ADDENDUM No. 1

RFP No. 18-23

Snyder/Edgewood Avenues Area Storm Water Improvements Project

Due: May 29, 2018 at 2:00 P.M. (local time)

The following changes, additions, and/or deletions shall be made to the Request for Proposal for Snyder/Edgewood Avenues Area Storm Water Improvements Project, RFP No. 18-23, on which proposals will be received on/or before the date and time listed above.

The information contained herein shall take precedence over the original documents and all previous addenda (if any), and is appended thereto. **This Addendum includes 587 pages and are comprised of the five (5) documents described below.**

The Proposer is to acknowledge receipt of this Addendum No. 1, including all attachments in its Proposal by so indicating in the proposal that the addendum has been received. Proposals submitted without acknowledgement of receipt of this addendum may be considered non-conforming.

The following forms provided within the RFP Document must be included in submitted proposal:

- **Attachment C - Non-Discrimination Declaration of Compliance**
- **Attachment D - Living Wage Declaration of Compliance**
- **Attachment E - Vendor Conflict of Interest Disclosure Form**

Proposals that fail to provide these completed forms listed above upon proposal opening will be rejected as non-responsive and will not be considered for award.

I. CORRECTIONS/ADDITIONS/DELETIONS

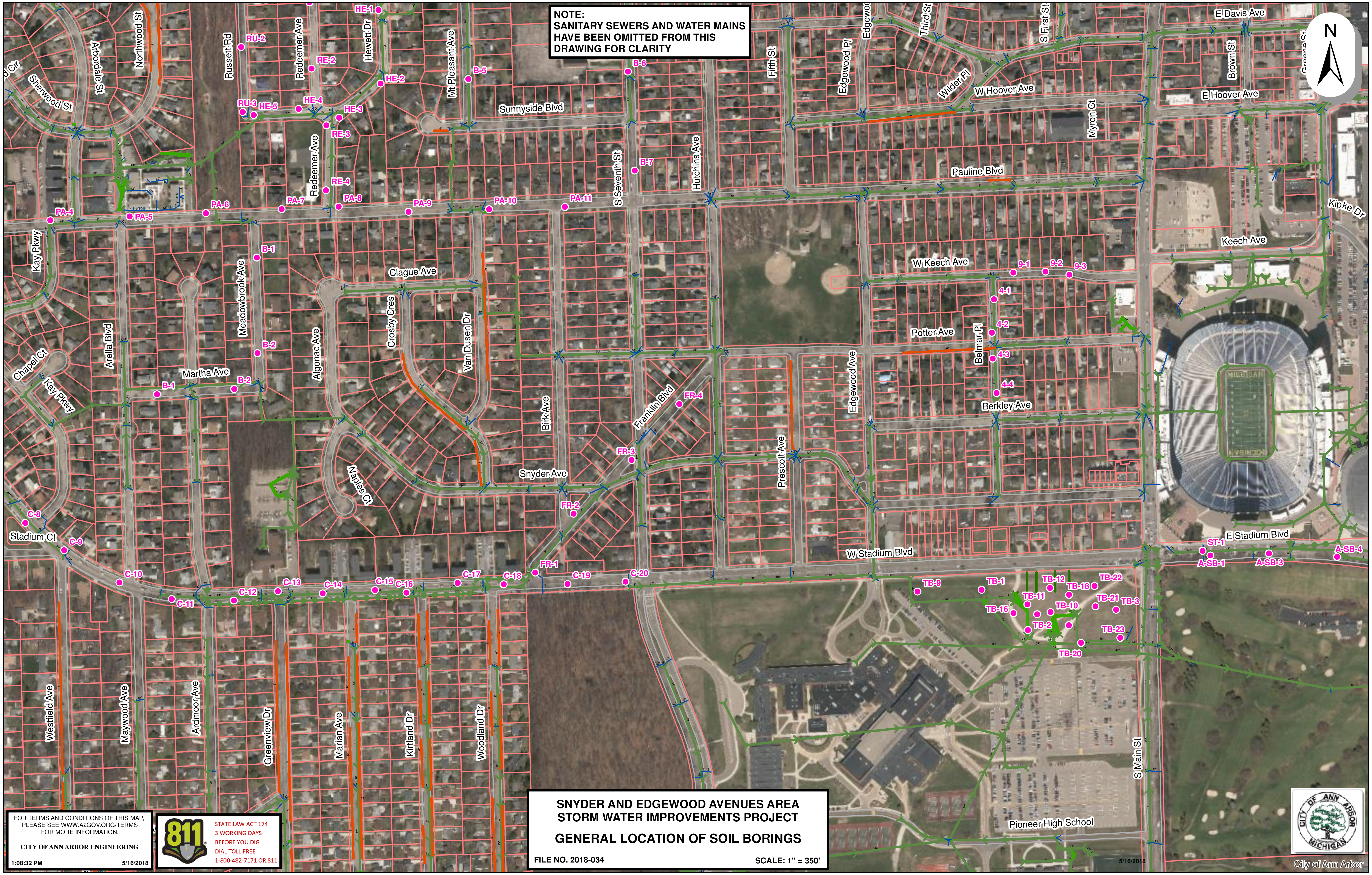
Changes to the RFP documents which are outlined below are referenced to a page or Section in which they appear conspicuously. Offerors are to take note in its review of the documents and include these changes as they may affect work or details in other areas not specifically referenced here.

Section/Page(s)	**Change**
Section II, Page 17	The City of Ann Arbor is providing as part of this Request for Proposal additional information to help inform the proposers of the general soil conditions of the area(s) surrounding the project limits. The information is as follows: 1. General Soil Boring Location drawing (1 page); 2. Soil boring logs as depicted in Item No. 1 (80 pages); 3. Stadium Boulevard Reconstruction Project – Final Geotechnical Report (196 pages); 4. Stadium Boulevard Bridges Replacement Project – Final Geotechnical Report (205 pages); and, 5. City of Ann Arbor Stormwater Model Calibration and Analysis Project - Final Report (103 pages).

II. QUESTIONS AND ANSWERS

No written questions were received by the City of Ann Arbor by the written question deadline; thus no answers are being provided.

Offerors are responsible for any conclusions that they may draw from the information contained in the Addendum.



FOR TERMS AND CONDITIONS OF THIS MAP, PLEASE SEE WWW.A2GOV.ORG/TERMS FOR MORE INFORMATION.

CITY OF ANN ARBOR ENGINEERING

1:08:32 PM 5/16/2018

811

STATE LAW ACT 174
3 WORKING DAYS
BEFORE YOU DIG
DIAL TOLL FREE
1-800-482-7171 OR 811

SNYDER AND EDGEWOOD AVENUES AREA STORM WATER IMPROVEMENTS PROJECT

GENERAL LOCATION OF SOIL BORINGS

FILE NO. 2018-034 SCALE: 1" = 350'

CITY OF ANN ARBOR MICHIGAN

Belmar Pl	2006	Belmar Pl 4-1 2006	G:\Public Services\Engineering\SoilBorings\Images\Belmar Pl 4-1 2006.pdf		1-Apr
Belmar Pl	2006	Belmar Pl 4-2 2006	G:\Public Services\Engineering\SoilBorings\Images\Belmar Pl 4-2 2006 .pdf		2-Apr
Belmar Pl	2006	Belmar Pl 4-3 2006	G:\Public Services\Engineering\SoilBorings\Images\Belmar Pl 4-3 2006.pdf		3-Apr
Belmar Pl	2006	Belmar Pl 4-4 2006	G:\Public Services\Engineering\SoilBorings\Images\Belmar Pl 4-4 2006.pdf		4-Apr
Keech Ave (W)	2006	Keech Ave (W) 9-1 2006	G:\Public Services\Engineering\SoilBorings\Images\Keech Ave (W) 9-1 2006.pdf		1-Sep
Keech Ave (W)	2006	Keech Ave (W) 9-2 2006	G:\Public Services\Engineering\SoilBorings\Images\Keech Ave (W) 9-2 2006.pdf		2-Sep
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Stadium Blvd (W)	2007	Stadium Blvd (W) C-16 2007	G:\Public Services\Engineering\SoilBorings\Images\Stadium Blvd (W) C-16 2007.pdf	C-16	
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Stadium Blvd (W)	2007	Stadium Blvd (W) C-20 2007	G:\Public Services\Engineering\SoilBorings\Images\Stadium Blvd (W) C-20 2007.pdf	C-20	
Mt Pleasant Ave	2010	Mt Pleasant Ave B-5 2010	G:\Public Services\Engineering\SoilBorings\Images\Mt Pleasant Ave B-5 2010.pdf	B-5	
Meadowbrook Ave	2011	Meadowbrook Ave B-1 2011	G:\Public Services\Engineering\SoilBorings\Images\Meadowbrook Ave B-1 2011.pdf	B-1	
Meadowbrook Ave	2011	Meadowbrook Ave B-2 2011	G:\Public Services\Engineering\SoilBorings\Images\Meadowbrook Ave B-2 2011.pdf	B-2	
S Seventh St	2011	S Seventh St B-6 2011	G:\Public Services\Engineering\SoilBorings\Images\S Seventh St B-6 2011.pdf	B-6	
S Seventh St	2011	S Seventh St B-7 2011	G:\Public Services\Engineering\SoilBorings\Images\S Seventh St B-7 2011.pdf	B-7	
Martha Ave	2012	Martha Ave B-1 2012	G:\Public Services\Engineering\SoilBorings\Images\Martha Ave B-1 2012.pdf	B-1	
Martha Ave	2012	Martha Ave B-2 2012	G:\Public Services\Engineering\SoilBorings\Images\Martha Ave B-2 2012.pdf	B-2	
Franklin Blvd	2012	Franklin Blvd FR-1 2012	G:\Public Services\Engineering\SoilBorings\Images\Franklin Blvd FR-1 2012.pdf	FR-1	
Franklin Blvd	2012	Franklin Blvd FR-2 2012	G:\Public Services\Engineering\SoilBorings\Images\Franklin Blvd FR-2 2012.pdf	FR-2	
Franklin Blvd	2012	Franklin Blvd FR-3 2012	G:\Public Services\Engineering\SoilBorings\Images\Franklin Blvd FR-3 2012.pdf	FR-3	
Franklin Blvd	2012	Franklin Blvd FN-4 2012	G:\Public Services\Engineering\SoilBorings\Images\Franklin Blvd FN-4 2012.pdf	FR-4	
Russett Rd	2012	Russett Rd RU-2 2012	G:\Public Services\Engineering\SoilBorings\Images\Russett Rd RU-2 2012.pdf	RU-2	
Russett Rd	2012	Russett Rd RU-3 2012	G:\Public Services\Engineering\SoilBorings\Images\Russett Rd RU-3 2012.pdf	RU-3	
Redeemer Ave	2012	Redeemer Ave RE-2 2012	G:\Public Services\Engineering\SoilBorings\Images\Redeemer Ave RE-2 2012.pdf	RE-2	
Redeemer Ave	2012	Redeemer Ave RE-3 2012	G:\Public Services\Engineering\SoilBorings\Images\Redeemer Ave RE-3 2012.pdf	RE-3	
Redeemer Ave	2012	Redeemer Ave RE-4 2012	G:\Public Services\Engineering\SoilBorings\Images\Redeemer Ave RE-4 2012.pdf	RE-4	
Hewett Dr	2012	Hewett Dr HE-1 2012	G:\Public Services\Engineering\SoilBorings\Images\Hewett Dr HE-1 2012.pdf	HE-1	
Hewett Dr	2012	Hewett Dr HE-2 2012	G:\Public Services\Engineering\SoilBorings\Images\Hewett Dr HE-2 2012.pdf	HE-2	
Hewett Dr	2012	Hewett Dr HE-3 2012	G:\Public Services\Engineering\SoilBorings\Images\Hewett Dr HE-3 2012.pdf	HE-3	
Hewett Dr	2012	Hewett Dr HE-4 2012	G:\Public Services\Engineering\SoilBorings\Images\Hewett Dr HE-4 2012.pdf	HE-4	
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Pauline Blvd	2012	Pauline Blvd PA-4 2012	G:\Public Services\Engineering\SoilBorings\Images\Pauline Blvd PA-4 2012.pdf	PA-4	
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Pioneer High School	2008	Pioneer High School TB-1 2008	G:\Public Services\Engineering\SoilBorings\Images\Pioneer High School TB-1 2008.pdf	TB-1
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Pioneer High School	2008	Pioneer High School TB-18 2008	G:\Public Services\Engineering\SoilBorings\Images\Pioneer High School TB-18 2008.pdf	TB-18
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Pioneer High School	2008	Pioneer High School TB-20 2008	G:\Public Services\Engineering\SoilBorings\Images\Pioneer High School TB-20 2008.pdf	TB-20
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Pioneer High School	2008	Pioneer High School TB-22 2008	G:\Public Services\Engineering\SoilBorings\Images\Pioneer High School TB-22 2008.pdf	TB-22
Pioneer High School	2008	Pioneer High School TB-23 2008	G:\Public Services\Engineering\SoilBorings\Images\Pioneer High School TB-23 2008.pdf	TB-23

ISC INSPECTION SERVICES COMPANY

LOG OF TEST BORING

PROJECT: Ann Arbor 2006 Street Resurfacing Program	
LOCATION: Belmar Pl. between Keech and Berkley	
PROJECT NO. : 61072	BORING NO. : 4-1
DATE : 02/02/06	PAGE : 1 of 1

Elev. (ft)	SOIL DESCRIPTION	Depth (ft)	Sample Type	Blows/ 6-Inches	SPT* (N)	Moisture Content (%)	Loss on Ignition (%)	Shear Strength (psf)
	Ground Surface							
	ASPHALT (4") 0.3'							
	BASE: Brown SAND and GRAVEL (3") 0.6'							
	Very stiff brown SILTY CLAY with trace sand and gravel	1						
		2		6				
				8				
			S-1	12	20	14.3		5000 **
		3						
				4				
				4				
	4.0'	4	S-2	4	8	13.7		5000 **
	END OF BORING	5						
		6						
		7						
		8						
	BORING LOCATION: In front of 1103 Belmar Pl. in the Northbound lane	9						
		10						

LEGEND	SAMPLE TYPE	DRILLING INFORMATION	
Organic soil	S-Split spoon	METHOD:	2-1/4" solid-stem augers
Sand	LS- Liner sample		
Clay	AS-Auger sample	CO. / REP:	Failane Drilling Co.
Silt	BS-Bulk sample		J. Faitel
Gravel	ST-Shelby tube	BACKFILL:	Soil + cold patch
Other	C-Core		

REMARKS

*Standard Penetration Test : Driving 2" OD Sampler 18" with 140# Hammer Falling 30", Count made at 6" Intervals.

** Determined by Pocket Penetrometer

GROUNDWATER

Encountered: None	After Completion: Dry

LOG OF TEST BORING

ISC INSPECTION SERVICES COMPANY

PROJECT: Ann Arbor 2006 Street Resurfacing Program	
LOCATION: Belmar Pl. between Keech and Berkley	
PROJECT NO.: 61072	BORING NO.: 4-2
DATE: 02/02/06	PAGE: 1 of 1

Elev. (ft)	SOIL DESCRIPTION	Depth (ft)	Sample Type	Blows/ 6-Inches	SPT* (N)	Moisture Content (%)	Loss on Ignition (%)	Shear Strength (psf)
	Ground Surface							
	ASPHALT (3") 0.2'							
	BASE: Brown SAND and GRAVEL (4") 0.6'							
	Hard brown SILTY CLAY with trace sand and gravel	1						
		2	S-1	4 8 11	19	11.8		9000+ **
		3						
	4.0'	4	S-2	6 9 13	22	13.5		9000+ **
	END OF BORING	5						
		6						
		7						
		8						
	BORING LOCATION: In front of 1108 Belmar Pl. in the Southbound lane	9						
		10						

LEGEND	SAMPLE TYPE
Organic soil	S-Split spoon
Sand	LS- Liner sample
Clay	AS-Auger sample
Silt	BS-Bulk sample
Gravel	ST-Shelby tube
Other	C-Core

DRILLING INFORMATION

METHOD: 2-1/4" solid-stem augers

CO. / REP: Failane Drilling Co. J. Faitel

BACKFILL: Soil + cold patch

REMARKS

*Standard Penetration Test : Driving 2" OD Sampler 18" with 140# Hammer Falling 30", Count made at 6" Intervals.

** Determined by Pocket Penetrometer

GROUNDWATER

Encountered: None | After Completion: Dry

ISC INSPECTION SERVICES COMPANY

LOG OF TEST BORING

PROJECT: Ann Arbor 2006 Street Resurfacing Program	
LOCATION: Belmar Pl. between Keech and Berkley	
PROJECT NO. : 61072	BORING NO. : 4-3
DATE : 02/02/06	PAGE : 1 of 1

Elev. (ft)	SOIL DESCRIPTION	Depth (ft)	Sample Type	Blows/ 6-Inches	SPT* (N)	Moisture Content (%)	Loss on Ignition (%)	Shear Strength (psf)
	Ground Surface							
	ASPHALT (6") 0.5'							
	BASE: Brown SAND and GRAVEL (6") 1.0'	1						
	Very stiff dark brown SILTY CLAY with trace sand (FILL MATERIAL) 2.5'	2	S-1	5 7 9	16	22.0		6000 **
	Hard brown SILTY CLAY with trace sand and gravel 4.0'	3 4	S-2	5 9 12	21	14.5		9000+ **
	END OF BORING	5						
		6						
		7						
		8						
	BORING LOCATION: In front of 1200 Belmar Pl. in the Southbound lane	9						
		10						

LEGEND	SAMPLE TYPE	DRILLING INFORMATION	
Organic soil	S-Split spoon	METHOD:	2-1/4" solid-stem augers
Sand	LS- Liner sample		
Clay	AS-Auger sample	CO. / REP:	Failane Drilling Co.
Silt	BS-Bulk sample		J. Faitel
Gravel	ST-Shelby tube	BACKFILL:	Soil + cold patch
Other	C-Core		

REMARKS

*Standard Penetration Test : Driving 2" OD Sampler 18" with 140# Hammer Falling 30", Count made at 6" Intervals.

** Determined by Pocket Penetrometer

GROUNDWATER

Encountered: None	After Completion: Dry

ISC INSPECTION SERVICES COMPANY

LOG OF TEST BORING

PROJECT: Ann Arbor 2006 Street Resurfacing Program	
LOCATION: Belmar Pl. between Keech and Berkley	
PROJECT NO. : 61072	BORING NO. : 4-4
DATE : 02/02/06	PAGE : 1 of 1

Elev. (ft)	SOIL DESCRIPTION		Depth (ft)	Sample Type	Blows/ 6-Inches	SPT* (N)	Moisture Content (%)	Loss on Ignition (%)	Shear Strength (psf)
	Ground Surface								
	ASPHALT (4")	0.3'							
	BASE: Brown-black SAND and GRAVEL (4")	0.7'							
	Very stiff brown SILTY CLAY with trace sand and gravel		1						
			2		4				
					5				
				S-1	8	13	16.2		6500 **
			3						
					3				
					3				
			4	S-2	4	7	15.7		4000 **
	END OF BORING								
			5						
			6						
			7						
			8						
	BORING LOCATION: In front of 1207 Belmar Pl. in Northbound lane								
			9						
			10						

LEGEND	SAMPLE TYPE
Organic soil	S-Split spoon
Sand	LS- Liner sample
Clay	AS-Auger sample
Silt	BS-Bulk sample
Gravel	ST-Shelby tube
Other	C-Core

DRILLING INFORMATION

METHOD:	2-1/4" solid-stem augers
CO. / REP:	Failane Drilling Co. J. Faitel
BACKFILL:	Soil + cold patch

REMARKS

*Standard Penetration Test : Driving 2" OD Sampler 18" with 140# Hammer Falling 30", Count made at 6" Intervals.

** Determined by Pocket Penetrometer

GROUNDWATER

Encountered: None	After Completion: Dry

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **FR-1**

G2 Consulting Group, LLC

SUBSURFACE PROFILE					SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A		DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (4-1/2 inches)	0.4		AS-1				
		Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 7-1/2 inches)	1.0		AS-2	8	24.8		
		Fill: Loose Dark Brown Clayey Sand with trace organic matter (Organic Matter Content = 4.8%)	2.0		AS-3	8	23.9		3500*
		Stiff to Very Stiff Brown and Gray Silty Clay with trace sand and gravel				10			
						9			
5			5.0	5	AS-4	11	23.2		4000*
		End of Boring @ 5ft							
10				10					
15				15					

Total Depth: 5ft
Drilling Date: September 25, 2012
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Hayball, P.E.

Drilling Method:
4-inch diameter diamond tipped core barrel; 3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 5 feet west of East Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **FR-2**

G2 Consulting Group, LLC

SUBSURFACE PROFILE / SOIL SAMPLE DATA

DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (4 inches) 0.3		AS-1				
		Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 6 inches) 0.8		AS-2	11	14.8		4000*
		Very Stiff Brown Sandy Clay with trace gravel			10			
		3.0			15			
		Very Stiff Brown and Gray Silty Clay with trace sand and gravel			16			
5		5.0	5	AS-3	15	15.3		7000*
		End of Boring @ 5ft						
10			10					
15			15					

Total Depth: 5ft
Drilling Date: September 25, 2012
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Hayball, P.E.

Drilling Method:
4-inch diameter diamond tipped core barrel; 3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 9 feet east of West Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Figure No. 21

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **FR-3**

G2 Consulting Group, LLC

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (6 inches) 0.5						
		Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 5 inches) 0.9		AS-1	12	18.8		5500*
				AS-2				
					10			
		Very Stiff Brown and Gray Silty Clay with trace sand and gravel			13			
					12			
5		5.0	5	AS-3	13	17.1		5000*
		End of Boring @ 5ft						
10			10					
15			15					

Total Depth: 5ft
Drilling Date: September 25, 2012
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Hayball, P.E.

Drilling Method:
4-inch diameter diamond tipped core barrel; 3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 7 feet west of East Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Figure No. 22

PAVEMENT CORE DCP 120547A.GPJ G2_CONS.GDT 10/19/12

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **FR-4**

G2 Consulting Group, LLC

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	PROFILE	DESCRIPTION	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
0.3		Bituminous Concrete (3-1/2 inches)		AS-1				
0.8		Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 5-1/2 inches)		AS-2	8	16.3		3000*
		Stiff to Very Stiff Brown and Gray Silty Clay with trace sand and gravel			8			
					11			
					12			
5.0			5	AS-3	12	15.7		4500*
		End of Boring @ 5ft						
10			10					
15			15					

Total Depth: 5ft
Drilling Date: September 25, 2012
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Hayball, P.E.

Drilling Method:
4-inch diameter diamond tipped core barrel; 3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 7 feet east of West Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Soil Boring No. **HE-1**

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

G2 Consulting Group, LLC

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	Description	Layer bottom (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
	Bituminous Concrete (5 inches)	0.4						
	Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 9 inches)	1.2						
	Fill: Stiff Dark Brown Sandy Clay with trace gravel and organic matter	4.5	S-1	3 4 3	7	17.1		3500*
5			S-2	4 5 9	14	15.4		5000*
	Very Stiff to Hard Brown Silty Clay with trace sand and gravel	7.5	S-3	6 11 15	26	13.9		9000*
	End of Boring @ 7.5ft							
10								
15								

Total Depth: 7.5ft
Drilling Date: October 4, 2012
Inspector:
Contractor: Strata Drilling, Inc.
Driller: B. Sienkiewicz

Drilling Method:
2-1/4 inch inside diameter hollow-stem augers

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 2 feet east of West Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **HE-2**

G2 Consulting Group, LLC

SUBSURFACE PROFILE				SOIL SAMPLE DATA					
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
		Bituminous Concrete (5 inches) 0.4							
		Fill: Very Loose Brown Sand with trace silt and gravel 4.0		S-1	2 2 2	4			
5		Stiff to Very Stiff Brown Silty Clay with trace sand and gravel and occasional sand seams	5	S-2	1 2 3	5	15.3		2000*
		7.5		S-3	2 3 2	5	18.0		4500*
		End of Boring @ 7.5ft							
10			10						
15			15						

Total Depth: 7.5ft
Drilling Date: October 4, 2012
Inspector:
Contractor: Strata Drilling, Inc.
Driller: B. Sienkiewicz

Drilling Method:
2-1/4 inch inside diameter hollow-stem augers

Water Level Observation:
3-1/2 feet during and upon completion of drilling operations

Notes:
Boring performed 3 feet west of East Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **HE-3**

G2 Consulting Group, LLC

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	PROFILE	DESCRIPTION	DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
0.4		Bituminous Concrete (5 inches)							
1.0		Fill: Brown Sand with trace silt and gravel							
4.0		Fill: Very Stiff Dark Brown Sandy Clay with trace gravel and organic matter		S-1	2 3 5	8	15.1		5000*
5.5		Loose Brown Clayey Sand with trace gravel	5	S-2	2 3 3	6			
7.5		Medium Compact Brown Sand with trace silt and gravel		S-3	4 9 6	15			
		End of Boring @ 7.5ft							

Total Depth: 7.5ft
Drilling Date: October 4, 2012
Inspector:
Contractor: Strata Drilling, Inc.
Driller: B. Sienkiewicz

Drilling Method:
2-1/4 inch inside diameter hollow-stem augers

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 5 feet west of East Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **HE-4**

G2 Consulting Group, LLC

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	Description	Bottom depth (ft)
0–0.4	Bituminous Concrete (4-1/4 inches)	0.4
0.4–3.0	Very Loose Brown Sand with trace silt and gravel	3.0
3.0–5.0	Loose to Medium Compact Dark Brown Silty Sand with trace clay and gravel	5.0
5.0–7.5	Hard Brown Silty Clay with trace sand and gravel	7.5
	End of Boring @ 7.5ft	

SOIL SAMPLE DATA

SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
AS-1	3			
	4			
	9			
AS-2	11			
	12			
AS-3	19	9.6		9000*
	21			

Total Depth: 7.5ft
Drilling Date: October 16, 2012
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Hayball, P.E.

Drilling Method:
4-inch diameter diamond tipped core barrel; 3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 4 feet south of North Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Figure No. 29

Soil Boring No. **HE-5**

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A   Longitude: N/A

G2 Consulting Group, LLC

SUBSURFACE PROFILE

DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)
0.4		Bituminous Concrete (4-1/2 inches)	
1.2		Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 10 inches)	
5.5		Fill: Stiff Dark Brown and Greenish Gray Silty Clay with trace sand and gravel and occasional sand seams	
7.5		Hard Brown Silty Clay with trace sand and gravel	
		End of Boring @ 7.5ft	

SOIL SAMPLE DATA

SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
AS-1				
AS-2	6	16.7		2500*
	7			
	5			
	8			
	6			
	23			
AS-3	20	11.8		9000*

Total Depth: 7.5ft
Drilling Date: October 16, 2012
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Hayball, P.E.

Drilling Method:
4-inch diameter diamond tipped core barrel; 3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 4 feet north of South Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Figure No. 30

ISC INSPECTION SERVICES COMPANY

LOG OF TEST BORING

PROJECT: Ann Arbor 2006 Street Resurfacing Program	
LOCATION: Keech St. between Main and Belmar	
PROJECT NO. : 61072	BORING NO. : 9-1
DATE : 02/01/06	PAGE : 1 of 1

Elev. (ft)	SOIL DESCRIPTION	Depth (ft)	Sample Type	Blows/ 6-Inches	SPT* (N)	Moisture Content (%)	Loss on Ignition (%)	Shear Strength (psf)
	Ground Surface							
	ASPHALT (4") 0.3'							
	BASE: Brown-black SAND and GRAVEL (4") 0.7'							
	Very stiff brown SILTY CLAY with trace sand, gravel and occ. sand seams	1						
		2		3				
				8				
			S-1	11	19	17.9		5000 **
		3						
				7				
				12				
	4.0'	4	S-2	18	30	15.3		7500 **
	END OF BORING	5						
		6						
		7						
		8						
	BORING LOCATION: In front of 406 Keech St. in Westbound lane	9						
		10						

LEGEND	SAMPLE TYPE
Organic soil	S-Split spoon
Sand	LS- Liner sample
Clay	AS-Auger sample
Silt	BS-Bulk sample
Gravel	ST-Shelby tube
Other	C-Core

DRILLING INFORMATION

METHOD:	2-1/4" solid-stem augers
CO. / REP:	Failane Drilling Co. J. Faitel
BACKFILL:	Soil + cold patch

REMARKS

*Standard Penetration Test : Driving 2" OD Sampler 18" with 140# Hammer Falling 30", Count made at 6" Intervals.

** Determined by Pocket Penetrometer

GROUNDWATER

Encountered: None	After Completion: Dry

ISC INSPECTION SERVICES COMPANY

LOG OF TEST BORING

PROJECT: Ann Arbor 2006 Street Resurfacing Program	
LOCATION: Keech St. between Main and Belmar	
PROJECT NO. : 61072	BORING NO. : 9-2
DATE : 02/01/06	PAGE : 1 of 1

Elev. (ft)	SOIL DESCRIPTION		Depth (ft)	Sample Type	Blows/ 6-Inches	SPT* (N)	Moisture Content (%)	Loss on Ignition (%)	Shear Strength (psf)
	Ground Surface								
	ASPHALT (5")	0.4'							
	BASE: Brown-black SAND and GRAVEL (5")	0.8'	1						
	Medium compact brown CLAYEY SAND with trace silt and gravel		2		2				
					4				
		2.5'		S-1	9	13	12.6		
	Very stiff to hard brown SILTY CLAY with occ. sand seams		3		6				
					12				
		4.0'	4	S-2	18	30	13.6		8000 **
	END OF BORING		5						
			6						
			7						
			8						
	BORING LOCATION: In front of 400 Keech St. in Westbound lane		9						
			10						

LEGEND	SAMPLE TYPE	DRILLING INFORMATION	
Organic soil	S-Split spoon	METHOD:	2-1/4" solid-stem augers
Sand	LS- Liner sample		
Clay	AS-Auger sample	CO. / REP:	Failane Drilling Co.
Silt	BS-Bulk sample		J. Faitel
Gravel	ST-Shelby tube	BACKFILL:	Soil + cold patch
Other	C-Core		

REMARKS

*Standard Penetration Test : Driving 2" OD Sampler 18" with 140# Hammer Falling 30", Count made at 6" Intervals.

** Determined by Pocket Penetrometer

GROUNDWATER

Encountered: None	After Completion: Dry

ISC INSPECTION SERVICES COMPANY

LOG OF TEST BORING

PROJECT: Ann Arbor 2006 Street Resurfacing Program	
LOCATION: Keech St. between Main and Belmar	
PROJECT NO. : 61072	BORING NO. : 9-3
DATE : 02/01/06	PAGE : 1 of 1

Elev. (ft)	SOIL DESCRIPTION	Depth (ft)	Sample Type	Blows/ 6-Inches	SPT* (N)	Moisture Content (%)	Loss on Ignition (%)	Shear Strength (psf)
	Ground Surface							
	ASPHALT (5") 0.4'							
	BASE: Brown-black SAND and GRAVEL (5") 0.8'	1						
	Very stiff brown SILTY CLAY with trace sand, gravel and organics (wood) (FILL MATERIAL) 2.5'	2	S-1	6 11 13	14	14.3	2.6	5000 **
	Stiff brown SANDY CLAY with trace silt, gravel and occ. sand seams 4.0'	3 4	S-2	4 4 7	11	15.8		3500 **
	END OF BORING	5 6 7 8 9 10						

BORING LOCATION: In front of 305 Keech St. in Eastbound lane

LEGEND	SAMPLE TYPE	DRILLING INFORMATION	
Organic soil	S-Split spoon	METHOD:	2-1/4" solid-stem augers
Sand	LS- Liner sample		
Clay	AS-Auger sample	CO. / REP:	Failane Drilling Co.
Silt	BS-Bulk sample		J. Faitel
Gravel	ST-Shelby tube	BACKFILL:	Soil + cold patch
Other	C-Core		

REMARKS

*Standard Penetration Test : Driving 2" OD Sampler 18" with 140# Hammer Falling 30", Count made at 6" Intervals.

** Determined by Pocket Penetrometer

GROUNDWATER

Encountered: None	After Completion: Dry

Testing Engineers & Consultants, Inc.

1343 Rochester Road - PO Box 249 - Troy, Michigan - 48099-0249
(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: M1 Martha

Job No.: 51989

Project: Miscellaneous Geotechnical Services, Bundle One

Client: City of Ann Arbor

Type of Rig: All-Terrain Vehicle

Location: Ann Arbor, Michigan

Drilling Method: Solid Stem Augers

Drilled By: I. Mickle

Ground Surface Elevation:

Started: 2/4/2012

Completed: 2/4/2012

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.33	ASPHALT (4")			
	LS	4 4 6	1.2	Moist Brown Gravelly Sand-FILL	20.7	118	4370
2.5			3	Firm Moist Gray CLAY With Some Silt			
	LS	4 5 6			18.8	118	3870
5.0			5	Firm Moist Brown Oxidized CLAY With Some Silt & Trace Of Gravel			
7.5				Bottom of Borehole at 5'			
10.0							
12.5							
15.0							
17.5							
20.0							
22.5							

"N" - Standard Penetration Resistance
SS - 2").D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: None

At Completion: None

Boring No. M1 Martha

Testing Engineers & Consultants, Inc.

1343 Rochester Road - PO Box 249 - Troy, Michigan - 48099-0249
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Fax (248) 588-6232

Boring No.: M2 Martha **Job No.:** 51989 **Project:** Miscellaneous Geotechnical Services, Bundle One

Client: City of Ann Arbor

Type of Rig: All-Terrain Vehicle **Location:** Ann Arbor, Michigan

Drilling Method: Solid Stem Augers **Drilled By:** I. Mickle

Ground Surface Elevation: **Started:** 2/4/2012

Completed: 2/4/2012

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.38	ASPHALT (4 1/2")			
	LS	4 5 5	.92	Moist Brown Gravelly Sand-FILL (6 1/2")	11.8	110	
2.5			2.4	Loose Moist Brown Clayey SAND With Trace Of Gravel			
	LS	5 8 12			11.6	138	5600
5.0			5	Stiff Moist Brown Oxidized CLAY With Some Silt & Trace Of Gravel			
				Bottom of Borehole at 5'			
7.5							
10.0							
12.5							
15.0							
17.5							
20.0							
22.5							

"N" - Standard Penetration Resistance
SS - 2").D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: None

At Completion: None

Boring No. M2 Martha

Testing Engineers & Consultants, Inc.

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(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: ME1 Meadowbrook 51989

Job No.:

Project: Miscellaneous Geotechnical Services, Bundle One

Client: City of Ann Arbor

Location: Ann Arbor, Michigan

Type of Rig: Truck

Drilled By: B. Adams

Drilling Method: Solid Stem Augers

Started: 11/5/2011

Ground Surface Elevation:

Completed: 11/5/2011

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.40	ASPHALT (4 3/4")			
	LS	5 6 6	1.5	Moist Brown Gravelly Well Graded Sand With Some Clay & Silt-FILL	13.7	142	
2.5			3	Firm Moist Discolored CLAY With Some Silt, Trace Of Gravel & Sand Seams-Possible Fill			
	LS	2 2 3			18.2	128	3300
5.0			5	Plastic Moist Discolored CLAY With Trace Of Fine Sand, Gravel & Silt-Possible Fill			
7.5				Bottom of Borehole at 5'			
10.0							
12.5							
15.0							
17.5							
20.0							
22.5							

"N" - Standard Penetration Resistance
SS - 2").D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: None

At Completion: None

Boring No. ME1 Meadowbrook

Testing Engineers & Consultants, Inc.

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(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: ME2 Meadowbrook 51989

Job No.:

Project: Miscellaneous Geotechnical Services, Bundle One

Client: City of Ann Arbor

Location: Ann Arbor, Michigan

Type of Rig: Truck

Drilled By: B. Adams

Drilling Method: Solid Stem Augers

Started: 11/5/2011

Ground Surface Elevation:

Completed: 11/5/2011

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.27	ASPHALT (3 1/4")			
			.67	Moist Brown Gravelly Well Graded Sand With Some Clay & Silt-FILL (4 3/4")			
	LS	2 5 8	3	Firm Moist Variegated CLAY With Some Silt & Gravel	21.2	126	
	LS	6 13 17	5	Stiff Moist Variegated CLAY With Some Silt & Trace Of Gravel	15.0	118	
				Bottom of Borehole at 5'			

Depth scale (ft): 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0, 22.5

"N" - Standard Penetration Resistance
SS - 2").D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: None

At Completion: None

Boring No. ME2 Meadowbrook

BORING NUMBER B-5 (Mt. Pleasant)

CTI and Associates Inc

CLIENT City of Ann Arbor

PROJECT NAME Miscellaneous Soil Borings

PROJECT NUMBER 102040084

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 11/1/10 **COMPLETED** 11/1/10

GROUND ELEVATION N/A

DRILLING CONTRACTOR CTI and Associates, Inc.

GROUND WATER LEVELS:

DRILLING METHOD 3-3/4 inch Hollow Stem Auger

DURING DRILLING None

LOGGED BY P. Cody **CHECKED BY** T. Marsik

AFTER DRILLING None

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0.0	3-1/2 inches of ASPHALT					
	14-1/2 inches of brown moist fine to medium SAND with some gravel and silt - (FILL)	GB	100			
2.5	Brown and dark brown variegated moist sandy CLAY with silt and traces of gravel and organics - (FILL)	SS 1	89	6-5-5 (10)		
5.0	Brown and dark gray variegated moist medium stiff clayey MARL with traces of sand and organics and occasional shells - (OL) Loss-on-Ignition = 3.6%	SS 2	78	4-3-3 (6)	0.75	16

▲ SPT N VALUE ▲ (20 40 60 80); PL MC LL (20 40 60 80); ☐ FINES CONTENT (%) ☐ (20 40 60 80)

Bottom of borehole at 5.5 feet.

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **PA-4**

G2 Consulting Group, LLC

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (6-1/4 inches) 0.5						
		Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 5-1/4 inches) 1.0		AS-1				
				AS-2	17			
					17			
		Fill: Medium Compact Brown Sand with trace silt and gravel			15			
					20			
5		5.0	5		19			
		End of Boring @ 5ft						
10			10					
15			15					

Total Depth: 5ft
Drilling Date: September 28, 2012
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Hayball, P.E.

Drilling Method:
4-inch diameter diamond tipped core barrel; 3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 4 feet south of North Curbline

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Figure No. 50

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **PA-5**

G2 Consulting Group, LLC

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (5-1/2 inches)	0.5					
		Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 5-1/2 inches)	0.9	AS-1				
				AS-2	8	20.5		5000*
					10			
		Very Stiff Brown and Gray Silty Clay with trace sand and gravel			11			
					10			
5			5.0 / 5		9			
		End of Boring @ 5ft						
10			10					
15			15					

Total Depth: 5ft
Drilling Date: September 28, 2012
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Hayball, P.E.

