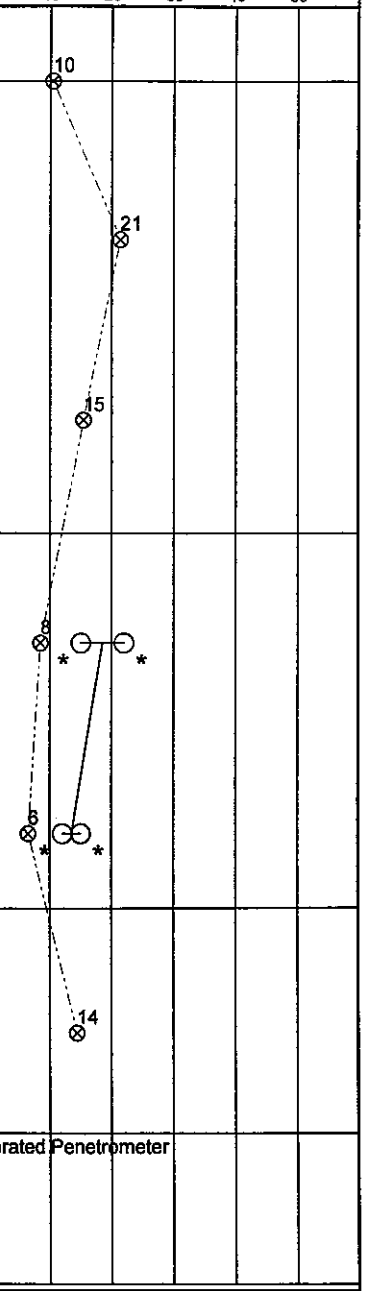
SITE LOCATION: Humboldt Greenway, Minneapolis, MN

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
						SURFACE ELEVATION Approx. 844.1 NGVD	
		1	SS		1.0	TOPSOIL: ORGANIC SILTY fine to medium SAND, with roots - black to dark brown - damp - loose to medium dense - (SM-OL)	
		1A	SS			Fine to coarse SAND, trace gravel and clay - light brown - damp - medium dense - random cobbles from 4.6 to 6.5 ' depth - (SW)	
2.5			HS				
		2	SS				
5.0			HS				
		3	SS		7.0		
7.5			HS			SANDY CLAY, trace gravel - gray - firm - (CL)	
		4	SS				
10.0			HS				
		5	SS		12.0		
12.5			HS			SILTY fine to medium SAND, trace gravel - brown - wet to saturated - medium dense - (SM)	
		6	SS				
15.0					15.0		
						End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 13 ' WS	BORING STARTED 7/7/00	STS OFFICE Minneapolis Area - 06	
WL 12.5 ' BCR	BORING COMPLETED 7/7/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: **MCDA**	LOG OF BORING NUMBER: **B-21**
PROJECT NAME: **Humboldt Greenway**	ARCHITECT-ENGINEER: **Nelson Termain Partnership**

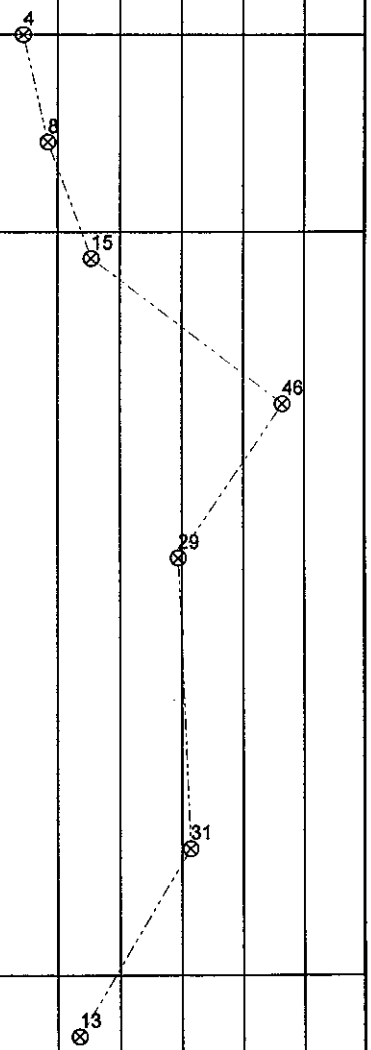
SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2} (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE / RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
				SURFACE ELEVATION Approx. 844.0 NGVD	
	1	SS		TOPSOIL: ORGANIC SILTY fine to medium sand, trace roots and gravel - black - damp - loose - (SM-OL)	
				1.5	
	1A	SS		Fine to medium SAND, trace gravel - brown to black - damp - loose - (SP)	
2.5		HS			
	2	SS			
5.0		HS		4.9	
		HS		Fine to coarse SAND, trace to little gravel - brown - damp to saturated - medium dense to dense - random cobbles from 4.9 to 6.0 ' depth - clay seam from 10 to 10.5 ' depth - (SW, Seam CL)	
	3	SS			
7.5		HS			
	4	SS			
10.0		HS			
	5	SS			
12.5					
		HS			
15.0					
	6	SS			
17.5		HS		17.7	
		HS		SANDY SILT, trace gravel - dark brown - saturated - medium dense - (ML)	
	7	SS			
20.0				20.0	
				End of boring at 20.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 15 ' WS	BORING STARTED 7/7/00	STS OFFICE Minneapolis Area - 06	
WL 13.2 ' BCR	BORING COMPLETED 7/7/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: MCDA	LOG OF BORING NUMBER: B-22
PROJECT NAME: Humboldt Greenway	ARCHITECT-ENGINEER: Nelson Termain Partnership

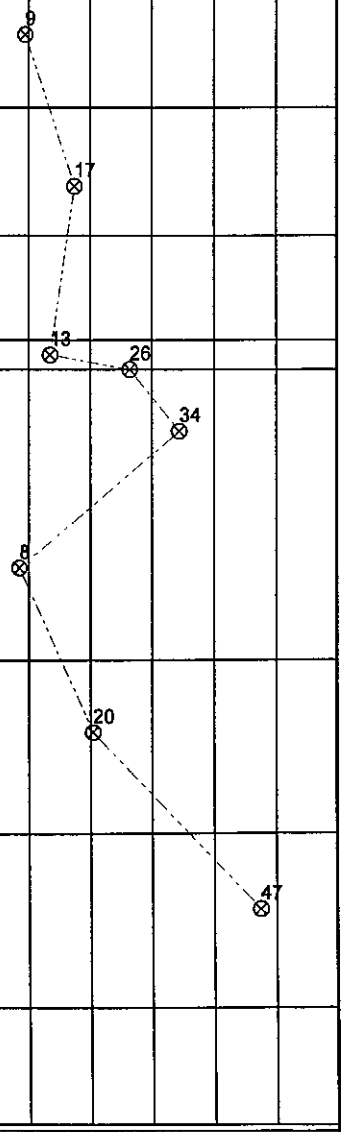
SITE LOCATION: Humboldt Greenway, Minneapolis, MN

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE / RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
				SURFACE ELEVATION Approx. 843.6 NGVD	
	1	SS		TOPSOIL: ORGANIC SILTY mostly fine SAND, trace gravel and roots - black - damp - loose - (SM-OL)	
				1.7	
2.5	1A	SS		SILTY fine to medium SAND, trace gravel - brown - damp - medium dense - (SM)	
		HS			
	2	SS			
				4.5	
5.0		HS		Fine to coarse SAND, trace gravel - red-brown - moist - medium dense - (SW)	
	3	SS			
				6.7	
	3A	SS		SILTY fine to medium SAND, trace gravel - brown - moist - medium dense - (SM)	
7.5		HS			
	4	SS			
				8.5	
	4A	SS		9.0 Fine to medium SAND, trace gravel - light brown - humid - medium dense - (SP)	
	4B	SS		Fine to coarse SAND, with GRAVEL - dark brown - moist to saturated - dense - random cobbles from 9 to 11 ' depth - (SW-GP)	
10.0		HS			
	5	SS			
12.5					
	6	SS			
				14.0	
		HS		SANDY fine GRAVEL - brown to dark brown - saturated - medium dense - (GP-SP)	
15.0					
	7	SS			
				17.0	
17.5		HS		SILTY fine to medium SAND, trace gravel - dark brown - saturated - dense - random cobbles from 17 to 20 ' depth - (SM)	
	8	SS			
20.0				20.0	
				End of boring at 20.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 13 ' WS	BORING STARTED 7/7/00	STS OFFICE Minneapolis Area - 06	
WL 12.6 ' BCR	BORING COMPLETED 7/7/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: **MCDA**	LOG OF BORING NUMBER: **B-23**
PROJECT NAME: **Humboldt Greenway**	ARCHITECT-ENGINEER: **Nelson Termain Partnership**