Drilling Method:
4-inch diameter diamond tipped core barrel; 3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 5 feet south of North Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **PA-6**

G2 Consulting Group, LLC

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (6 inches) 0.5						
		Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 8 inches) 1.0		AS-1				
				AS-2	12			
		Fill: Loose to Medium Compact Dark Brown Clayey Sand with trace gravel and organic matter (Organic Matter Content = 3.7%)			11			
					9			
		4.0			9			
5		Stiff Brown and Gray Silty Clay with trace sand and gravel 5.0	5	AS-3	6	18.5		2500*
		End of Boring @ 5ft						
10			10					
15			15					

Total Depth: 5ft
Drilling Date: September 28, 2012
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Hayball, P.E.

Drilling Method:
4-inch diameter diamond tipped core barrel; 3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 5 feet south of North Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **PA-7**

G2 Consulting Group, LLC

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (4-1/2 inches) 0.4		AS-1				
		Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 7-1/2 inches) 1.0		AS-2	11	21.7		5000*
		Very Stiff Brown and Gray Silty Clay with trace sand and gravel			12			
					13			
					11			
5		5.0	5		12			
		End of Boring @ 5ft						
10			10					
15			15					

Total Depth: 5ft
Drilling Date: September 28, 2012
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Hayball, P.E.

Drilling Method:
4-inch diameter diamond tipped core barrel; 3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 4 feet south of North Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Figure No. 53

PAVEMENT CORE DCP 120547A.GPJ G2_CONS.GDT 10/19/12

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **PA-8**

G2 Consulting Group, LLC

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	PROFILE	DESCRIPTION	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
0.4		Bituminous Concrete (5 inches)						
1.0		Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 7 inches)		AS-1				
				AS-2	8	27.2		3500*
					11			
		Stiff to Very Stiff Brown and Gray Silty Clay with trace sand and gravel			10			
					10			
5.0			5	AS-3	11	11.4		7500*
		End of Boring @ 5ft						

Total Depth: 5ft

Drilling Date: September 28, 2012

Inspector:

Contractor: G2 Consulting Group, LLC

Driller: J. Hayball, P.E.

Drilling Method:
4-inch diameter diamond tipped core barrel; 3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 15 feet south of North Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Figure No. 54

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

G2 Consulting Group, LLC

Soil Boring No. **PA-9**

SUBSURFACE PROFILE / SOIL SAMPLE DATA

DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (7-1/2 inches)	0.6	AS-1				
		Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 3-1/2 inches)	0.9	AS-2	8	22.7		3500*
		Stiff to Very Stiff Brown and Gray Silty Clay with trace sand and gravel			9			
					12			
					14			
5			5.0 / 5	AS-3	13	16.3		7000*
		End of Boring @ 5ft						
10			10					
15			15					

Total Depth: 5ft
Drilling Date: September 28, 2012
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Hayball, P.E.

Drilling Method:
4-inch diameter diamond tipped core barrel; 3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 4 feet north of South Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **PA-10**

G2 Consulting Group, LLC

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (5 inches)	0.6					
		Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 7 inches)	1.0	AS-1				
				AS-2	18			
		Fill: Medium Compact Brown Silty Sand with trace clay and gravel	2.5		17			
		Stiff to Very Stiff Brown and Gray Silty Clay with trace sand and gravel			9			
					9			
5			5.0 / 5	AS-3	8	22.2		3500*
		End of Boring @ 5ft						
10			10					
15			15					

Total Depth: 5ft

Drilling Date: September 28, 2012

Inspector:

Contractor: G2 Consulting Group, LLC

Driller: J. Hayball, P.E.

Drilling Method:
4-inch diameter diamond tipped core barrel; 3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 13 feet north of South Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Figure No. 56

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **PA-11**

G2 Consulting Group, LLC

SUBSURFACE PROFILE				SOIL SAMPLE DATA				
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE/NO.	DCP BLOWS/ 1.75-INCHES	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCOF. COMP. ST. (PSF)
		Bituminous Concrete (4-1/2 inches) 0.4						
		Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 6-1/2 inches) 0.9		AS-1	8	21.1		4500*
				AS-2				
		Very Stiff Brown and Gray Silty Clay with trace sand and gravel			10			
					12			
					10			
5		5.0	5		8			
		End of Boring @ 5ft						
10			10					
15			15					

Total Depth: 5ft
Drilling Date: September 28, 2012
Inspector:
Contractor: G2 Consulting Group, LLC
Driller: J. Hayball, P.E.

Drilling Method:
4-inch diameter diamond tipped core barrel; 3-inch diameter hand auger

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 15 feet north of South Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Figure No. 57

CTI and Associates, Inc.
12482 Emerson Drive
Brighton, MI 48116
(248) 486-5100 phone
(248) 486-5050 fax

LOG OF TEST BORING

NO.:	TB-1	PROJECT NO.:	82040288
DATE:	10/21/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
0' 6"	Dark brown moist sandy TOPSOIL - (FILL)								
			1						
			2	7					
	Brown and dark brown variegated moist silty CLAY with traces of gravel, sand and organics and frequent silt partings - (FILL)	SS-1		9					
			3	10					
			4						
				6					
		SS-2	5	7					
				7					
			6						
			7	3					
7' 6"		SS-3		6					
			8	10					
			9						
	Brown moist very stiff silty CLAY with traces of gravel and sand and occasional sand partings - (CL-ML)			4					
		SS-4	10	8				8000*	
				12					
			11						
			12						
			13						
			14						
				3					
		SS-5	15	4					
15' 3"				6					
			16						
	Brown moist stiff sandy CLAY with a little gravel and occasional clayey sand seams - (CL)		17						
			18						
19' 0"			19						
				5					
		SS-6	20	5					
				4					
	Brown moist to wet loose to medium compact silty fine SAND with trace of gravel and occasional clay lenses - (SM)		21						
			22						
			23						
			24						
				5					
		SL-7	25	8		14.0			
				13					
			26						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon SL-Split Spoon w/liner ST-Shelby Tube	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: 24' 0"
	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: 22' 0"
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: 31' 0"

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LOG OF TEST BORING

NO.:	TB-1	PROJECT NO.:	82040288
DATE:	10/21/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
	Brown moist to wet loose to medium compact silty fine SAND with trace of gravel and occasional clay lenses - (SM)		27						
			28						
29' 0"			29						
	Brown wet compact fine to coarse SAND with a little gravel, trace of silt and occasional fine sand seams - (SP-SM)			6					
		SS-8	30	10					
				21					
			31						
			32						
			33						
34' 0"			34						
	Gray moist very stiff CLAY with a little silt, traces of gravel and sand and occasional wet sand partings - (CL)			6					
		SS-9	35	9		10.1		5000*	
				13					
			36						
			37						
			38						
			39						
				4					
		SS-10	40	6		14.8			
40' 6"				14					
	End of Boring		41						
			42						
			43						
			44						
			45						
			46						
			47						
			48						
			49						
			50						
			51						
			52						

TYPE OF SAMPLE:
SS-Split Spoon
SL-Split Spoon w/liner
ST-Shelby Tube

DRILLING METHOD: 3 3/4" ID Hollow Stem Auger
DRILLING FOREMAN: P. Cody
BACKFILL MATERIAL: Cuttings
* Pocket Penetrometer Value
Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30", Count Made at 6" Intervals

GROUNDWATER:
ENCOUNTERED AT: 24' 0"
AFTER COMPLETION: 22' 0"
COLLAPSE DEPTH: 31' 0"

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LOG OF TEST BORING

NO.:	TB-2	PROJECT NO.:	82040288
DATE:	10/17/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
0' 5"	Dark brown moist sandy TOPSOIL - (FILL)								
			1						
			2	5					
	Brown and gray variegated moist CLAY with a little silt, traces of gravel and sand, occasional hair roots and occasional silt partings - (FILL)	SS-1		7					
			3	9					
			4						
				3					
		SS-2	5	4					
				4					
6' 0"			6						
			7	2					
		SS-3		3					
	Brown, gray and dark brown variegated moist CLAY with a little silt and traces of gravel, sand and organics - (FILL)		8	5					
			9						
				2					
	- Loss-on-Ignition = 5.1%	SS-4	10	3		24.7			
				4					
			11						
			12						
			13						
14' 0"			14						
				4					
		SS-5	15	10				9000+*	
				14					
	Brown moist hard CLAY with a little silt, traces of gravel and sand and frequent silt partings - (FILL)		16						
			17						
			18						
19' 0"			19						
				2					
	Reddish-brown moist loose fine to medium SAND with traces of gravel, silt, clay and organics - (FILL) - Loss-on-Ignition = 2.9%	SS-6	20	2		9.8			
				2					
			21						
			22						
23' 0"			23						
			24						
	Brown moist compact fine to medium SAND with traces of gravel and silt - (SP-SM)			7					
		SS-7	25	13		9.2			
				18					
			26						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon SL-Split Spoon w/liner ST-Shelby Tube	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: None
	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: None
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: None

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LOG OF TEST BORING

NO.:	TB-2	PROJECT NO.:	82040288
DATE:	10/17/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
	Brown moist compact fine to medium SAND with traces of gravel and silt - (SP-SM)		27						
			28						
29' 0"			29						
	Gray moist stiff CLAY with a little silt and traces of gravel and sand - (CL)			2					
		SS-8	30	2		11.1		2000*	
				5					
			31						
			32						
			33						
			34						
				4					
		SS-9	35	5		12.6		2500*	
				9					
			36						
			37						
			38						
			39						
				3					
		SS-10	40	4		14.4		3000*	
40' 6"				7					
	End of Boring		41						
			42						
			43						
			44						
			45						
			46						
			47						
			48						
			49						
			50						
			51						
			52						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: None
SL-Split Spoon w/liner		
ST-Shelby Tube	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: None
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: None

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LOG OF TEST BORING

NO.:	TB-3	PROJECT NO.:	82040288
DATE:	10/20/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI PAGE: 1 OF: 1

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
0' 5"	Dark brown moist sandy TOPSOIL - (FILL)								
			1						
			2	6					
	Brown and gray variegated moist silty CLAY with traces of gravel, sand and organics and occasional sand partings - (FILL)	SS-1		7					
			3	8					
			4						
				2					
		SS-2	5	6					
				9					
			6						
			7	3					
		SS-3		3					
8' 0"			8	4					
			9						
				2					
	Brown and dark brown variegated moist silty CLAY with traces of gravel, sand and organics and occasional sand partings - (FILL)	SS-4	10	2					
				4					
			11						
			12						
			13						
14' 0"			14						
	Black moist loose silty fine SAND with traces of clay and organics - (POSSIBLE TOPSOIL) - Loss-on-Ignition = 5.5%			3					
		SS-5	15	3					
				3					
			16						
17' 0"			17						
			18						
	Brown and gray variegated moist hard CLAY with a little silt, traces of gravel and sand and occasional cobbles - (CL)		19						
				6					
		SS-6	20	11		18.7		9000+*	
				15					
			21						
			22						
			23						
			24						
		SS-7		50/4"					
25' 0"			25						
	End of Boring								
	Note: Boring terminated upon encountering auger refusal.		26						

TYPE OF SAMPLE:
SS-Split Spoon
SL-Split Spoon w/liner
ST-Shelby Tube

DRILLING METHOD: 3 3/4" ID Hollow Stem Auger

DRILLING FOREMAN: P. Cody

BACKFILL MATERIAL: Cuttings

* Pocket Penetrometer Value

Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals

GROUNDWATER:
ENCOUNTERED AT: None
AFTER COMPLETION: None
COLLAPSE DEPTH: None

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LOG OF TEST BORING

NO.:	TB-9	PROJECT NO.:	82040288
DATE:	10/21/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
0' 5"	Dark brown moist sandy TOPSOIL - (FILL)								
	Brown and dark brown variegated moist silty CLAY with traces of gravel, sand and organics, frequent silt partings and occasional hair roots - (FILL)		1						
			2	6					
		SS-1		11					
			3	11					
4' 0"			4						
	Brown moist very stiff CLAY with a little silt, traces of gravel and sand and frequent silt partings - (FILL)			3					
		SS-2	5	3				5500*	
				4					
			6						
6' 6"									
	Brown moist medium compact silty fine SAND with a little clay and trace of gravel - (SM-POSSIBLE FILL)		7	2					
		SS-3		4					
8' 0"			8	10					
	Brown moist stiff CLAY with a little silt and traces of gravel, sand and organics - (FILL) - Loss-on-Ignition = 4.0%		9						
				1					
		SS-4	10	2		17.2		2000*	
				4					
			11						
			12						
			13						
14' 0"			14						
	Brown moist very stiff CLAY with a little silt, traces of gravel and sand and occasional silt partings - (CL)			2					
		SS-5	15	5				6000*	
				7					
			16						
			17						
			18						
19' 0"			19						
	Brown moist to wet loose silty fine SAND with trace of clay - (SM)			2					
		SS-6	20	2					
				4					
			21						
			22						
			23						
			24						
				3					
25' 0"		SL-7	25	8		17.2	133.6		
	Brown moist very stiff CLAY with a little silt and traces of gravel and sand - (CL)			14					
			26						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: 24' 0"
SL-Split Spoon w/liner		
ST-Shelby Tube	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: 25' 0"
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30", Count Made at 6" Intervals	COLLAPSE DEPTH: 30' 0"

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LOG OF TEST BORING

NO.:	TB-9	PROJECT NO.:	82040288
DATE:	10/21/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
	Brown moist very stiff CLAY with a little silt and traces of gravel and sand - (CL)		27						
			28						
29' 0"			29						
	Gray moist stiff to very stiff CLAY with a little silt and traces of gravel and sand - (CL)			1					
		SS-8	30	3		11.4		2000*	
				4					
			31						
			32						
			33						
			34						
				2					
		SS-9	35	4		10.6		4500*	
				9					
			36						
			37						
			38						
39' 0"			39						
	Gray moist compact silty fine SAND with occasional clay seams - (SM)			3					
		SS-10	40	20					
40' 6"				18					
	End of Boring		41						
			42						
			43						
			44						
			45						
			46						
			47						
			48						
			49						
			50						
			51						
			52						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon SL-Split Spoon w/liner ST-Shelby Tube	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: 24' 0"
	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: 25' 0"
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: 30' 0"

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LOG OF TEST BORING

NO.:	TB-10	PROJECT NO.:	82040288
DATE:	10/21/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
0' 7"	Dark brown moist sandy TOPSOIL - (FILL)								
	Brown and gray variegated moist silty CLAY with traces of gravel, sand and organics and frequent silt partings - (FILL)		1						
			2	6					
		SS-1		9					
			3	9					
4' 0"			4						
	Reddish-brown moist clayey fine SAND with traces of gravel and organics and occasional clay seams and cobbles - (FILL)			10					
		SS-2	5	11					
				7					
			6						
	**Obstruction encountered at an approximate depth of 6' 9"	SS-3	7	25/3"					
				Obst.					
			8						
9' 0"			9						
	Brown moist hard CLAY with a little silt, traces of gravel and sand and frequent silt partings - (CL)			10					
		SS-4	10	14				9000+*	
				27					
			11						
			12						
			13						
14' 0"			14						
	Brown moist loose fine SAND with trace of silt - (SP-SM)			9					
		SS-5	15	2					
				2					
			16						
			17						
			18						
19' 0"			19						
	Brown moist very compact silty fine SAND with traces of gravel - (SM)			24					
		SS-6	20	30					
				30					
			21						
			22						
			23						
			24						
				40					
		SL-7	25	44		6.9	141.9		
				50/5"					
			26						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon SL-Split Spoon w/liner ST-Shelby Tube	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: 29' 0"
	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: 35' 0"
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: 38' 0"

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LOG OF TEST BORING

NO.:	TB-10	PROJECT NO.:	82040288
DATE:	10/21/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
27' 0"	Brown moist very compact silty fine SAND with traces of gravel - (SM)		27						
	Brown moist to wet very compact fine to coarse SAND with a little gravel, traces of silt and clay and occasional cobbles - (SP-SM)		28						
			29						
		SS-8		50/3"					
			30						
			31						
32' 0"			32						
	Gray moist stiff CLAY with a little silt and traces of gravel and sand - (CL)		33						
			34						
				3					
		SL-9	35	3		16.8	139.6	5000*	
				5					
			36						
			37						
			38						
39' 0"			39						
	Gray moist hard silty CLAY with frequent silt partings and occasional wet sand seams - (CL-ML)			5					
		SS-10	40	10		20.4			
40' 6"				27					
	End of Boring		41						
			42						
			43						
			44						
			45						
			46						
			47						
			48						
			49						
			50						
			51						
			52						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon SL-Split Spoon w/liner ST-Shelby Tube	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: 29' 0"
	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: 35' 0"
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: 38' 0"

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LOG OF TEST BORING

NO.:	TB-11	PROJECT NO.:	82040288
DATE:	10/17/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
0' 4"	Dark brown moist sandy TOPSOIL - (FILL)								
			1						
	Brown and gray variegated moist silty CLAY with traces of gravel and sand - (FILL)		2	7					
		SS-1		9					
			3	12					
			4						
				5					
5' 0"		SS-2	5	5					
				7					
	Dark brown moist silty CLAY with traces of gravel, sand and organics - (FILL)		6						
6' 6"									
			7	7					
		SS-3		6				6000*	
	Brown moist very stiff CLAY with a little silt, trace of gravel and sand and occasional sand seams and partings - (CL)		8	7					
9' 0"			9						
				4					
		SS-4	10	5				6000*	
				7					
	Brown moist very stiff silty CLAY with traces of gravel and sand - (CL-ML)		11						
			12						
			13						
			14						
				3					
		SS-5	15	6				6500*	
				10					
			16						
			17						
			18						
19' 0"			19						
				3					
		SS-6	20	4		10.0			
				5					
	Brown moist loose silty fine SAND with trace of clay - (SM)		21						
			22						
			23						
24' 0"			24						
				2					
	Brown moist stiff silty CLAY with traces of gravel and sand and frequent sand seams - (CL-ML)	SS-7	25	3					
				11					
			26						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: None
SL-Split Spoon w/liner		
ST-Shelby Tube	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: None
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: None

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LOG OF TEST BORING

NO.:	TB-11	PROJECT NO.:	82040288
DATE:	10/17/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
	Brown moist stiff silty CLAY with traces of gravel and sand and frequent sand seams - (CL-ML)		27						
			28						
29' 0"			29						
				3					
		ST-8	30	6		20.2	133.0	6500*	
				7					
	Brown and gray variegated moist stiff sandy CLAY with trace of gravel and occasional wet sand seams - (CL)		31						
			32						
			33						
34' 0"			34						
				HW					
		SS-9	35	HW					
				2					
	Gray very moist very soft sandy CLAY with trace of gravel - (CL)		36						
			37						
			38						
39' 0"			39						
				6					
	Gray moist hard sandy, silty CLAY with trace of gravel - (CL-ML)	SS-10	40	12		9.2			
40' 6"				21					
	End of Boring		41						
			42						
			43						
			44						
			45						
			46						
			47						
			48						
			49						
			50						
			51						
			52						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon SL-Split Spoon w/liner ST-Shelby Tube	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: None
	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: None
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: None

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LOG OF TEST BORING

NO.:	TB-12	PROJECT NO.:	82040288
DATE:	10/17/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI PAGE: 1 OF: 2

Depth	SOIL DESCRIPTION	Sample Type		Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
0' 6"	Dark brown moist sandy TOPSOIL - (FILL)									
				1						
	Brown and gray variegated moist very stiff to hard silty CLAY			2	5					
	with trace of gravel and sand - (FILL)	SS-1			10					
				3	12					
				4						
					6					
		SS-2		5	12					
					20					
				6						
				7	5					
7' 6"		SS-3			10				7500*	
				8	14					
				9						
	Gray moist very stiff CLAY with a little silt and traces of gravel				3					
	and sand - (CL)	SS-4		10	6				5500*	
					8					
				11						
				12						
				13						
				14						
					3					
		SS-5		15	5		16.7		4500*	
					7					
				16						
				17						
				18						
				19						
					3					
		SS-6		20	4		17.3		5000*	
20' 3"					8					
				21						
	Brown moist SILT with traces of sand and clay - (ML)			22						
				23						
24' 0"				24						
					3					
	Gray moist very stiff sandy CLAY with trace of gravel and	SS-7		25	6		11.6		5000*	
	occasional silt partings - (CL)				7					
				26						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: None
SL-Split Spoon w/liner		
ST-Shelby Tube	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: None
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: None

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LOG OF TEST BORING

NO.:	TB-12	PROJECT NO.:	82040288
DATE:	10/17/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
	Gray moist very stiff sandy CLAY with trace of gravel and occasional silt partings - (CL)		27						
			28						
29' 0"			29						
	Gray very moist medium stiff to stiff sandy CLAY with trace of gravel and occasional silt partings - (CL)			HW					
		SS-8	30	HW		12.4		1000*	
				4					
			31						
			32						
			33						
			34						
				3					
		SS-9	35	4		11.8			
				10					
			36						
			37						
			38						
39' 0"			39						
	Gray moist very compact silty fine SAND with traces of gravel			39					
40' 0"	clay - (SM)	SS-10	40	50/4"		7.7			
	End of Boring								
			41						
			42						
			43						
			44						
			45						
			46						
			47						
			48						
			49						
			50						
			51						
			52						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: None
SL-Split Spoon w/liner		
ST-Shelby Tube	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: None
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: None

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LOG OF TEST BORING

NO.:	TB-16	PROJECT NO.:	82040308
DATE:	12/5/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
0' 9"	Dark brown moist sandy TOPSOIL - (FILL)								
			1						
	Brown, gray and dark brown variegated moist silty CLAY with traces of gravel, sand and organics and occasional silt partings - (FILL)		2	3					
		SS-1		7					
			3	5					
			4						
				3					
		SS-2	5	7					
				7					
			6						
			7	3					
		SS-3		3					
			8	5					
9' 0"			9						
				2					
	Brown moist stiff CLAY with a little silt, traces of gravel and sand and occasional sand partings - (CL)	SS-4	10	3		14.3		3000*	
				4					
			11						
			12						
			13						
14' 0"			14						
				7					
	Brown moist medium compact silty fine to medium SAND with traces of gravel and clay - (SM)	SS-5	15	7					
				10					
			16						
			17						
			18						
19' 0"			19						
				5					
	Brown moist loose clayey fine to medium SAND with a little gravel and occasional clay seams - (SC)	SS-6	20	4					
				4					
			21						
			22						
			23						
24' 0"			24						
				3					
	Brown moist medium compact silty fine to coarse SAND with a little clay and trace of gravel - (SM)	SS-7	25	5					
				9					
			26						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon SL-Split Spoon w/liner ST-Shelby Tube	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: None
	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: None
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: N/A

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LOG OF TEST BORING

NO.:	TB-16	PROJECT NO.:	82040308
DATE:	12/5/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
	Brown moist medium compact silty fine to coarse SAND with a little clay and trace of gravel - (SM)		27						
			28						
29' 0"			29						
	Gray moist very stiff to stiff CLAY with a little sand and silt, trace of gravel and occasional silt seams - (CL)			4					
		SS-8	30	4		9.8		5000*	
				7					
			31						
			32						
			33						
			34						
				3					
		SS-9	35	3		11.6		3500*	
				5					
			36						
			37						
			38						
			39						
				3					
		SS-10	40	4		15.1		2000*	
40' 6"				5					
	End of Boring		41						
			42						
			43						
	Note: Following completion of the drilling, a 2-inch diameter temporary well with a 15-foot screen was set at a depth of 30 feet. Sand pack was placed around the well screen to a depth of 14 feet below grade, followed by a 2-foot thick bentonite seal and cuttings to the ground surface.		44						
			45						
			46						
			47						
			48						
			49						
			50						
			51						
			52						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon SL-Split Spoon w/liner ST-Shelby Tube	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: None
	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: None
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30", Count Made at 6" Intervals	COLLAPSE DEPTH: N/A

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LOG OF TEST BORING

NO.:	TB-17	PROJECT NO.:	82040308
DATE:	12/5/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
0' 6"	Dark brown moist sandy TOPSOIL - (FILL)								
	Brown, gray and dark brown variegated moist silty CLAY with traces of gravel, sand and organics and occasional silt partings - (FILL)		1						
			2	3					
		SS-1		3					
			3	6					
			4						
				1					
		SS-2	5	5					
				9					
6' 0"			6						
	Brown and gray variegated moist very stiff CLAY with a little silt, traces of gravel and sand and occasional silt partings - (CL)								
			7	3					
		SS-3		3		19.1		6500*	
			8	6					
			9						
				3					
		SS-4	10	5		14.5		8000*	
				9					
			11						
			12						
			13						
14' 0"			14						
	Brown moist loose to medium compact silty fine SAND with occasional silt partings - (SM)			4					
		SS-5	15	4					
				5					
			16						
			17						
			18						
			19						
				5					
		SS-6	20	7					
				12					
			21						
			22						
			23						
24' 0"			24						
	Brown moist to wet medium compact silty fine to coarse SAND with a little gravel and trace of clay - (SM)			5					
		SS-7	25	7					
				7					
			26						

TYPE OF SAMPLE:

SS-Split Spoon
SL-Split Spoon w/liner
ST-Shelby Tube

DRILLING METHOD: 3 3/4" ID Hollow Stem Auger

DRILLING FOREMAN: P. Cody

BACKFILL MATERIAL: Cuttings

* Pocket Penetrometer Value

Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals

GROUNDWATER:

ENCOUNTERED AT: 28' 0" & 39' 0"

AFTER COMPLETION: N/A

COLLAPSE DEPTH: N/A

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LOG OF TEST BORING

NO.:	TB-17	PROJECT NO.:	82040308
DATE:	12/5/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
29' 0"	Brown moist to wet medium compact silty fine to coarse SAND with a little gravel and trace of clay - (SM)		27						
			28						
			29						
39' 0"	Gray moist very stiff to stiff CLAY with a little sand and silt, trace of gravel and occasional silt seams - (CL)			5					
		SS-8	30	5		11.7		7000*	
				7					
			31						
			32						
			33						
			34						
				2					
		SS-9	35	3		16.0		2000*	
				4					
			36						
			37						
			38						
			39						
40' 6"	Gray wet compact fine SAND with traces of gravel and silt - (SP-SM)			5					
		SS-10	40	12					
				20					
	End of Boring		41						
	Note: Following completion of the drilling, a 2-inch diameter temporary well with a 10-foot screen was set at a depth of 30 feet. Sand pack was placed around the well screen to a depth of 19 feet below grade, followed by a 2-foot thick bentonite seal and cuttings to the ground surface.		42						
			43						
			44						
			45						
			46						
			47						
			48						
			49						
			50						
			51						
			52						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: 28' 0" & 39' 0"
SL-Split Spoon w/liner	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: N/A
ST-Shelby Tube	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: N/A

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LOG OF TEST BORING

NO.:	TB-18	PROJECT NO.:	82040308
DATE:	12/4/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
0' 9"	Dark brown moist sandy TOPSOIL - (FILL)								
			1						
	Brown and gray variegated moist silty CLAY with traces of gravel, sand and organics and occasional sand partings - (FILL)		2	2					
		SS-1		5					
			3	7					
4' 0"			4						
				2					
		SS-2	5	3					
	Brown moist fine SAND with trace gravel and organics - (FILL)			7					
			6						
6' 6"									
			7	4					
		SS-3		10		12.6		9000+*	
			8	13					
	Brown moist hard CLAY with a little silt, traces of gravel and sand and occasional silt partings - (CL)								
			9						
				4					
		SS-4	10	10		14.7		9000+*	
				16					
			11						
			12						
			13						
14' 0"			14						
				4					
		SS-5	15	9		13.3		9000+*	
				13					
	Brown and gray variegated moist hard CLAY with a little silt and traces of gravel and sand - (CL)		16						
			17						
			18						
19' 0"			19						
				6					
		SS-6	20	11					
				13					
	Brown moist medium compact fine to coarse SAND with traces of gravel and clay - (SP-SC)		21						
			22						
			23						
24' 0"			24						
				7					
	Gray moist stiff CLAY with a little sand and silt, trace of gravel and occasional very moist sand partings - (CL)	SS-7	25	7		11.1		2500*	
				7					
			26						

TYPE OF SAMPLE:

SS-Split Spoon
SL-Split Spoon w/liner
ST-Shelby Tube

DRILLING METHOD: 3 3/4" ID Hollow Stem Auger

DRILLING FOREMAN: P. Cody

BACKFILL MATERIAL: Cuttings

* Pocket Penetrometer Value

Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals

GROUNDWATER:

ENCOUNTERED AT: 39' 0"

AFTER COMPLETION: N/A

COLLAPSE DEPTH: N/A

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LOG OF TEST BORING

NO.:	TB-18	PROJECT NO.:	82040308
DATE:	12/4/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI PAGE: 2 OF: 2

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
	Gray moist stiff CLAY with a little sand and silt, trace of gravel and occasional very moist sand partings - (CL)		27						
			28						
			29						
29' 6"				8					
	Gray moist very compact silty fine SAND with traces of gravel and clay and occasional clay lenses - (SM)	SS-8	30	38					
				50/4"					
			31						
			32						
			33						
34' 0"			34						
	Gray moist hard CLAY with a little silt and traces of gravel and sand - (CL)			10					
		SS-9	35	14		11.5		9000+*	
				19					
			36						
			37						
			38						
39' 0"			39						
	Gray wet compact fine to medium SAND with traces of gravel and silt and occasional silt seams - (SP-SM)			19					
		SS-10	40	21					
40' 6"				21					
	End of Boring		41						
			42						
			43						
	Note: Following completion of the drilling, a 2-inch diameter temporary well with a 10-foot screen was set at a depth of 30 feet. Sand pack was placed around the well screen to a depth of 19 feet below grade, followed by a 2-foot thick bentonite seal and cuttings to the ground surface.		44						
			45						
			46						
			47						
			48						
			49						
			50						
			51						
			52						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: 39' 0"
SL-Split Spoon w/liner		
ST-Shelby Tube	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: N/A
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: N/A

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LOG OF TEST BORING

NO.:	TB-19	PROJECT NO.:	82040308
DATE:	12/5/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
0' 8"	Dark brown moist sandy TOPSOIL - (FILL)								
	Brown, gray and dark brown variegated moist silty CLAY with traces of gravel, sand and organics and occasional silt partings - (FILL)		1						
			2	3					
		SS-1		6					
			3	6					
			4						
				3					
		SS-2	5	5					
				6					
			6						
7' 0"			7	2					
	Dark brown and gray variegated moist CLAY with a little silt; traces of gravel, sand and organics; and occasional pieces of wood - (FILL)	SS-3		3					
			8	3					
			9						
				2					
		SS-4	10	3					
				4					
			11						
			12						
			13						
14' 0"			14						
	Reddish-brown moist medium compact clayey fine SAND with trace of gravel and occasional clay seams - (SC)			5					
		SS-5	15	7					
				8					
			16						
			17						
			18						
19' 0"			19						
	Reddish-brown moist medium compact fine to medium sand with a little clay and occasional clay lenses - (SP-SC)			3					
		SS-6	20	6					
				5					
			21						
			22						
			23						
24' 0"			24						
	Brown moist hard CLAY with a little silt, traces of gravel and sand and frequent silty sand seams - (CL)			6					
		SS-7	25	14					
				28					
			26						

TYPE OF SAMPLE:

SS-Split Spoon
SL-Split Spoon w/liner
ST-Shelby Tube

DRILLING METHOD: 3 3/4" ID Hollow Stem Auger

DRILLING FOREMAN: P. Cody

BACKFILL MATERIAL: Cuttings

* Pocket Penetrometer Value

Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals

GROUNDWATER:

ENCOUNTERED AT: 24' 0" & 39' 0"

AFTER COMPLETION: None

COLLAPSE DEPTH: None

CTI and Associates, Inc.
12482 Emerson Drive
Brighton, MI 48116
(248) 486-5100 phone
(248) 486-5050 fax

LOG OF TEST BORING

NO.:	TB-19	PROJECT NO.:	82040308
DATE:	12/5/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
	Brown moist hard CLAY with a little silt, traces of gravel and sand and frequent silty sand seams - (CL)		27						
			28						
29' 0"			29						
	Gray moist hard to very stiff CLAY with a little sand and silt, trace of gravel and occasional silt partings - (CL)			6					
		SS-8	30	8		9.5		9000+*	
				13					
			31						
			32						
			33						
			34						
				5					
		SS-9	35	7		13.0		6500*	
				12					
			36						
			37						
			38						
39' 0"			39						
	Gray wet very compact silty fine SAND with occasional sand sand and gravel seams - (SM)			25					
		SS-10	40	37					
40' 6"				41					
	End of Boring		41						
			42						
			43						
			44						
			45						
			46						
			47						
			48						
			49						
			50						
			51						
			52						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon SL-Split Spoon w/liner ST-Shelby Tube	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: 24' 0" & 39' 0"
	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: None
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: None

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LOG OF TEST BORING

NO.:	TB-20	PROJECT NO.:	82040308
DATE:	12/9/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI PAGE: 1 OF: 2

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
0' 5"	Dark brown moist sandy TOPSOIL - (FILL)								
	Brown moist CLAY with a little silt; traces of gravel, sand and organics; and occasional sand partings - (FILL)		1						
			2	3					
		SS-1		6					
			3	8					
			4						
				3					
		SS-2	5	4					
				9					
			6						
			7	3					
		SS-3		2					
			8	4					
			9						
				2					
		SS-4	10	2					
				4					
			11						
			12						
			13						
14' 0"			14						
	Brown, gray and dark brown variegated moist CLAY with a little silt and traces of gravel, sand and organics - (FILL)			2					
		SS-5	15	4					
				6					
			16						
			17						
			18						
19' 0"			19						
	Brown moist loose clayey fine to medium SAND with some gravel and trace of silt - (SC)			3					
		SS-6	20	5					
				3					
			21						
			22						
			23						
24' 0"			24						
	Brown moist medium compact fine SAND with traces of gravel and silt and occasional cobbles - (SP-SM)			10					
		SS-7	25	14					
				12					
			26						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon SL-Split Spoon w/liner ST-Shelby Tube	DRILLING FOREMAN: V. Corrin	ENCOUNTERED AT: None
	BACKFILL MATERIAL: Cuttings * Pocket Penetrometer Value	AFTER COMPLETION: None
	Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: None

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(248) 486-5050 fax

LOG OF TEST BORING

NO.:	TB-20	PROJECT NO.:	82040308
DATE:	12/9/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type		Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
26' 0"	Brown moist medium compact fine SAND with traces of gravel and silt and occasional cobbles - (SP-SM)			27						
	End of Boring			28						
				29						
	Note: Boring terminated upon encountering auger refusal on an apparent cobble bed			30						
				31						
				32						
				33						
				34						
				35						
				36						
				37						
				38						
				39						
				40						
				41						
				42						
				43						
				44						
				45						
				46						
				47						
				48						
				49						
				50						
				51						
				52						

TYPE OF SAMPLE:

SS-Split Spoon
SL-Split Spoon w/liner
ST-Shelby Tube

DRILLING METHOD: 3 3/4" ID Hollow Stem Auger

DRILLING FOREMAN: P. Cody

BACKFILL MATERIAL: Cuttings

* Pocket Penetrometer Value

Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals

GROUNDWATER:

ENCOUNTERED AT: None

AFTER COMPLETION: None

COLLAPSE DEPTH: None

CTI and Associates, Inc.
12482 Emerson Drive
Brighton, MI 48116
(248) 486-5100 phone
(248) 486-5050 fax

LOG OF TEST BORING

NO.:	TB-21	PROJECT NO.:	82040308
DATE:	12/4/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
0' 5"	Dark brown moist sandy TOPSOIL - (FILL)								
	Brown and gray variegated moist silty CLAY with traces of gravel, sand and organics and occasional hair roots - (FILL)		1						
			2	3					
		SS-1		6					
			3	10					
4' 0"			4						
	Brown and dark brown variegated moist CLAY with a little silt and traces of gravel, sand and organics - (FILL)			3					
		SS-2	5	5					
				6					
			6						
			7	2					
		SS-3		3					
			8	7					
			9						
				4					
		SS-4	10	3					
				4					
			11						
			12						
			13						
14' 0"			14						
	Brown and dark brown variegated moist sandy CLAY with traces of gravel and organics and occasional very moist sand partings - (FILL)			2					
		SS-5	15	2					
				4					
			16						
			17						
			18						
19' 0"			19						
	Brown moist hard silty CLAY with traces of sand and gravel and occasional silt partings - (CL-ML)			7					
		SS-6	20	17		15.0		9000+*	
				25					
			21						
			22						
			23						
24' 0"			24						
	Brown moist compact silty fine to coarse SAND with trace of gravel and occasional clay lenses - (SM)			11					
		SS-7	25	18					
				14					
			26						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon SL-Split Spoon w/liner ST-Shelby Tube	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: 39' 0"
	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: N/A
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: N/A

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(248) 486-5050 fax

LOG OF TEST BORING

NO.:	TB-21	PROJECT NO.:	82040308
DATE:	12/4/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
			27						
	Brown moist compact silty fine to coarse SAND with trace of gravel and occasional clay lenses - (SM)								
			28						
29' 0"			29						
				5					
		SS-8	30	12					
				18					
			31						
	Gray moist medium compact silty fine SAND with a little clay, trace of gravel and occasional clay lenses - (SM/SC)								
			32						
			33						
			34						
				9					
		SS-9	35	11					
				10					
			36						
			37						
			38						
39' 0"			39						
				18					
	Gray wet very compact fine SAND with traces of gravel and silt - (SP-SM)	SS-10	40	38					
40' 6"				50/5"					
	End of Boring		41						
			42						
			43						
	Note: Following completion of the drilling, a 2-inch diameter temporary well with a 20-foot screen was set at a depth of 39 feet. Sand pack was placed around the well screen to a depth of 18 feet below grade, followed by a 2-foot thick bentonite seal and cuttings to the ground surface.		44						
			45						
			46						
			47						
			48						
			49						
			50						
			51						
			52						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon SL-Split Spoon w/liner ST-Shelby Tube	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: 39' 0"
	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: N/A
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: N/A

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LOG OF TEST BORING

NO.:	TB-22	PROJECT NO.:	82040308
DATE:	12/4/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
0' 5"	Dark brown moist sandy TOPSOIL - (FILL)								
			1						
			2	4					
	Brown and dark brown variegated moist CLAY with a little silt; traces of gravel, sand and organics; and occasional silt partings - (FILL)	SS-1		6					
			3	8					
			4						
				4					
		SS-2	5	5					
				7					
			6						
			7	6					
7' 6"		SS-3		6		17.2		4500*	
	Reddish-brown moist very stiff sandy CLAY with trace of gravel - (CL)		8	7					
9' 0"			9						
	Brown and gray variegated moist hard CLAY with a little silt, traces of gravel and sand and frequent sand partings - (CL)			6					
		SS-4	10	10		12.2		9000+	
				16					
			11						
			12						
			13						
			14						
				8					
		SS-5	15	14		13.8		9000+*	
				17					
			16						
			17						
			18						
			19						
				4					
20' 0"		SS-6	20	7					
	Gray moist very stiff CLAY with a little silt, traces of gravel and sand and occasional silt partings - (CL)			13		15.5		6500*	
			21						
			22						
			23						
			24						
24' 6"				6					
	Brown moist compact silty fine SAND with trace of gravel and occasional clay lenses - (SM)	SS-7	25	18					
				20					
			26						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon SL-Split Spoon w/liner ST-Shelby Tube	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: 39' 0"
	BACKFILL MATERIAL: Cuttings * Pocket Penetrometer Value	AFTER COMPLETION: N/A
	Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: N/A

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LOG OF TEST BORING

NO.:	TB-22	PROJECT NO.:	82040308
DATE:	12/4/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI PAGE: 2 OF: 2

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
	Brown moist compact silty fine SAND with trace of gravel and occasional clay lenses - (SM)		27						
			28						
29' 0"			29						
	Gray moist very stiff sandy CLAY with trace of gravel - (CL)			2					
		SS-8	30	50/5"				8000*	
			31						
			32						
			33						
34' 0"			34						
	Gray moist to wet very compact to compact silty fine SAND with trace of gravel - (SM)	SS-9		50/6"					
			35						
			36						
			37						
			38						
			39						
				9					
		SS-10	40	15					
40' 6"				16					
	End of Boring		41						
			42						
			43						
			44						
			45						
			46						
			47						
			48						
			49						
			50						
			51						
			52						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon SL-Split Spoon w/liner ST-Shelby Tube	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: 39' 0"
	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: N/A
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: N/A

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LOG OF TEST BORING

NO.:	TB-23	PROJECT NO.:	82040308
DATE:	12/9/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI PAGE: 1 OF: 2

Depth	SOIL DESCRIPTION	Sample Type	Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
0' 5"	Dark brown moist sandy TOPSOIL - (FILL)								
	Brown and dark brown variegated moist CLAY with a little silt; traces of gravel, sand and organics; and occasional sand partings - (FILL)		1						
			2	2					
		SS-1		5					
			3	14					
			4						
				4					
5' 3"		SS-2	5	8					
	Brown and gray variegated moist CLAY with a little silt, traces of gravel and sand and occasional pieces of wood - (FILL)			12					
			6						
			7	3					
		SS-3		3					
			8	4					
			9						
				2					
		SS-4	10	3					
				4					
			11						
			12						
			13						
14' 0"			14						
	Brown moist hard CLAY with a little silt, traces of gravel and sand and occasional sand partings - (CL)			4					
		SS-5	15	7		12.0		9000+*	
				6					
			16						
			17						
			18						
			19						
				3					
20' 0"		SS-6	20	12		14.1		8500*	
	Brown moist medium compact fine SAND with traces of gravel and silt and occasional cobbles - (SP-SM)			28					
			21						
			22						
			23						
24' 0"			24						
	Brown moist hard sandy, silty CLAY with trace of gravel and occasional wet sand and gravel seams - (CL-ML)			6					
		SS-7	25	10		13.9		9000+*	
				11					
26' 0"		SS-8	26	6					

TYPE OF SAMPLE:

SS-Split Spoon
SL-Split Spoon w/liner
ST-Shelby Tube

DRILLING METHOD: 3 3/4" ID Hollow Stem Auger

DRILLING FOREMAN: V. Corrin

BACKFILL MATERIAL: Cuttings

* Pocket Penetrometer Value

Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals

GROUNDWATER:

ENCOUNTERED AT: 24' 0"

AFTER COMPLETION: None

COLLAPSE DEPTH: None

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(248) 486-5050 fax

LOG OF TEST BORING

NO.:	TB-23	PROJECT NO.:	82040308
DATE:	12/9/2008	SURFACE ELEV.:	N/A

PROJECT NAME: Pioneer High School Storm Water Improvements - Ann Arbor, MI

Depth	SOIL DESCRIPTION	Sample Type		Depth Feet	Penetration Blows for 6"	PID	Moisture %	Natural Wt. P.C.F.	Unconfined Comp. Str. P.S.F.	STR %
	Gray moist medium compact silty, clayey fine SAND with	SS-8			10		10.4			
	trace of gravel - (SM/SC)			27	13					
27' 6"					4					
	Gray moist very stiff sandy CLAY with trace of gravel and	SS-9		28	10		11.4		7000*	
28' 6"	occasional cobbles - (CL)				12					
	End of Boring			29						
				30						
	Note: Boring terminated upon encountering auger refusal on									
	an apparent cobble bed			31						
				32						
				33						
				34						
				35						
				36						
				37						
				38						
				39						
				40						
				41						
				42						
				43						
				44						
				45						
				46						
				47						
				48						
				49						
				50						
				51						
				52						

TYPE OF SAMPLE:	DRILLING METHOD: 3 3/4" ID Hollow Stem Auger	GROUNDWATER:
SS-Split Spoon	DRILLING FOREMAN: P. Cody	ENCOUNTERED AT: 24' 0"
SL-Split Spoon w/liner		
ST-Shelby Tube	BACKFILL MATERIAL: Cuttings	AFTER COMPLETION: None
	* Pocket Penetrometer Value Standard Penetration Test - Driving 2" OD Sampler 18" With 140# Hammer Falling 30"; Count Made at 6" Intervals	COLLAPSE DEPTH: None

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **RE-2**

G2 Consulting Group, LLC

SUBSURFACE PROFILE				SOIL SAMPLE DATA					
DEPTH (ft)	PRO-FILE	GROUND SURFACE ELEVATION: N/A	DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
0.3		Bituminous Concrete (4 inches)							
2.5		Loose Brown Sand with trace silt and gravel		S-1	2 3 3	6			
5		Hard Brown and Gray Silty Clay with trace sand and gravel	5	S-2	2 4 7	11	14.8		9000*
7.5				S-3	5 8 9	17	10.3		9000*
		End of Boring @ 7.5ft							
10			10						
15			15						

Total Depth: 7.5ft
Drilling Date: October 4, 2012
Inspector:
Contractor: Strata Drilling, Inc.
Driller: B. Sienkiewicz

Drilling Method:
2-1/4 inch inside diameter hollow-stem augers

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 2 feet east of West Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **RE-3**

G2 Consulting Group, LLC

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	Description	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
0.0–0.5	Bituminous Concrete (6-1/2 inches)						
0.5–0.8	Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 2-1/2 inches)						
0.8–3.0	Hard Brown and Gray Silty Clay with trace sand and gravel	S-1	3 4 5	9	13.6		8500*
3.0–7.5	Very Loose Brown Clayey Sand with trace gravel	S-2	1 1 2	3			
		S-3	1 2 2	4			
7.5	End of Boring @ 7.5ft						

Total Depth: 7.5ft
Drilling Date: October 4, 2012
Inspector:
Contractor: Strata Drilling, Inc.
Driller: B. Sienkiewicz

Drilling Method:
2-1/4 inch inside diameter hollow-stem augers

Water Level Observation:
6 feet during and upon completion of drilling operations

Notes:
Boring performed 4-1/2 feet east of West Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Figure No. 70

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **RE-4**

G2 Consulting Group, LLC

SUBSURFACE PROFILE / SOIL SAMPLE DATA

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	PROFILE DESCRIPTION	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
0.5	Bituminous Concrete (6 inches)						
0.7	Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 2 inches)						
1.5	Fill: Dark Brown Silty Clay with trace sand, gravel, and organic matter						
4.5	Very Stiff Brown and Gray Silty Clay with trace sand and gravel	S-1	3 4 4	8	21.1		5500*
7.5	Loose Brown Silty Sand with trace clay and gravel	S-2	2 4 3	7			
		S-3	2 3 4	7			
	End of Boring @ 7.5ft						

Total Depth: 7.5ft
Drilling Date: October 4, 2012
Inspector:
Contractor: Strata Drilling, Inc.
Driller: B. Sienkiewicz

Drilling Method:
2-1/4 inch inside diameter hollow-stem augers

Water Level Observation:
6-1/2 feet during and upon completion of drilling operations

Notes:
Boring performed 4 feet east of West Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Figure No. 71

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **RU-2**

G2 Consulting Group, LLC

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	Description
0.0–0.4	Bituminous Concrete (4-1/2 inches)
0.4–0.8	Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 5-1/2 inches)
0.8–7.5	Very Stiff to Hard Brown Silty Clay with trace sand and gravel
7.5	End of Boring @ 7.5ft

SOIL SAMPLE DATA

SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
S-1	4 6 7	13	11.2		8500*
S-2	4 8 7	15	11.7		6500*
S-3	3 6 8	14	12.4		9000*

Total Depth: 7.5ft
Drilling Date: October 4, 2012
Inspector:
Contractor: Strata Drilling, Inc.
Driller: B. Sienkiewicz

Drilling Method:
2-1/4 inch inside diameter hollow-stem augers

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 6 feet east of West Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Figure No. 76

SOIL / PAVEMENT BORING 120547A.GPJ G2_CONS.GDT 10/19/12

Project Name: Ann Arbor Geotechnical

Project Location: Ann Arbor, Michigan

G2 Project No. 120547A

Latitude: N/A Longitude: N/A

Soil Boring No. **RU-3**

G2 Consulting Group, LLC

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION: N/A

DEPTH (ft)	Description
0–0.5	Bituminous Concrete (6-1/2 inches)
0.5–0.9	Fill: Brown Sand and Gravel with trace silt (Natural Aggregate Base, 4 inches)
0.9–7.5	Very Stiff to Hard Brown Silty Clay with trace sand and gravel
7.5	End of Boring @ 7.5ft

SOIL SAMPLE DATA

DEPTH (ft)	SAMPLE TYPE-NO.	BLOWS/ 6-INCHES	STD. PEN. RESISTANCE (N)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP. STR. (PSF)
	S-1	4 4 6	10	16.1		8000*
5	S-2	6 8 11	19	13.0		7000*
	S-3	6 10 14	24	12.4		9000*

Total Depth: 7.5ft
Drilling Date: October 4, 2012
Inspector:
Contractor: Strata Drilling, Inc.
Driller: B. Sienkiewicz

Drilling Method:
2-1/4 inch inside diameter hollow-stem augers

Water Level Observation:
Dry during and upon completion of drilling operations

Notes:
Boring performed 6 feet east of West Curbline
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Borehole backfilled with auger cuttings and capped with cold patch

Figure No. 77

Testing Engineers & Consultants, Inc.

1343 Rochester Road - PO Box 249 - Troy, Michigan - 48099-0249
(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: SB6 Seventh
Job No.: 51989
Project: Miscellaneous Geotechnical Services, Bundle One
Client: City of Ann Arbor
Type of Rig: Truck
Location: Ann Arbor, Michigan
Drilling Method: Solid Stem Augers
Drilled By: I. Mickle
Ground Surface Elevation:
Started: 12/2/2011
Completed: 12/2/2011

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.58	ASPHALT (7")			
2.5	LS	12 7 6	3	Brown Sandy Gravel With Some Clay-FILL	5.7	103	
5.0	LS	4 4 4	5.5	Plastic Moist Dark Brown CLAY With Some Silt, Trace Of Sand & Gravel	18.2	131	2060
7.5	LS	5 6 9		Firm Moist Brown Oxidized CLAY With Some Silt & Trace Of Gravel	16.1	137	2720
10.0	LS	4 5 6	10		14.9	129	
				Bottom of Borehole at 10'			
12.5							
15.0							
17.5							
20.0							
22.5							

"N" - Standard Penetration Resistance
SS - 2").D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: 2'0"
At Completion: Caved At 1'10"
Boring No. SB6 Seventh

Testing Engineers & Consultants, Inc.
1343 Rochester Road - PO Box 249 - Troy, Michigan - 48099-0249
(248) 588-6200 or (313) T-E-S-T-I-N-G
Fax (248) 588-6232

Boring No.: SB7 Seventh
Job No.: 51989
Project: Miscellaneous Geotechnical Services, Bundle One
Client: City of Ann Arbor
Type of Rig: Truck
Location: Ann Arbor, Michigan
Drilling Method: Solid Stem Augers
Drilled By: I. Mickle
Ground Surface Elevation:
Started: 12/2/2011
Completed: 12/2/2011

Depth (ft)	Sample Type	N	Strata Change	Soil Classification	w	d	qu
			.58	ASPHALT (6 1/4")			
	LS	5 4 5	1	Moist Brown Gravelly Sand With Some Clay-FILL (5 3/4")			
2.5			3				
	LS	2 3 3		Firm Moist Brown CLAY With Some Silt & Trace Of Gravel			
5.0			5.5	Plastic Moist Brown Clay With Some Silt, Trace Of Sand & Gravel-FILL			
	LS	8 10 16		Stiff Moist Brown Oxidized CLAY With Some Silt & Trace Of Gravel	17.4	123	6670
7.5							
	LS	6 8 11			25.0	129	8980
10.0			10	Bottom of Borehole at 10'			
12.5							
15.0							
17.5							
20.0							
22.5							

"N" - Standard Penetration Resistance
SS - 2").D. Split Spoon Sample
LS - Sectional Liner Sample
ST - Shelby Tube Sample
AS - Auger Sample

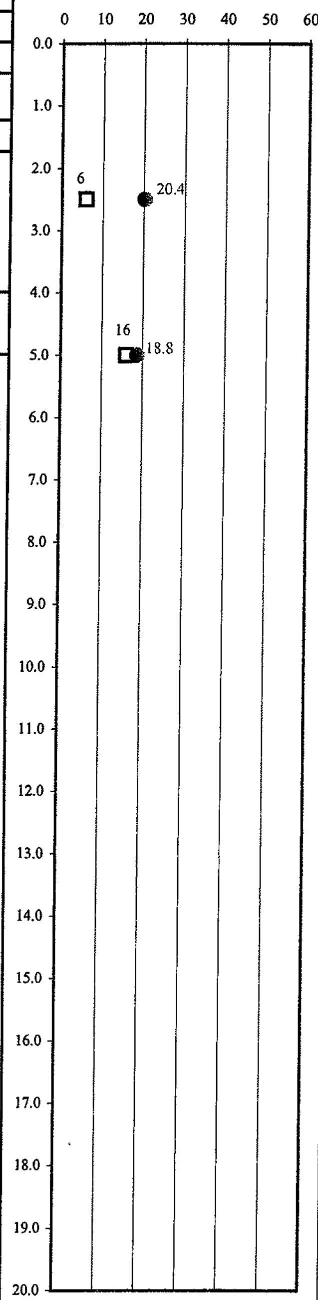
w - H2O, % of dry weight
d - Bulk Density, pcf
qu - Unconfined Compression, psf
DP - Direct Push

Water Encountered: None
At Completion: None
Boring No. SB7 Seventh

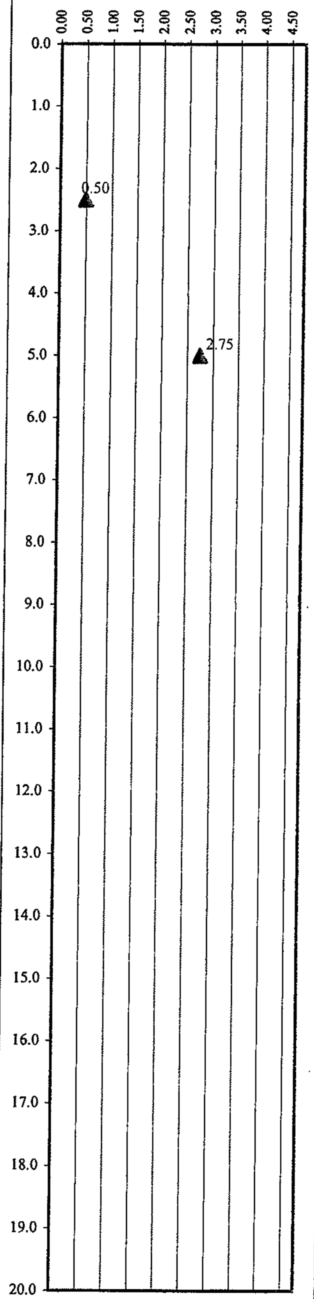
Project: City of Ann Arbor 2008 Road Construction Project	TES CONSULTANTS, P.C.
Client: City of Ann Arbor	23943 Industrial Park Drive
Location: Ann Arbor, Michigan	Farmington Hills, MI 48335
Project #: 07-1192 Boring Log #: C-8-Stadium	Ph: (248) 615-3000 Fx: (248) 615-3512

Sample No./Type	Recovery (in.)	Depth (ft.)	Description of Material
		0	Ground Surface Elevation =
			5.0" Bituminous Concrete
		1	10.0" PCC Pavement
SS-1	18		NOTE 1
		2–3	ORGANIC SANDY CLAY - trace gravel - occasional root matter - medium - black - (OL)
SS-2	18	4–5	SILTY CLAY - trace sand and gravel - very stiff - mottled brown and gray - (CL)
		6–7	NOTE 1: 3.0" FINE TO COARSE SAND FILL - traces silt and gravel - moist - brown - (SP-SM-Fill)
		8–20	
			End of Boring (ft): 5.0'

Moisture Content (%) - circles
N-Value (blows/ft) - squares



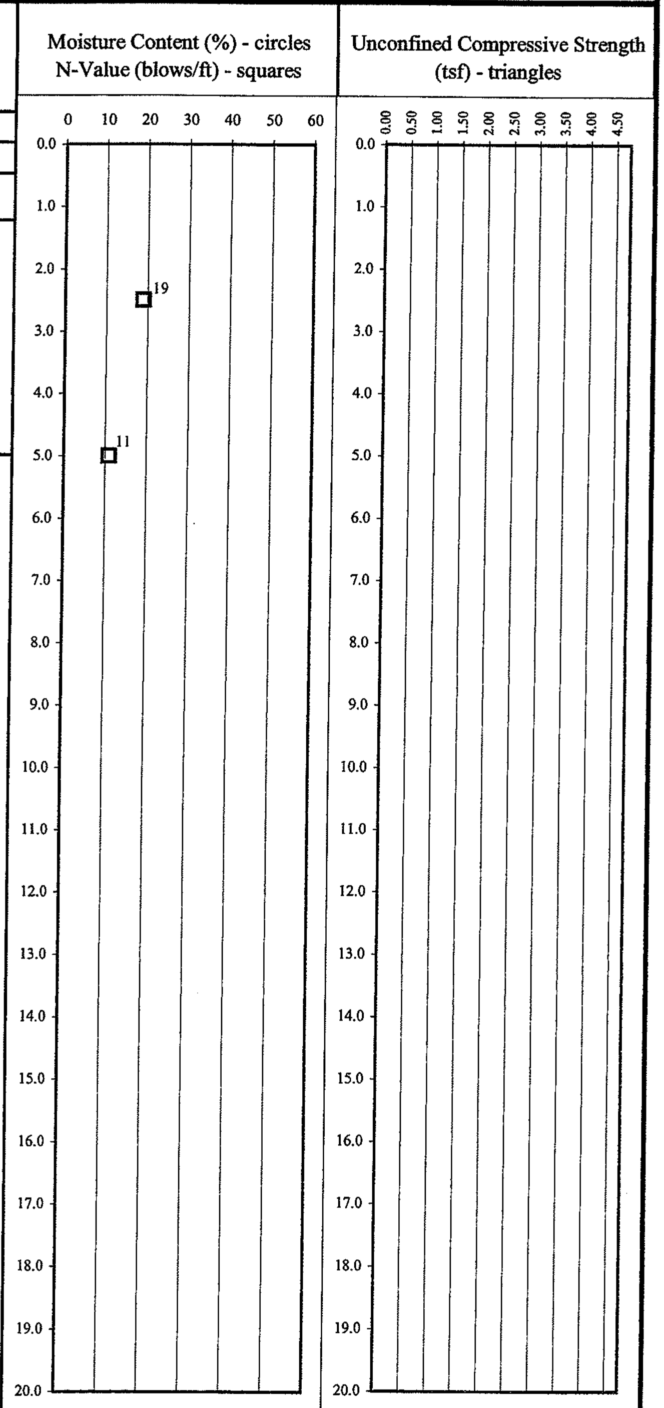
Unconfined Compressive Strength (tsf) - triangles



Water Level Observations:		
While Drilling: Dry	Boring Started: 9/27/07	Approved: [signature]
At Completion: Dry	Boring Completed: 9/27/07	Drawn By: AH
Cave-In At:	Rig: CME 55	
	Driller: J. Faitel	

Project: City of Ann Arbor 2008 Road Construction Project	**TES CONSULTANTS, P.C.**
Client: City of Ann Arbor	**23943 Industrial Park Drive**
Location: Ann Arbor, Michigan	**Farmington Hills, MI 48335**
Project #: 07-1192 **Boring Log #:** C-9-Stadium	**Ph: (248) 615-3000 Fx: (248) 615-3512**

Sample No./Type	Recovery (in.)	Depth (ft.)	Description of Material
		0	Ground Surface Elevation =
			5.0" Bituminous Concrete
		1	9.0" PCC Pavement
SS-1	18	2	FINE TO COARSE SAND FILL - trace silt - some gravel - medium dense - moist - brown - (SP-SM-Fill)
		3	
SS-2	18	4	
		5	
		6–20	
			End of Boring (ft): 5.0'

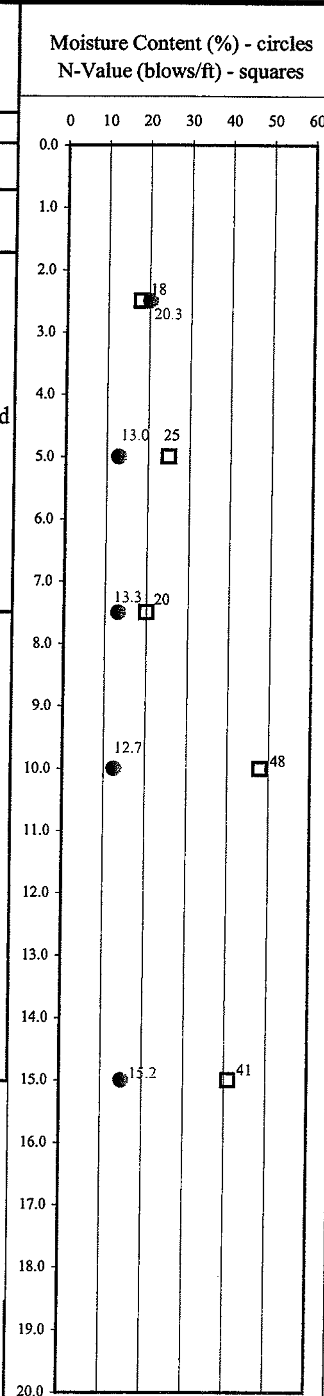


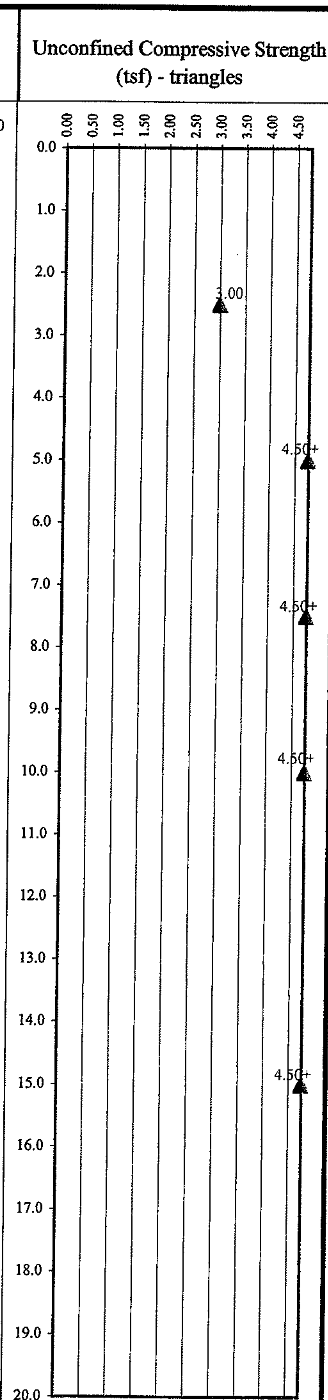
Water Level Observations:	**Boring Started:** 9/26/07	**Approved:** [signature]
While Drilling: Dry	**Boring Completed:** 9/26/07	
At Completion: Dry	**Rig:** CME 55	**Drawn By:** AH
Cave-In At:	**Driller:** J. Faitel	

Project: City of Ann Arbor 2008 Road Construction Project	**TES CONSULTANTS, P.C.**
Client: City of Ann Arbor	**23943 Industrial Park Drive**
Location: Ann Arbor, Michigan	**Farmington Hills, MI 48335**
Project #: 07-1192 **Boring Log #:** C-10	**Ph: (248) 615-3000 Fx: (248) 615-3512**

Sample No./Type	Recovery (in.)	Depth (ft.)	Description of Material
		0	Ground Surface Elevation =
		0–0.7	8.0" Bituminous Concrete
		0.7–1.25	7.0" PCC Pavement
SS-1	18	1.5–3	SILTY CLAY - trace sand and gravel - very stiff to hard - mottled brown and gray - (CL)
SS-2	18	4–5.5	
SS-3	18	6.5–8	
SS-4	18	9–10.5	SILTY CLAY - trace sand and gravel - hard - brown changing to gray below 14.5' - (CL)
SS-5	18	13.5–15	
		15–20	NOTE: Driller Reported No Aggregate Base Below PCC Pavement

End of Boring (ft): 15.0'

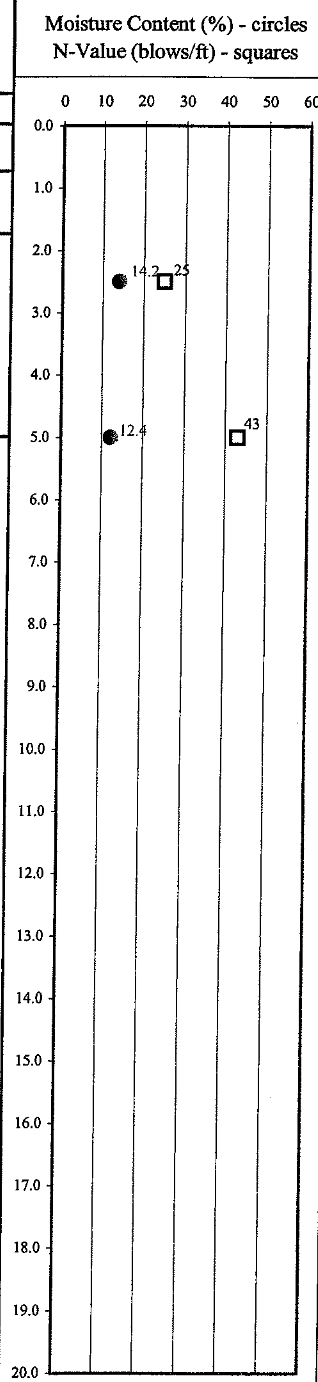


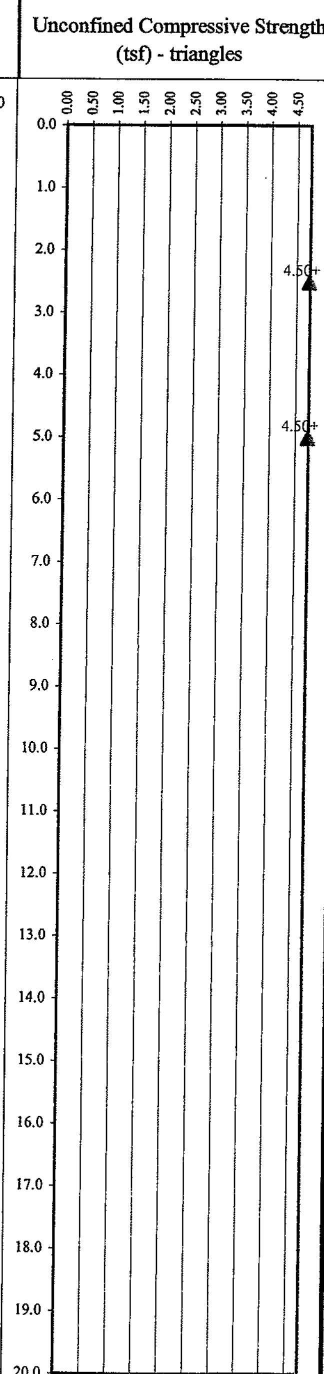


Water Level Observations:	**Boring Started:** 9/25/07	**Approved:** [signature]
While Drilling: Dry	**Boring Completed:** 9/25/07	
At Completion: Dry	**Rig:** CME 55	**Drawn By:** AH
Cave-In At:	**Driller:** J. Faitel	

Project: City of Ann Arbor 2008 Road Construction Project	TES CONSULTANTS, P.C.
Client: City of Ann Arbor	23943 Industrial Park Drive
Location: Ann Arbor, Michigan	Farmington Hills, MI 48335
Project #: 07-1192 Boring Log #: C-11	Ph: (248) 615-3000 Fx: (248) 615-3512

Sample No./Type	Recovery (in.)	Depth (ft.)	Description of Material
		0	Ground Surface Elevation =
		0–0.75	9.0" Bituminous Concrete
		0.75–1.6	10.0" PCC Pavement
SS-1	18	1.6–5	SILTY CLAY - trace sand and gravel - hard - mottled brown and gray - (CL)
SS-2	18		
		5–20	NOTE: Driller Reported No Aggregate Base Below PCC Pavement
			End of Boring (ft): 5.0'

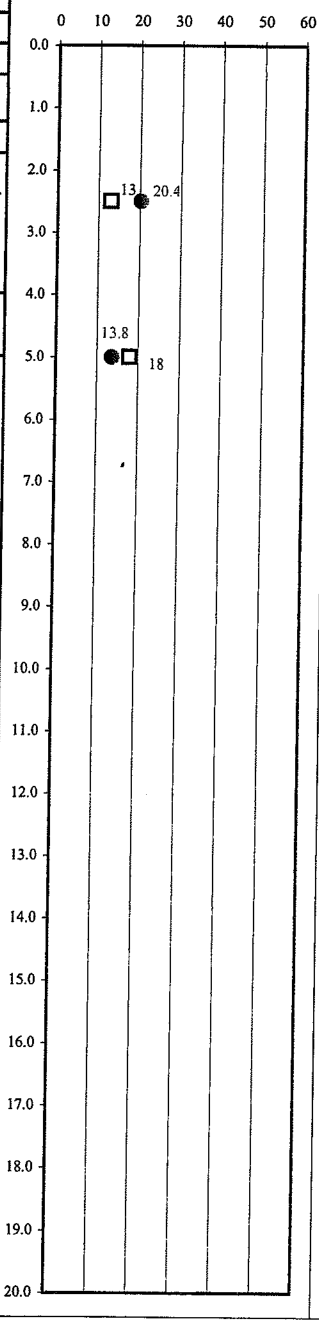


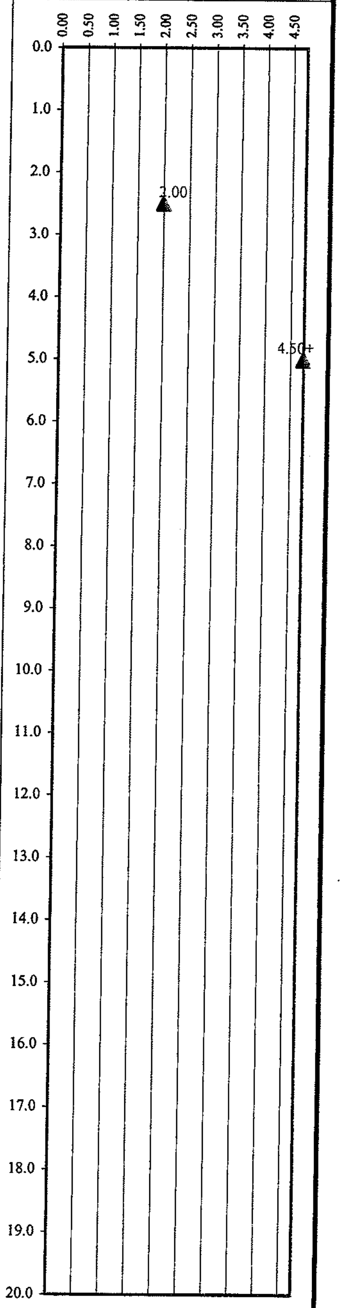


Water Level Observations:		
While Drilling: Dry	Boring Started: 9/27/07	Approved:
At Completion: Dry	Boring Completed: 9/27/07	
Cave-In At:	Rig: CME 55	Drawn By: AH
	Driller: J. Faitel	

Project: City of Ann Arbor 2008 Road Construction Project	**TES CONSULTANTS, P.C.**
Client: City of Ann Arbor	**23943 Industrial Park Drive**
Location: Ann Arbor, Michigan	**Farmington Hills, MI 48335**
Project #: 07-1192 **Boring Log #:** C-12	**Ph: (248) 615-3000 Fx: (248) 615-3512**

Sample No./Type	Recovery (in.)	Depth (ft.)	Description of Material
		0	Ground Surface Elevation =
			5.0" Bituminous Concrete
		1	11.0" PCC Pavement
			NOTE 1
SS-1	18	2–3	MIXED SILTY LAY AND CLAYEY TOPSOIL FILL - trace sand - very stiff - brown and black - (Mixed CL + OP Fill)
SS-2	18	4–5	SILTY CLAY - trace sand and gravel - hard - mottled brown and gray - (CL)
			NOTE 1: 4.0" FINE TO MEDIUM SAND FILL - trace sand and gravel - moist - brown - (SP-SM-Fill)
		20	End of Boring (ft): 5.0'





Water Level Observations:
While Drilling: Dry
At Completion: Dry
Cave-In At:

Boring Started: 9/27/07
Boring Completed: 9/27/07
Rig: CME 55
Driller: J. Faitel

Approved: [signature]
Drawn By: AH

Project: City of Ann Arbor 2008 Road Construction Project	**TES CONSULTANTS, P.C.**
Client: City of Ann Arbor	**23943 Industrial Park Drive**
Location: Ann Arbor, Michigan	**Farmington Hills, MI 48335**
Project #: 07-1192 **Boring Log #:** C-13	**Ph: (248) 615-3000 Fx: (248) 615-3512**

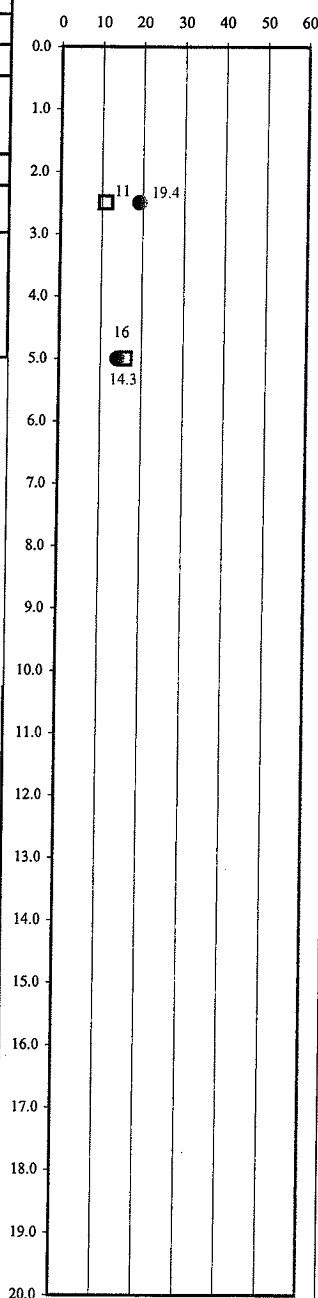
Sample No./Type	Recovery (in.)	Depth (ft.)	Description of Material
		0	Ground Surface Elevation =
		0–0.4	5.0" Bituminous Concrete
SS-1	18	0.4–1.2	9.0" PCC Pavement
		1.2–2.0	NOTE 1
		2.0–3.0	NOTE 2
SS-2	18	3.0–5.0	SILTY CLAY - trace sand and gravel - hard - mottled brown and gray - (CL)

NOTE 1: 3.0" FINE TO MEDIUM SAND FILL - trace silt and gravel - moist - brown - (SP-SM-Fill)

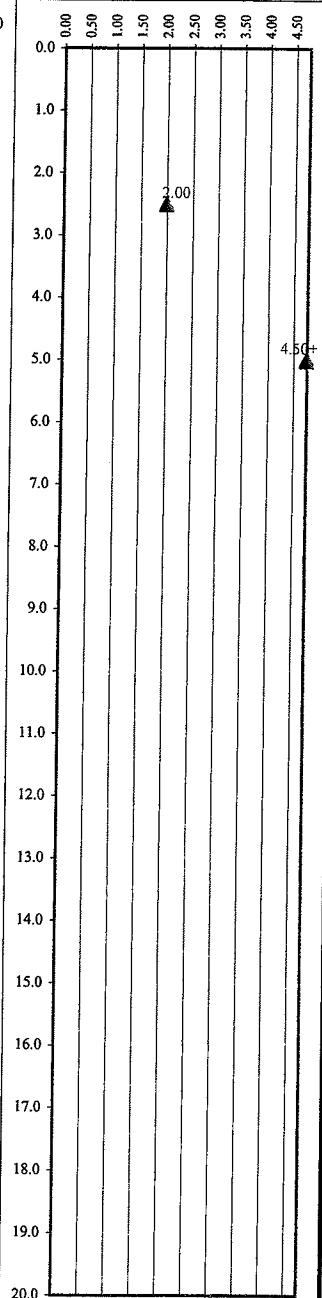
NOTE 2: SILTY CLAY FILL - trace sand and gravel - occasional clayey topsoil seams - very stiff - brown and black - (CL-Fill)

End of Boring (ft): 5.0'