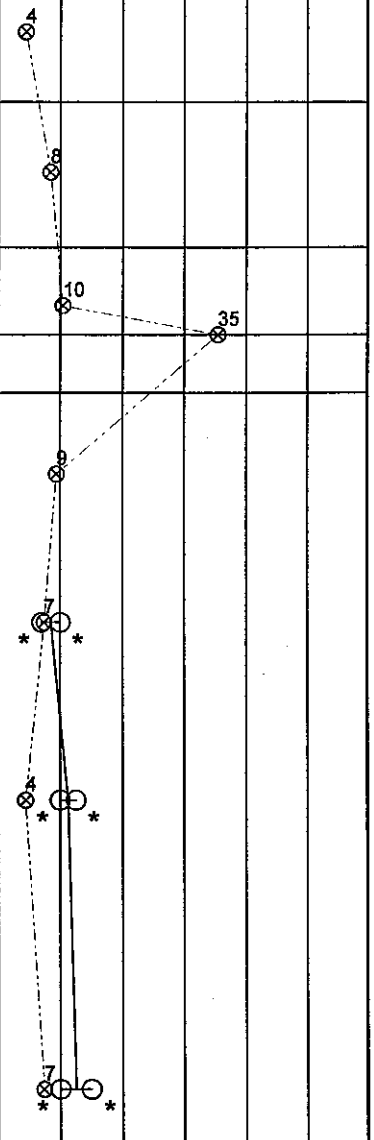
SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
					SURFACE ELEVATION Approx. 844.3 NGVD	
	1	SS		2.0	TOPSOIL: ORGANIC SILTY mostly fine SAND, trace roots - black - damp - loose - (SM-OL)	
2.5		HS			SILTY fine to medium SAND, trace gravel - light brown - damp - loose - (SM)	
	2	SS		4.5		
5.0		HS			SILTY mostly fine SAND - gray-brown - damp to moist - medium dense - (SM)	
	3A	SS		6.0		
	3B	SS		7.0	Fine to coarse SAND, with GRAVEL - light brown - humid - dense - random cobbles from 6 to 7 ' depth - (SW)	
7.5		HS			SANDY CLAY, trace gravel - gray - soft to stiff - (CL)	
	4	SS				
10.0		HS				
	5	SS				
12.5		HS				
	6	SS				
15.0						
		HS				
17.5						
	7	SS				
20.0				20.0	End of boring at 20.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 13 ' WS	BORING STARTED 7/7/00	STS OFFICE Minneapolis Area - 06	
WL Dry BCR	BORING COMPLETED 7/7/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: MCDA	LOG OF BORING NUMBER: B-24
PROJECT NAME: Humboldt Greenway	ARCHITECT-ENGINEER: Nelson Termain Partnership

SITE LOCATION: Humboldt Greenway, Minneapolis, MN

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1, 2, 3, 4, 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10, 20, 30, 40, 50)

STANDARD PENETRATION BLOWS/FT. (10, 20, 30, 40, 50)

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
					SURFACE ELEVATION Approx. 844.5 NGVD	
	1	SS			FILL: SANDY SILT, trace clay and gravel - dark brown - loose - (ML)	
					1.5	
	1A	SS			FILL: SILTY fine to medium SAND, mildly organic, some roots, trace gravel - black to brown - damp - loose - (SM)	
2.5		HS				
	2	SS				
5.0		HS			5.0	
	3	SS			FILL: SANDY CLAY, with WOOD FRAGMENTS, trace gravel - brown - firm - (CL)	
		HS			7.3	
7.5		HS			SANDY CLAY, trace gravel - gray-brown - firm - (CL)	
	4	SS				
10.0		HS				
	5	SS				
12.5		HS				
					13.0	
	6	SS			SANDY SILT, trace gravel - gray-brown - saturated - loose - (ML)	
15.0					15.0	
					End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	

* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 14 ' WS	BORING STARTED 7/7/00	STS OFFICE Minneapolis Area - 06	
WL Dry BCR	BORING COMPLETED 7/7/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: MCDA	LOG OF BORING NUMBER: B-25
PROJECT NAME: Humboldt Greenway	ARCHITECT-ENGINEER: Nelson Termain Partnership

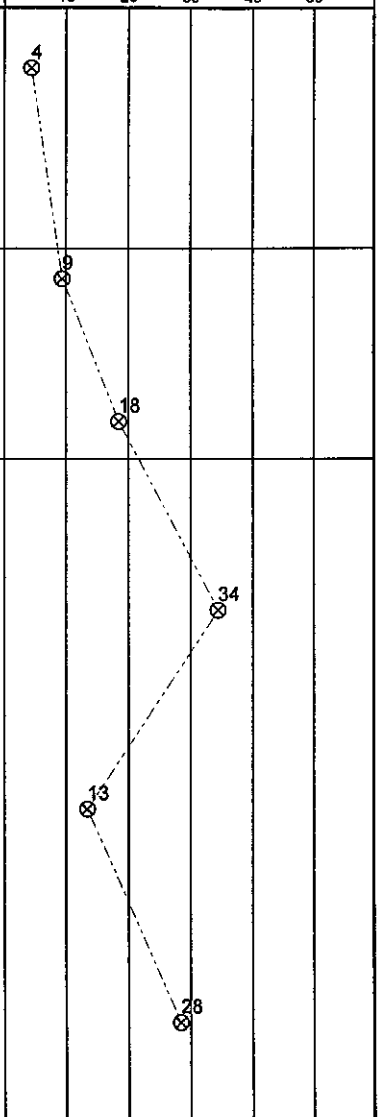
SITE LOCATION: Humboldt Greenway, Minneapolis, MN

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
					SURFACE ELEVATION Approx. 844.2 NGVD	
	1	SS			TOPSOIL: ORGANIC SILTY fine to medium SAND, trace gravel - black - moist - loose - (SM-OL)	
2.5		HS				
	2	SS		3.2		
	2A	SS			SILTY mostly fine SAND - light brown - damp - loose to medium dense - (SM)	
5.0		HS				
	3	SS		6.0		
	3A	SS			Fine to coarse SAND, little gravel - brown - damp to saturated - medium dense to dense - (SW)	
7.5		HS				
	4	SS				
10.0		HS				
	5	SS				
12.5		HS				
	6	SS				
15.0				15.0		
					End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 13 ' WS	BORING STARTED 7/7/00	STS OFFICE Minneapolis Area - 06	
WL 13 ' BCR	BORING COMPLETED 7/7/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: **MCDA**	LOG OF BORING NUMBER: **B-26**
PROJECT NAME: **Humboldt Greenway**	ARCHITECT-ENGINEER: **Nelson Termain Partnership**

SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}	UNCONFINED COMPRESSIVE STRENGTH TONS/FT.^{2} (1 2 3 4 5) / PLASTIC LIMIT % / WATER CONTENT % / LIQUID LIMIT % (10 20 30 40 50) / STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)
					SURFACE ELEVATION Approx. 845.0 NGVD		
	1	SS			TOPSOIL: ORGANIC SILTY mostly fine SAND, trace roots - black - damp - loose - (SM-OL)		6
					1.7		
	1A	SS			Mostly fine SAND, trace gravel - light brown - damp - loose to medium dense - (SP)		
2.5		HS					
	2	SS					9
5.0		HS			5.0		
	3	SS			Fine to coarse SAND, little to some GRAVEL - brown - damp to saturated - medium dense - (SW)		13
7.5		HS					
	4	SS					17
10.0		HS					
	5	SS					17
12.5		HS					
	6	SS					13
15.0					15.0		
					End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings		

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 13 ' WS	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL 13.2 ' BCR	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: MCDA	LOG OF BORING NUMBER: B-27
PROJECT NAME: Humboldt Greenway	ARCHITECT-ENGINEER: Nelson Termain Partnership

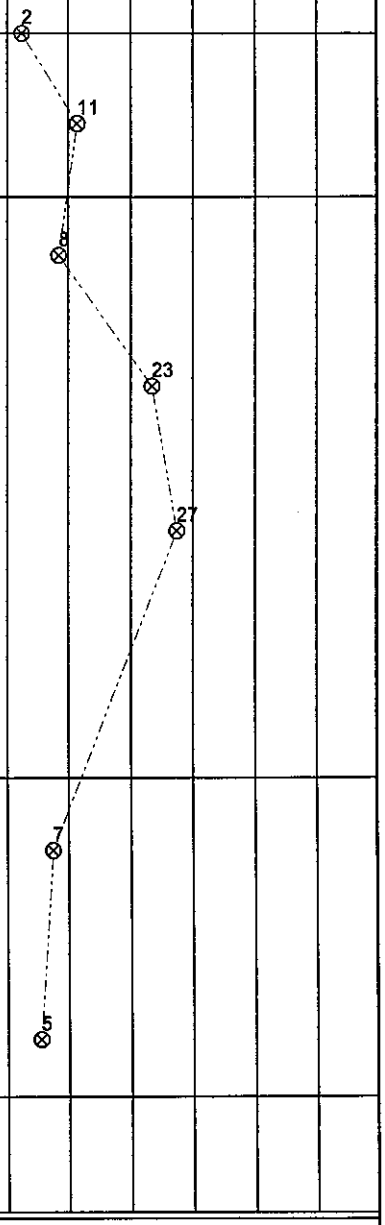
SITE LOCATION: Humboldt Greenway, Minneapolis, MN

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
						SURFACE ELEVATION Approx. 844.8 NGVD	
		1	SS			FILL: Fine to medium SAND, trace roots - dark brown - damp - very loose - (SM)	
		1A	SS				
2.5			HS			Fine to medium SAND, trace gravel - brown - damp to moist - medium dense - (SP)	
		2	SS				
5.0			HS			Fine to coarse SAND, little gravel - light brown - humid to moist - loose to medium dense - (SW)	
		3	SS				
7.5			HS				
		4	SS				
10.0			HS				
		5	SS				
12.5			HS				
15.0			HS			SILTY fine SAND, trace gravel - gray to brown - wet to saturated - loose - (SM)	
		6	SS				
17.5			HS				
		7	SS				
20.0						End of boring at 20.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 13.3 ' WD	BORING STARTED 7/7/00	STS OFFICE Minneapolis Area - 06	
WL	BORING COMPLETED 7/7/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: **MCDA**	LOG OF BORING NUMBER: **B-28**
PROJECT NAME: **Humboldt Greenway**	ARCHITECT-ENGINEER: **Nelson Termain Partnership**

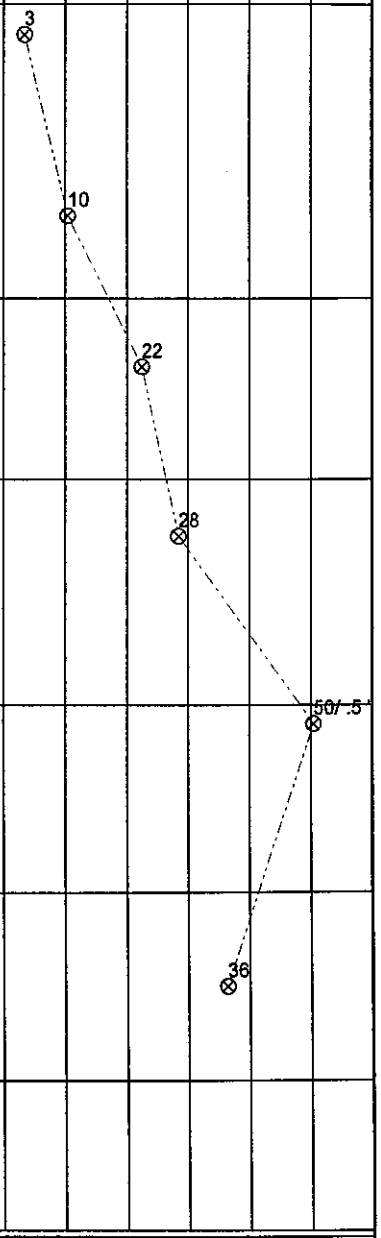
SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
						SURFACE ELEVATION Approx. 843.0 NGVD	
		1	SS		0.7	TOPSOIL: ORGANIC SILTY fine to medium SAND, trace roots - dark brown to black - moist - very loose - (SM-OL)	
		1A	SS			SILTY fine to medium SAND, trace gravel - brown - damp - medium dense - (SM)	
2.5			HS				
		2	SS		4.6		
5.0			HS			Fine to medium SAND, trace gravel - tan - humid - medium dense - (SP)	
		3	SS		7.0		
7.5			HS			Fine to medium SAND, with GRAVEL - brown - damp - medium dense - (SP-GP)	
		4	SS				
10.0			HS		10.0		
		5	SS			Fine SAND, with gravel - brown - damp - dense - (SP)	
12.5			HS		12.5		
			HS			SILTY fine SAND, trace gravel - dark brown - moist - dense - (SM)	
		6	SS		15.0		
15.0						End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL Dry	BORING STARTED 7/7/00	STS OFFICE Minneapolis Area - 06	
WL	BORING COMPLETED 7/7/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: **MCDA**	LOG OF BORING NUMBER: **B-32**
PROJECT NAME: **Humboldt Greenway**	ARCHITECT-ENGINEER: **Nelson Termain Partnership**

SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
					SURFACE ELEVATION Approx. 844.7 NGVD	
	1	SS			TOPSOIL: ORGANIC SITLY mostly fine SAND, trace roots - black - damp - loose - (SM-OL)	
				2.0		
2.5		HS			SILTY fine to medium SAND, trace gravel and roots - brown - damp - loose - (SM)	
	2	SS				
5.0		HS				
	3	SS		6.0		
	3A	SS			Fine to coarse SAND, little to some GRAVEL - brown - humid to damp - loose to medium dense - (SW-GP)	
7.5		HS				
	4	SS				
10.0		HS				
	5	SS		12.0		
12.5		HS			Fine SAND, trace gravel - brown - saturated - medium dense - (SP)	
	6	SS				
15.0				15.0		
					End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL: **12 ' WS**	BORING STARTED: **7/7/00**	STS OFFICE: **Minneapolis Area - 06**	
WL	BORING COMPLETED: **7/7/00**	ENTERED BY: **SSW**	SHEET NO.: **1** OF **1**
WL	RIG/FOREMAN: **D-50/D.Z.**	APP'D BY	STS JOB NO.: **97836**

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: **MCDA**	LOG OF BORING NUMBER: **B-33**
PROJECT NAME: **Humboldt Greenway**	ARCHITECT-ENGINEER: **Nelson Termain Partnership**

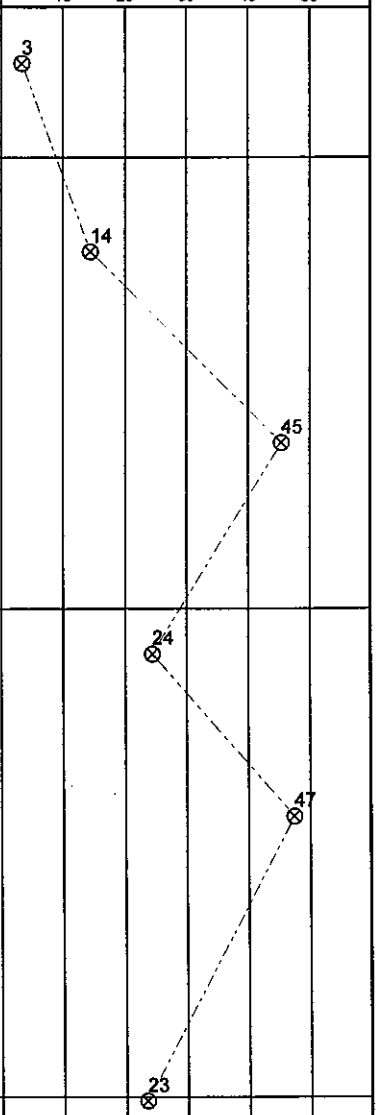
SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
					SURFACE ELEVATION Approx. 844.0 NGVD	
	1	SS			SILTY fine to medium SAND - brown to dark brown - damp - very loose - (SM)	
				2.0		
2.5		HS			Fine to coarse SAND, little gravel - light brown - damp - medium dense - (SW)	
	2	SS				
5.0		HS				
	3	SS				
7.5		HS				
	4	SS		8.0		
	4A	SS			SILTY fine to medium SAND, little to some GRAVEL - dark brown - medium dense to dense - (SM-GP)	
10.0		HS				
	5	SS				
12.5		HS				
	6	SS				
				14.5		
15.0	6A	SS		15.0	Fine to coarse SAND, little gravel - brown - medium dense - saturated - (SW)	
					End of boring at 15.0 feet.	
					Advanced borehole using HSA to full depth.	
					Borehole backfilled with cuttings	