Moisture Content (%) - circles
N-Value (blows/ft) - squares



Unconfined Compressive Strength (tsf) - triangles



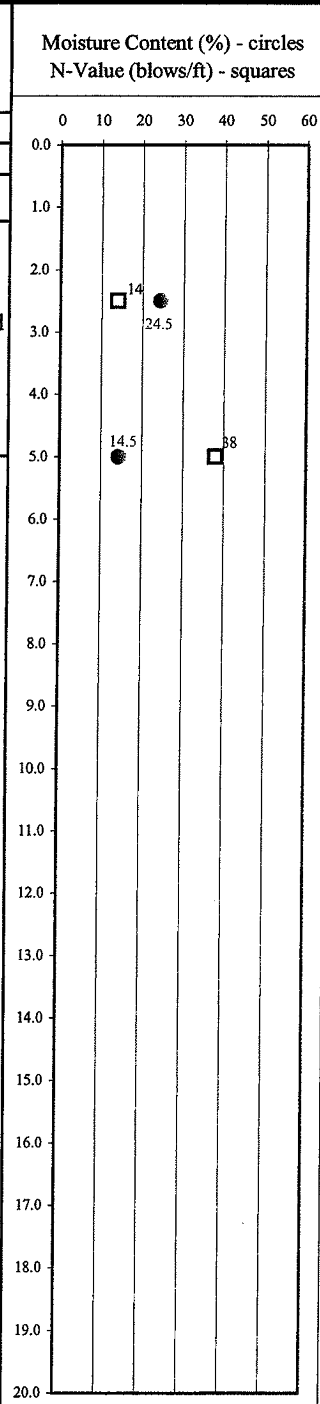
Water Level Observations:
While Drilling: Dry
At Completion: Dry
Cave-In At:

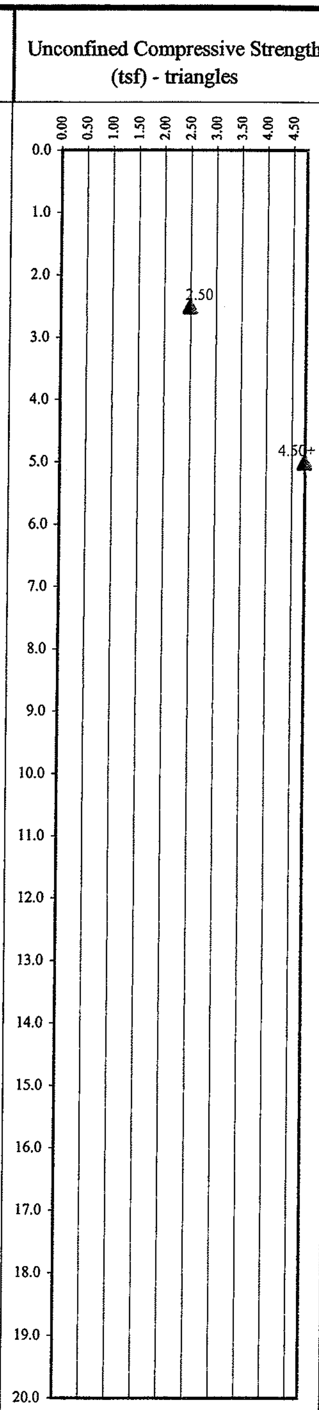
Boring Started: 9/25/07
Boring Completed: 9/25/07
Rig: CME 55
Driller: J. Faitel

Approved: JTA
Drawn By: AH

Project: City of Ann Arbor 2008 Road Construction Project	TES CONSULTANTS, P.C.
Client: City of Ann Arbor	23943 Industrial Park Drive
Location: Ann Arbor, Michigan	Farmington Hills, MI 48335
Project #: 07-1192 Boring Log #: C-14	Ph: (248) 615-3000 Fx: (248) 615-3512

Sample No./Type	Recovery (in.)	Depth (ft.)	Description of Material
		0	Ground Surface Elevation =
			6.5" Bituminous Concrete
		1	7.0" PCC Pavement
SS-1	18	2	SILTY CLAY - trace sand and gravel - very stiff to hard - mottled brown and gray - (CL)
		3	
SS-2	18	4	
		5	NOTE: Driller Reported No Aggregate Base Below PCC Pavement
		6–20	
			End of Boring (ft): 5.0'



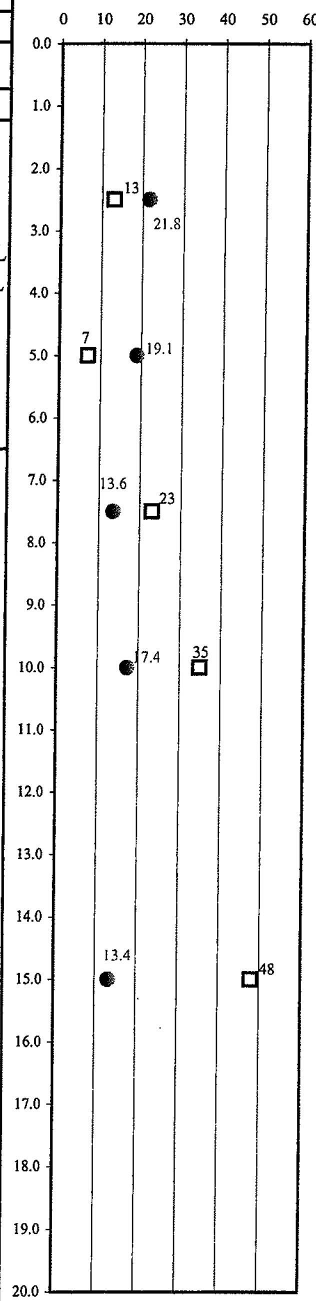


Water Level Observations:		
While Drilling: Dry	Boring Started: 9/25/07	Approved: [signature]
At Completion: Dry	Boring Completed: 9/25/07	Drawn By: AH
Cave-In At:	Rig: CME 55	
	Driller: J. Faitel	

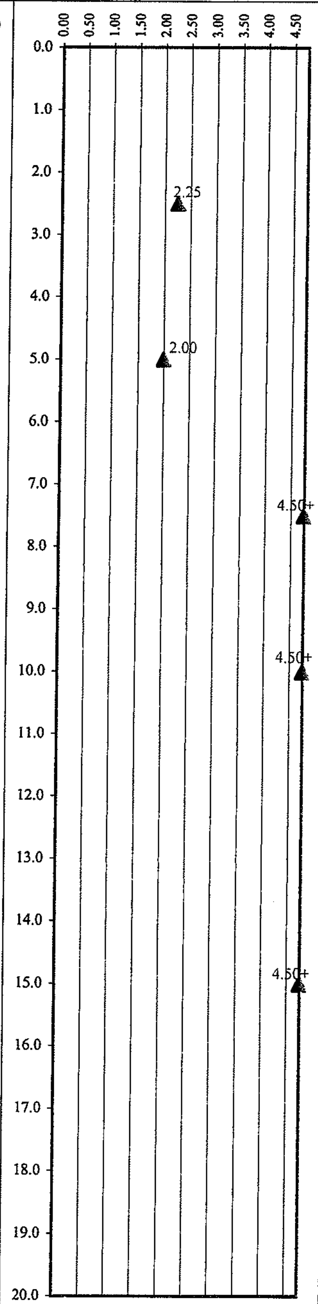
Project: City of Ann Arbor 2008 Road Construction Project	TES CONSULTANTS, P.C.
Client: City of Ann Arbor	23943 Industrial Park Drive
Location: Ann Arbor, Michigan	Farmington Hills, MI 48335
Project #: 07-1192 Boring Log #: C-15	Ph: (248) 615-3000 Fx: (248) 615-3512

Sample No./Type	Recovery (in.)	Depth (ft.)	Description of Material
		0	Ground Surface Elevation =
			8.0" Bituminous Concrete Pavement
		1	7.0" PCC Pavement
SS-1	18	2	
		3	
SS-2	18	4	MIXED SILTY CLAY AND CLAYEY TOPSOIL FILL - trace gravel - very stiff - brown and black - (Mixed CL + OL Fill)
		5	
		6	
SS-3	18	7	
		8	
SS-4	18	9	
		10	SILTY CLAY - trace sand and gravel - hard - mottled brown and gray - (CL)
		11	
		12	
		13	
SS-5	18	14	
		15	
		16	NOTE: Driller Reported No Aggregate Base Present Below the PCC Pavement
		17	
		18	
		19	
		20	
			End of Boring (ft): 15.0'

Moisture Content (%) - circles
N-Value (blows/ft) - squares



Unconfined Compressive Strength (tsf) - triangles

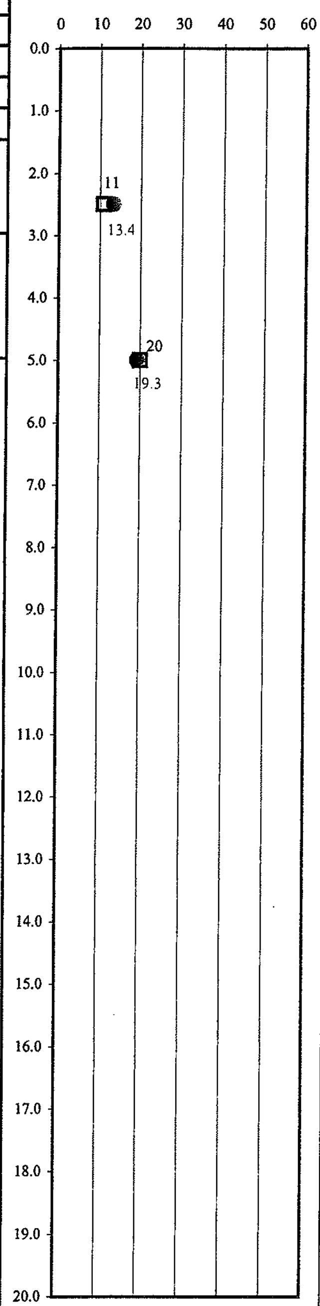


Water Level Observations:		
While Drilling: Dry	Boring Started: 9/28/07	Approved: [signature]
At Completion: Dry	Boring Completed: 9/28/07	
Cave-In At:	Rig: CME 55	Drawn By: AH
	Driller: J. Faitel	

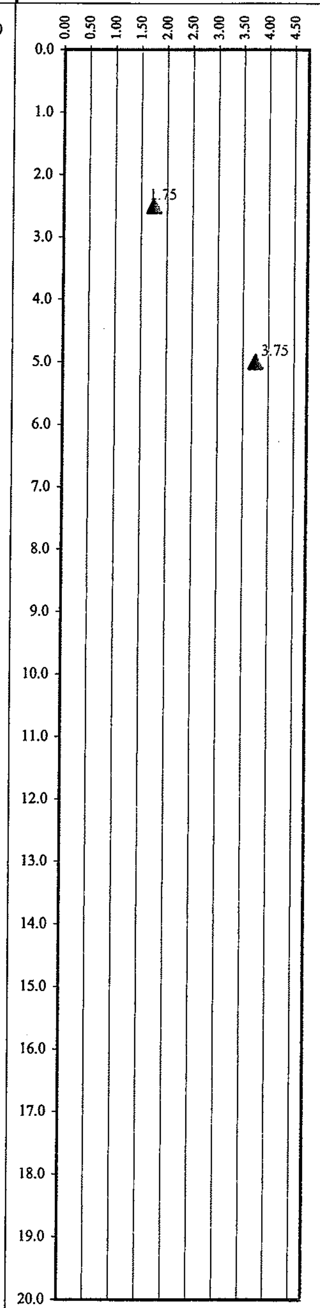
Project: City of Ann Arbor 2008 Road Construction Project	**TES CONSULTANTS, P.C.**
Client: City of Ann Arbor	**23943 Industrial Park Drive**
Location: Ann Arbor, Michigan	**Farmington Hills, MI 48335**
Project #: 07-1192 **Boring Log #:** C-16	**Ph: (248) 615-3000 Fx: (248) 615-3512**

Sample No./Type	Recovery (in.)	Depth (ft.)	Description of Material
		0	Ground Surface Elevation =
			4.5" Bituminous Concrete Pavement
		1	8.0" PCC Pavement
			FINE TO MEDIUM SAND FILL - trace sand and gravel - stiff - moist - brown - (SP-SM-Fill)
SS-1	18	2	SILTY CLAY FILL - some sand - trace gravel - stiff - brown - (CL-Fill)
		3	SILTY CLAY - trace sand and gravel - very stiff - mottled brown and gray - (CL)
SS-2	18	4	
		5	
		6	
		7	
		8	
		9	
		10	
		11	
		12	
		13	
		14	
		15	
		16	
		17	
		18	
		19	
		20	

Moisture Content (%) - circles
N-Value (blows/ft) - squares



Unconfined Compressive Strength (tsf) - triangles

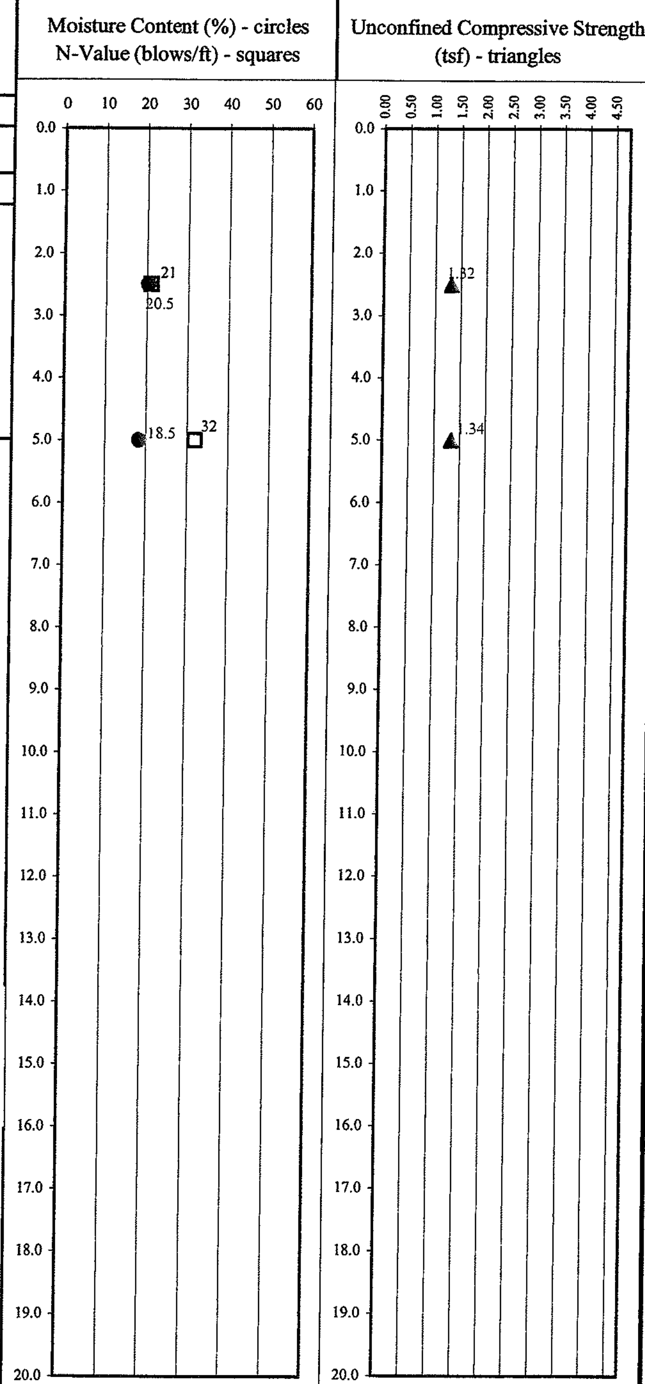


End of Boring (ft): 5.0'

Water Level Observations:	**Boring Started:** 9/28/07	**Approved:** [signature]
While Drilling: Dry	**Boring Completed:** 9/28/07	
At Completion: Dry	**Rig:** CME 55	**Drawn By:** AH
Cave-In At:	**Driller:** J. Faitel	

Project: City of Ann Arbor 2008 Road Construction Project	TES CONSULTANTS, P.C.
Client: City of Ann Arbor	23943 Industrial Park Drive
Location: Ann Arbor, Michigan	Farmington Hills, MI 48335
Project #: 07-1192 Boring Log #: C-17	Ph: (248) 615-3000 Fx: (248) 615-3512

Sample No./Type	Recovery (in.)	Depth (ft.)	Description of Material
		0	Ground Surface Elevation =
		0–0.5	5.5" Bituminous Concrete Pavement
		0.5–1	8.5" PCC Pavement
SS-1	18	1–5	SILTY CLAY - trace sand and gravel - hard - mottled brown and gray changing to brown below 8' - (CL)
SS-2	18		
			NOTE: Driller Reported No Aggregate Base Present Below the PCC Pavement
			End of Boring (ft): 5.0'



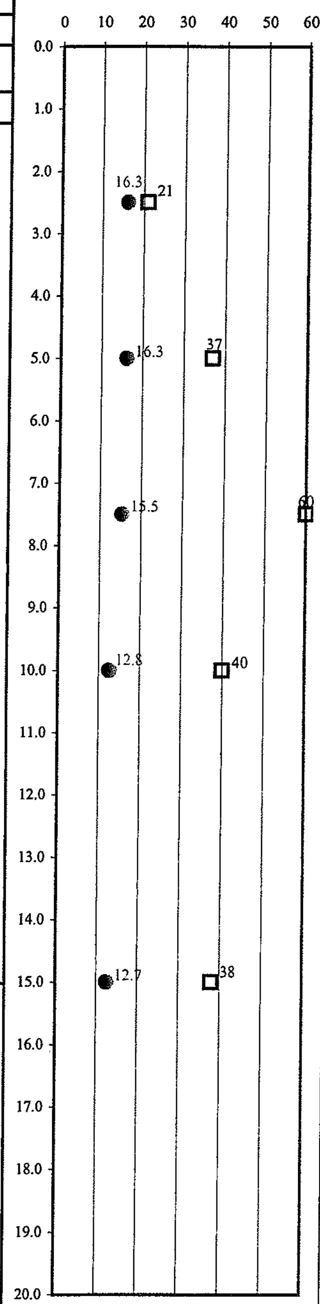
Water Level Observations:		
While Drilling: Dry	Boring Started: 9/25/07	Approved:
At Completion: Dry	Boring Completed: 9/25/07	Drawn By: AH
Cave-In At:	Rig: CME 55	
	Driller: J. Faitel	

Project: City of Ann Arbor 2008 Road Construction Project	**TES CONSULTANTS, P.C.**
Client: City of Ann Arbor	**23943 Industrial Park Drive**
Location: Ann Arbor, Michigan	**Farmington Hills, MI 48335**
Project #: 07-1192 **Boring Log #:** C-18	**Ph: (248) 615-3000 Fx: (248) 615-3512**

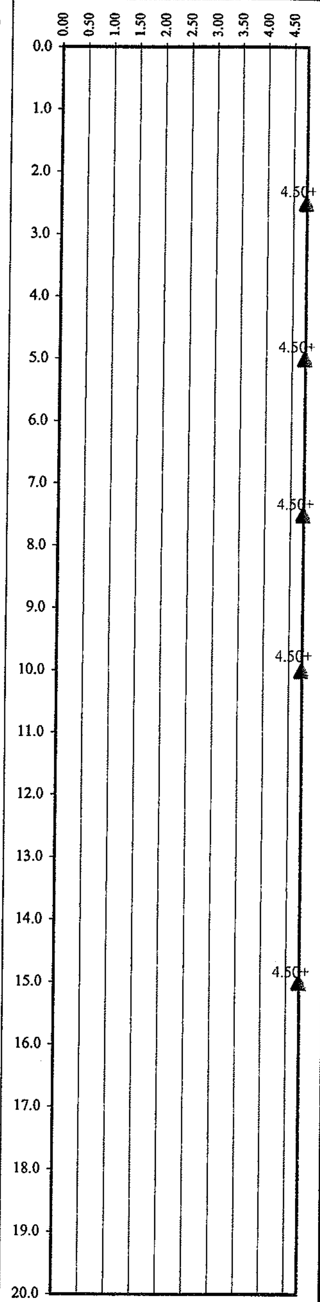
Sample No./Type	Recovery (in.)	Depth (ft.)	Description of Material
		0	Ground Surface Elevation =
		0–0.6	7.5" Bituminous Concrete Pavement
		0.6–1.2	6.5" PCC Pavement
SS-1	18	1–2.5	SILTY CLAY - trace sand and gravel - hard - mottled brown and gray changing to brown below 8' - (CL)
SS-2	18	3.5–5	
SS-3	18	6–7.5	
SS-4	18	8.5–10	
SS-5	18	13.5–15	
		15–20	NOTE: Driller Reported No Aggregate Base Present Below the PCC Pavement

End of Boring (ft): 15.0'

Moisture Content (%) - circles
N-Value (blows/ft) - squares



Unconfined Compressive Strength (tsf) - triangles

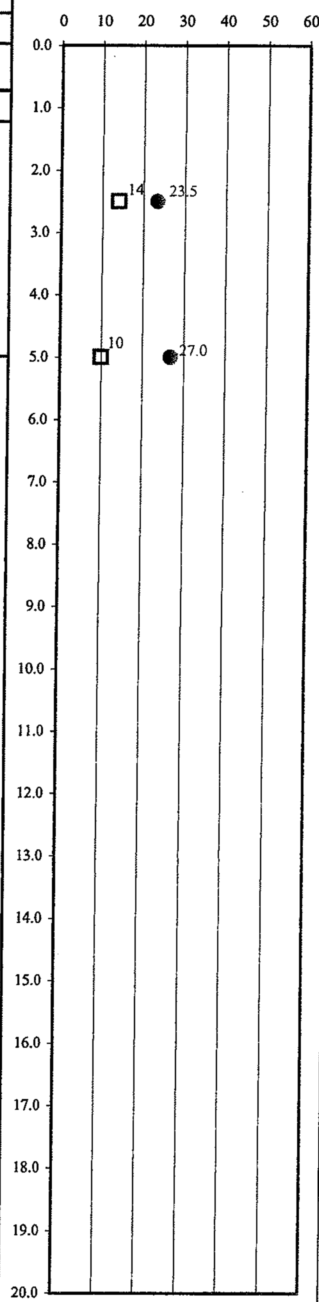


Water Level Observations:	**Boring Started:** 9/25/07	**Approved:** [signature]
While Drilling: Dry	**Boring Completed:** 9/25/07	
At Completion: Dry	**Rig:** CME 55	**Drawn By:** AH
Cave-In At:	**Driller:** J. Faitel	

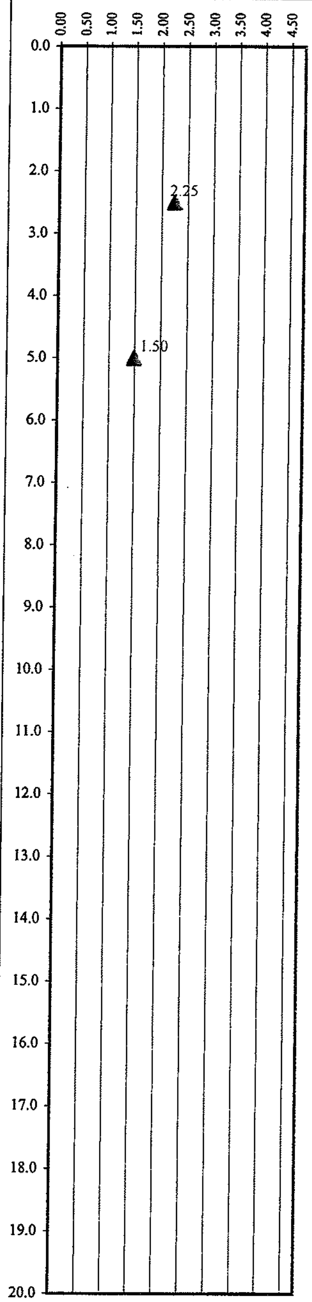
Project: City of Ann Arbor 2008 Road Construction Project	**TES CONSULTANTS, P.C.**
Client: City of Ann Arbor	**23943 Industrial Park Drive**
Location: Ann Arbor, Michigan	**Farmington Hills, MI 48335**
Project #: 07-1192 **Boring Log #:** C-19	**Ph: (248) 615-3000 Fx: (248) 615-3512**

Sample No./Type	Recovery (in.)	Depth (ft.)	Description of Material
		0	Ground Surface Elevation =
		0–0.6	7.5" Bituminous Concrete Pavement
		0.6–1.2	7.0" PCC Pavement
SS-1	18	1.2–5.0	SILTY CLAY FILL - trace sand - occasional topsoil layers - very stiff to stiff - dark gray - (CL-Fill)
SS-2	18		
			NOTE: Driller Reported No Aggregate Base Present Below the PCC Pavement
			End of Boring (ft): 5.0'

Moisture Content (%) - circles
N-Value (blows/ft) - squares



Unconfined Compressive Strength (tsf) - triangles

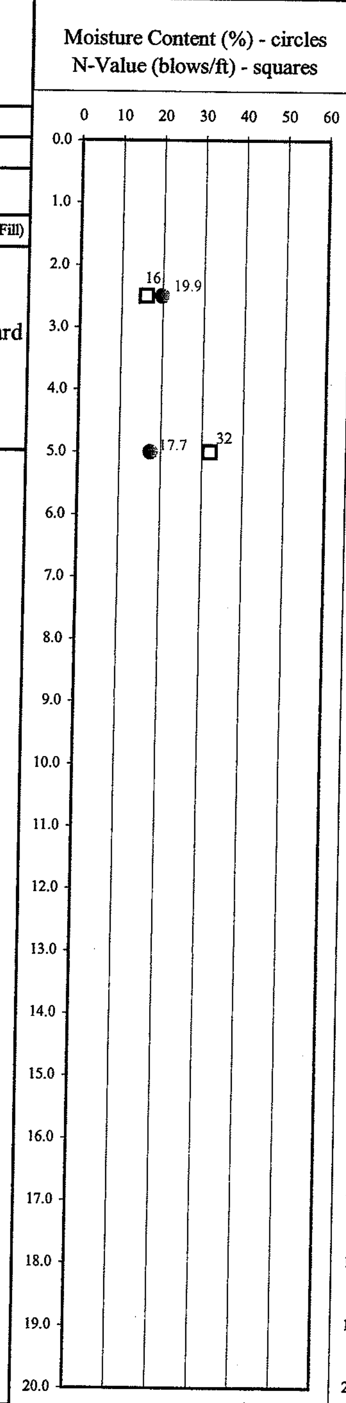


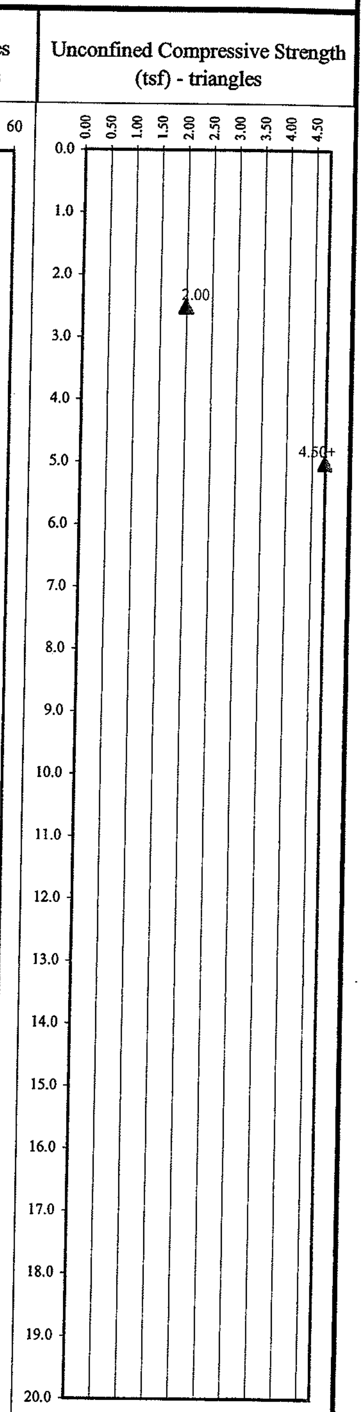
Water Level Observations:	**Boring Started:** 9/27/07	**Approved:** [signature]
While Drilling: Dry	**Boring Completed:** 9/27/07	
At Completion: Dry	**Rig:** CME 55	**Drawn By:** AH
Cave-In At:	**Driller:** J. Faitel	

Project: City of Ann Arbor 2008 Road Construction Project
Client: City of Ann Arbor
Location: Ann Arbor, Michigan
Project #: 07-1192 **Boring Log #:** C-20

TES CONSULTANTS, P.C.
23943 Industrial Park Drive
Farmington Hills, MI 48335
Ph: (248) 615-3000 Fx: (248) 615-3512

Sample No./Type	Recovery (in.)	Depth (ft.)	Description of Material
		0	Ground Surface Elevation =
			5.75" Bituminous Concrete Pavement
		1	8.5" PCC Pavement
SS-1	18		FINE TO MEDIUM SAND FILL - trace sand and gravel - moist - brown - (SP-SM-Fill)
		2–5	SILTY CLAY - trace sand and gravel - very stiff to hard - mottled brown and gray - (CL)
SS-2	18		
		20	End of Boring (ft): 15.0'





Water Level Observations:
While Drilling: Dry
At Completion: Dry
Cave-In At:

Boring Started: 9/28/07
Boring Completed: 9/28/07
Rig: CME 55
Driller: J. Faitel

Approved: [signature]
Drawn By: AH

CTI and Associates, Inc.

GEOTECHNICAL INVESTIGATION
STADIUM BOULEVARD RECONSTRUCTION
ANN ARBOR, MICHIGAN
CTI PROJECT NO. 3142040052

Revised: May 15, 2015

Prepared For:

Northwest Consultants, Inc.
3220 Central Park West
Toledo, Ohio 43617

Prepared by:

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Revised: May 15, 2015

Mr. Andrew Kilpatrick, P.E.
Northwest Consultants, Inc.
3220 Central Park West
Toledo, Ohio 43617

RE: Geotechnical Investigation
Stadium Boulevard Reconstruction
Ann Arbor, Michigan
CTI Project No. 3142040052

Dear Mr. Kilpatrick:

As requested, CTI and Associates, Inc. (CTI) has completed a geotechnical investigation for the proposed Stadium Boulevard Reconstruction project in the city of Ann Arbor, Washtenaw County, Michigan. The enclosed report presents the results of our findings and an engineering interpretation of these with respect to the soil related phases of the project including support of pavements and utilities, retaining walls and construction recommendations.

In general, the geotechnical investigation revealed that Stadium Boulevard was typically covered with 3 to 7 inches of asphalt pavement underlain by 4 to 12 inches of concrete pavement. A defined aggregate base layer was observed in only five of the nineteen borings performed along Stadium Boulevard. The subgrade soils typically consisted of 3 to 6 feet of sand and clay fill, underlain by apparently native loose to medium dense sand and stiff to hard clay layers. Isolated organic clay seams and very loose/medium stiff soils were encountered. On the remaining streets, the encountered pavement sections typically consisted of 4 to 8 inches of asphalt with 4 to 12 inches of aggregate base. The subgrade soils generally consisted of loose to dense sand and stiff to hard clay. Some near surface fill and isolated organic soils were encountered. Recommendations for subgrade preparation, pavement support, retaining walls, and soil permeability for use in designing storm water controls are included in the report sections that follow to aid design.

We appreciate the opportunity to be of service to you on this project. If you have any questions regarding this report or if we can be of further assistance, such as providing field monitoring and quality control inspection services during construction, please contact our office.

Sincerely,

CTI and Associates, Inc.

Theresa M. Marsik, P.E., LEED AP
Senior Project Engineer

Kevin Foye, Ph.D., P.E.
Project Engineer

CTI and Associates, Inc.

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CTI and Associates, Inc.

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GEOTECHNICAL INVESTIGATION
STADIUM BOULEVARD RECONSTRUCTION
ANN ARBOR, MICHIGAN
CTI PROJECT NO. 3142040052

REVISED: MAY 15, 2015

1.0 INTRODUCTION

1.1. General

This report presents the results of the geotechnical investigation performed by CTI and Associates, Inc. (CTI) for the proposed Stadium Boulevard Reconstruction project. The proposed reconstruction area includes W. Stadium Boulevard from Hutchins to S. Main Street, E. Stadium Boulevard from S. Main Street to Kipke Drive, and portions of S. Main Street, Potter Avenue, Prescott Avenue and Edgewood Avenue in the city of Ann Arbor, Washtenaw County, Michigan.

In general, the geotechnical investigation revealed that Stadium Boulevard was typically covered with 3 to 7 inches of asphalt pavement underlain by 4 to 12 inches of concrete pavement. A defined aggregate base layer was observed in only five of the nineteen borings performed along Stadium Boulevard. The subgrade soils typically consisted of 3 to 6 feet of sand and clay fill, underlain by apparently native loose to medium dense sand and stiff to hard clay layers. Isolated organic clay seams and very loose/medium stiff soils were encountered. On the remaining streets, the encountered pavement sections typically consisted of 4 to 8 inches of asphalt with 4 to 12 inches of aggregate base. The subgrade soils generally consisted of loose to dense sand and stiff to hard clay. Some near surface fill and isolated organic soils were encountered. Recommendations for subgrade preparation, pavement support, retaining walls, and soil permeability for use in designing storm water controls are included in the report sections that follow to aid design.

Our evaluation was performed in general accordance with the scope of services outlined in CTI Proposal No. 114PR02040-116 dated June 16, 2014 with preliminary authorization provided by Mr. Andrew Kilpatrick, P.E. of Northwest Consultants, Inc. (NCI) on July 23, 2014. Final authorization was predicated on NCI receiving their final contract from the City of Ann Arbor, which occurred in mid-October, 2014.

1.2. Purpose and Scope

The purpose of this study was to determine the general subsurface conditions at the site by drilling test borings and to evaluate the data collected while drilling with respect to site development requirements for the proposed project. Specifically, the report presents our evaluations and recommendations regarding the following items:

A. General subsurface (soil and groundwater) conditions at the site.

B. Design recommendations: These include allowable bearing pressures for retaining wall and traffic signal mast arm foundations, recommendations for retaining walls, recommendations regarding soil permeability and infiltration, support of pavements, and flexible and rigid pavement designs based on provided traffic count data.

C. Construction recommendations: These include site preparation and earthwork operations, groundwater conditions and controls, potential construction problems and recommendations regarding quality control during construction.

The evaluations and recommendations discussed in this report are based on the soil conditions encountered in the test borings performed at the specific boring locations, and on the date indicated on the boring logs. The soil conditions may vary at locations other than the actual soil boring locations. These variations may not become evident until the time of construction.

If variations in the reported soil conditions are encountered, CTI should be contacted immediately. In such a case, it may be necessary for CTI to reevaluate the recommendations of this report. Such a reevaluation may be possible from on-site observations or may require additional investigations. If any such variations are revealed, they may result in increased construction costs. A contingency should be provided in the project budget to accommodate such variations.

CTI's authorized scope of services included a geotechnical study of the subject site with limited environmental sampling and analytical testing. It did not include an environmental assessment for determining the presence or absence of hazardous or toxic materials in the soil or groundwater at, below or around the site. Any statement contained within this report or presented on the soil boring logs regarding odors, colors or unusual items are strictly for informational purposes only.

2.0 SITE AND PROJECT CHARACTERISTICS

2.1. Site Conditions

The project extents include W. Stadium Boulevard from Hutchins to S. Main Street, E. Stadium Boulevard from S. Main Street to Kipke Drive, S. Main Street from about 350 feet north to 350 feet south of Stadium Boulevard, Potter Avenue from S. Seventh Street to Edgewood Avenue, Edgewood Avenue from W. Stadium Boulevard to Potter Avenue, and Prescott Avenue from W. Stadium Boulevard to Potter Avenue in the city of Ann Arbor, Washtenaw County, Michigan. Each roadway was covered by asphalt pavement. The age of the pavement was not provided. Several areas of pavement distress were observed on each roadway, indicative of multiple years of service. In some isolated areas, pavement distress indicated subgrade instability.

NCI provided the ground surface elevation at each boring location. Based on our visual observations and the provided topographic information, W. Stadium Boulevard sloped downward toward the east with a maximum elevation difference from Hutchins to S. Main Street of up to 23 feet. From S. Main Street to Kipke Drive, E. Stadium Boulevard sloped downward toward the east with a maximum elevation difference of up to 30 feet. In general, the remaining roadways that are oriented north-south (S. Main, Edgewood and Prescott) sloped downward away from Stadium and then sloped upward toward the north. Potter Avenue sloped downward toward to west with a maximum elevation difference of up to 8 feet.

2.2. Project Description

The proposed project includes the reconstruction of Stadium Boulevard from Hutchins to Kipke Drive. In addition to the complete reconstruction of the roadway, the project will aim to improve pedestrian features and maintain the design elements and aesthetic features from recently completed projects along East and West Stadium Boulevard. Elements of the design will include:

- A continuation of the 8-foot wide path along the south side of E. Stadium, from Main Street to the U-M Golf Course;
- Retaining walls associated with the 8-foot wide path;
- On-street bicycle lanes;

- The relocation of a pedestrian island;
- Upsizing the existing 20-inch diameter raw water main, between U-M Golf Course and proceeding west to Prescott, then north to Potter, and west to S. Seventh;
- Replacing and upsizing the existing 6-inch diameter domestic water main within W. Stadium, from Main Street to the western project limits;
- Storm water improvements;
- Traffic signal mast arm and poles at the Stadium Boulevard and Main Street intersection.

The location of the traffic signal mast arms has not yet been determined. Once the location has been selected, additional field exploration will be performed and an addendum letter to this report will be issued.

We anticipate that the top of pavement elevation will match the existing pavement grades. The proposed utility bearing elevations are anticipated to be at or slightly below the existing utility bearing elevations.

The recommendations presented in this report are based on the provided and/or assumed project information and the results of our geotechnical exploration. Once the design conditions have been finalized, or if any of the above noted project information is considered incorrect or is changed, CTI should be informed in writing so that a review can be performed and any necessary revisions to our recommendations can be made.

3.0 INVESTIGATION PROCEDURES

NCI provided CTI with a final proposed boring location plan and revised scope of field services on November 3, 2014. CTI marked the soil borings in the field on November 4, 2014 based on the provided boring location plan and on the existing site conditions. Falling Weight Deflectometer (FWD) testing was performed by Applied Research Associates, Inc. (ARA) on November 6, 2014. After determining that the utilities had been marked and relocating the proposed boring locations so that they were not in conflict with the marked utilities, the drilling operations began on November 10, 2014 and concluded on November 14, 2014.

3.1. Field Investigation – Falling Weight Deflectometer

FWD testing is used to measure the ability of pavement to bear its working load, by measuring the vertical deflection response of the tested pavement surface to a series of impulse loads. When combined with pavement layer thickness obtained from the drilling operations, the subgrade resilient modulus (Mr) can be determined for use in pavement design using FWD data. As requested by the project team, ARA performed the FWD testing at the approximate boring locations – both on Stadium Boulevard and the explored side streets – on November 6, 2014. Using the pavement thickness information from the boring logs, ARA backcalculated the pavement and subgrade moduli to determine the Mr and modulus of subgrade reaction (k-value) for use in CTI's pavement design analysis.