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 14.5 ' WS	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: **MCDA**	LOG OF BORING NUMBER: **B-34**
PROJECT NAME: **Humboldt Greenway**	ARCHITECT-ENGINEER: **Nelson Termain Partnership**

SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³	STANDARD PENETRATION BLOWS/FT.
						SURFACE ELEVATION Approx. 844.2 NGVD		
		1	SS		1.6	TOPSOIL: ORGANIC SILTY mostly fine SAND, trace roots - black - damp - loose - (SM-OL)		14
		1A	SS			SILTY mostly fine SAND, trace roots and gravel - black - damp - medium dense - (SM)		
2.5			HS					
		2	SS					13
5.0			HS		5.0			
		3	SS			Fine to coarse SAND, with GRAVEL - light brown - humid - dense - random cobbles from 5 to 8.3 ' depth - (SW-GP)		34
7.5			HS					
		4	SS		8.3			54
		4A	SS		9.5	Fine to medium SAND - little gravel - dark brown - damp - dense - (SP)		
10.0			HS			Fine to coarse SAND, little to some GRAVEL - brown - moist to saturated - medium dense - (SW-GP)		
		5	SS					16
12.5			HS					
		6	SS					14
15.0					15.0			
						End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings		

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 12 ' WD	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: MCDA	LOG OF BORING NUMBER: B-35
PROJECT NAME: Humboldt Greenway	ARCHITECT-ENGINEER: Nelson Termain Partnership

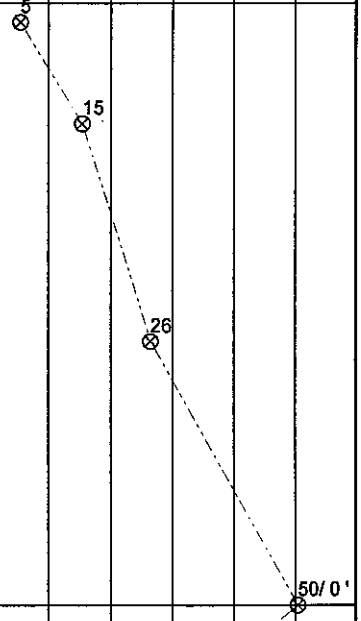
SITE LOCATION: Humboldt Greenway, Minneapolis, MN

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
					SURFACE ELEVATION Approx. 843.3 NGVD	
	1	SS			TOPSOIL: ORGANIC SILTY fine to medium SAND - black - damp - loose - (SM-OL)	
					1.0	
	1A	SS			Fine to coarse SAND, little gravel - brown - damp - medium dense - random cobbles from 6 to 9 ' depth - (SW)	
2.5		HS				
	2	SS				
5.0		HS				
	3	SS				
7.5		HS				
	4	AS				
					9.0	
	4A	AS			Fine to medium SAND, trace to a little gravel - dark brown - moist - (SP)	
10.0		HS			10.0	
	5	SS			SILTY mostly fine SAND, trace gravel - dark brown - wet to saturated - medium dense - (SM)	
12.5		HS				
	6	SS				
15.0					15.0	



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 11.3 ' WS	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL 13.4 ' BCR	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/21/00

STS Consultants Ltd.

OWNER: **MCDA**	LOG OF BORING NUMBER: **B-36**
PROJECT NAME: **Humboldt Greenway**	ARCHITECT-ENGINEER: **Nelson Termain Partnership**

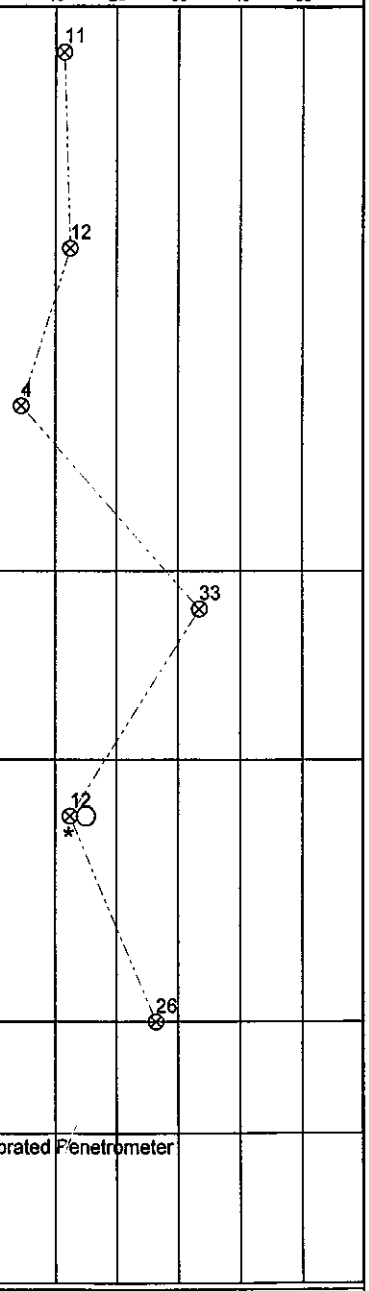
SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
					SURFACE ELEVATION Approx. 844.7 NGVD	
	1	SS			FILL: SILTY fine to medium SAND, trace to a little gravel, mildly organic - brown to black - moist - medium dense - (SM)	
2.5		HS				
	2	SS				
5.0		HS				
	3	SS				
7.5		HS			7.5	
	4	SS			Fine to coarse SAND - little to some gravel brown - moist - dense - random cobbles fron 7.5 to 9.5 ' depth - (SW)	
10.0		HS			10.0	
	5	SS			SANDY CLAY, trace gravel - dark brown - stiff to very stiff - (CL)	
12.5		HS				
	6	SS			13.5	
	6A	SS			Fine to coarse SAND, with GRAVEL - brown - saturated - medium dense - (SW)	
15.0					15.0	
					End of boring at 15.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 13.5 ' WS	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL 15.0 ' BCR	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING_LOG 97836.GPJ STS.GDT 7/24/00

STS Consultants Ltd.

OWNER: **MCDA**

LOG OF BORING NUMBER: **B-37**

PROJECT NAME: **Humboldt Greenway**

ARCHITECT-ENGINEER: **Nelson Termain Partnership**

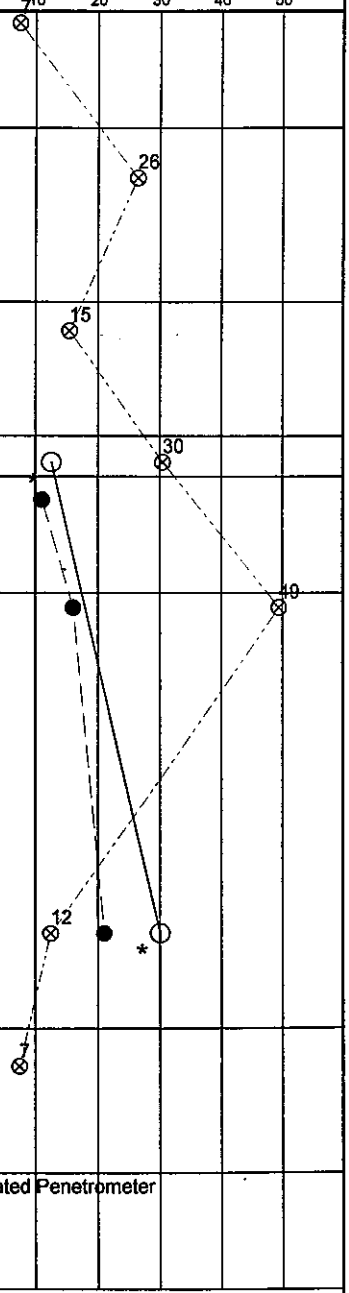
SITE LOCATION: **Humboldt Greenway, Minneapolis, MN**

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1 2 3 4 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10 20 30 40 50)

STANDARD PENETRATION BLOWS/FT. (10 20 30 40 50)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
						SURFACE ELEVATION Approx. 844.7 NGVD	
		1	SS			TOPSOIL: ORGANIC SILTY mostly fine SAND, trace roots - black - moist - loose - (SM-OL)	
					2.0		
2.5			HS			Mostly fine SAND, little gravel - brown - damp - medium dense - (SP)	
		2	SS				
5.0			HS		5.0		
		3	SS			Fine to medium SAND - little gravel - brown - damp - medium dense - (SP)	
			HS		7.3		
7.5			HS			SANDY CLAY, trace gravel - gray-brown - stiff - (CL)	
		4	SS		8.0		
		4A	SS			Fine to coarse SAND, with GRAVEL - brown - damp - medium dense - (SW-GP)	
10.0			HS		10.0		
		5	SS			SANDY CLAY, trace to a little gravel - red0brown - very stiff to stiff - sand and gravel lenses from 11 to 12 ' and 16.5 to 17 ' depths - (CL, Lenses SP-GP)	
12.5			HS				
15.0		6	SS				
17.5			HS		17.5		
			HS			CLAYEY SAND, trace gravel - dark brown - saturated - loose - (SC)	
		7	SS				
20.0					20.0		
						End of boring at 20.0 feet. Advanced borehole using HSA to full depth. Borehole backfilled with cuttings	



*Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL 10 ' WS	BORING STARTED 7/5/00	STS OFFICE Minneapolis Area - 06	
WL 11.8 ' BCR	BORING COMPLETED 7/5/00	ENTERED BY SSW	SHEET NO. 1 OF 1
WL	RIG/FOREMAN D-50/D.Z.	APP'D BY	STS JOB NO. 97836

BORING LOG 97836.GPJ STS.GDT 7/21/00

STS General Boring Log Notes

DRILLING & SAMPLING SYMBOLS:

SS :	Split Spoon- 1 3/8" I.D., 2" O.D. Unless otherwise noted	PA:	Power Auger - 4 1/4" unless otherwise noted
ST :	Shelby Tube-2" O.D., Unless otherwise noted	HS :	Hollow Stem Auger
AS:	Auger Sample	RB :	Tri-Cone Rotary Bit
WS :	Wash Sample	FT :	Fish Tail Bit
OS :	Osterberg Sampler - 3" Shelby Tube	DB:	Diamond Coring Bit
BS :	Bulk Sample from Exposed Material	VS:	Vane Shear
CS :	Continuous Sample Tube	PM :	Pressuremeter Test, In-Situ
		HA:	Hand Auger

Standard Penetration Test N-value: Total blows for last foot of penetration of a 2 inch O.D. split spoon sampler driven by a 140 pound hammer falling 30 inches, except where otherwise noted.

WATER LEVEL MEASUREMENT SYMBOLS:

WL:	Water Level	WCI :	Wet Cave In
WS:	While Sampling	DCI :	Dry Cave In
WD:	While Drilling	BCR :	Before Casing Removal
AB:	After Boring	ACR :	After Casing Removal

Water levels indicated on the boring logs are the levels measured in the boreholes at the time indicated. In relatively pervious soils (e.g. sands and gravels), the indicated groundwater levels are considered reliable. In relatively impervious soils (e.g. silts and clays), the indicated groundwater levels may not be reliable. For boreholes or wells in low permeability soils, relatively long periods of time are usually required for the groundwater to obtain an equilibrium position. Generally, a more accurate determination of water levels can be made from monitoring wells or piezometers sensing aquifers of interest with readings over a period of weeks to months.

GRADATION DESCRIPTION & TERMINOLOGY:

Coarse grained or granular soils have more than 50% of their dry weight retained on a #200 sieve; they are generally described as: boulders, cobbles, gravel or sand. Fine grained soils have less than 50% of their dry weights retained on a No. 200 sieve; they are generally described as: clays, silty clays, or clayey silts if they are cohesive and silts if they are non-cohesive. Granular soils are also described on the basis of their relative in-place density and fine grained soils are described on the basis of their strength, consistency and plasticity.

Major Component of Sample	Size Range	Description Of Components Also Present in Sample	Percent of Dry Weight
Boulders	Over 12 in. (200 mm)	Trace	1-9
Cobbles	12 inches to 3 inches (200 mm to 75 mm)	Little	10-19
Gravel	3 inches to #4 sieve (75 mm to 4.76 mm)	Some	20-34
Sand	#4 to #200 sieve (4.76 mm to 0.074 mm)	And	35-50
Silt	Passing #200 sieve (0.074 mm to 0.002 mm)		
Clay	Passing #200 sieve Smaller than 0.002 mm		

CONSISTENCY OF COHESIVE SOILS

Unconfined Compressive Strength, Qu (tsf)	Consistency
0.25	Very Soft
0.25-0.49	Soft
0.50-0.99	Medium (Firm)
1.00-1.99	Stiff
2.00-3.99	Very Stiff
4.00-8.00	Hard
>8.00	Very Hard

RELATIVE DENSITY OF GRANULAR SOILS:

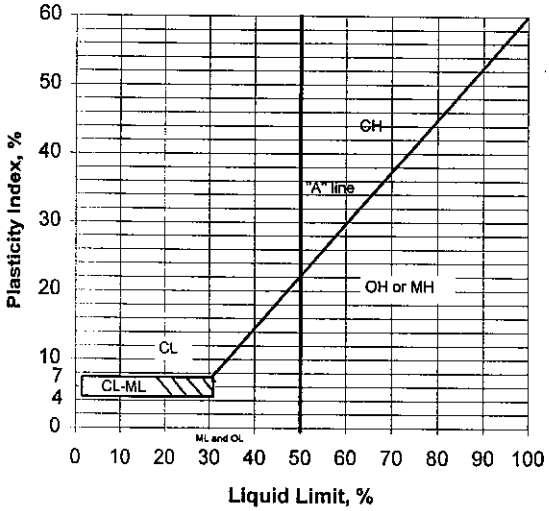
SPT N-Value (blows/ft)	Relative Density
0-3	Very Loose
4-9	Loose
10-29	Medium Dense
30-49	Dense
50-80	Very Dense
>80	Extremely Dense

STS Soil Classification System

UNIFIED SOIL CLASSIFICATION SYSTEM

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

Liquid Limit Plasticity Chart



For classification of fine-grained soils and fine fraction of coarse-grained soils.

Atterberg Limits plotting in hatched area are borderline classifications requiring use of dual symbols.

Hand Auger Drilling (HA)

In this procedure, a split-barrel sampler or Shelby tube is driven into the soil by repeated blows of a sledge hammer or a guided drop hammer. After the sampler is driven to the desired sample depth, a soil sample is retrieved. The hole is then advanced by manually turning and withdrawing a hand auger until the next sampling depth increment is reached. This hand auger drilling between sampling intervals helps to clean and enlarge the bore hole in preparation for obtaining the next sample. Casing is not utilized to maintain an open bore hole.

Power Auger Drilling (PA)

In this type of drilling procedure, solid-stem, continuous flight helical augers are used to advance the bore holes. Normally 4 1/4-inch diameter augers are utilized. They are turned and hydraulically advanced and withdrawn by an engine powered drill rig mounted on a skid, truck or all-terrain vehicle. In auger drilling, casing and drilling mud are not utilized to maintain open bore hole.

Hollow Stem Auger Drilling (HS)

In this drilling procedure, continuous flight augers having open stems are used to advance the bore holes. Typically, the hollow stem auger has a 6 to 8-inch outside diameter and a 2 1/4 to 4 1/4-inch inside diameter. The open stem allows the sampling tool to be used without removing the augers from the bore hole. Hollow stem augers thus provide support to the sides of the bore hole during the sampling operations. Drilling fluid is normally not used with this method.

Rotary Bit Drilling (RB)

In employing rotary drilling methods, various cutting bit types and bit diameters are rotated and pushed hydraulically to advance the bore holes. In this process, near surface casing and/or drilling fluids are used to maintain open bore holes. The drilling fluid typically consists of a soil-water mix, a bentonite-soil slurry or a colloidal gel-soil slurry that is circulated down through the drill rod and bit and up the bore hole annulus with drill cuttings.

Diamond Core Drilling (DB)

Diamond core drilling is used to sample hard, cemented formations such as rock. In this procedure, a double tube (or triple tube) core barrel with diamond teeth cuts an annular space around a cylindrical column of the material being sampled. The sample is retrieved by a catcher just above the bit. Samples recovered by this procedure are placed in sturdy containers in sequential order from top to bottom.

STS Sampling Procedures

Auger Sampling (AS)

In this procedure, soil samples are collected from cuttings off of the auger flights as they are removed from the ground. The samples are typically retained in sealed jars or plastic bags, then shipped to a laboratory for further examination and testing. Such samples provide a general indication of subsurface conditions; however, they do not provide undisturbed samples, nor do they provide samples from discrete depths.

Split-barrel Sampling (SS) - (ASTM Standard D-1586)

In the split-barrel sampling procedure, a 1.375-inch I.D., 2-inch O.D., split barrel sampler is driven into the soil a distance of 18 inches by means of a 140 pound hammer falling 30 inches. The value of the Standard Penetration Resistance, N, is obtained by counting the number of blows of the hammer over the final 12 inches of driving. This value provides a qualitative indication of the in-place relative density of cohesionless soils and consistency of cohesive soils. The indication is qualitative only, because many factors such as soil composition, gravel and cobble content, type of hammer, sample depth and groundwater seepage pressure can significantly affect the Standard Penetration Resistance N Value. Results in similar soils obtained by drill crews using different rigs, drilling procedures, and hammer-rod-spoon assemblies may not correlate directly. A representative portion of the recovered sample is placed in a sample jar, labeled and then shipped to a laboratory for further analysis and testing.