3.2. Field Investigation – Drilling Activities

Our field investigation consisted of drilling forty soil borings at the subject site. For ease of marking in the field, the borings were denoted B-1 through B-40. Once the borings were completed, the borings were renamed their assigned designation, FF-01, FF-02, FFSB-01 through FFSB-06, RWFF-01 through RWFF-03, and SB-01 through SB-29. The number, depth and general locations of the soil borings were selected by Northwest Consultants, Inc. and the City of Ann Arbor. The borings were extended to depths ranging from approximately 5 to 30 feet below the existing ground surface.

CTI had originally planned to perform RWFF-01 and RWFF-02 to a depth of 25 feet. However, the borings were extended to a depth of 30 feet in an effort to find a sand layer suitable for infiltration at a reasonable depth. A sand layer was not encountered; therefore, the borings were terminated at 30 feet.

The borings were located in the field by CTI personnel. Ground surface elevations at the soil boring locations were provided by NCI on December 22, 2014. The approximate locations of the soil borings are shown on the Boring Location Plan sheets prepared by NCI, which have been included in the Appendix of this report.

The drilling operations were performed by Brax Drilling, under the direction of CTI personnel, on November 10th through November 14th, 2014 utilizing a truck-mounted drill rig. Typically, the shallow (5-foot) soil borings were advanced using continuous flight solid-stem augers. One soil boring (SB-10) was advanced using a hand auger due to the proximity of the existing utilities to the planned boring location and any potential offset locations. The deeper soil borings were advanced using continuous flight hollow-stem augers. Soil samples were obtained at intervals of 2½ feet within the upper 15 feet and at intervals of 5 feet thereafter. The soil samples were obtained by the Standard Penetration Test Method (ASTM D1586), whereby a 2-inch outside diameter split-barrel sampler is driven into the soil with a 140-pound weight falling freely through a distance of 30 inches. The sampler is generally driven three successive 6-inch increments, with the number of blows for each increment being recorded. The combined number of blows required to advance the sampler the second and third 6-inch increments is termed the Standard Penetration Resistance, N. A limited number of liner samples were obtained in conjunction with the split barrel sampler in an effort to determine the in-situ density of granular soils. The soil samples obtained with the split-barrel sampler were sealed in glass jar containers and transported to our laboratory for further classification and testing. After completion of the drilling operations, the boreholes were backfilled with excavated soil (i.e., auger cuttings) and patched with a cold asphalt patch.

Soil and groundwater conditions observed in the test borings have been evaluated and are presented on the Borings Logs included in the Appendix. To aid in understanding the data presented on the boring logs, “General Notes for Soil Classification,” describing nomenclature used in soil descriptions, are also included in the Appendix. It should be noted that the soil descriptions reported on the test boring logs are based upon field logs prepared by experienced drillers with modifications made based on the results of laboratory testing and engineering review.

3.3. <u>Laboratory Testing – Geotechnical</u>

The laboratory testing program was directed towards determining the general soil classification and physical properties of the soil pertinent for pavement design, storm water system improvements and site preparation. All laboratory testing was performed in general accordance with applicable ASTM test method standards. The laboratory testing consisted of visual soil classification of every sample; and grain size analysis, constant head and falling head permeability testing, unconfined compressive strength testing, natural density and moisture content determination, loss-on-ignition (organic content) testing and corrosivity testing (pH, oxidation-reduction potential, and soil resistivity) testing of selected samples. The unconfined compressive strength of several cohesive samples was also estimated based on the resistance to a calibrated spring-loaded hand penetrometer.

The soil samples were visually classified in general accordance with the Unified Soil Classification System (USCS). The estimated USCS group symbol is shown in parentheses following the written description of the various natural strata on the test boring logs. The results of all laboratory tests are indicated on the boring logs at the depths the samples were obtained and/or on the “Summary of Laboratory Test Results” included in the Appendix.

3.4. <u>Laboratory Testing – Analytical</u>

Due to client-expressed concerns about the presence of hydrocarbon-contaminated soils in the vicinity of a former LUST site at the northwest corner of Stadium and Main and concerns about Michigan metals in the soils within the project limits, CTI obtained representative soil samples for analytical testing. Samples for metals were placed in laboratory prepared glass jars and placed in a cooler with ice until transported to the laboratory under appropriate chain of custody protocol. Samples for volatile organic compound (VOC) analysis were collected and preserved in accordance with USEPA Method 5035 (methanol preservation) and placed in a cooler with ice until transported to the laboratory under appropriate chain of custody protocol. The analytical results are included in the Appendix and are for information only. CTI’s scope did not include environmental recommendations for this project.

4.0 GENERAL SUBSURFACE CONDITIONS

The following paragraphs present generalized soil and groundwater conditions encountered at the subject site based on the available test borings. For a more detailed description of the subsurface conditions encountered at the site, please refer to the individual soil boring logs and the Boring Location Plan sheets provided in the Appendix.

4.1. Soil Conditions

4.1.1. Soil Conditions – Stadium Boulevard

A total of nineteen soil borings were performed along Stadium Boulevard, from just west of Prescott Avenue to approximately 150 feet west of Kipke Drive. The borings performed along Stadium Boulevard included FF-01, FF-02, FFSB-01 through FFSB-05, RWFF-01 through RWFF-03, and SB-01 through SB-09.

Pavement Section

Approximately 3 to 7 inches of asphalt pavement was encountered at the boring locations. The asphalt pavement was typically underlain by 4 to 12 inches of concrete pavement, except at the locations of FF-02 and FFSB-04 where concrete pavement was not encountered. Below the pavement encountered at FFSB-01, FFSB-03, FFSB-04, FF-01, FF-02, SB-03 and SB-05, approximately 5 to 12 inches of aggregate base material was encountered. A defined aggregate base layer was not encountered at the remaining boring locations along Stadium Boulevard.

Fill/Possible Fill Material

Layers of sand and/or clay fill materials were encountered below the pavement sections at the locations of Borings FF-01, FFSB-01 through FFSB-03, FFSB-05, RWFF-01, SB-02 through SB-04, and SB-08. The fill/possible fill materials extended to the final explored depth of SB-02 and SB-04, and to depths of 3 to 6 feet below the existing pavement surface at the remaining borings. In the absence of foreign debris, it is difficult to distinguish between native soils and clean fill within a relatively small diameter boring.

Loss-on-ignition testing was performed on the fill materials encountered within FF-01, FFSB-03, FFSB-05, RWFF-01, SB-02, and SB-04. Loss-on-ignition testing indicated that the tested samples had an organic content in the range of approximately 2.1 to 3.8 percent.

Below the fill encountered within FFSB-02, apparently native organic-containing clay was encountered to a depth of 7¼ feet below the existing pavement surface. Loss-on-ignition testing indicated that the tested sample had an organic content of approximately 2.5 percent.

Brown/Mottled Brown and Gray Clay

Below the pavement sections encountered at FF-02, FFSB-04, RWFF-02, SB-01, SB-06, SB-07, and SB-09; below the fill materials encountered within FF-01, FFSB-01, FFSB-03 through FFSB-05, RWFF-02, and SB-03; and below the organic-containing clay encountered within FFSB-02, apparently native brown/mottled brown and gray clay was encountered. The brown/mottled brown and gray clay layer extended to the final explored depths of SB-01, SB-03, SB-06 and SB-07; and to depths ranging from 3 to 12½ feet below the existing grade at the remaining boring locations.

The Standard Penetration Test (SPT) resistance (N) values recorded within this stratum typically ranged from 7 to 21 blows per foot. The unconfined compressive strength of the tested samples typically ranged from approximately 3,000 pounds per square foot (psf) to more than 9,000 psf, indicating stiff to hard consistencies. The moisture contents of representative clay samples from this stratum ranged from approximately 12 to 27 percent. The brown/mottled brown and gray clay samples appeared to be in a moist condition when examined in the laboratory.

Granular Soils

Below the pavement section encountered at RWFF-03 and SB-05; below the fill materials encountered within SB-08; and below the brown/mottled brown and gray clay layer within FF-01, FF-02, FFSB-0 through FFSB-05, and SB-09, granular soils of varying gradation containing varying amounts of silt and clay were encountered. The granular soils extended to the final explored depths of FF-02, FFSB-03, RWFF-03, SB-05, SB-08 and SB-09, and to depths of 9 to 24½ feet within the remaining borings.

N-values recorded within the granular soils encountered to a depth of about 18 feet typically ranged from 2 to 7 blows per foot, indicating very loose to loose relative densities. Below a depth of about 18 feet, the N-values recorded within the granular soils typically ranged from 11 to 27 blows per foot, indicating a medium dense relative density.

Higher N-values of 11 to 19 blows per foot were encountered within FFSB-05 and RWFF-03 to depths of 11 and 5 feet, respectively. Within FF-02, N-values for the entire explored depth of the boring ranged from 18 to 35 blows per foot, indicating medium dense to dense relative densities.

The granular samples appeared to be in a moist to wet condition when examined in the laboratory.

Gray Clay

Below the fill materials encountered within RWFF-01; below the brown/mottled brown and gray clay encountered within FFSB-01 and RWFF-02; and below the granular soils encountered within FF-01, FFSB-02, FFSB-04 and FFSB-05, gray clay was encountered. The gray clay stratum extended to a depth of about 15½ feet within FFSB-01 and to the final explored depths of the remaining borings.

N-values recorded within the gray clay typically ranged from 8 to 14 blows per foot. A higher N-value of 52 blows per foot was recorded at a depth of 25 feet within FF-01 due to cobbles. The unconfined compressive strength of the tested samples typically ranged from approximately 3,000 psf to more than 9,000 psf, indicating stiff to hard consistencies. The moisture contents of representative clay samples from this stratum ranged from approximately 8 to 18 percent. The gray clay samples appeared to be in a moist condition when examined in the laboratory.

Granular Soils

Below the gray clay encountered within FFSB-01, silty sand was encountered to a depth of 20 feet. An N-value of 26 blows per foot was recorded within the silty sand, indicating a medium dense relative density. The silty sand samples appeared to be in a moist to wet condition when examined in the laboratory.

Gray Clay

The silty sand encountered within FFSB-01 was underlain by gray clay to the final explored depth of 25 feet. An N-value of 20 blows per foot was recorded within the gray clay layer. The unconfined compressive strength of the tested sample was approximately 5,000 psf, indicating a very stiff consistency. The moisture content of the tested clay sample from this stratum was approximately 8 percent. The gray clay sample appeared to be in a moist condition when examined in the laboratory.

4.1.2. Soil Conditions – S. Main Street

A total of eight soil borings were performed along S. Main Street, from approximately 350 feet south to 350 feet north of Stadium Boulevard. The borings performed along S. Main Street included SB-10 through SB-17.

Pavement Section

Approximately 6 to 8 inches of asphalt pavement was encountered at the boring locations, underlain by approximately 6 to 12 inches of aggregate base material. A defined aggregate base layer was not encountered within SB-13 through SB-15.

Fill Material

Layers of sand and/or clay fill materials were encountered below the pavement sections at the locations of Borings SB-16 and SB-17. The fill materials extended to the final explored depth of SB-16 and to a depth of about 4¾ feet within SB-17.

Granular Soils

Below the pavement section encountered at SB-10 through SB-15, granular soils of varying gradation containing varying amounts of silt were encountered. The granular soils extended to the final explored depths of SB-10 and SB-15, and to depths of about 3 feet within the remaining borings.

N-values recorded within the granular soils typically ranged from 12 to 21 blows per foot, indicating a medium dense relative density. A higher N-value of 41 blows per foot was recorded within SB-15, indicating a dense relative density. The granular samples appeared to be in a moist condition when examined in the laboratory.

Brown/Mottled Brown and Gray Clay

Below the fill material encountered within SB-17 and below the granular soils encountered within the remaining borings, brown/mottled brown and gray clay was encountered to the final explored depths of the borings.

The N-values recorded within the clay ranged from 7 to 13 blows per foot. The unconfined compressive strength of the tested samples ranged from approximately 5,000 psf to more than 9,000 psf, indicating very stiff to hard consistencies. The moisture contents of representative clay samples from this stratum ranged from approximately 14 to 16 percent. The clay samples appeared to be in a moist condition when examined in the laboratory.

4.1.3. Soil Conditions – Potter Avenue

A total of six soil borings were performed along Potter Avenue, from S. Seventh Street to Edgewood Avenue. The borings performed along Potter Avenue included SB-18 through SB-23.

Pavement Section

Approximately 5 to 6 inches of asphalt pavement was encountered at the boring locations, underlain by approximately 6 to 18 inches of aggregate base material.

Fill Material

Clay fill materials were encountered below the pavement sections at the locations of Borings SB-19 and SB-20. The fill materials extended to a depth of about 3 feet.

Loss-on-ignition testing was performed on the fill material encountered within SB-19. Loss-on-ignition testing indicated that the tested sample had an organic content of approximately 3.9 percent.

Brown/Mottled Brown and Gray Clay

Below the pavement sections encountered at SB-18 and SB-21 through SB-23, and below the fill material encountered within SB-19 and SB-20, apparently native brown/mottled brown and gray clay was encountered to the final explored depths of the borings.

The N-values recorded within the clay ranged from 6 to 26 blows per foot. The unconfined compressive strength of the tested samples ranged from approximately 2,000 psf to more than 9,000 psf, indicating stiff to hard consistencies. The moisture contents of representative clay samples from this stratum ranged from approximately 13 to 20 percent. The clay samples appeared to be in a moist condition when examined in the laboratory.

4.1.4. Soil Conditions – Prescott Avenue

A total of five soil borings were performed along Prescott Avenue from W. Stadium Boulevard to Potter Avenue. The borings performed along Prescott Avenue included SB-24 through SB-28.

Pavement Section

Approximately 4 to 5 inches of asphalt pavement was typically encountered at the boring locations, underlain by approximately 4 to 14 inches of aggregate base material. A defined aggregate base layer was not encountered at the location of SB-27.

Fill Material

Layers of sand and/or clay fill materials were encountered below the pavement sections at the locations of Borings SB-26 through SB-28. The fill materials extended to the final explored depth of SB-26, and to depths of 2½ to 3 feet below the existing pavement surface at SB-27 and SB-28.

Loss-on-ignition testing was performed on the fill materials encountered within SB-26, and SB-28. Loss-on-ignition testing indicated that the tested samples had an organic content in the range of approximately 4.0 to 5.4 percent.

Brown/Mottled Brown and Gray Clay

Below the pavement sections encountered at SB-24 and SB-25 and below the fill materials encountered within SB-27 and SB-28, apparently native brown/mottled brown and gray clay was encountered. The brown/mottled brown and gray clay layer extended to the final explored depths of SB-24, SB-27 and SB-28; and to a depth of about 2½ feet below the existing grade at SB-25.

N-values recorded within this stratum typically ranged from 6 to 20 blows per foot. The unconfined compressive strength of the tested samples typically ranged from approximately 3,000 psf to more than 9,000 psf, indicating stiff to hard consistencies. The moisture contents of representative clay samples from this stratum ranged from approximately 11 to 18 percent. The brown/mottled brown and gray clay samples appeared to be in a moist condition when examined in the laboratory.

Granular Soils

Below the clay encountered within SB-25, silty sand was encountered to the final explored depth of the boring. An N-value of 8 blows per foot was recorded within the silty sand, indicating a loose relative density. The silty sand appeared to be in a moist condition when examined in the laboratory.

4.1.5. Soil Conditions – Edgewood Avenue

A total of two soil borings were performed along Edgewood Avenue from W. Stadium Boulevard to Potter Avenue. The borings performed along Edgewood Avenue included FFSB-06 and SB-29.

Pavement Section

Approximately 6 inches of asphalt pavement was encountered at the boring locations. A defined aggregate base layer was not encountered at the boring locations on Edgewood Avenue.

Fill Material

Layers of sand or clay fill materials were encountered below the surficial pavement. The fill materials extended to depths of 3 to 4 feet below the existing pavement surface

Below the fill encountered within FFSB-06, apparently native organic-containing clay was encountered to a depth of 6½ feet below the existing pavement surface. Loss-on-ignition testing indicated that the tested sample had an organic content of approximately 4.6 percent.

Brown Clay

Below the fill materials encountered within SB-29, apparently native brown clay was encountered to the final explored depth of 5 feet. An N-value of 13 blows per foot was recorded within this stratum. The unconfined compressive strength of the tested sample was approximately 6,000 psf, indicating a very stiff consistency. The moisture content of representative clay sample from this stratum was 15 percent. The brown clay sample appeared to be in a moist condition when examined in the laboratory.

Granular Soils

Below the organic-containing clay encountered within FFSB-06, apparently native granular soils containing some silt were encountered to a depth of 23¾ feet. N-values recorded within the granular soils ranged from 2 to 6 blows per foot, indicating very loose to loose relative densities. The granular samples appeared to be in a moist to wet condition when examined in the laboratory.

Gray Clay

Below the granular soils, gray clay with occasional sand seams was encountered to the final explored depth of FFSB-06. An N-value of 13 blows per foot was recorded within the gray clay. The unconfined compressive strength of the tested sample was approximately 6,500 psf, indicating a very stiff consistency. The moisture content of the representative clay sample from this stratum was approximately 18 percent. The gray clay sample appeared to be in a moist condition when examined in the laboratory.

The above subsurface description is of a generalized nature, and is intended to highlight the major stratification features and material characteristics. The individual test boring logs should be reviewed for specific information. The stratification depths shown on the test boring logs represent the soil conditions at the actual boring locations only. Variations may occur between and/or beyond the boring locations. The nature and extent of any variations may not become evident until the time of construction. If significant variations in the soil conditions are discovered during construction, it should be immediately brought to the attention of CTI, before removal.

4.2. Groundwater Conditions

During drilling of the soil borings, groundwater seepage or perched water was encountered within FF-01, FF-02, FFSB-01, FFSB-05, FFSB-06, RWFF-03, SB-05 and SB-08 at depths in the range of 3½ to 23 feet (Elevation 851.5 to 902.9 feet). Collapse of the boreholes upon removal of the augers precluded accurate measurement of the groundwater level following drilling operations. Groundwater seepage was not observed either during or after the drilling operations within the remaining test borings.

The short-term groundwater level observations from the borings are not necessarily indicative of the static, long-term groundwater conditions. The groundwater within cohesive soil deposits (clays) is typically confined within discontinuous sand or silt seams interbedded within the clay soil. Drilling operations in these soils have a tendency to seal off the paths of groundwater flow due to the slurry created during drilling. Seams of water-bearing sand or silt are possible at various depths and locations within the native clay soils. Groundwater seepage through the clays soils at this site will depend highly on the frequency of sand seams present within the soil.

Due to the inherent low permeability of the native clay soils, a long time would be required for the water level in an open borehole to stabilize with the long-term, hydrostatic groundwater level. It would be necessary to install and monitor a series of observation wells (piezometers) over an extended period of time to accurately determine the position of the long-term hydrostatic groundwater level in these soil conditions. The installation of groundwater monitoring wells was beyond the scope of our services for this project.

Normally, if a boring is drilled in cohesive soils, groundwater may not reach a static level immediately after drilling. The groundwater may rise or fall to a static level if the boring is left open for an extended period of time, possibly several days. The depth at which the soil color changes from brown to gray is often an indication of the long-term piezometric level. This color change generally results from the lack of oxidation in the soil below the zone of saturation. Based on the results of the test borings, the long-term piezometric level at this site appears to typically be at depths in the range of 4 to 24½ feet (approximately Elevation 854.4 to 897.9 feet).

The groundwater conditions discussed herein and indicated on the soil boring logs represent those encountered at the time of the field investigation. The groundwater levels, including perched groundwater accumulations, should be expected to fluctuate seasonally, based on variations in precipitation, evaporation, surface run-off and other factors not evident at the time of our investigation. The actual groundwater levels at the time of construction may vary from those provided herein.

The above soil and groundwater conditions represent a generalized summary of the subsurface conditions and material characteristics. The individual Boring Logs and Boring Location Plan sheets should be reviewed for specific information and details relating to specific areas of the site.

4.3. Corrosivity Testing

Corrosivity testing consisting of pH determination, resistivity testing and oxidation-reduction potential testing were performed in our laboratory on the representative samples collected at depths of about 5 feet. The American Water Works Association (AWWA) developed an American National Standard – ANSI/AWWA C105/A21.5 – that addressed the need for polyethylene encasement for ductile iron pipes. The corrosivity testing was performed in accordance with the Soil Survey Tests and Observations section of that standard, which assigns a number of points based on the results of the corrosivity testing. If a soil meets or exceeds a score of 10 points, the standard states that the soils are corrosive to ductile iron pipe and protection is needed. The results of our laboratory corrosivity tests are presented in Table 1 below. Table 1 also presents the points assigned by the AWWA standard based on the test results.

Table 1. Corrosivity Test Results						
Boring Number	Resistivity (ohm-cm)	pH	Oxidation-Reduction Potential (mV)	Sulfides (Negative, Trace or Positive)	Moisture (Poor, Fair or Good Drainage)	Total Points per ANSI/AWWA C105/A21.5 (not including Sulfides)
SB-01	2,700	7.79	202	Not Tested	Poor	3
FFSB-02	2,750	7.81	205	Not Tested	Poor	3
SB-07	1,830	9.06	182	Not Tested	Poor	10
RWFF-01	2,220	8.77	262	Not Tested	Poor	7
RWFF-03	2,000	8.13	241	Not Tested	Good	5
SB-15	1,580	8.96	172	Not Tested	Good	11
SB-11	5,790	8.78	214	Not Tested	Poor	5
SB-21	1,670	8.67	236	Not Tested	Poor	13
SB-24	3,000	8.49	243	Not Tested	Poor	3
SB-29	2,000	8.03	203	Not Tested	Poor	7

Based on the test results, three of the ten tested samples (highlighted in Table 1) indicate the soil to be highly corrosive to ductile iron pipe, meeting or exceeding the 10 point threshold requiring protection in the AWWA standard. The test results for four additional samples indicate that the soil at those locations are moderately corrosive to ductile iron pipe. The presence of sulfides in the soil samples was not tested. If a soil tests positive for sulfides, the maximum additional points that would be assigned would be 3.5. Conservatively assuming the presence of sulfides, 80 percent of the tested soil would classify as moderately to highly corrosive to ductile iron pipe. In accordance with the AWWA guidelines, we recommend a provision for polyethylene encasement of ductile iron pipes be made in the contract documents.

5.0 ANALYSIS AND DESIGN RECOMMENDATIONS

At the time this report was prepared, the overall project was in the planning and design stage. The following recommendations have been developed based on the previously assumed/described project characteristics and subsurface conditions. If there is any significant change in the project characteristics from those presented earlier, a review should be made by CTI to determine if any modifications in the evaluations and recommendations included in this report will be required.

As mentioned previously, the proposed project includes replacing and upsizing the 20-inch diameter raw water main that runs along Stadium Boulevard from the U-M Golf Course west to Prescott, north to Potter, and then west to Seventh Street. The new raw water main will be 30-inch diameter ductile iron pipe. The project also includes replacing and upsizing the existing 6-inch diameter domestic water main that runs along Stadium from S. Main Street to the western limits of the project. The new domestic water main is anticipated to be 8-inch diameter ductile iron pipe. Storm water improvements, which include treatment of both the first flush and bank-full rain events, are also planned. The proposed depths and alignments of the new utility lines have not been provided. Based on review of existing utility data, we anticipate that the existing storm and sanitary sewer lines are located approximately 8 to 10 feet below the existing grade, and the existing water lines are located approximately 5 to 8 feet below the existing grade.

Based on the available soil and project information, the explored portions of the roadway rights-of-way appear to be suitable for installation of the proposed utilities using either open-cut excavation or directional drilling methods. Based on the available project information, CTI anticipates that the majority of the utility lines will be constructed utilizing open-cut excavations. Where open cut excavations are made in the vicinity of at-grade structures (e.g. retaining walls, light poles, sidewalks, etc.) or adjacent utilities, some measure of shoring will be necessary to protect those structures.

In general, granular and/or cohesive fill materials containing varying amounts of organics were encountered to varying depths across portions of each explored roadway. The presence and thickness of fill materials and/or organic-containing soils may vary across the project limits. Some of the existing fill (where present) will likely be removed during open-cut excavation for utility construction. If the owner is willing to assume the risks related to decreased pavement life/serviceability by doing so, some or all of the remaining fill could be left in place for pavement support, following proper subgrade preparation activities described in this report.

5.1. <u>Utility Installation Recommendations – Open Cut Method</u>

In general, the placement of utility lines within the soil profile does not greatly increase the load on the underlying soil. However, it is important that the utility pipe be placed on a firm and stable subgrade, along the design alignment and at the proper grade to prevent the pipe from becoming over-stressed in hoop compression or bending.

Based on the available project information, we anticipate that the invert elevations (bottom of pipe) of new storm and sanitary sewer lines will be located approximately 8 to 10 feet below the existing pavement surface, and the invert elevations of new water lines will be located approximately 5 to 8 feet below the existing pavement surface. Based on the soil conditions encountered at the boring locations, the soil at the utility invert elevation along Stadium Boulevard is anticipated to be stiff to hard clay and/or very loose to loose sands. Based on FFSB-06, performed on Edgewood Boulevard, the soil at the utility invert elevation is anticipated to be organic-containing clay and/or loose sand. The organic-containing clay is not considered suitable for support of the proposed utilities, and should be removed and replaced with suitable engineered fill. The borings on the remaining streets were primarily performed to facilitate pavement design. However, based on the soils encountered within the test borings, we anticipate that the soils present at the utility invert elevations will be similar to those encountered along Stadium Boulevard.

All excavations should comply with MIOSHA guidelines, as described in Section 5.3 of this report. After excavating to the proposed utility invert elevation, the exposed soils should be thoroughly inspected to verify that they are in a stable condition. We recommend that the contractor verify the actual groundwater conditions at the time of construction. Depending on the condition of the exposed subgrade soils, it may be necessary to stabilize the soils with a layer of crushed stone prior to placing pipe bedding material.

Additionally, due to the proximity of existing slopes and retaining walls to the proposed utility improvements, additional excavation protection such as shoring/bracing is expected to be required to meet safe excavation requirements and to protect adjacent infrastructure.

In general, sufficient bedding material should be placed and compacted below the utility pipes. Unless the design requirements are otherwise, we recommend a minimum of 6 inches of bedding material be placed below the utility pipe invert elevation. The bedding materials shall be placed in the trench bottom over stable subgrade soils and extend up and around the utility lines and compacted in accordance with the project specifications. Granular backfill around the utility pipes should be tamped in place evenly to avoid imparting excessive and/or unequal pressure on the pipe and to avoid disturbance of the pipe and joints.

Trenches and excavations shall be backfilled as soon as practical after the utility lines have been properly installed. The engineered backfill soils should be placed as described in this report.

5.2. Utility Installation Recommendations – Directional Drilling Method

As mentioned in the previous section, we anticipate the soil at the majority of the pipe invert elevations will consist of stiff to hard clay and/or very loose to loose sands. Based on the test borings, the soils at the proposed invert elevation should generally provide adequate support for the proposed utility lines, provided the soils are free of unsuitable soils and stable at the time of construction.

Based on an evaluation of the data collected during the course of this exploration, directional drilling methods should be satisfactory, where necessary. Special care should be taken to ensure the stability of the unprotected face at the cutting edge. Hard cohesive soils may pose significant resistance during directional drilling and may require advance excavation or drilling ahead of the cutting shield. Methods such as breasting may be required to prevent running ground within granular soils. Lubrication may be necessary around the utility pipe to minimize the frictional resistance associated with directional drilling through granular soils.

The presence of cobbles and boulders would not be unusual within the glacial depositional environment of the project site. Exploratory drill augers, such as those used during performance of this geotechnical exploration, may displace cobbles and boulders, which may prevent advancement of other types of drilling equipment. The directional drilling contractor should be prepared for these occurrences.

The near-surface granular soils are not anticipated to be stable under open cut excavation. Therefore, entrance and exit pits may require shoring, bracing or sheeting.

5.3. Utility Excavations

In general, all excavations should be safely sheeted, shored, sloped or braced in accordance with MIOSHA guidelines. Construction traffic, stockpiles of soil and construction materials should be kept away from the edges of the excavations a lateral distance at least 1.5 times the depth of the excavation.

Utility excavations are generally expected to consist of open-cut methods. In this regard, the utility trench sidewalls should be adequately braced or sloped back to prevent sloughing and caving. In any case, appropriate measures will be required to maintain the stability of excavation sidewalls. The required measures will depend on the depth and width of excavations, groundwater conditions, and adjacent features at specific locations. The excavation support system for utilities could consist of internally braced sheeting, timber lagging, sliding trench shields, or similar suitable measures. If material is stored or equipment is operated near an excavation, stronger shoring must be used to resist the extra pressure due to the superimposed loads.

The angle of the excavation side slopes should be decided based on the soil type and unconfined compressive strength of the excavated soil per MIOSHA requirements. For excavations greater than 5 feet and less than 20 feet in depth, MIOSHA has different sloping requirements for a variety of soil types. The table presented below provides a summary of the requirements for informational purposes only. Prior to designing or constructing a stable and safe excavation, the contractor must refer to MIOSHA standards.

Table 2. Maximum Allowable Angle of Repose for the Side of an Excavation			
Soil Type	Maximum Allowable Excavation Side Slope		Maximum Angle of Repose (Degrees)
	Horizontal	Vertical	
Clay with minimum unconfined compressive strength of 2.5 tsf	1	2	63
Clay with minimum unconfined compressive strength of 1.5 tsf	2	3	56
Clay with minimum unconfined compressive strength of 1.0 tsf; Dry granular soils; Dry sand and clay mixtures	1	1	45
Granular soil with wet clay or silt seams; Clay with a minimum unconfined compressive strength of 1.0 tsf that contains running sand seams	1½	1	34
Saturated granular soil; Clay with an unconfined compressive strength less than 1.0 tsf	2	1	26
Running/sloughing soil (clay or very loose to loose sand)	3	1	18

The contractor is solely responsible for designing and constructing stable and safe temporary excavations and should shore, slope or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor should be aware that slope height, slope inclination and excavation depth should not exceed the specified local, state and federal regulations.

5.4. Storm Water Improvement Considerations

CTI understands that storm water controls designed to divert a portion of the storm water runoff from the existing storm water system and incorporate some measure of below-grade storage or infiltration are desired. To aid in design of such features, CTI performed permeability testing on selected samples from the deeper soil borings. The permeability tests approximated the in-situ relative density and moisture conditions found in the moist sand layers. No permeability tests were performed on saturated sand. The hydraulic conductivity rates presented below will give an indication of the time that it will take for water to move through the existing sand layers at the in-situ moisture content. Since no additional water storage capacity is available in saturated soils, any planned storm water controls should be placed within moist, unsaturated granular soils.

Table 3. Hydraulic Conductivity Rates for Moist Granular Soils			
Boring Number	**Depth of Tested Sample (ft)**	**Sample Description**	**Hydraulic Conductivity K (cm/sec)**
FF-02	3 – 5	SAND (SP-SM) – brown, fine to medium, some silt, trace gravel, medium dense	*7.64×10^{-4}
FFSB-01	15.5 – 18.5	SAND (SM) – brown, fine, with silt, trace of gravel and clay, medium dense	4.38×10^{-4}
FFSB-02	15 – 17	SAND (SM) – brown, fine, with silt, very loose	3.20×10^{-4}
FFSB-03	13 – 16	SAND (SP-SC) – brown, fine, some clay, trace gravel, very loose	1.38×10^{-2}
FFSB-06	8 – 12	SAND (SP-SM) – brown, fine, some silt, traces of gravel and clay, loose	*7.02×10^{-4}
RWFF-03	10 - 13	SAND (SM) – brown, fine, with silt, trace gravel, very loose	1.13×10^{-2}

* The samples from FF-02 and FFSB-06 were compacted to a slightly higher density in the lab than the in-situ density. Therefore, the in-situ hydraulic conductivity rates at these two locations are anticipated to be slightly greater than the test results indicate. We estimate that the in-situ hydraulic conductivity rates within FF-02 and FFSB-06 at the noted depths are on the order of 10^{-3} cm/sec.

In February 2015, CTI was informed that an infiltration trench/detention bed is planned from approximately STA 88+00 to STA 104+00 (W. Stadium from Hutchins to west of Main Street) and STA 113+00 to 119+00 (E. Stadium near the AAGOC). The infiltration trench may be up to 11 feet wide and up to 16 feet deep. CTI understands that MDOT 4AA coarse aggregate will be placed in the bottom 6 feet of the trench, with the remaining upper portion of the trench being backfilled with other materials. We recommend placing a woven geotextile fabric between the MDOT 4AA coarse aggregate and the remaining backfill material so that the upper backfill material does not migrate into the coarse aggregate. The woven geotextile should be selected based on the compatibility between the geotextile's apparent opening size and the backfill placed above it, and the hydraulic requirements of the project. We recommend a Mirafi FW-series woven geotextile be considered for this application.

5.5. Subgrade Preparation

At the start of earthwork operations, all existing pavement and any other deleterious materials should be removed in their entirety from the proposed pavement and utility areas. The presence and thickness of uncontrolled fill and/or unsuitable soils will vary across the project limits. The depth of unsuitable soil to be removed should be determined by CTI at the time of stripping and rough grading. A CTI representative should also be on-site during the subgrade preparation operations to determine the suitability of the subgrade for utility, pavement and/or engineered fill support.

Based on the results of the soil borings, uncontrolled fill materials containing varying amounts of organics are present at approximately half of the explored boring locations. The fill extended to depths of about 3 to 6 feet below the pavement surface. The tested samples of fill material contained 2.1 percent to 5.4 percent organics. Below the fill at two locations (FFSB-02 and FFSB-06), apparently native clay containing 2.5 percent to 4.6 percent organics was encountered to depths of 6½ to 7¼ feet below the existing pavement surface. The fill and organic-containing native soils are not considered suitable for direct support of pavement sections and utilities. Where encountered, we recommend that the existing fill and organic-containing native soils be completely removed from below the proposed utilities and pavement and replaced with engineered fill.

The subgrade soils should be evaluated and prepared during construction as follows. After rough grade has been achieved in cut areas and prior to fill placement in fill areas, the exposed subgrade should be thoroughly proofrolled or proof-compacted. Proofrolling of the pavement subgrade soils should be performed after the completion of utility installation, with a heavily loaded front-end loader, tandem-axle dump truck or other suitable rubber-tired vehicles. Proof-compaction of the utility subgrade soils should be performed with static compaction equipment. The purpose of proofrolling/proof-compacting operations is to locate areas of excessively loose, soft or weak subgrade soils which may be present at the time of construction. Soils that are observed to rut or deflect excessively during proofrolling/proof-compacting should be removed or stabilized by conventional methods such as disking, drying and re-compacting.

If it is not feasible to dry and re-compact the unsuitable subgrade soils due to unfavorable weather conditions, scheduling, etc., it may be necessary to remove such soils and replace them with engineered fill. The thickness of the undercut will depend on the severity of the unstable soils encountered at specific locations. If significant subgrade instability is observed, a layer of crushed aggregate may be necessary to stabilize the subgrade before placement of the selected engineered fill material. The use of a woven geotextile below the crushed aggregate layer could also be considered to provide additional subgrade stability.

5.6. Engineered Fill Placement

After subgrade preparation and observation have been completed, any fill placement required to bring the site to the design subgrade level (i.e. the bottom of the proposed aggregate base course) may begin. Any fill placed below the proposed pavement areas should be an approved material that is free of topsoil, organics, frozen soil or any other unsuitable material. In general, the encountered free-draining granular soils that are free of organics are suitable for re-use as engineered fill. Since any fill and utility backfill placed will be within the influence of the roadways, such fill will need to meet MDOT Class II specifications which allow a maximum of 7 percent fines, per City of Ann Arbor Standard Specifications. At a minimum, CTI recommends that the pipe bedding material and backfill material placed to a minimum of 2 feet over the utility consist of MDOT Class II.

The existing soils encountered in the test borings contained varying amounts of fines (i.e., silt or clay) and was of varying gradation. If the City of Ann Arbor waives the requirement for using MDOT Class II material as backfill and allows the use of on-site excavated material as backfill, close placement control will be required. CTI recommends that the placement of engineered fill be constantly monitored and frequently tested.

If soils containing greater than 12 percent fines are used as fill, close moisture content control will be required to achieve the recommended degree of compaction. Any fill materials encountered at locations other than the boring locations can be further evaluated during site preparation to determine if some of the soils can be reused as engineered fill.

The engineered fill should be placed in uniform horizontal layers not exceeding 8 to 12 inches in loose thickness for clean granular soils and 4 to 6 inches in loose thickness for clay soils (or clayey granular soils exhibiting cohesive characteristics), depending on the type and size of compaction equipment used. The lift thickness for sands that have an appreciable amount of fines should be decreased accordingly. The engineered fill should be compacted to achieve a density of not less than 95 percent of the maximum dry density as determined by the Modified Proctor Compaction Test (ASTM D1557). Also, the upper 12 inches of the subgrade soils should be compacted, prior to any fill placement, to achieve a density of not less than 95 percent of the maximum dry density as determined by the Modified Proctor test. The as-compacted moisture content of the engineered fill should be within 2 to 3 percent of the optimum moisture content for the soil. The placement and testing of engineered fill should be observed and properly documented in the field by CTI.

We recommend that the contract specifications include provisions for moisture conditioning of any on-site soils that are to be used as engineered fill. Some of the natural soils may require moisture conditioning to allow for proper compaction. The success of aeration and drying of clay soils will be dependent on the time of year, the prevailing weather conditions and the contractor's effort. During cold and/or wet periods of the year, the saturated or disturbed clay soils will be more difficult to dry. In this case, the contractor may have to use drier on-site soils or imported sand.

If site grading or other construction activity is planned during cold weather, it is recommended that proper winter construction practices are followed. All snow and ice should be removed from cut and fill areas prior to grading. Frozen materials should not be used as engineered fill and no fill or pavement should be placed on soils that are frozen or contain frozen material.

5.7. Support of Pavement

The subgrade soils for support of the pavement sections should be prepared in accordance with the methods presented in Section 5.5 of this report. As discussed previously, we recommend the subgrade be subjected to a comprehensive proofrolling and evaluation program to determine the overall suitability at the time of construction. The areas requiring subgrade improvement should be determined in the field by CTI by proper inspection and evaluation at the time of construction. Provisions should be established in the construction documents for this purpose.

The long-term performance of the pavement will typically be a function of the quality of the subgrade soil at the time of construction along with the quality, thickness and strength of the overall pavement section. The most critical portion of the subgrade is the 3 feet immediately beneath the pavement section, which provides the primary strength needed for pavement section support. Uncontrolled fill materials present within the upper 2 to 3 feet of the pavement subgrade can be detrimental if the design does not account for this substandard soil condition, especially during the spring freeze-thaw cycles.