Shelby Tube Sampling Procedure (ST) - (ASTM Standard D-1587)

In the Shelby tube sampling procedure, a thin-walled steel seamless tube with a beveled cutting edge is pushed hydraulically into the soil and then pulled to obtain a relatively undisturbed sample. This procedure is typically used to sample firm to hard cohesive soils. Two-inch diameter tubes are generally utilized. Three-inch diameter tubes are occasionally utilized to sample softer soils where minimally disturbed samples are desired. The tubes are sealed, labeled, and then shipped to a laboratory for extrusion, further analysis and testing.

Bulk Sample (BS)

Bulk samples are typically obtained by hand tool digging into soil or rock deposits that are exposed at the ground surface or within an excavation (walls or bottom). Bulk samples are typically retained in sealed jars or plastic bags.

Continuous Sample Tube (CS)

This type of sampling device consists of 5-ft. sections of thin-wall tubes or split-barrel pipes which are capable of retrieving continuous columns of soil in 5-ft. maximum increments. Because of a continuous slot in the sampling tubes, the sampler allows field determination of stratification boundaries and containerization of soil samples from any sampling depth within the 5-ft. interval. This sampler is used inside a hollow-stem auger and is advanced slightly ahead of the auger head as the auger is turned into the soil. Split-barrel samples are typically opened in the field. Recovered soil is logged and representative samples retained in sealed jars. Tube samples are sealed, labeled and shipped to a laboratory for extrusion and testing.

STS Laboratory Index Test Procedures

Water Content (Wc) (ASTM 2216)

The water content of a soil is the ratio of the weight of water in a given soil mass to the weight of the dry soil. Generally, the soil is dried in a conventional or microwave oven. Water content is commonly expressed as a percentage.

Hand Penetrometer (Qp)

In the hand penetrometer test, the unconfined compressive strength of a soil is estimated, to a maximum value of 4.5 tons per square foot (tsf), by measuring the resistance of a representative portion of a cohesive soil sample to penetration by a 1/4-inch diameter, spring-calibrated cylinder. Results from penetrating into a stone or obviously disturbed portions of the sample are generally disregarded. Hand penetrometer testing has been carefully correlated with unconfined compressive strength tests, and when performed correctly provides a useful and a relatively simple testing procedure in which soil strength can be quickly and reliably estimated.

Unconfined Compression Test (Qu) (ASTM D 2166)

In the unconfined compression strength test, a undisturbed cylinder of cohesive soil 2 to 3 inches in diameter with a height of 4 to 6 inches is loaded axially until failure or until a 20% stain has been reached, whichever occurs first. It provides an indication of the samples undrained shear strength.

Atterberg Limits (ASTM D 318)

Atterberg Limits tests provide a measure of a cohesive soils plasticity. The **liquid limit** is the water content at which a 1/2-inch wide groove that is cut into a shallow cup of remolded soil closes with 25 10mm drops of the cup. The **plastic limit** is the water content below which the soil no longer behaves as a plastic material based on behavior of rolled soil ribbons. The **Plasticity Index** is the difference between the liquid and plastic limits.

Grain Size Analysis (ASTM D 422)

Grain size analyses are performed to determine the distribution of particles by weight for a soil sample. The distribution of particles larger than 0.075 mm (retained on a No. 200 sieve) is determined by sifting a dried and broken soil sample through a series of generally smaller sieves, then weighing the retained portions. If specified, the distribution of particles smaller than 0.075 mm is also determined using a hydrometer to determine particle dispersion and settlement within water.

Classification of Samples

In conjunction with the sample testing program, retained soil samples are examined in our laboratory and are classified on the basis of their texture and plasticity in accordance with the United Soil Classification System (USCS). The soil descriptions on the boring logs are in conformance with this system and the estimated group symbols according to this system are included in parentheses following the soil descriptions on the boring logs. A separate sheet entitled "STS Soil Classification System" provides a brief explanation of this system of soil classification and is also included in the Appendix.

STS Standard Boring Log Procedures

In the process of obtaining and testing samples and preparing this report, common procedures are followed regarding field logs, laboratory data sheets and samples.

Field logs are prepared during performance of the drilling and sampling operations and are intended to document field test data, subsurface observations, sampling depths and exploration procedures. Samples obtained in the field are generally subjected to additional testing and reclassification in the laboratory by more experienced soil technicians, engineers or geologists. The engineer preparing the report reviews the field boring logs and laboratory sample descriptions, classifications and test data. The engineer then uses judgment and experience in interpreting this data and compiling it into the final boring logs. As a result, differences between the field and final boring logs may exist described in the text of the report, as appropriate. The descriptive terms and symbols used on the logs are described on the attached sheet, entitled: "General Boring Log Notes".

We follow a common practice of the geotechnical engineering profession by generally not including field logs and laboratory data sheets in our engineering reports. We do this because the field logs do not represent the engineer's final opinions on appropriateness of field descriptions of conditions encountered in the exploration and testing work. On the other hand, we are aware that certain contractors and subcontractors submitting bids or proposals on work might have an interest in studying these documents before submitting a bid or proposal. For this reason, the field logs are retained in our office for review after authorization by our client. We welcome interpretation questions and an opportunity to explain how the information was obtained and why any boring log changes were made in the preparation of our final logs and report.

Samples taken in the field, some of which are later subjected to laboratory tests, are retained in our laboratory for sixty days and then are eventually disposed unless special disposition is requested by our client. Samples retained over a long period of time, even in sealed jars, are subject to moisture loss which changes the density and strength of cohesive soil-generally increasing soil strength from that which was originally encountered in the field. Since these samples are then no longer representative of the moisture, density and strength conditions initially encountered, potential observers of these samples should recognize this factor if considering sample re-examination weeks or months after samples were retained.

AMERICAN SOCIETY FOR TESTING AND MATERIALS

Standard Method for

PENETRATION TEST AND SPLIT-BARREL SAMPLING OF SOILS[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of the last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This method has been approved for use by agencies of the Department of Defense and for listing in the DOD Index of Specifications and Standards.

1. Scope

1.1 This method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2 This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. For a specific precautionary statement, see 5.4.1.

1.3 The values stated in inch-pound units are to be regarded as the standard.

2. Applicable Documents

2.1 ASTM Standards:

D2487 Test Method for Classification of Soils for Engineering Purposes[2]

D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D4220 Practice for Preserving and Transporting Soil Samples[2]

3. Descriptions of Terms Specific to This Standard

3.1 anvil—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.2 cathead—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.3 drill rods—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.4 drive-weight assembly—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.5 hammer—that portion of the drive-weight assembly consisting of the 140 ± 2 lb (63.5 ± 1 kg) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.6 hammer drop system—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.7 hammer fall guide—that part of the drive-weight assembly used to guide the fall of the hammer.

3.8 N-value—the blowcount representation of the penetration resistance of the soil. The N-value, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.9 ΔN—the number of blows obtained from each of the 6-in. (150-mm) intervals of sampler penetration (see 7.3).

3.10 number of rope turns—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.11 sampling rods—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.12 SPT—abbreviation for Standard Penetration Test, a term by which engineers commonly refer to this method.

4. Significance and Use

4.1 This method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample.

4.2 This method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and widely published correlations which relate SPT blowcount, or N-value, and the engineering behavior of earthworks and foundation are available.

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[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved Sept. 11, 1984. Published November 1984. Originally published as D1586—58T. Last previous edition D1586—67 (1974).

[2] Annual Book of ASTM Standards, Vol 04.08.

5. Apparatus

5.1 Drilling Equipment—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions.

5.1.1 Drag, Chopping, and Fishtail Bits, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharging bits are permitted.

5.1.2 Roller-Cone Bits, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 Hollow-Stem Continuous Flight Augers, with or without a center bit assembly, may be used to drill the boring. The inside diameter of the hollow-stem augers shall be less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm).

5.1.4 Solid, Continuous Flight, Bucket and Hand Augers, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used if the soil on the side of the boring does not cave onto the sampler or sampling rods during sampling.

5.2 Sampling Rods—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod which has an outside diameter of 1⅝ in. (41.2 mm) and an inside diameter of 1⅛ in. (28.6 mm).