As mentioned previously, uncontrolled fill materials containing varying amounts of organics were encountered at approximately half of the explored boring locations. The fill extended to depths of about 3 to 6 feet below the pavement surface. CTI recommends that where organic-containing soils are encountered within the critical subgrade zone (the upper 3 feet of subgrade immediately below the bottom of the aggregate base layer), the existing fill and organic-containing native soils be completely removed and replaced with engineered fill. The City of Ann Arbor may elect to leave any fill/organic soils in place below the critical subgrade zone, provided a minimum of 3 feet of engineered fill is present above the remaining unsuitable soils. If the unsuitable soils are left in place, the City should understand that there is an increased risk of settlement associated with that choice.

5.8. Pavement Recommendations - Roadways

Our analysis is based on the 1993 American Association of State Highway and Transportation Officials (AASHTO) Guide for Design of Pavement Structures. At the time of this investigation, no information was available regarding the proposed top of pavement elevation for the five explored roadways. We anticipate that the top of pavement elevations may be at or slightly above the existing pavement grades.

NCI provided CTI with traffic count data collected by URS Corporation. The traffic count data was obtained for both travel directions on East Stadium Boulevard, West Stadium Boulevard, South Main Street and Seventh Street at Stadium Boulevard. The final traffic count data, presenting the Average Daily Traffic (ADT) and percent commercial vehicles was provided to CTI on April 1, 2015 and is presented in Table 4.

Table 4. Traffic Count Summary			
Roadway Segment	**2014 ADT**	**2034 ADT**	**% Commercial**
W. Stadium Boulevard (Seventh to Main)	17,529	18,438	3.4
E. Stadium Boulevard (Main to Kipke)	21,072	21,199	1.8
Main Street at Stadium Boulevard	21,962	23,087	2.6
Seventh Street at Stadium Boulevard	6,284	6,606	2.4

Additional traffic count information, from which the traffic counts presented above were derived, was provided to CTI on April 30, 2015. The additional information presented the recorded traffic counts for each FHWA vehicle classification during the monitoring period. The design growth rate for East Stadium Boulevard was 0.482%. For all other roadways, the design growth rate was approximately 0.253%. Main Street and Stadium Boulevard both have two travel lanes in each direction. Seventh Street (north of Stadium Boulevard) has one travel lane in each direction. We have assumed that 80 percent of trucks travel in the design lanes on Stadium and Main, and that 100 percent of trucks travel in the design lane on Seventh Street. Based on these assumptions, the provided traffic count data, and a 20-year design period, the Equivalent 18-kip Single Axle Loads (ESALs) were calculated in accordance with AASHTO and FHWA methodology. The ESAL calculation sheet is provided in the Appendix for reference.

Table 5. Calculated 2034 Equivalent 18-kip Single Axle Loads	
Roadway Segment	**ESALs**
W. Stadium Boulevard (Seventh to Main)	2,493,092
E. Stadium Boulevard (Main to Kipke)	1,699,936
Main Street at Stadium Boulevard	2,682,172
Seventh Street at Stadium Boulevard	1,237,253
Stadium Boulevard and Main Street Intersection	5,175,264**
Stadium Boulevard and Seventh Street Intersection	3,730,345**

** ESALs at the intersections reflect the addition of the calculated ESALs from the referenced roadway segments

Complete traffic count information was not provided for the explored residential roadways (Potter Avenue, Prescott Avenue and Edgewood Avenue). A traffic count for southbound Edgewood at Stadium was provided, but the total vehicular traffic counted in a 24-hour period was 170. Since there are several streets that intersect Edgewood between Stadium and Potter, we anticipate that the traffic counts may have been higher both in the northbound direction and at other locations along Edgewood. We have conservatively estimated an ESAL of 200,000 for use in our pavement design. The total ESALs used for design purposes for the intersection of Seventh Street and Potter Avenue was 1,437,253.

Design parameters were provided to CTI by City of Ann Arbor based on their design standards. The design parameters used for our pavement analysis include a terminal serviceability of 2.5, an initial serviceability of 4.5, reliability (R) of 95%. A standard deviation (S_o) of 0.45 was used for flexible pavement and a S_o of 0.34 was used for rigid pavement, in accordance with City of Ann Arbor Standard Specifications. Should any of these assumptions be found incorrect, CTI should be contacted and requested to re-evaluate the pavement design recommendations based on the revised data.

The back-calculated subgrade resilient modulus, (M_r) values for each of the explored roadways and the modulus of subgrade reaction, (k) for Stadium Boulevard determined by the FWD testing is summarized in Table 6. The effective resilient modulus used in our design is based on the encountered soils and the back-calculated M_r, and takes into account the effects of subgrade weakening during the spring thaw. Since soil borings and FWD testing on Seventh Street was not included in our scope of services, the values presented for Seventh Street are assumed and should be confirmed as the design proceeds. Using the design criteria listed above, a minimum Structural Number (SN) was determined for each roadway, using SpectraPave4 PRO software version 4.6.1, which is based on the 1993 AASHTO Guide for Design of Pavement Structures. See the Appendix for the SpectraPave4 PRO output files.

Table 6. Resilient Moduli, Modulus of Subgrade Reaction and Minimum Structural Number					
Roadway	**Range of Back-Calculated Resilient Modulus, M_r (psi)**	**Design Effective Resilient Modulus, M_r (psi)**	**Range of Modulus of Subgrade reaction, k (pci)**	**Design Modulus of Subgrade reaction, k (pci)**	**Minimum Structural Number, SN**
West Stadium Boulevard	4,250 – 9,850	6,000	110 - 185	130	4.55
East Stadium Boulevard	4,250 – 9,850	6,000	110 - 185	130	4.31
Stadium and Main Intersection	N/A	6,000	N/A	130	**
S. Main Street	5,800 – 9,450	7,000	N/A	140	**
Stadium and Seventh Intersection	N/A	6,000	N/A	130	4.81
Seventh Street	N/A	4,000	N/A	N/A	4.58
Seventh and Potter Intersection	N/A	4,000	N/A	N/A	4.68
Potter Avenue	2,050 – 3,650	2,600	N/A	N/A	4.11
Prescott Avenue	1,600 – 2,500	2,250	N/A	N/A	4.11
Edgewood Avenue	2,000 – 2,100	2,050	N/A	N/A	4.11

**Main Street and the Stadium Boulevard/Main Street intersection will be constructed as a rigid pavement section. Therefore, a structural number for flexible pavement design was not calculated.

Due to the relatively weak subgrade encountered at the borings performed along Prescott, Potter and Edgewood Avenue, some measure of subgrade improvement should be anticipated prior to pavement construction.

We have formulated our flexible pavement design recommendations with the assumption that the roadways will remain partially open during construction and, as such, "staged" construction is planned. We anticipate that the leveling course of the pavement section may be used as a construction platform. Therefore, the pavement design accounts for the additional loading of construction traffic and has been increased by a minimum of 0.5 inches to reflect the damage which could occur during construction. If distress is caused by construction traffic, it should be repaired prior to placement of the wearing course.

Based on the minimum structural numbers and the assumption that construction will be staged, we offer the proposed flexible pavement sections:

Table 7. Flexible Pavement Section – West Stadium Boulevard (Seventh to Main)

Layer	Material	Thickness (inches)	Structural Layer Coefficient	Structural Number (SN)
HMA Surface	MDOT 5E3 or 4C	2.0	0.44	0.88
HMA Leveling	MDOT 4E3 or 3C	3.0	0.44	1.32
HMA Base	MDOT 3E3 or 2C	3.0	0.36	1.08
Aggregate Base	MDOT 21AA crushed limestone	8.0	0.14	0.78
Sand Subbase	MDOT 2NS	7.0	0.10	0.49
			Total SN =	4.55 = 4.55

Table 8. Flexible Pavement Section – East Stadium Boulevard (Main to Kipke)

Layer	Material	Thickness (inches)	Structural Layer Coefficient	Structural Number (SN)
HMA Surface	MDOT 5E3 or 4C	2.0	0.44	0.88
HMA Leveling	MDOT 4E3 or 3C	2.5	0.44	1.10
HMA Base	MDOT 3E3 or 2C	3.0	0.36	1.08
Aggregate Base	MDOT 21AA crushed limestone	8.0	0.14	0.78
Sand Subbase	MDOT 2NS	7.0	0.10	0.49
			Total SN =	4.33 > 4.31

Table 9. Flexible Pavement Section – Stadium Boulevard and Seventh Street Intersection				
Layer	**Material**	**Thickness (inches)**	**Structural Layer Coefficient**	**Structural Number (SN)**
HMA Surface	MDOT 5E3 or 4C	2.0	0.44	0.88
HMA Leveling	MDOT 4E3 or 3C	3.0	0.44	1.32
HMA Base	MDOT 3E3 or 2C	3.5	0.36	1.26
Aggregate Base	MDOT 21AA crushed limestone	8.0	0.14	0.78
Sand Subbase	MDOT 2NS	9.0	0.10	0.63
			Total SN =	4.87 > 4.81

Table 10. Flexible Pavement Section – Seventh Street				
Layer	**Material**	**Thickness (inches)**	**Structural Layer Coefficient**	**Structural Number (SN)**
HMA Surface	MDOT 5E3 or 4C	2.0	0.44	0.88
HMA Leveling	MDOT 4E3 or 3C	2.5	0.44	1.10
HMA Base	MDOT 3E3 or 2C	3.5	0.36	1.26
Aggregate Base	MDOT 21AA crushed limestone	8.0	0.14	0.78
Sand Subbase	MDOT Class II	8.0	0.10	0.56
			Total SN =	4.58 = 4.58

Table 11. Flexible Pavement Section – Seventh and Potter Intersection				
Layer	**Material**	**Thickness (inches)**	**Structural Layer Coefficient**	**Structural Number (SN)**
HMA Surface	MDOT 5E3 or 4C	2.0	0.44	0.88
HMA Leveling	MDOT 4E3 or 3C	3.0	0.44	1.32
HMA Base	MDOT 3E3 or 2C	3.0	0.36	1.08
Aggregate Base	MDOT 21AA crushed limestone	8.0	0.14	0.78
Sand Subbase	MDOT Class II	9.0	0.10	0.63
			Total SN =	4.69 > 4.68

Table 12. Flexible Pavement Section – Potter Avenue, Prescott Avenue, Edgewood Avenue				
Layer	**Material**	**Thickness (inches)**	**Structural Layer Coefficient**	**Structural Number (SN)**
HMA Surface	MDOT 13A or 5E3	2.0	0.44	0.88
HMA Leveling	MDOT 13A or 4E3	2.0	0.44	0.88
HMA Base	MDOT 3E3 or 2C	3.0	0.36	1.08
Aggregate Base	MDOT 21AA crushed limestone	8.0	0.14	0.78
Sand Subbase	MDOT Class II	8.0	0.10	0.56
			Total SN =	4.18 > 4.11

If staged construction is not planned for the project, the design thickness of the asphalt leveling course may be decreased by 0.5 inches.

The aggregate base and sand subbase layers should be placed in uniform horizontal layers not exceeding 8 inches in loose thickness. Where the design aggregate base and/or sand subbase layers exceed 8 inches, the materials must be placed in two lifts. The sand subbase should be compacted to achieve a density of not less than 95 percent of the maximum dry density as determined by the Modified Proctor Compaction Test (ASTM D1557). The aggregate base should be compacted to achieve a density of not less than 98 percent of the maximum dry density as determined by the Modified Proctor Compaction Test.

Other pavement design sections, from those presented herein, which provide equivalent structural capacity can also be considered. Crushed concrete, recycled asphalt millings or MDOT 22A should not be substituted for the recommended aggregate base material without at least a 25 percent increase of the thickness of the aggregate base to account for the structural differences of the materials.

As an alternate to a flexible pavement design, a rigid pavement design has been determined utilizing the "AASHTO Guide for Rigid Pavement Design." We have assumed Portland cement concrete pavement would be used, with proper joint spacing. We understand that the use of Plain concrete, instead of reinforced concrete, for the rigid pavement design is desired. Design parameters used in the pavement design include an effective modulus of subgrade reaction of 130 psi per inch and 140 psi per inch for Stadium Boulevard and Main Street, respectively, a load transfer coefficient of 3.2 (typical for doweled plain concrete pavement), and the 18-kip ESALs noted in Table 4 for the concrete pavement.

For the anticipated soil conditions and loads, we have calculated a minimum required concrete pavement thickness for Stadium Boulevard and Main Street, and the intersection of Stadium Boulevard and Main Street. The 1993 AASHTO Rigid Pavement Structural Design calculator presented by Pavement Interactive was used to determine the minimum concrete thickness. See the Appendix for the output file information. If a rigid pavement section is selected, we recommend the following pavement sections:

Table 13. Plain Concrete Rigid Pavement Section – West Stadium Boulevard

Pavement Material	Section Thickness (inches)
Type I Portland Cement Concrete (MDOT Grade P-1)	10.0
Aggregate Base Course (MDOT 21AA)	6.0
Sand Subbase (MDOT 2NS)	12.0

Table 14. Plain Concrete Rigid Pavement Section – East Stadium Boulevard	
Pavement Material	**Section Thickness (inches)**
Type I Portland Cement Concrete (MDOT Grade P-1)	10.0
Aggregate Base Course (MDOT 21AA)	6.0
Sand Subbase (MDOT 2NS)	12.0

Table 15. Plain Concrete Rigid Pavement Section – Main Street	
Pavement Material	**Section Thickness (inches)**
Type I Portland Cement Concrete (MDOT Grade P-1)	10.0
Aggregate Base Course (MDOT 21AA)	6.0
Sand Subbase (MDOT 2NS)	12.0

Table 16. Plain Concrete Rigid Pavement Section – Stadium Boulevard and Main Street Intersection	
Pavement Material	**Section Thickness (inches)**
Type I Portland Cement Concrete (MDOT Grade P-1)	11.0
Aggregate Base Course (MDOT 21AA)	6.0
Sand Subbase (MDOT 2NS)	12.0

Concrete design parameters include a 28-day mean modulus of rupture of 670 psi and a 28-day mean elastic modulus of slab of approximately 3,600,000 psi. The concrete mix design should consist of a minimum 6-sack, normal weight concrete with a minimum 28-day compressive strength of 4,000 psi when tested in accordance with ASTM C39. The concrete should contain an air entrainment mixture to resist the effects of freezing and thawing. The pavement should be suitably doweled at construction joints to permit the proper transfer of loads. The design of joints, joint spacing, doweling and steel/wire mesh reinforcement (if included in the design) was not included in our scope of services, but should conform to the applicable City of Ann Arbor, Washtenaw County or MDOT requirements.

During a meeting on April 27, 2015 between City of Ann Arbor, NCI and CTI, potential reuse of the existing aggregate base and sand subbase materials during the reconstruction of Main Street was discussed. The existing pavement section was constructed approximately 20 to 23 years ago, and the City has detailed records of material placement during construction. The pavement sections used on Main Street to the north and south of Stadium Boulevard consisted of 6 inches of asphalt with 8 to 9 inches of MDOT 21AA aggregate base course and 10 to 12 inches of MDOT 2NS sand subbase, respectively.

Since the majority of the structural support from the rigid pavement section comes from the concrete slab thickness, a reduction of the sand subbase thickness was also discussed. In order to maintain the integrity of the aggregate base course, CTI recommends that the existing pavement and aggregate base course materials be removed at the start of construction. We do not recommend reusing the aggregate base course materials, due to anticipated degradation of the aggregate base course materials over the design life of the pavement. Once the existing aggregate base course has been removed, the existing sand subbase materials should be observed for signs of clogging or intrusion of subgrade soils. As long as the remaining MDOT 2NS sand subbase layer is found in an acceptable condition and consists of a minimum of 6 inches, the City of Ann Arbor will accept reusing the existing sand subbase in lieu of replacing it with new materials. A sand subbase layer of at least 6 inches in thickness should provide an acceptable level of drainage for the rigid pavement section.

At the time of this report, both flexible and rigid pavements were being considered. If rigid pavement is used at intersections and flexible pavement is used for the remaining roadway alignment, we recommend that the rigid pavement be extended further than the limits of the intersection. This extension of the rigid pavement will aid in avoiding pavement creep due to traffic stopping at the intersections.

The pavement system should be properly drained to reduce the potential for weakening the subgrade. Provisions should be made to prevent surface run-off water from accumulating within the aggregate base course of the pavement. The pavement and underlying subgrade should be suitably crowned or sloped to promote effective surface drainage and prevent water ponding. Due to the relatively low permeability of the near-surface soils encountered at this site, finger drains should be installed at all catch basin locations to provide drainage for surface water that may become trapped in the pavement aggregate base section. If a rigid pavement design is utilized, edge drains should be installed in order to limit water infiltration into the aggregate base course. The use of a geotextile separator layer may be necessary between the aggregate base course layer and the underlying subgrade soils. If a separator layer is not installed, there is a potential for migration of fines into the aggregate base course, which could limit the permeability of and result in water becoming trapped in the aggregate base course.

It should be recognized that all pavements require regular maintenance and occasional repairs to keep them in a serviceable condition. Sealing of joints and cracks should be performed at least annually as needed, to prevent water from entering the pavement section. If water is allowed to penetrate the pavement section, it can lead to deterioration of the pavement during freeze-thaw cycles. The need for such routine maintenance and repair is not necessarily indicative of premature pavement failure. However, if appropriate maintenance and repairs are not performed regularly, the serviceable life of the pavement can be reduced significantly.

Actual pavement section thickness should be provided by the design civil engineer based on the selected subgrade preparation method, traffic loads and volume and the owners design life requirements. All pavement materials and procedures should conform to standard MDOT or appropriate local municipal agency requirements.

5.9. Pavement Recommendations – Pedestrian Path

An 8-foot wide pedestrian path is planned along the south side of East Stadium Boulevard, from S. Main Street to the University of Michigan Golf Course. While no soil borings were performed within the proposed pedestrian path, CTI recommends the following minimum pavement sections based on the soils encountered near the proposed pedestrian path and our understanding of City of Ann Arbor design standards.

Table 17. Flexible Pavement Section – Pedestrian Path	
Pavement Material	**Section Thickness (inches)**
HMA (MDOT 13A)	3.0
Aggregate Base Course (MDOT 21AA)	6.0

Table 18. Rigid Pavement Section – Pedestrian Path	
Pavement Material	**Section Thickness (inches)**
Type I Portland Cement Concrete (MDOT Grade S-2)	4.0
Aggregate Base Course (MDOT Class II)	4.0

5.10. Retaining Wall Recommendations

As part of the extension of the pedestrian path from Main Street to the U-M Golf Course, two retaining walls are planned along the south edge of E. Stadium Boulevard. The soil to be retained is south of the existing roadway and proposed pedestrian path. The existing land use is a golf course. Therefore, a surcharge load at the top of the proposed retaining walls is not anticipated. One retaining structure will be located at the southeast corner of Main Street and Stadium Boulevard, near the tee box at the Ann Arbor Golf and Outing Club (AAGOC), and the other will be located further east toward the entrance drive to AAGOC. The existing retaining wall is comprised of stacked paving stones with wall heights ranging from about 2 to 6 feet.

CTI performed three soil borings in the vicinity of the proposed retaining walls (RWFF-01 through RWFF-03). In addition, we reviewed previous soil boring information provided to CTI by the City of Ann Arbor, performed by PSI (PSI Project No. 381-65050 dated January 31, 2007). Based on review of PSI's borings RW-1 through RW-4 and CTI's borings RWFF-01 through RWFF-02, the encountered soils consisted predominantly of stiff to hard clay. At the location of RWFF-03, the encountered soils consisted of medium dense sand to a depth of about 5 feet, underlain by loose to very loose sand to a depth of 14 feet, followed by medium dense sands to the explored depth of 25 feet.

The following soil parameters and recommended design earth pressure coefficients may be used for evaluating the retaining wall design. These parameters are based on the soils encountered in borings RWFF-01 through RWFF-03 and PSI's borings RW-1 through RW-4.

Table 19. Retaining Wall Design Soil Parameters and Earth Pressure Coefficients

Material	Moist unit weight of soil, ¥ (pcf)	Friction angle, Φ (degrees)	Coefficient of active earth pressure, K_a	Coefficient of passive earth pressure, K_p	Coefficient of at-rest earth pressure, K_o	Undrained shear strength, Su (psf)
Very stiff to hard clay, 0' to 10'	138	10	0.70	1.42	0.83	4,000
Stiff to very stiff clay, 10' to 30'	130	12	0.66	1.52	0.79	1,500
Medium dense sand, 0' to 5'	120	30	0.33	3.00	0.50	N/A
Very loose to loose sand, 5' to 14'	105	28	0.36	2.76	0.53	N/A
Medium dense sand, 14' to 25'	120	30	0.33	3.00	0.50	N/A

The development of an "active" or "passive" condition requires that the wall is flexible and the deflection would allow "active" and "passive" conditions to develop. No passive resistance should be considered for the soils above the frost line. A movement of approximately 0.001 times the height of the wall is generally required to develop the active state for granular soils.

The movement required to mobilize passive pressure is approximately 0.004 times the wall height for granular soils. A movement of approximately 0.01 times the height of the wall is generally required to develop the active state for cohesive soils. The movement required to mobilize passive pressure is approximately 0.04 times the wall height for cohesive soils.

Based on the soils encountered in the vicinity of the proposed retaining walls and due to the relatively short height of the proposed retaining walls, several design options are available to control installation cost. Viable design alternatives for the proposed retaining wall include:

- Stone gravity wall, similar to existing wall
- Precast concrete block gravity wall
- Gabion wall
- Sheet pile wall
- Soldier pile wall

We understand that a soldier pile wall with precast concrete panels is preferred. We further understand that a sheet pile wall may also be considered during the removal of the existing retaining wall. Mechanically Stabilized Earth (MSE) retention systems and retaining walls with tie-backs or anchors are not being considered due to limited right-of-way and the proximity to the edge of the existing AAGOC course. A gravity retaining wall consisting of either natural stone, stone gabions, or precast concrete blocks may be an economical alternative to the preferred design given the favorable soil conditions. Precast concrete blocks in particular offer an aesthetic appearance that can complement nearby buildings. Based on the soils encountered in the vicinity of the proposed retaining walls, gravity walls should be at least 18 inches wide and embedded at least 18 inches below the toe of the wall.

Based on the encountered soils, we have the following recommendations for a sheet pile wall and a soldier pile wall with precast concrete panels. We recommend a minimum embedment depth of 9 feet below the top of the proposed pedestrian path be used for sheet piles, and a minimum embedment depth of 12 feet be used for soldier piles. Design embedment depths should be extended to greater depths if utility excavations will be performed near the retaining walls. The embedment depth may need to be extended below the excavation depth, depending on the lateral distance between the excavation and the retaining wall.

For a soldier pile wall, steel H-piles should have a minimum size of HP8x36 and have a maximum spacing of 5 feet. For a sheet pile wall, cold formed steel sheet piling should meet the minimum requirements of SKL9 or hot rolled steel sheet puling should meet the minimum requirements of PZ22. Specifications for steel sheet piles and steel H-piles produced by Skyline Steel Corporation are included in the Appendix.

Positive drainage of the soils behind the wall should be provided to relieve a build-up of hydrostatic pressure. For sheet pile walls, this may be accomplished through the installation of weep holes. For the remaining wall types, clean, free-draining granular backfill with a positive drainage system should be installed.

The backfill materials should be placed in appropriate lift thicknesses for the equipment being used and compacted to 95 percent of the Modified Proctor maximum dry density according to ASTM D1557. We recommend that the backfill directly behind the walls consist of MDOT Class II or MDOT 2NS and be compacted with light, hand-held compactors. Heavy compactors and grading equipment should not be allowed to operate within 10 feet of the walls during backfilling to avoid developing excessive temporary or long-term lateral soil pressures.

We recommend a positive drainage system be installed behind the wall at the wall foundation level (gravity walls) or at the level of the pedestrian path sand subbase layer. A typical drain would consist of a minimum 4-inch diameter perforated pipe surrounded by drainage aggregate. The aggregate surrounding the perforated pipe should be a clean, highly permeable, open graded material. A non-woven filter fabric (non-woven geotextile) should envelop the aggregate and perforated pipe to reduce the risk of loss of fine soil particles into the drainage system.

6.0 GENERAL CONSTRUCTION PROCEDURES / RECOMMENDATIONS

6.1. General

Experience indicates that variations in soil conditions are encountered during construction. In order to permit correlation between the soil boring data and the actual soil conditions encountered during construction, it is recommended that a continuous inspection and review of the soil related phases of construction work be carried out. We recommend the site preparation activities, engineered fill placement and construction be observed by a qualified engineering technician. The technician should perform the appropriate type and number of field tests needed to verify compliance with construction specifications and that the subgrade material is suitable.

The silty sand and clay soils encountered at the boring locations could be potentially troublesome for some earthwork operations, depending on the prevailing moisture content. These soils have relatively poor drainage characteristics and are susceptible to ponding, subsequent softening and pumping due to construction traffic. During a wet season or periods of heavy precipitation, the subgrade soils with high moisture contents may become unstable and provide limited support for some rubber-tired construction equipment. If pumping of the subgrade occurs due to construction traffic, an evaluation of the site and construction procedures should be made by a geotechnical engineer.

6.2. Groundwater Control

Based on the observed groundwater conditions in the test borings, some groundwater seepage could be encountered within general excavations throughout the project due to pockets of perched groundwater accumulations trapped within or above the clay soils. Proper groundwater control measures should be maintained during all earthwork activities in order to limit the disturbance of the subgrade soils.

For relatively shallow excavations, it appears that minor perched groundwater accumulations should be controllable by conventional pumping methods from standard sump pits extending into the native clay soils.

For deeper excavations, such as utility installations, a more significant dewatering effort may be required. An evaluation of the need for these dewatering efforts should be made once the design progresses.

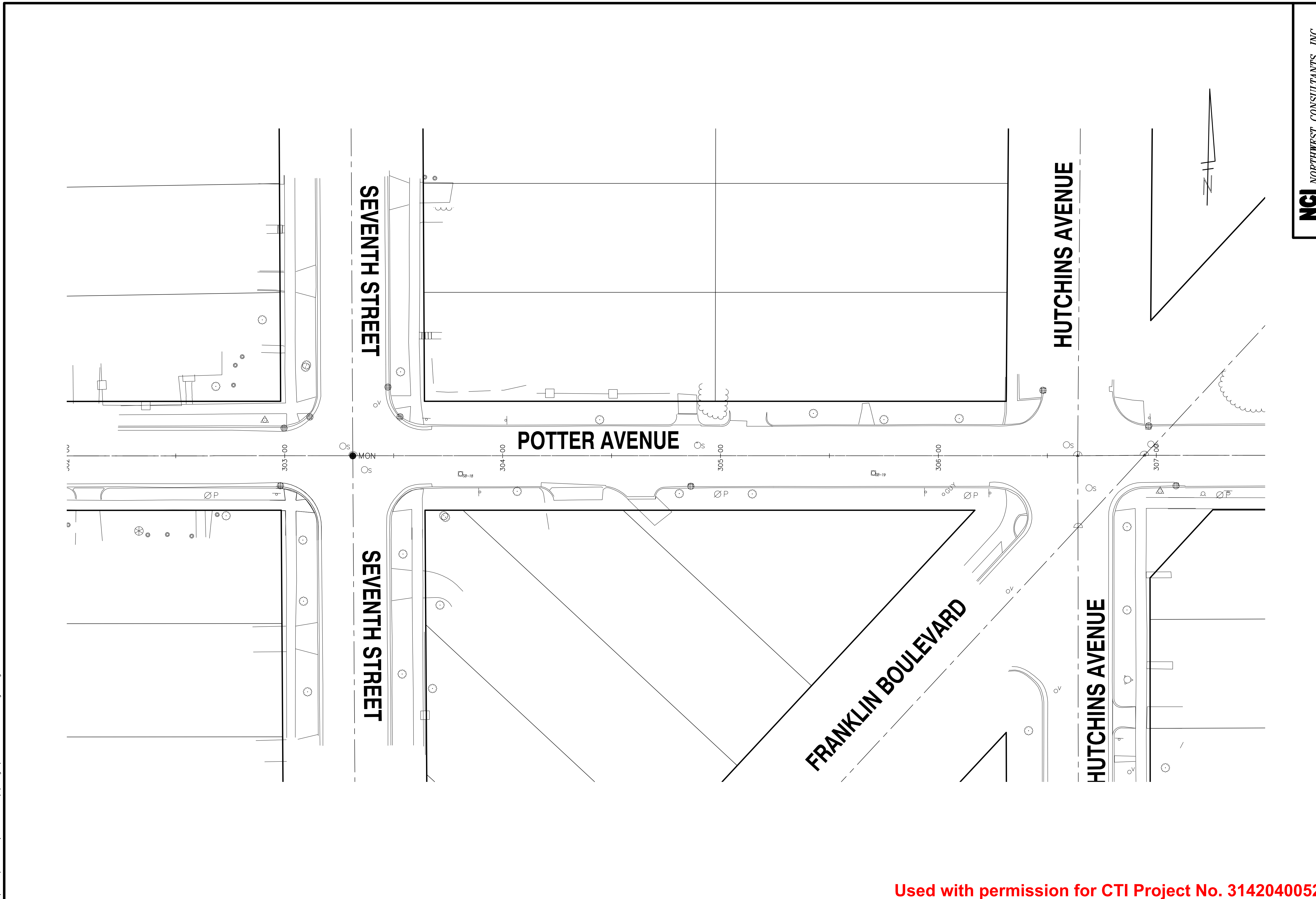
The most appropriate method of groundwater control will depend on many factors including the actual design grades, locations/depths of excavations and the specific soil conditions. Any groundwater related problems should be evaluated in the field by a qualified geotechnical engineer so that the best remedial measures can be determined.

APPENDIX

Boring Location Plan (Sheets 1 through 14)
Boring Logs
Laboratory Test Reports
Summary of Laboratory Test Results
Analytical Laboratory Test Report and Summary Tables
Falling Weight Deflectometer Report
ESAL Calculation and Pavement Designs
Skyline Steel Corporation Sheet Pile and H-Pile Specifications
General Notes for Soil Classification

CTI and Associates, Inc.

Boring Location Plan
(Sheets 1 through 14)



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STADIUM BOULEVARD RECONSTRUCTION PROJECT

SOIL BORING LAYOUTS

POTTER AVENUE STA 302+00 TO STA 307+50

SCALE PLAN: 1" = 20'

DRAWING No. 2014035-SB01

SHEET No. 1 OF 14

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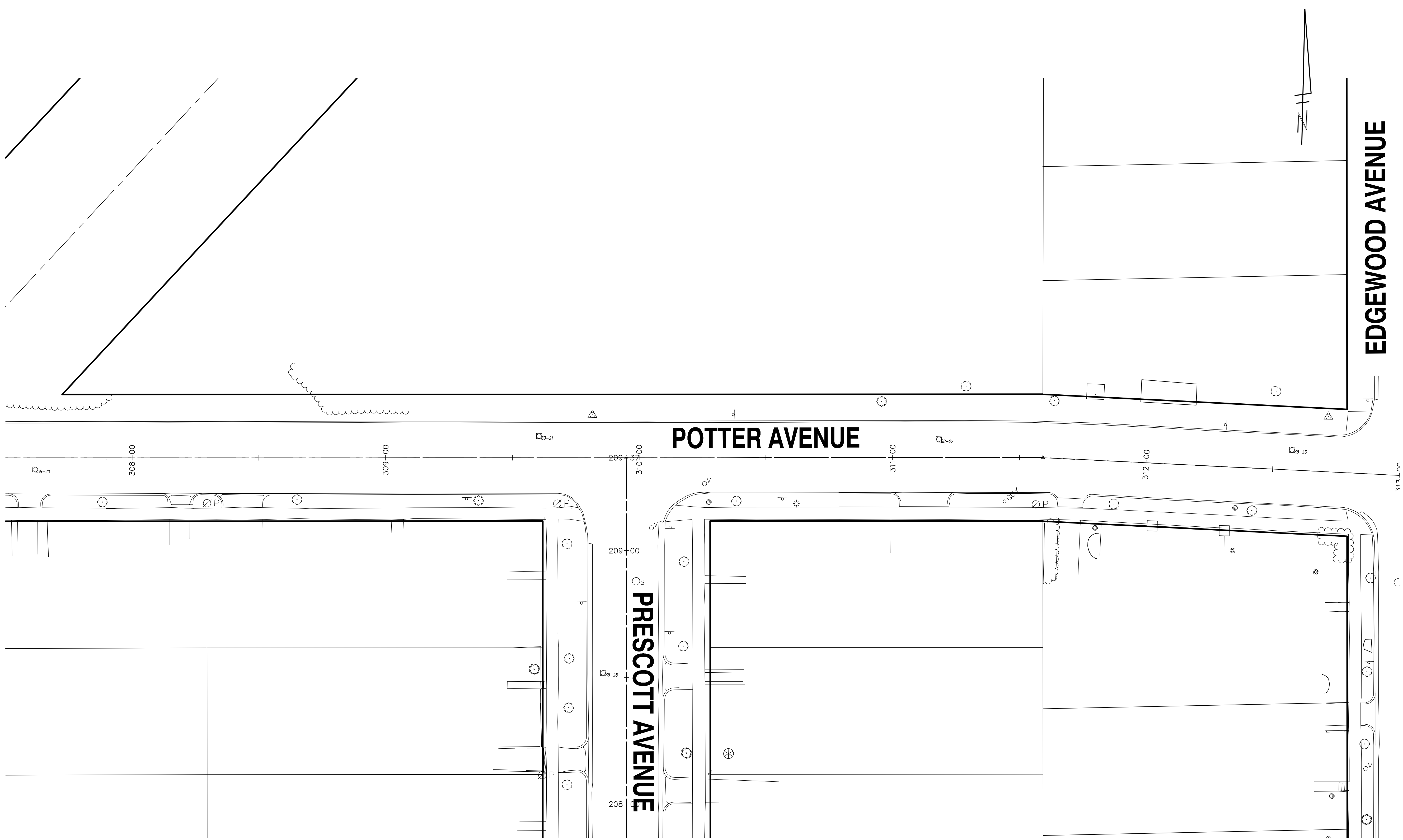

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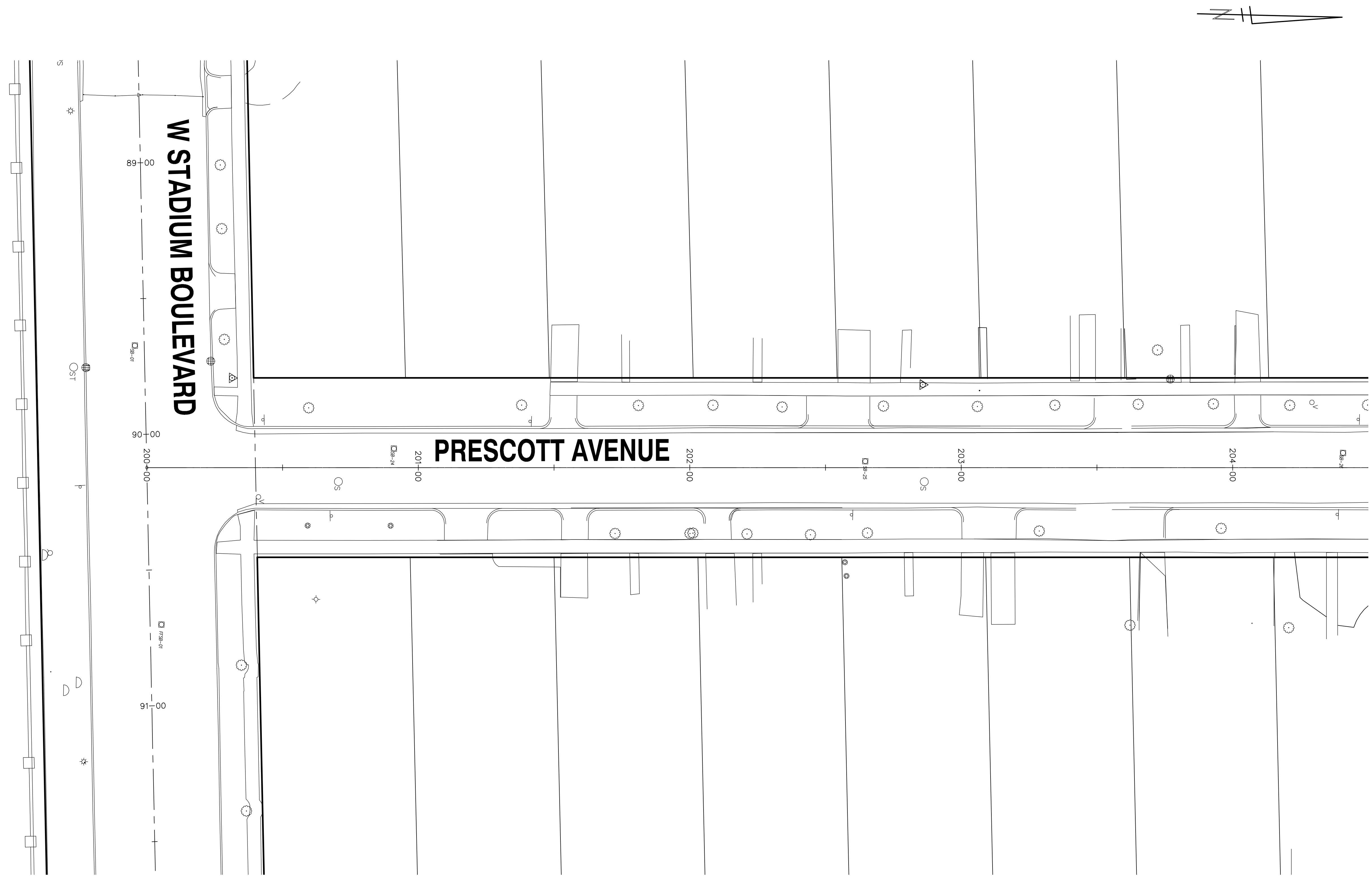

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SOIL BORING LAYOUTS

PRESCOTT AVENUE STA 200+00 TO STA 204+50

SCALE PLAN: 1" = 20'

DRAWING No. 2014035-SB03

SHEET No. 3 OF 14

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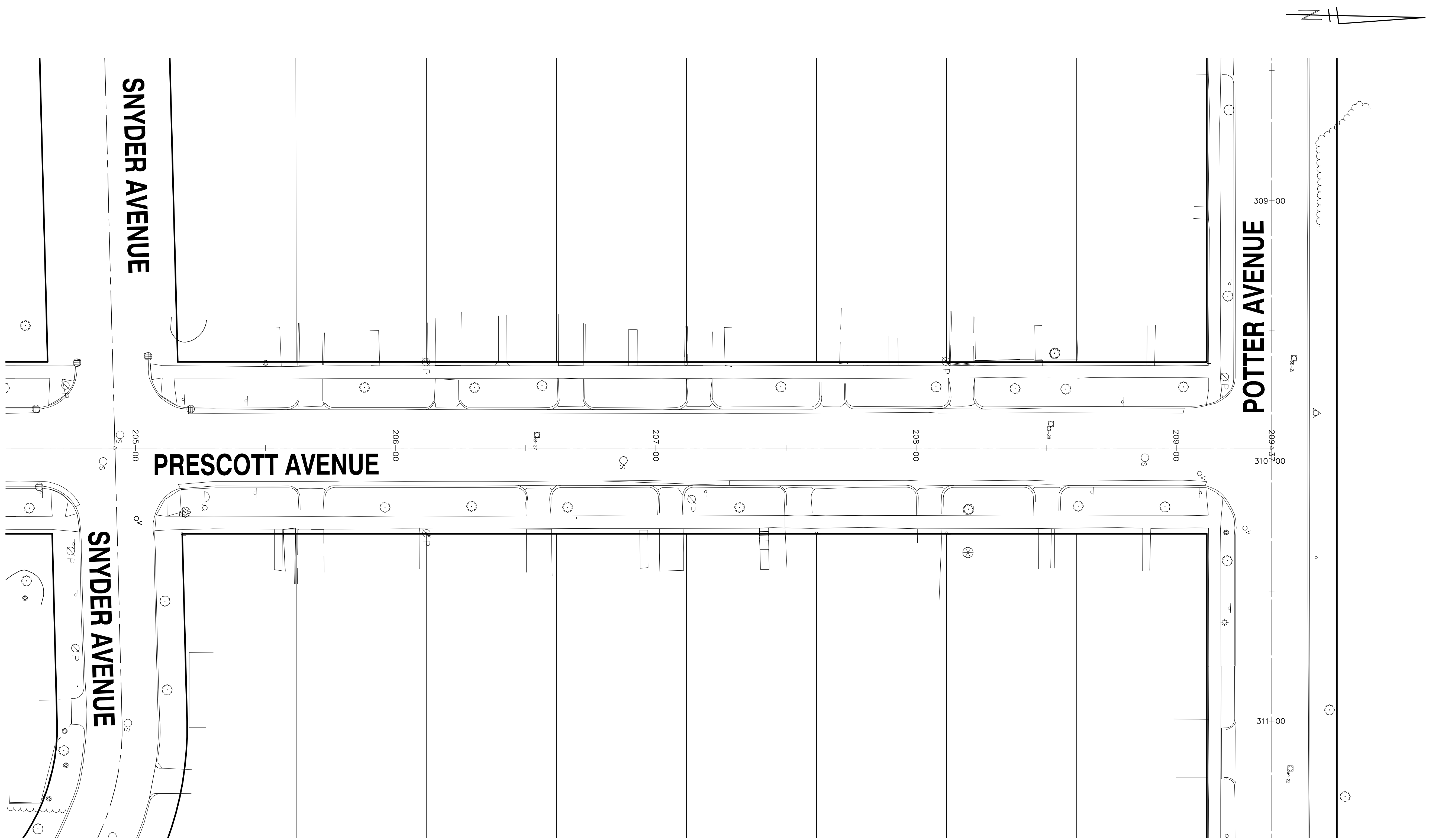

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PROJECT MANAGEMENT - PUBLIC SERVICES - CITY OF ANN ARBOR

STADIUM BOULEVARD RECONSTRUCTION PROJECT

SOIL BORING LAYOUTS

PRESCOTT AVENUE STA 204+50 TO STA 209+37

SCALE PLAN: 1" = 20'

DRAWING No. **2014035-SB04**

SHEET No. **4 OF 14**

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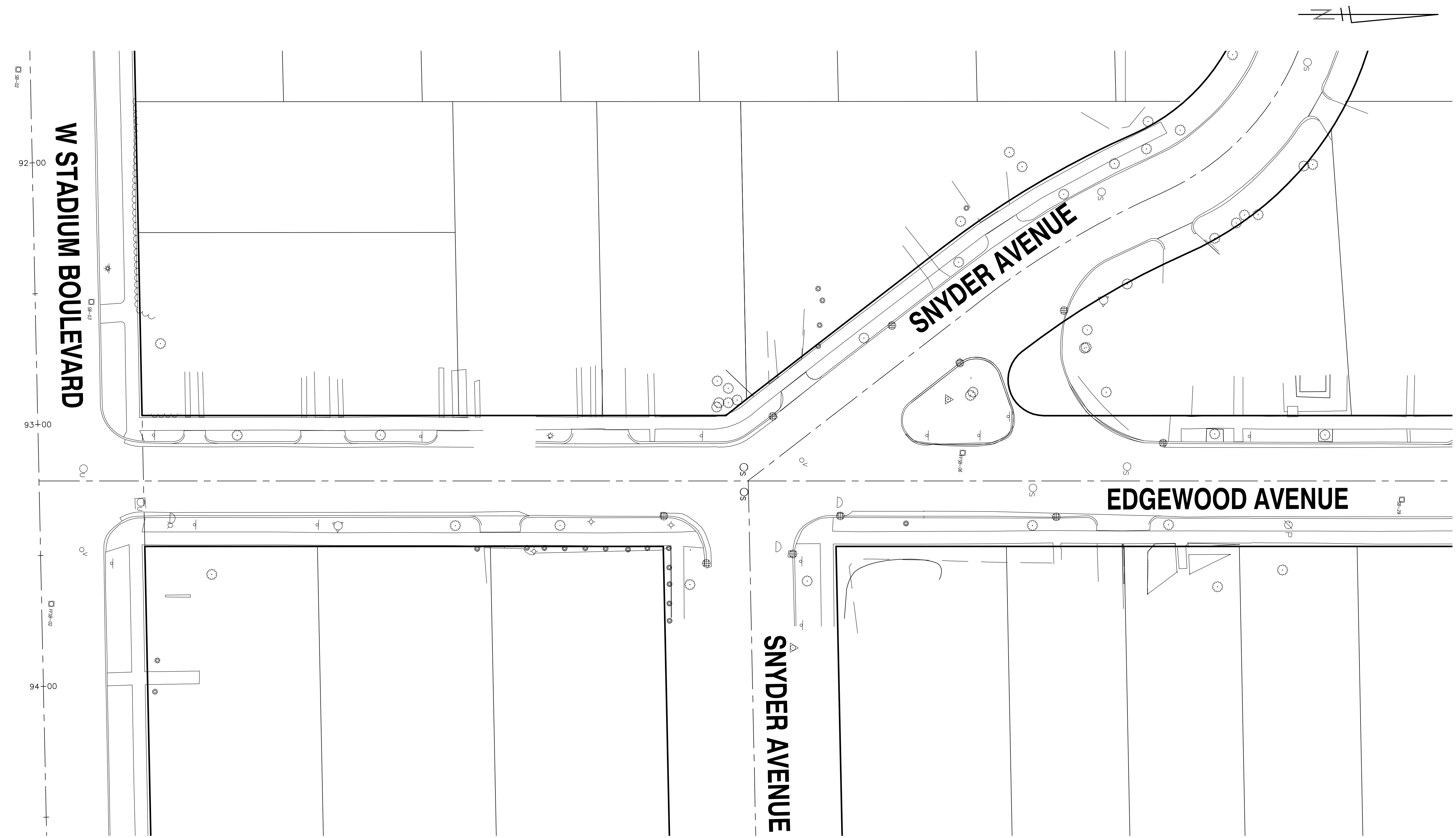

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SOIL BORING LAYOUTS
EDGEWOOD AVENUE

SCALE PLAN: 1" = 20'

DRAWING No. 2014035-SB05

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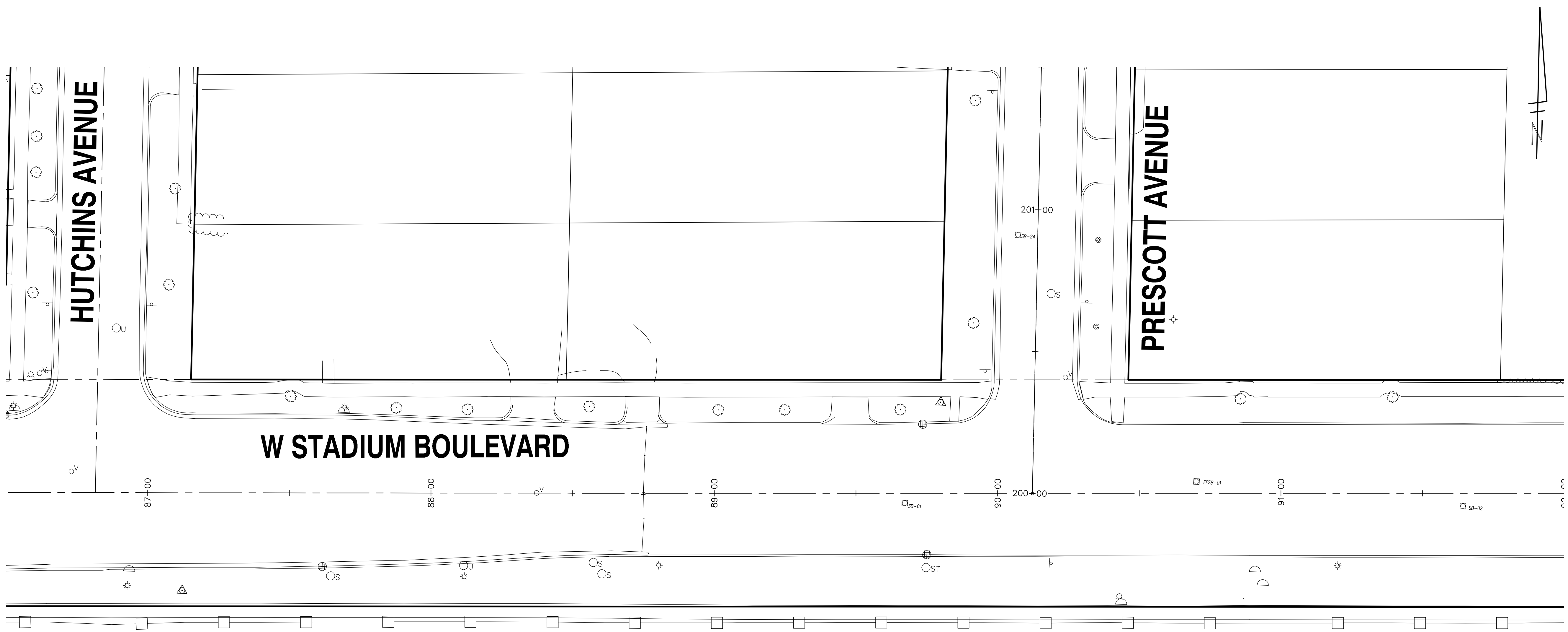

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STADIUM BOULEVARD RECONSTRUCTION PROJECT

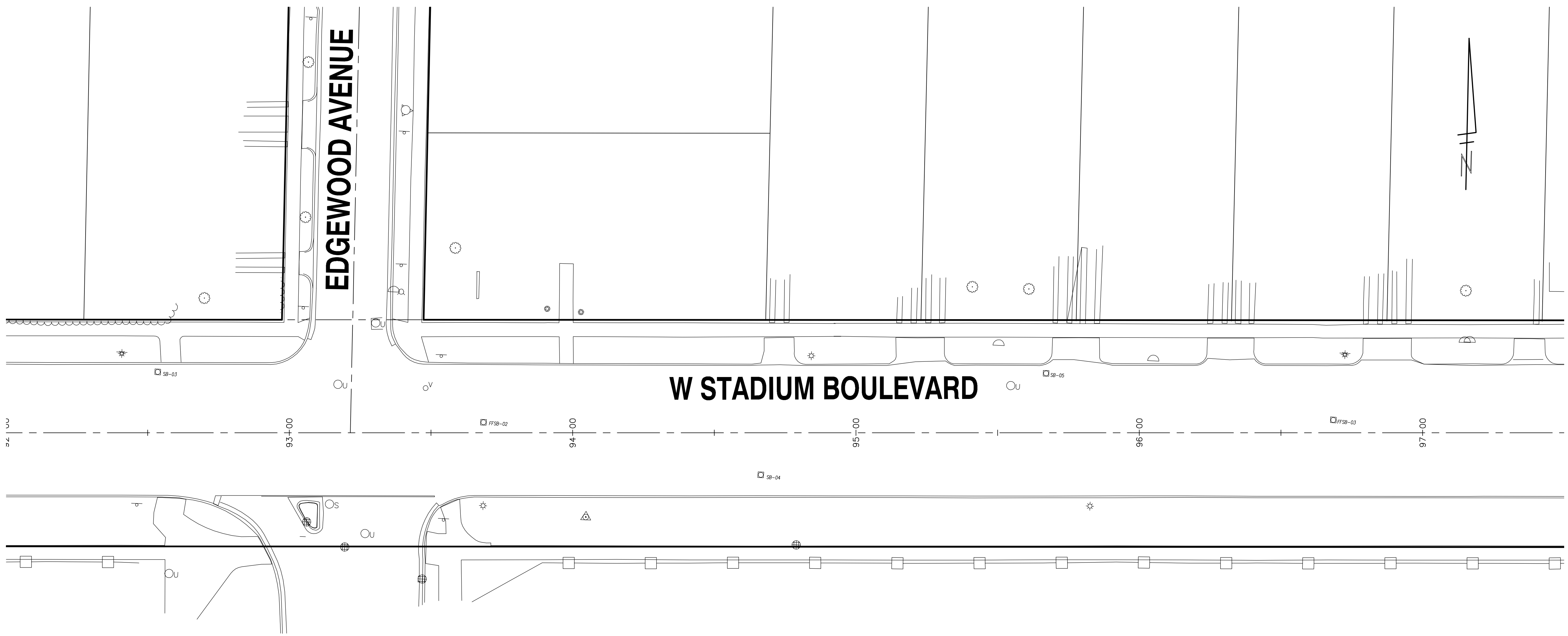
SOIL BORING LAYOUTS

STADIUM BOULEVARD STA 86+50 TO STA 93+00

SCALE PLAN: 1" = 20'

DRAWING No. 2014035-SB06

SHEET No. 6 OF 14



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PROJECT MANAGEMENT - PUBLIC SERVICES - CITY OF ANN ARBOR

STADIUM BOULEVARD RECONSTRUCTION PROJECT

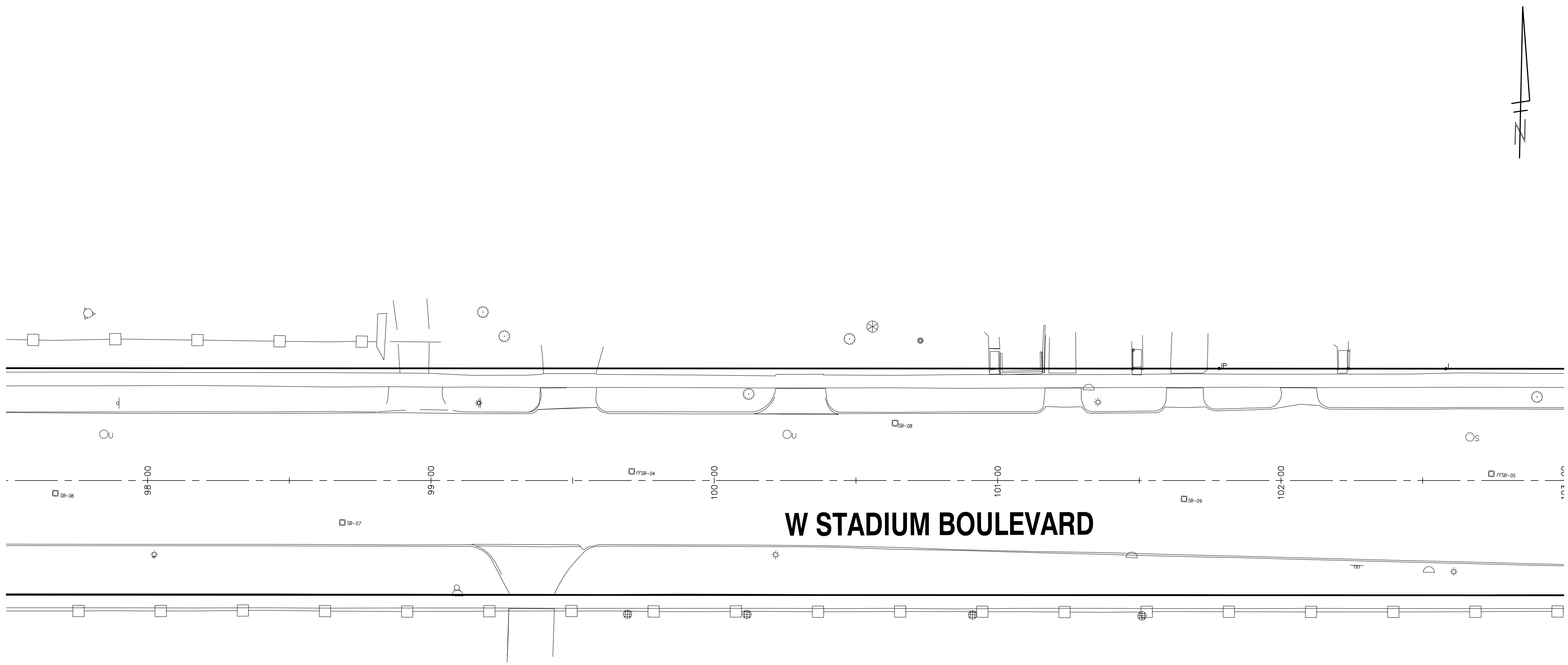
SOIL BORING LAYOUTS
STADIUM BOULEVARD STA 93+00 TO STA 97+50

SCALE PLAN: 1" = 20'

DRAWING No. 2014035-SB07

SHEET No. 7 OF 14

K:\ACAD\14255016(AA-Stadium)\Design\aa_stad-sheets.dwg Dwg Created: 8-Jan-15 - _a2 standard bw.stb - Plot Date: 9-Jan-15



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PROJECT MANAGEMENT - PUBLIC SERVICES - CITY OF ANN ARBOR

STADIUM BOULEVARD RECONSTRUCTION PROJECT

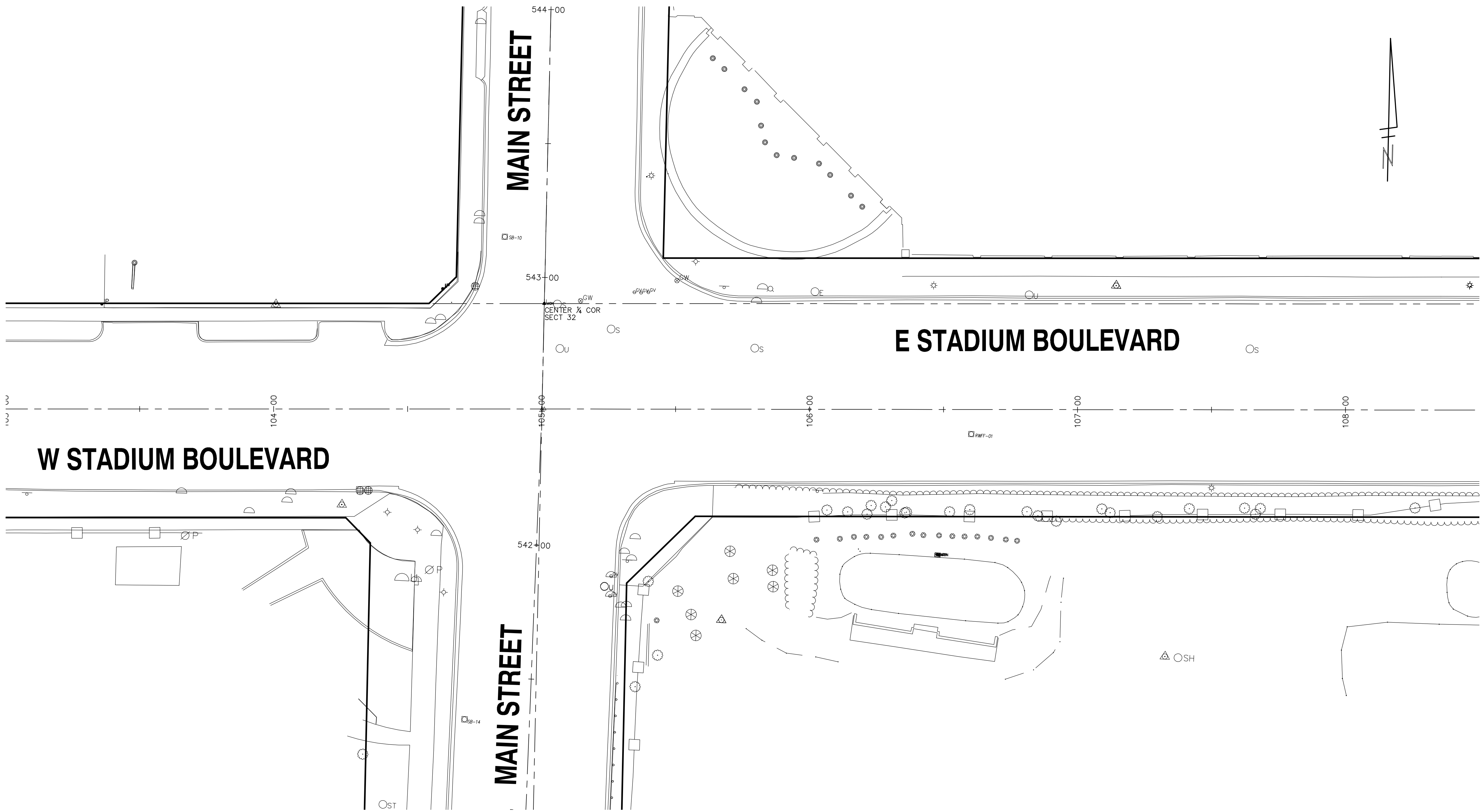
SOIL BORING LAYOUTS
STADIUM BOULEVARD STA 97+50 TO STA 103+00

SCALE PLAN: 1" = 20'

DRAWING No. 2014035-SB08

SHEET No. 8 OF 14

K:\ACAD\14255016(AA-Stadium)\Design\aa_stad-sheets.dwg Dwg Created: 8-Jan-15 - _a2 standard bw.stb - Plot Date: 9-Jan-15



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CITY OF ANN ARBOR MICHIGAN

PROJECT MANAGEMENT - PUBLIC SERVICES - CITY OF ANN ARBOR

STADIUM BOULEVARD RECONSTRUCTION PROJECT

SOIL BORING LAYOUTS

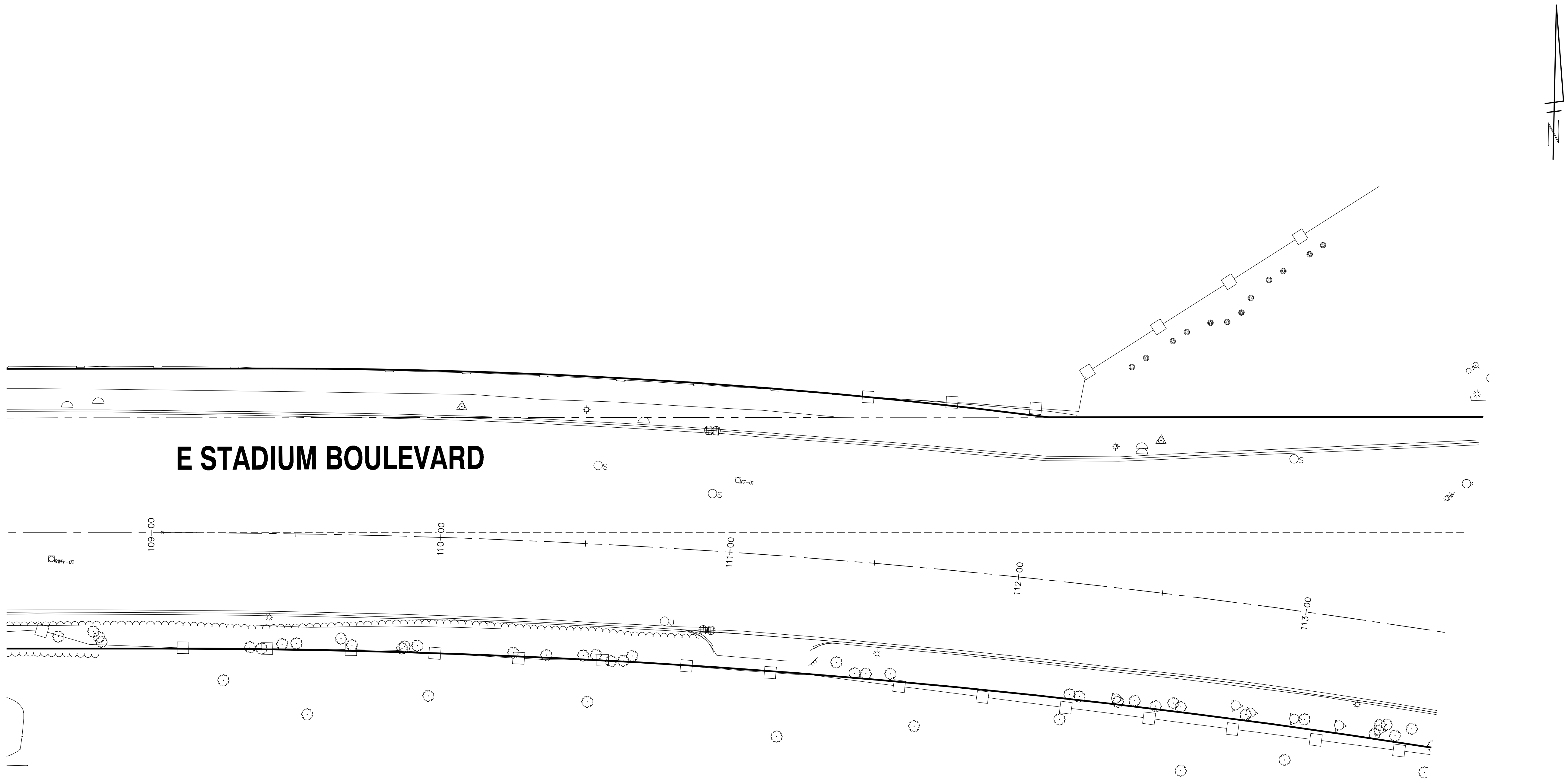
STADIUM BOULEVARD STA 103+00 STA 108+50

SCALE PLAN: 1" = 20'

DRAWING No. 2014035-SB09

SHEET No. 9 OF 14

K:\ACAD\14255016(AA-Stadium)\Design\aa_stad-sheets.dwg Dwg Created: 8-Jan-15 — _a2 standard bw.stb — Plot Date: 9-Jan-15



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PROJECT MANAGEMENT - PUBLIC SERVICES - CITY OF ANN ARBOR

STADIUM BOULEVARD RECONSTRUCTION PROJECT

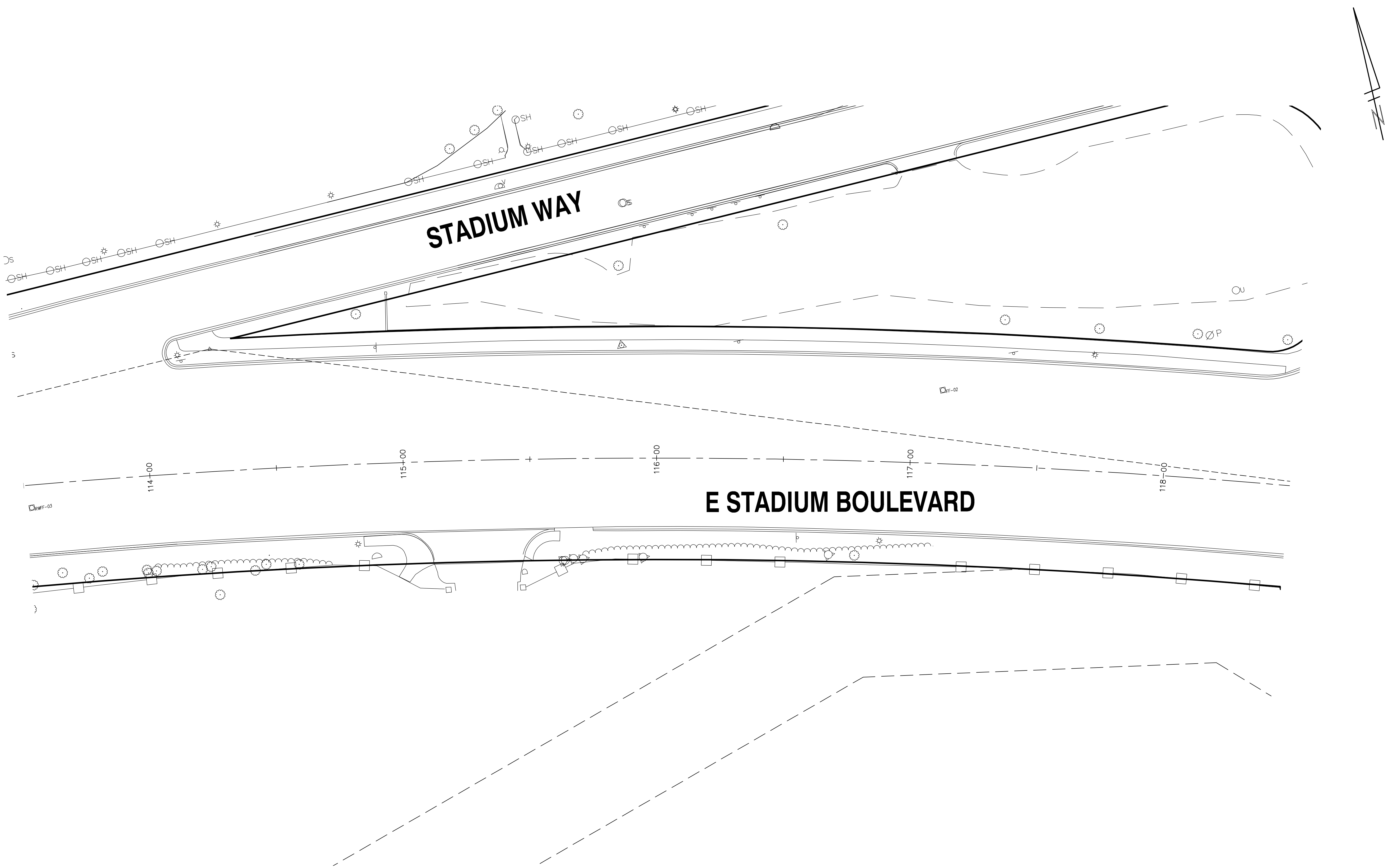
SOIL BORING LAYOUTS

STADIUM BOULEVARD STA 108+50 STA 113+50

SCALE PLAN: ########

DRAWING No. 2014035-SB10

K:\ACAD\14255016(AA-Stadium)\Design\aa_stad-sheets.dwg Dwg Created: 8-Jan-15 — _a2 standard bw.stb — Plot Date: 9-Jan-15



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PROJECT MANAGEMENT - PUBLIC SERVICES - CITY OF ANN ARBOR

STADIUM BOULEVARD RECONSTRUCTION PROJECT

SOIL BORING LAYOUTS

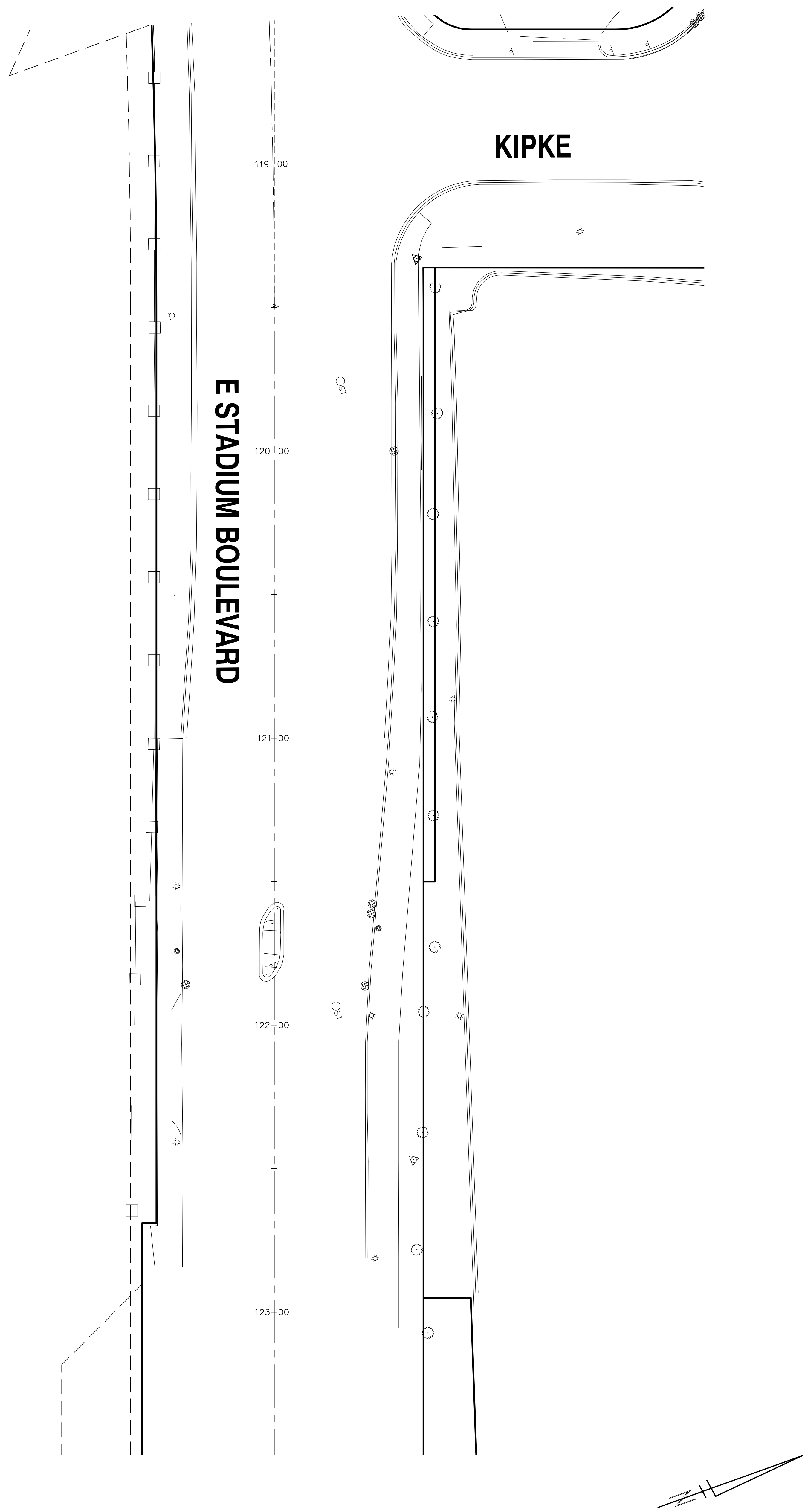
STADIUM BOULEVARD STA 113+50 TO STA 118+50

SCALE PLAN: ########

DRAWING No. 2014035-SB11

K:\ACAD\14255016(AA-Stadium)\Design\aa_stad-sheets.dwg Dwg Created: 8-Jan-15 -- _a2 standard bw.stb -- Plot Date: 9-Jan-15

K:\ACAD\14255016(AA-Stadium)\Design\aa_stad-sheets.dwg Dwg Created: 8-Jan-15 - _a2 standard bw.stb - Plot Date: 9-Jan-15



NCI NORTHWEST CONSULTANTS, INC.