NOTE 1—Recent research and comparative testing indicates the type rod used, with stiffness ranging from "A" size rod to "N" size rod, will usually have a negligible effect on the N-values to depths of at least 100 ft (30 m).

5.3 Split-Barrel Sampler—The sampler shall be constructed with the dimensions indicated in Fig. 2. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The use of liners to produce a constant inside diameter of 1⅜ in. (35 mm) is permitted, but shall be noted on the penetration record if used. The use of a sample retainer basket is permitted, and should also be noted on the penetration record if used.

NOTE 2—Both theory and available test data suggest that N-values may increase between 10 to 30% when liners are used.

5.4 Drive-Weight Assembly:

5.4.1 Hammer and Anvil—The hammer shall weigh 140 ± 2 lb (63.5 ± 1 kg) and shall be a solid rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting a free fall shall be used. Hammers used with the cathead and rope method shall have an unimpeded overlift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged.

NOTE 3—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 Hammer Drop System—Rope-cathead, trip, semi-automatic, or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration of the sampler while re-engaging and lifting the hammer.

5.5 Accessory Equipment—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The boring shall be advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 m) or less in homogeneous strata with test and sampling locations at every change of strata.

6.2 Any drilling procedure that provides a suitably clean and stable hole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures have proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1 Open-hole rotary drilling method.

6.2.2 Continuous flight hollow-stem auger method.

6.2.3 Wash boring method.

6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable borings. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the boring below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a boring with bottom discharge bits is not permissible. It is not permissible to advance the boring for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the boring or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, prepare for the test with the following sequence of operations.

7.1.1 Attach t..e split-barrel sampler to the sampling rods and lower into borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the boring, remove the sampler and sampling rods from the boring and remove the cuttings.

7.1.4 Mark the drill rods in three successive 6-in. (0.15-m) increments

so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-in. (0.15-m) increment.

7.2 Drive the sampler with blows from the 140-lb (63.5-kg) hammer and count the number of blows applied in each 6-in. (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 6-in. (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 18 in. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.3 Record the number of blows required to effect each 6 in. (0.15m) of penetration or fraction thereof. The first 6 in. is considered to be a seating drive. The sum of the number of blows required for the second and third 6 in. of penetration is termed the "standard penetration resistance", or the "N-value". If the sampler is driven less than 18 in. (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 6-in. (0.15-m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 1 in. (25 mm), in addition to the number of blows. If the sampler advances below the bottom of the boring under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lb (63.5-kg) hammer shall be accomplished using either of the following two methods:

7.4.1 By using a trip, automatic, or semi-automatic hammer drop system which lifts the 140-lb (63.5-kg) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 25 mm) unimpeded.

7.4.2 By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM, or the approximate speed of rotation shall be reported on the boring log.

7.4.2.3 No more than 2¼ rope turns on the cathead may be used during the performance of the penetration test, as shown in Fig. 1.

NOTE 4—The operator should generally use either 1¾ of 2¼ rope turns, depending upon whether or not the rope comes off the top (1¾ turns) or the bottom (2¼ turns) of the cathead. It is generally known and accepted that 2¾ or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be maintained in a relatively dry, clean, and unfrayed condition.

7.4.2.4 For each hammer blow, a 30-in. (0.76-m) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

7.5 Bring the sampler to the surface and open. Record the percent recovery or length of sample recovered. Describe the soil samples recovered as to composition, color, stratification, and condition, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 6-in. (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel.

8. Report

8.1 Drilling information shall be recorded in the field and shall include the following:

8.1.1 Name and location of job,

8.1.2 Names of crew,

8.1.3 Type and make of drilling machine,

8.1.4 Weather conditions,

8.1.5 Date and time of start and finish of boring,

8.1.6 Boring number and location (station and coordinates, if available and applicable),

8.1.7 Surface elevation, if available,

8.1.8 Method of advancing and cleaning the boring,

8.1.9 Method of keeping boring open,

8.1.10 Depth of water surface and drilling depth at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

8.1.11 Location of strata changes,

8.1.12 Size of casing, depth of cased portion of boring,

8.1.13 Equipment and method of driving sampler,

8.1.14 Type of sampler and length and inside diameter of barrel (note use of liners),

8.1.15 Size, type, and section length of the sampling rods, and

8.1.16 Remarks.

8.2 Data obtained for each sample shall be recorded in the field and shall include the following:

8.2.1 Sample depth and, if utilized, the sample number,

8.2.2 Description of soil,

8.2.3 Strata changes within sample,

8.2.4 Sampler penetration and recovery lengths, and

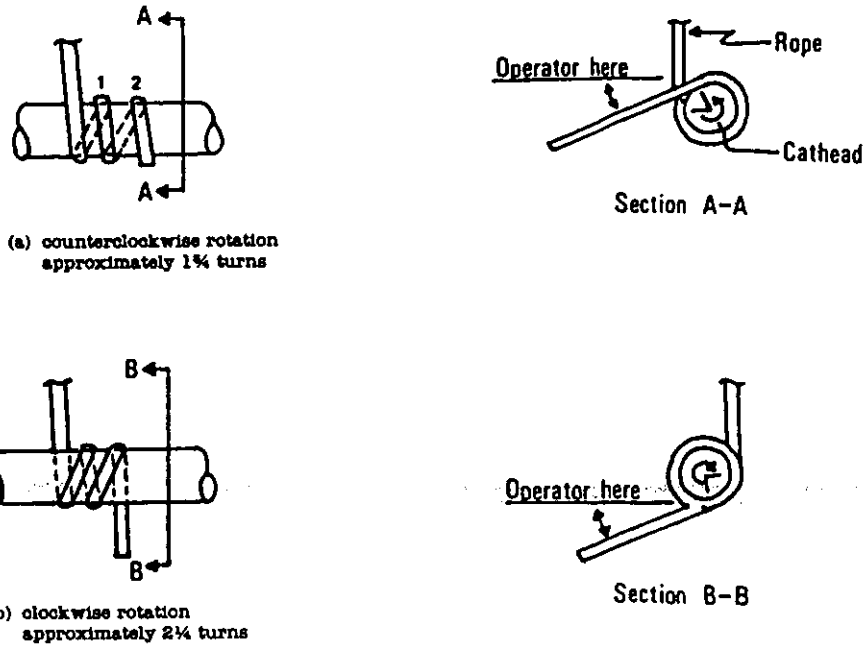
8.2.5 Number of blows per 6-in. (0.15-m) or partial increment.

9. Precision and Bias

9.1 Variations in N-values of 100% or more have been observed when using different standard penetration test apparatus and drillers for adjacent borings in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, N-values in the same soil can be reproduced with a coefficient of variation of about 10%.

9.2 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in N-values obtained between operator-drill rig systems.

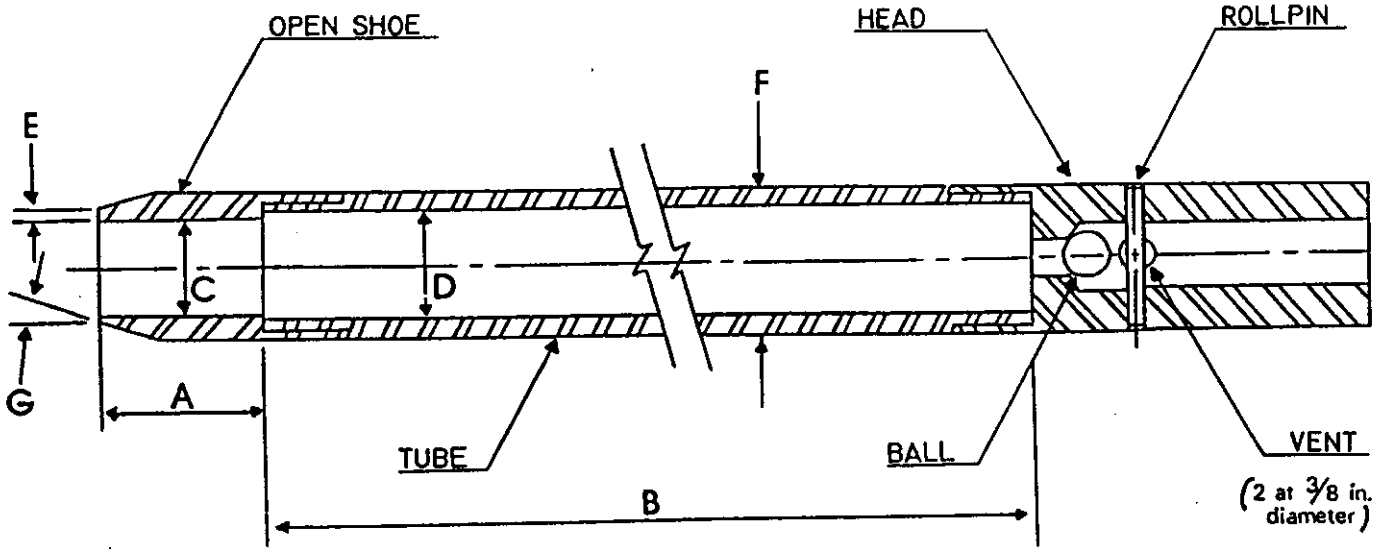
9.3 The variability in N-values produced by different drill rigs and operators may be reduced by measuring that part of the hammer energy delivered into the drill rods from the sampler and adjusting N on the basis of comparative energies. A method for energy measurement and N-value adjustment is currently under development.



(a) counterclockwise rotation approximately 1¾ turns

(b) clockwise rotation approximately 2¼ turns

FIG. 1 Definitions of the Number of Rope Turns and the Angle for (a) Counterclockwise Rotation and (b) Clockwise Rotation of the Cathead



A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375 ± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 – 0.00 in. (38.1 ± 1.3 – 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 – 0.00 in. (50.8 ± 1.3 – 0.0 mm)
G = 16.0° to 23.0°

The 1½ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

FIG. 2 Split-Barrel Sampler

STS Subgrade Protection Guideline

Care should be exercised to minimize disturbance and degradation of subgrade soils for foundations, slabs-on-grade, pavements and areas to be filled. Water should not be allowed to pond on the surface of exposed subgrade soils, as this could cause a softening of the subgrade, particularly when subjected to construction traffic. Disturbed or softened subgrade soils should be removed to a suitable undisturbed subgrade prior to fill or concrete placement.

Wet subgrade conditions may result from precipitation, runoff and groundwater seepage through excavation walls and bottom. Precipitation risk can be minimized by scheduling construction for drier seasons. The subgrade should be sloped to drainage ditches and sumps to minimize water accumulations. Runoff from adjacent areas should be eliminated by use of berms and ditches to channel water away. Groundwater seepage may be minimized by use of dewatering systems such as wells and/or groundwater isolation systems such as cutoff walls or trenches. Dewatering wells and/or groundwater isolation systems are recommended where upward seepage is likely to cause the subgrade to loosen and become "quick" or where lateral seepage may erode the face soil or cause "piping" of fines from the soil matrix as exhibited by muddy or silt laden water.

If moisture or disturbance sensitive subgrade soils and wet conditions are expected and construction of facilities bearing on the subgrade will not promptly protect the subgrade soils, then consideration should be given to protecting the subgrade by promptly placing appropriate combinations of a geotextile, a gravel base course and a lean concrete mud mat over the prepared and approved subgrade. Geotextiles should be considered for use to separate the subgrade and gravel where subgrade soils are at risk of migrating into the gravel base course. A suitably designed gravel base course should help surcharge the subgrade and act as a drainage layer for removing water accumulations. A lean concrete or flowable fill mud mat with a thickness of several inches or more may be placed directly on the subgrade if upward seepage does not exist. If base drainage is needed, a lean concrete or flowable fill mud mat may be placed over a gravel base course. A mud mat will help to isolate water, provide surcharge against loosening and will provide a stable surface which is resistant to disturbance from construction traffic. Sump and pump systems or dewatering wells should be used to remove any accumulating water or water pressure in the gravel base course.

In any areas where unsuitable conditions develop despite protection measures, subgrade stabilization should be performed as described in a separate sheet entitled "STS Subgrade Stabilization Guideline".

STS Subgrade Stabilization Guideline

Subgrade stabilization may be required if zones of unsuitable soil are encountered upon excavating to the subgrade level or if subgrade degradation occurs from construction traffic, moisture accumulations, freeze-thaw cycles or other causes. Care should always be used to minimize disturbance and degradation of subgrade soils below foundations, slabs-on-grade, pavements and fill areas. Water should not be allowed to pond on the surface of exposed subgrade soils, as this could cause a softening of the subgrade, particularly when subjected to construction traffic. Detrimental groundwater seepage should not be allowed to soften or loosen the subgrade.

Unsuitable subgrade soils that are encountered or subgrade soils that become disturbed or softened after exposure should be improved prior to concrete or new material placement. The unsuitable soils should either be properly compacted in place (if feasible based on material type, moisture content and thickness), or over-excavations should extend through the unsuitable soils to remove them to an underlying competent soil stratum.

If improvement by over-excavating is performed, footing walls can be extended deeper and supported at the level where suitable soil is encountered. Alternatively, the over-excavations can be backfilled to the design level using either a suitable compacted structural fill material or a flowable cementitious fill.

If the over-excavations are backfilled using structural soil fill, the over-excavations should extend a minimum of 1 foot horizontally from each edge of the footing for each foot of fill required below the footing base. The structural soil fill should be placed, compacted and tested in accordance with a separate document entitled STS Earthwork Guideline. Generally, a well-graded granular material is more suitable for stabilization work than cohesive soils. If an open-graded granular material is planned as the backfill and the new subgrade or surrounding soils contain zones of cohesionless fine sands or silts which may migrate into the open-graded backfill, then an appropriately designed geotextile should be utilized to separate the stabilization material from the subgrade and surrounding trench soils. Failure to provide such separation may cause lost ground from surrounding soils and detrimental settlements.

Horizontal over-excavation is unnecessary if footing walls are extended to the lower suitable subgrade level or if flowable fill is used to backfill the over-excavated area. Flowable fill should have a sufficient Portland cement and/or fly ash content to achieve 28 day unconfined compressive strengths in the range of 50 to 200 pounds per square inch (psi).

Fill or backfill required on the project should consist of a non-frozen, non-organic granular material, aggregate or natural soil that is free of debris and particles larger than 25 percent of the loose lift thickness. The natural water content of cohesive fill soil at the time of compaction should generally be within -2 to +3 percent of the optimum water content as determined by the Standard Proctor test (ASTM D-698). Difficulty in obtaining the desired degree of compaction is expected for soil that is too dry or too wet. The water content should be adjusted by sprinkling if too dry or by scarifying and aerating if too wet. Blending with an additive such as fly ash or drier soil may also help produce an acceptable water content.

Fill or backfill which is relatively uniform should be used on the project. Non-uniform materials or mixing two or more materials will reduce the degree of certainty in the test results and will tend to cause variable compressibility of the fill.

Fill or backfill should be placed on a firm, checked subgrade in horizontal lifts with a loose thickness not greater than 12 inches for granular material and 9 inches for cohesive soil. It should then be compacted with equipment that is suited to the soil type and compaction requirements. Normally, vibratory roller or plate compactors are better suited for granular soils, while a sheepsfoot or other "kneading" type of compactors are more effective in cohesive soils. Lighter, hand-propelled compactors should generally be utilized to compact backfill within 5 feet of structures unless the structure is designed to resist expected lateral pressures from use of heavier compactors. When using lighter, hand-propelled compactors, a maximum loose lift thickness of 8 inches should be used for granular material and 6 inches for cohesive soil.

Unless stated otherwise in the report text, fill or backfill that supports foundations, floor slabs that are loaded in excess of 400 psf, and roadway pavement that is subjected to concentrated automobile or truck traffic should be compacted to a dry density of 95% or more of the maximum dry density determined by Standard Proctor tests (ASTM D-698) on representative samples of the fill material. Fill or backfill that supports lightly loaded floor slabs, sidewalks or pavement that is subjected to dispersed automobile traffic should be compacted to a dry density of 90% or more of the maximum dry density determined by Standard Proctor tests on representative samples of the fill material. Compaction tests may be considered satisfactory if the average of five consecutive tests on similarly compacted material exceeds the required compaction and no individual test is more than 2% below the required percentage of compaction.

Proper compaction is generally difficult to achieve near the edge of a slope or embankment fill due to lack of confinement. For this reason, we recommend that the compacted fill or backfill zone extend horizontally beyond the edge of foundations a minimum of 1 foot at the subgrade level and then with depth at a minimum slope of 1 horizontal to 1 vertical.

Fill material acceptability, subgrade preparation and testing for suitability, fill placement and fill compaction should be monitored continuously or at least regularly by a qualified soils technician whom reports to the geotechnical engineer for the project. Compaction density for structural fill should be tested at a minimum frequency of once per 5000 ft^2 of fill area or once per 200 yd^3 of compacted material placed unless stated otherwise in our report. In non-structural fill areas, testing frequencies may be reduced in half.