PROJECT MANAGEMENT - PUBLIC SERVICES - CITY OF ANN ARBOR

SCALE PLAN: ########

DRAWING No. 2014035-SB12

STADIUM BOULEVARD RECONSTRUCTION PROJECT

SOIL BORING LAYOUTS

STADIUM BOULEVARD STA 118+50 TO STA 123+50

CITY OF ANN ARBOR MICHIGAN

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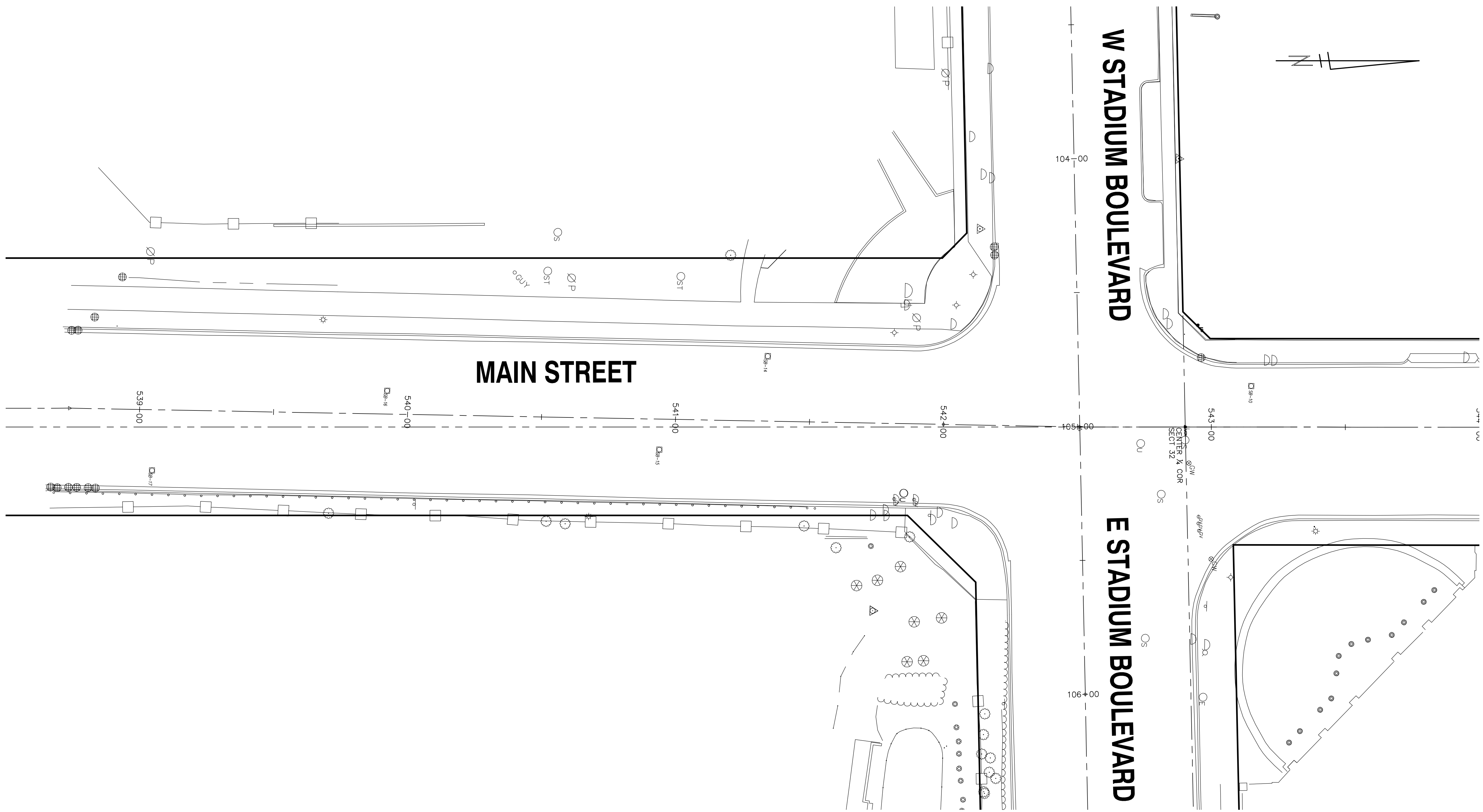
SHEET No. 12 OF 14



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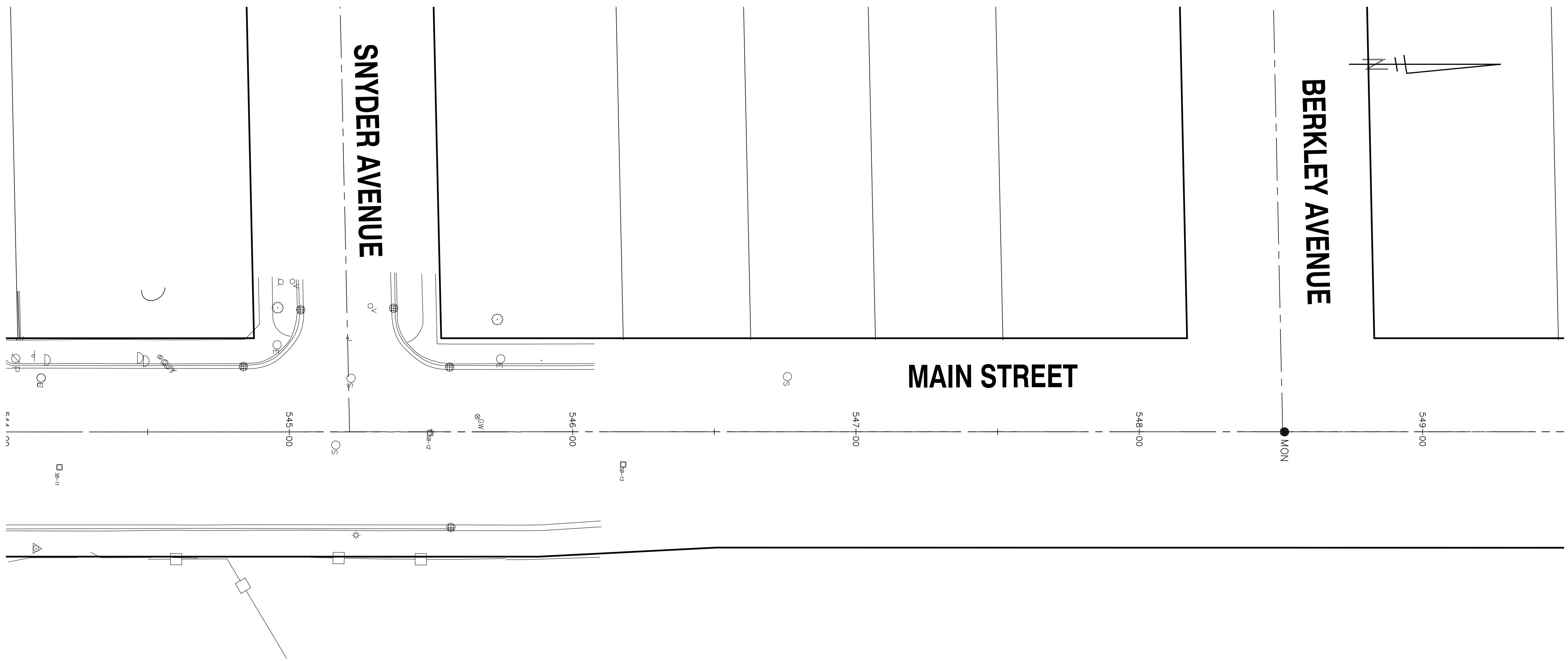
CITY OF ANN ARBOR MICHIGAN

PROJECT MANAGEMENT - PUBLIC SERVICES - CITY OF ANN ARBOR
STADIUM BOULEVARD RECONSTRUCTION PROJECT
SOIL BORING LAYOUTS
MAIN STREET STA 538+50 TO STA 544+00

SCALE PLAN: 1" = 20'

DRAWING No. 2014035-SB13

SHEET No. 13 OF 14



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PROJECT MANAGEMENT - PUBLIC SERVICES - CITY OF ANN ARBOR

STADIUM BOULEVARD RECONSTRUCTION PROJECT

SOIL BORING LAYOUTS
MAIN STREET STA 544+00 TO STA 549+50

SCALE PLAN: 1" = 20'

DRAWING No. 2014035-SB14

SHEET No. 14 OF 14

K:\ACAD\14255016(AA-Stadium)\Design\aa_stad-sheets.dwg Dwg Created: 8-Jan-15 - _a2 standard bw.stb - Plot Date: 9-Jan-15

CTI and Associates, Inc.

Boring Logs

(FF-01, FF-02, FFSB-01 through FFSB-06, RWFF-01 through RWFF-03, and SB-01 through SB-29)

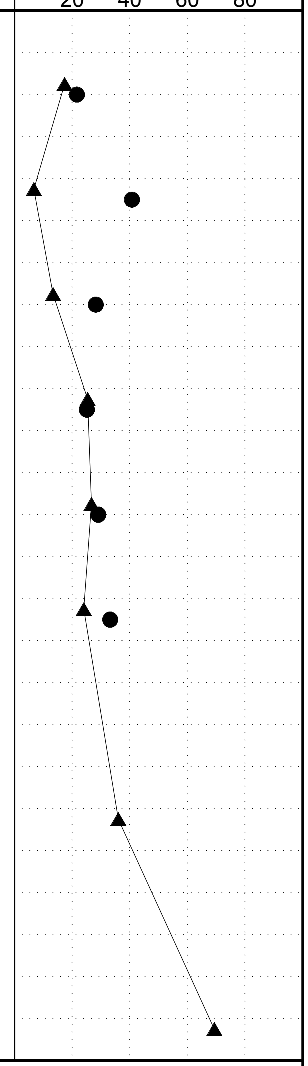
CTI and Associates, Inc.

BORING NUMBER FF-01

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/11/14 **COMPLETED** 11/11/14
GROUND ELEVATION 878.9 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 3-1/4 inch Hollow Stem Auger
DURING DRILLING 13'
LOGGED BY D. Kent **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH 23' 6"

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0	3 inches of ASPHALT PAVEMENT					
	4 inches of CONCRETE PAVEMENT					
	11 inches of SAND and GRAVEL FILL (Aggregate Base)	SS 1	56	3-5-8 (13)		11
	SANDY CLAY FILL - (CL-FILL) - mottled dark brown and dark gray, with silt, some gravel, trace organics, occasional sand seams, moist					
5	CLAY FILL - (CL-FILL) - dark brown, with silt, some organics, traces of sand and gravel, moist Loss-on-Ignition (organic content) = 3.4%	SS 2	89	3-3-2 (5)		20
	CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, occasional wet sand and silt partings, hard, moist	SS 3	100	3-3-7 (10)	4.0	14
10		SS 4	89	3-8-11 (19)	4.5+	13
		SS 5	83	4-9-11 (20)	4.5+	15
15	CLAY (CL) - brown, with silt, traces of sand and gravel, occasional wet sand seams and silt partings, hard to stiff, moist	SS 6	89	5-8-10 (18)	4.5+	17
20		SS 7	72	5-12-15 (27)	1.0	
	SAND (SP-SM) - brown to gray, fine to medium, some silt, trace gravel, wet					
25		SS 8	6	15-25-27 (52)		
	CLAY (CL) - gray, with silt, traces of sand and gravel, occasional cobbles, moist					

▲ SPT N VALUE ▲ (15, 30, 45, 60); PL — MC ● — LL (10, 20, 30, 40); □ FINES CONTENT (%) □ (20, 40, 60, 80)



Bottom of borehole at 25.0 feet.

Boring performed on Stadium Boulevard - STA 111+00, 25' L of CL

BORING NUMBER FF-02

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.

PROJECT NAME Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 11/11/14 **COMPLETED** 11/11/14

GROUND ELEVATION 860 ft +/-

DRILLING CONTRACTOR Brax Drilling

GROUND WATER LEVELS:

DRILLING METHOD 3-1/4 inch Hollow Stem Auger

DURING DRILLING 8' 6"

LOGGED BY D. Kent **CHECKED BY** T. Marsik

AFTER DRILLING 9' 7"

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH 12' 5"

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / □ FINES CONTENT (%) □ 20 40 60 80
0	7 inches of ASPHALT PAVEMENT						
	11 inches of GRAVEL FILL						
	CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, occasional silt partings, stiff, moist	SS 1	72	3-5-5 (10)	1.5	14	
	SAND (SP-SM) - brown, fine to medium, some silt, trace gravel, medium dense, moist	SS 2	83	5-9-11 (20)		5	
5	SILTY SAND (SM) - brown, fine, traces of gravel and clay, medium dense to dense, moist to wet	SS 3	94	5-8-10 (18)			
	**Becomes wet	SS 4	100	7-10-12 (22)			
10		SS 5	89	9-13-14 (27)			
		SS 6	72	14-17-18 (35)			
15	SAND (SP-SM) - brown, fine to medium, some silt, medium dense, wet						
		SS 7	100	3-7-12 (19)			
20	SAND (SP-SM) - gray, fine to medium, some silt, medium dense, wet						
25		SS 8	100	4-8-15 (23)			

Bottom of borehole at 25.0 feet.

Boring performed on Stadium Boulevard - STA 117+12, 30' L of CL

BORING NUMBER FFSB-01

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/10/14 **COMPLETED** 11/10/14
GROUND ELEVATION 909.35 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 3-1/4 inch Hollow Stem Auger
DURING DRILLING 6' 6"
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING 8'
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH 21' 6"

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0	7 inches of ASPHALT PAVEMENT					
	5 inches of CONCRETE PAVEMENT					
	6 inches of SANDY GRAVEL FILL	SS 1	72	3-5-5 (10)		17
	CLAY FILL (CL-FILL) - mottled brown and dark brown; with silt; traces of sand, gravel and organics; occasional sand partings; moist					
5	CLAY (CL) - brown to mottled brown and gray, with silt, traces of sand and gravel, occasional wet sand seams, very stiff, moist	SS 2	56	3-3-7 (10)	3.25	15
		SS 3	100	2-3-4 (7)	2.0	14
10	CLAY (CL) - brown, with silt, traces of sand and gravel, occasional silt seams, very stiff, moist	SS 4	100	4-7-11 (18)	4.0 6940	16
	CLAY (CL) - gray, with silt, traces of sand and gravel, very stiff, moist	SS 5	89	3-4-6 (10)	2.0	17
15	SANDY CLAY (CL) - gray, with silt, traces of gravel, very stiff, moist	SS 6	100	3-6-8 (14)	3.5	8
	SAND (SM) - brown, fine, with silt, traces of clay and gravel, medium dense, moist					
20	SILTY SAND (SM) - brown, fine, traces of clay and gravel, medium dense, wet	SS 7	67	8-12-14 (26)		
	SANDY CLAY (CL) - gray, with silt, traces of gravel, very stiff, moist					
25		SS 8	100	7-9-11 (20)	2.5	8

Plot columns: ▲ SPT N VALUE ▲ (15, 30, 45, 60); PL — MC — LL (10, 20, 30, 40); ☐ FINES CONTENT (%) ☐ (20, 40, 60, 80)

Bottom of borehole at 25.0 feet.

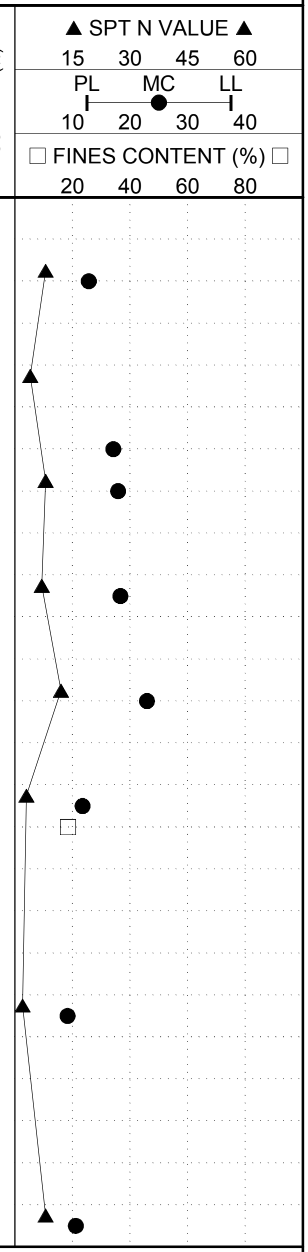
Boring performed on Stadium Boulevard - STA 90+65, 5' R of CL

BORING NUMBER FFSB-02

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/10/14 **COMPLETED** 11/10/14
GROUND ELEVATION 900.56 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 3-1/4 inch Hollow Stem Auger
DURING DRILLING None
LOGGED BY D. Kent **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH 22' 10"

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0	6 inches of ASPHALT PAVEMENT					
	6 inches of CONCRETE PAVEMENT					
	SILTY SAND (SM-POSSIBLE FILL) - brown, fine, some clay, trace gravel, loose, moist	SS 1	83	3-3-5 (8)		13
5		SS 2	72	2-2-2 (4)		
						17
	CLAY (CL-OL) - dark brown, with sand and silt, trace organics, moist Loss-on-Ignition (organic content) = 2.5%	SS 3	67	2-3-5 (8)	1.25	18
	CLAY (CL) - brown, with silt, traces of sand and gravel, stiff to very stiff, moist	SS 4	94	2-3-4 (7)	3.0	18
10		SS 5	83	3-5-7 (12)	3.0	23
	SAND (SM) - brown, fine, with silt, very loose, moist	SS 6	100	2-1-2 (3)		12
15						
	SAND (SC) - brown, fine to medium, with clay, trace gravel, very loose, moist	SS 7	100	2-1-1 (2)		9
20						
	CLAY (CL) - brown to gray, with silt, some sand, trace gravel, stiff, moist ** color change to gray	SS 8	100	2-3-5 (8)	1.5	11
25						



Bottom of borehole at 25.0 feet.

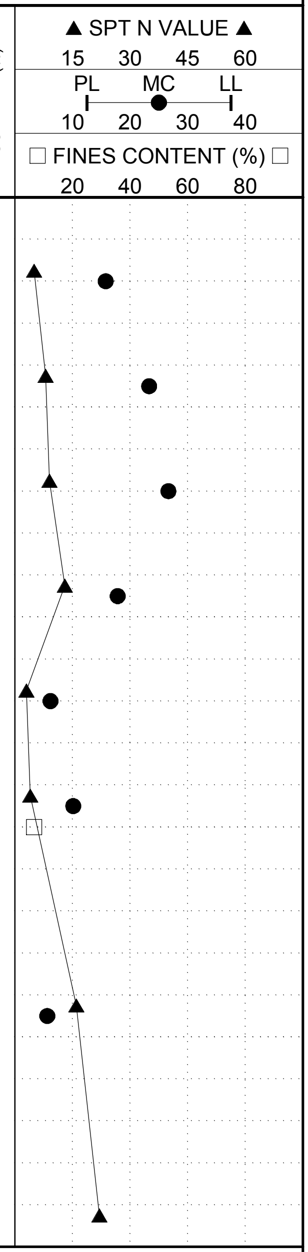
Boring performed on Stadium Boulevard - STA 93+81, 3' L of CL

BORING NUMBER FFSB-03

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/10/14 **COMPLETED** 11/10/14
GROUND ELEVATION 897.41 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 3-1/4 inch Hollow Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH None

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0	6 inches of ASPHALT PAVEMENT					
	4 inches of CONCRETE PAVEMENT					
	5 inches of SANDY GRAVEL FILL- brown	SS 1	83	3-2-3 (5)		16
	SANDY CLAY FILL (CL- FILL) - dark brown, with silt, traces of gravel and organics, moist Loss-on-Ignition (organic content) = 2.2%					
5	CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, occasional silt partings, very stiff to hard, moist	SS 2	100	2-3-5 (8)	2.75	23
		SS 3	78	2-4-5 (9)	4.25	27
10	CLAY (CL) - brown, with silt, traces of sand and gravel, occasional silt partings, hard, moist	SS 4	100	4-5-8 (13)	4.5+	18
	SAND (SP-SC) - brown, fine, some clay, trace gravel, very loose, moist	SS 5	83	2-2-1 (3)		6
15		SS 6	83	1-1-3 (4)		10
20	SILTY SAND (SM) - brown, fine, occasional silt and clay lenses, medium dense, moist	SS 7	89	5-7-9 (16)		6
25		SS 8	83	7-9-13 (22)		



Bottom of borehole at 25.0 feet.

Boring performed on Stadium Boulevard - STA 96+69, 5' L of CL

BORING NUMBER FFSB-04

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/10/14 **COMPLETED** 11/10/14
GROUND ELEVATION 896.57 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 3-1/4 inch Hollow Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH 22' 7"

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0	6 inches of ASPHALT PAVEMENT					
	6 inches of SAND and GRAVEL FILL					
	SANDY CLAY (CL) - reddish-brown, with silt, trace gravel, very stiff, moist	SS 1	72	4-5-6 (11)	2.5	14
	CLAY (CL) - brown, with silt, traces of sand and gravel, occasional very moist sand partings, stiff to hard, moist	SS 2	67	3-3-4 (7)	1.5	15
5		SS 3	83	3-7-10 (17)	4.5+	13
	SAND (SP-SM) - brown, fine to medium, some silt, trace gravel, moist					
10	CLAY (CL) - gray, with silt, some sand, trace gravel, hard, moist	SS 4	100	3-6-7 (13)	4.5+	17
	CLAY (CL) - gray, with silt, traces of sand and gravel, stiff, moist					
15		SS 5	100	2-3-5 (8)	1.5	15
20		SS 6	100	3-3-6 (9)	1.5	13
25		SS 7	100	3-5-8 (13)	1.5	14

▲ SPT N VALUE ▲: 15 30 45 60
PL MC LL: 10 20 30 40
☐ FINES CONTENT (%) ☐: 20 40 60 80

Bottom of borehole at 25.0 feet.

Boring performed on Stadium Boulevard - STA 99+72, 3' L of CL

BORING NUMBER FFSB-05

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/11/14 **COMPLETED** 11/11/14
GROUND ELEVATION 894.49 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 3-1/4 inch Hollow Stem Auger
DURING DRILLING 8'
LOGGED BY D. Kent **CHECKED BY** T. Marsik
AFTER DRILLING 14' 1"
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH 14' 6"

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0	6 inches of ASPHALT PAVEMENT					
	6 inches of CONCRETE PAVEMENT					
	CLAYEY SAND FILL (SC-FILL) - dark brown, fine to medium, traces of gravel and organics, moist Loss-on-Ignition (organic content) = 2.1%	SS 1	61	6-8-8 (16)		12
5	CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, very stiff to hard, moist	SS 2	100	3-4-6 (10)	2.5	17
		SS 3	83	3-6-7 (13)	4.5+	14
10	SAND (SP-SM) - brown, fine to medium, some silt, trace gravel, medium dense, wet	SS 4	72	3-5-6 (11)		23
	CLAY (CL) - gray, with silt, traces of sand and gravel, stiff, moist	SS 5	83	2-4-6 (10)	2.0	17
15		SS 6	89	3-4-6 (10)	2.0	15
20		SS 7	100	3-3-6 (9)	2.0	18
25		SS 8	100	3-4-7 (11)	1.5	16

▲ SPT N VALUE ▲ 15 30 45 60
PL MC LL 10 20 30 40
☐ FINES CONTENT (%) ☐ 20 40 60 80

Bottom of borehole at 25.0 feet.

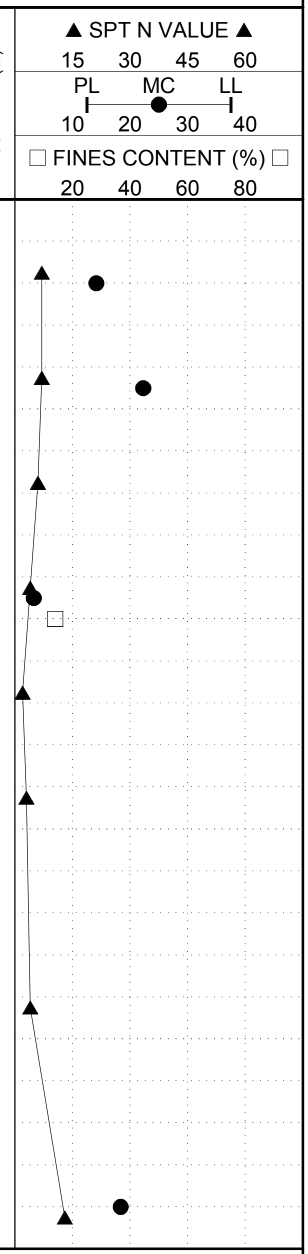
Boring performed on Stadium Boulevard - STA 102+75, 2' L of CL

BORING NUMBER FFSB-06

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/14/14 **COMPLETED** 11/14/14
GROUND ELEVATION 893.33 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 3-1/4 inch Hollow Stem Auger
DURING DRILLING 23'
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING 22'
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH 22' 6"

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0	6 inches of ASPHALT PAVEMENT					
	SANDY CLAY FILL - (CL-FILL) - brown to dark brown, with silt, traces of gravel and organics, moist	SS 1	100	3-3-4 (7)		14
5	CLAY (CL-OL) - dark brown, with silt, some organics, trace sand, medium stiff, moist Loss-on-Ignition (organic content) = 4.6%	SS 2	61	3-3-4 (7)		22
	SAND (SP-SM) - brown, fine, some silt, traces of gravel and clay, loose to very loose, moist	SS 3	89	3-3-3 (6)		
10		SS 4	100	1-2-2 (4)		3
		SS 5	61	1-1-1 (2)		
15		SS 6	89	1-1-2 (3)		
20		SS 7	100	1-2-2 (4)		
	SAND (SP-SM) - brown, fine, some silt, traces of gravel and clay, loose, wet					
25	CLAY (CL) - gray, with silt, traces of sand and gravel, very stiff, moist	SS 8	100	3-3-10 (13)	3.25	18
	SAND (SC) - gray, fine, with clay, medium dense, wet					



Bottom of borehole at 25.0 feet.

Boring performed on Edgewood Avenue - 84' N of Snyder Avenue CL, 11' W of Edgewood CL

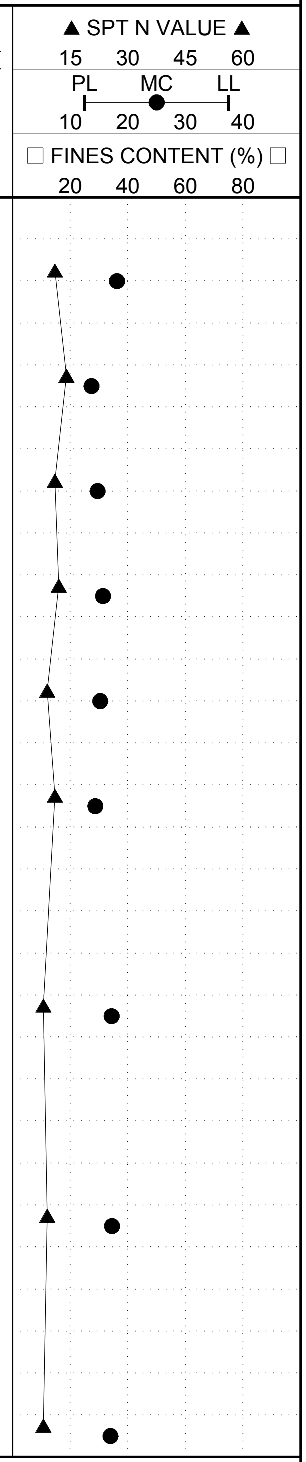
BORING NUMBER RWFF-01

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/13/14 **COMPLETED** 11/13/14
GROUND ELEVATION 887.9 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 3-1/4 inch Hollow Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH 23'

DEPTH (ft)	MATERIAL DESCRIPTION
0	6 inches of ASPHALT PAVEMENT
	7 inches of CONCRETE PAVEMENT
	CLAY FILL (CL-FILL) - dark brown, with silt, traces of sand and gravel, moist
	CLAY (CL- FILL) - grayish-brown, with silt, traces of sand and gravel, moist Loss-on-Ignition (organic content) = 3.2%
5	CLAY (CL) - gray, with silt, traces of sand and gravel, very stiff to stiff, moist
30	Bottom of borehole at 30.0 feet.

SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
SS 1	78	4-5-6 (11)	4.0	18
SS 2	83	4-5-9 (14)	4.0 6890	14
SS 3	72	3-4-7 (11)	2.25	15
SS 4	100	3-5-7 (12)	4.0	16
SS 5	89	2-3-6 (9)	2.5	15
SS 6	100	3-4-7 (11)	2.0	14
SS 7	100	3-3-5 (8)	1.5	17
SS 8	100	3-3-6 (9)	1.5	17
SS 9	100	4-4-4 (8)	1.5	17



Boring performed on Stadium Boulevard - STA 106+60, 10' R of CL

BORING NUMBER RWFF-02

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/13/14 **COMPLETED** 11/13/14
GROUND ELEVATION 884.36 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 3-1/4 inch Hollow Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH 23'

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60; PL MC LL 10 20 30 40; ☐ FINES CONTENT (%) ☐ 20 40 60 80
0	4 inches of ASPHALT PAVEMENT						
	7 inches of CONCRETE PAVEMENT						
	CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, hard, moist	SS 1	61	3-7-10 (17)	4.5+	14	
5		SS 2	94	10-9-11 (20)	4.5+ / 10830	14	
		SS 3	89	3-8-13 (21)	4.5+	16	
10		SS 4	94	3-6-8 (14)	4.5+	15	
	CLAY (CL) - gray, with silt, traces of sand and gravel, stiff to very stiff, moist	SS 5	67	3-6-4 (10)	1.5		
15		SS 6	100	3-4-4 (8)	1.5 / 4050	15	
20		SS 7	100	2-3-5 (8)	1.75	16	
25		SS 8	100	2-4-6 (10)	1.75	18	
30		SS 9	100	4-5-5 (10)	2.0	17	

Bottom of borehole at 30.0 feet.

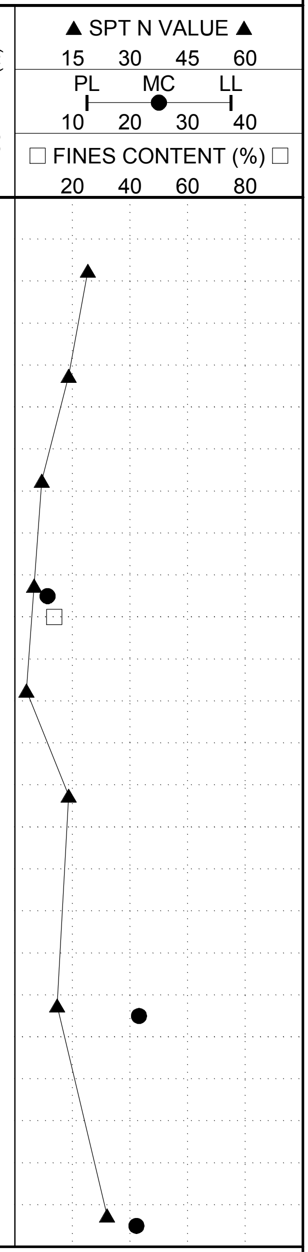
Boring performed on Stadium Boulevard - STA 108+66, 10' R of CL

BORING NUMBER RWFF-03

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/13/14 **COMPLETED** 11/13/14
GROUND ELEVATION 871.29 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 3-1/4 inch Hollow Stem Auger
DURING DRILLING 19'
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING 22'
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH 23'

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0	4 inches of ASPHALT PAVEMENT					
	7 inches of CONCRETE PAVEMENT					
	SAND (SM) - brown, fine to coarse, with silt, some gravel, medium dense to loose, moist	SS 1	100	6-9-10 (19)		
5		SS 2	89	9-6-8 (14)		
		SS 3	83	4-3-4 (7)		
10	SAND (SM) - brown, fine, with silt, trace gravel, loose to very loose, moist	SS 4	100	3-2-3 (5)		6
		SS 5	89	2-1-2 (3)		
15	SAND (SP-SM) - brown, fine, some silt, trace gravel, medium dense, moist	SS 6	78	3-7-7 (14)		
20	SAND (SM) - brown, fine to coarse, with silt, some gravel, medium dense, wet	SS 7	83	5-7-4 (11)		22
25		SS 8	94	7-10-14 (24)		21



Bottom of borehole at 25.0 feet.

Boring performed on Stadium Boulevard - STA 113+52, 10' R of CL

BORING NUMBER SB-01

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.

PROJECT NAME Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 11/13/14 **COMPLETED** 11/13/14

GROUND ELEVATION 913.41 ft +/-

DRILLING CONTRACTOR Brax Drilling

GROUND WATER LEVELS:

DRILLING METHOD 2-1/4 inch Solid Stem Auger

DURING DRILLING None

LOGGED BY R. Rajan **CHECKED BY** T. Marsik

AFTER DRILLING None

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH None

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0	3 inches of ASPHALT PAVEMENT					
	8 inches of CONCRETE PAVEMENT					
	CLAY (CL) - brown, with silt, traces of sand and gravel, occasional silt partings, hard, moist	SS 1	67	5-7-7 (14)	4.0	15
	CLAY (CL) - brown, with silt, traces of sand and gravel, hard, moist	SS 2	100	5-7-9 (16)	4.5+	12
5						

Chart column scales:

▲ SPT N VALUE ▲	15	30	45	60
PL — MC — LL	10	20	30	40
□ FINES CONTENT (%) □	20	40	60	80

Bottom of borehole at 5.0 feet.

Boring performed on Stadium Boulevard - STA 89+68, 3' R of CL

BORING NUMBER SB-02

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.

PROJECT NAME Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 11/13/14 **COMPLETED** 11/13/14

GROUND ELEVATION 906.04 ft +/-

DRILLING CONTRACTOR Brax Drilling

GROUND WATER LEVELS:

DRILLING METHOD 2-1/4 inch Solid Stem Auger

DURING DRILLING None

LOGGED BY R. Rajan **CHECKED BY** T. Marsik

AFTER DRILLING None

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60; PL MC LL 10 20 30 40; □ FINES CONTENT (%) □ 20 40 60 80
0		6 inches of ASPHALT PAVEMENT						
		8 inches of CONCRETE PAVEMENT						
		CLAY FILL (CL-FILL) - mottled brown, dark brown and dark gray; with silt; traces of sand, gravel and organics; moist Loss-on-Ignition (organic content) = 3.8%	SS 1	67	3-3-4 (7)		16	
5		SANDY CLAY (CL-POSSIBLE FILL) - dark brown, with silt, traces of gravel and organics, occasional hair roots, medium stiff, moist Loss-on-Ignition (organic content) = 2.3%	SS 2	78	3-3-3 (6)	0.5	16	

Bottom of borehole at 5.0 feet.

Boring performed on Stadium Boulevard - STA 91+65, 5' R of CL

BORING NUMBER SB-03

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/12/14 **COMPLETED** 11/12/14
GROUND ELEVATION 903.11 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 2-1/4 inch Solid Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH None

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0	6 inches of ASPHALT PAVEMENT					
	8 inches of CONCRETE PAVEMENT					
	10 inches of SAND and GRAVEL FILL - gray	SS 1	78	3-3-5 (8)		24
	SAND FILL (SM-FILL) - brown, with silt, moist					
	CLAY FILL (CL-FILL) - mottled brown, dark brown and dark gray; with silt; traces of sand, gravel and organics; moist	SS 2	89	3-3-4 (7)	3.5	22
5	CLAY (CL) - brown, with silt, traces of sand and gravel, very stiff, moist					

SPT N VALUE scale: 15 30 45 60; PL MC LL scale: 10 20 30 40; FINES CONTENT (%) scale: 20 40 60 80

Bottom of borehole at 5.0 feet.

Boring performed on Stadium Boulevard - STA 92+53, 21' L of CL

BORING NUMBER SB-04

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/13/14 **COMPLETED** 11/13/14
GROUND ELEVATION 898.5 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 2-1/4 inch Solid Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH None

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0	4 inches of ASPHALT PAVEMENT					
	9 inches of CONCRETE PAVEMENT					
	SANDY CLAY FILL (CL-FILL) - mottled brown, dark brown and dark gray; with silt; traces of gravel and organics; moist Loss-on-Ignition (organic content) = 2.9%	SS 1	72	2-3-4 (7)		6
	CLAY (CL-POSSIBLE FILL) - brown, with silt, some sand, traces of gravel, medium stiff, very moist	SS 2	100	1-2-2 (4)	0.5	17
5						

▲ SPT N VALUE ▲ (15, 30, 45, 60); PL — MC — LL (10, 20, 30, 40); □ FINES CONTENT (%) □ (20, 40, 60, 80)

Bottom of borehole at 5.0 feet.

Boring performed on Stadium Boulevard - STA 94+68, 15' R of CL

BORING NUMBER SB-05

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.

PROJECT NAME Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 11/12/14 **COMPLETED** 11/12/14

GROUND ELEVATION 898.2 ft +/-

DRILLING CONTRACTOR Brax Drilling

GROUND WATER LEVELS:

DRILLING METHOD 2-1/4 inch Solid Stem Auger

DURING DRILLING 3' 6"

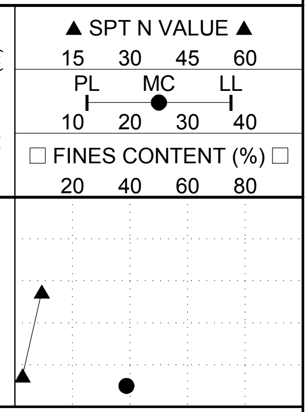
LOGGED BY R. Rajan **CHECKED BY** T. Marsik

AFTER DRILLING None

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0		3 inches of ASPHALT PAVEMENT					
		12 inches of CONCRETE PAVEMENT					
		12 inches of SAND and GRAVEL FILL					
		SAND (SP-SC) - brown, fine, some clay, trace gravel, loose, very moist	SS 1	78	3-3-4 (7)		
5		CLAYEY SAND (SC) - gray, fine, trace gravel, occasional clay seams and peat lenses, very loose, wet	SS 2	100	1-1-1 (2)		19



Bottom of borehole at 5.0 feet.

Boring performed on Stadium Boulevard - STA 95+67, 21' L of CL

BORING NUMBER SB-06

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/13/14 **COMPLETED** 11/13/14
GROUND ELEVATION 897.21 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 2-1/4 inch Solid Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / □ FINES CONTENT (%) □ 20 40 60 80
0		4 inches of ASPHALT PAVEMENT						
		6 inches of CONCRETE PAVEMENT						
		CLAY (CL) - brown, with silt, traces of sand and gravel, hard, moist	SS 1	56	3-4-6 (10)	4.5+	15	
5			SS 2	89	6-9-10 (19)	4.5+	15	

Bottom of borehole at 5.0 feet.

Boring performed on Stadium Boulevard - STA 97+68, 5' R of CL

BORING NUMBER SB-07

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.

PROJECT NAME Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 11/13/14 **COMPLETED** 11/13/14

GROUND ELEVATION 896.61 ft +/-

DRILLING CONTRACTOR Brax Drilling

GROUND WATER LEVELS:

DRILLING METHOD 2-1/4 inch Solid Stem Auger

DURING DRILLING None

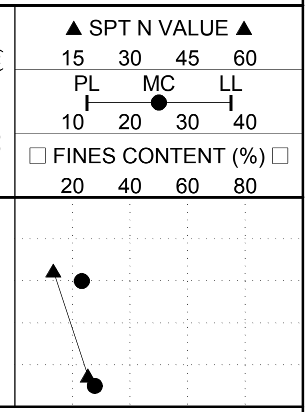
LOGGED BY R. Rajan **CHECKED BY** T. Marsik

AFTER DRILLING None

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0		3 inches of ASPHALT PAVEMENT					
		9 inches of CONCRETE PAVEMENT					
		CLAY (CL) - brown to mottled brown and gray, with silt, traces of sand and gravel, very stiff to hard, moist	SS 1	83	3-4-6 (10)	2.5	12
5		** becomes mottled brown and gray	SS 2	100	3-8-11 (19)	4.5+	14



Bottom of borehole at 5.0 feet.

Boring performed on Stadium Boulevard - STA 98+68, 15' R of CL

BORING NUMBER SB-08

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/12/14 **COMPLETED** 11/12/14
GROUND ELEVATION 896.05 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 2-1/4 inch Solid Stem Auger
DURING DRILLING 4' 6"
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING 3' 8"
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH 3' 8"

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60; PL MC LL 10 20 30 40; □ FINES CONTENT (%) □ 20 40 60 80
0		3 inches of ASPHALT PAVEMENT						
		8" of CONCRETE PAVEMENT						
		SILTY SAND (SM-FILL) - grayish-brown, fine, trace gravel, occasional clay lenses, medium dense, very moist	SS 1	100	5-4-6 (10)			
			SS 2	100	5-3-2 (5)			
5		SILTY SAND (SM) - brown, fine, trace gravel, loose, wet						

Bottom of borehole at 5.0 feet.

Boring performed on Stadium Boulevard - STA 100+64, 20' L of CL

CTI and Associates, Inc.

BORING NUMBER SB-09

CLIENT Northwest Consultants, Inc.

PROJECT NAME Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 11/13/14 **COMPLETED** 11/13/14

GROUND ELEVATION 895.66 ft +/-

DRILLING CONTRACTOR Brax Drilling

GROUND WATER LEVELS:

DRILLING METHOD 2-1/4 inch Solid Stem Auger

DURING DRILLING None

LOGGED BY R. Rajan **CHECKED BY** T. Marsik

AFTER DRILLING None

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60; PL MC LL 10 20 30 40; ☐ FINES CONTENT (%) ☐ 20 40 60 80
0		7 inches of ASPHALT PAVEMENT						
		8 inches of CONCRETE PAVEMENT						
		CLAY (CL) - brown, with silt, traces of sand and gravel, very stiff to hard, moist	SS 1	78	4-5-6 (11)	3.5	23	
			SS 2	61	3-3-4 (7)	4.5+	20	
5		CLAYEY SAND (SC) - brown, fine to medium, trace gravel, loose, very moist						

Bottom of borehole at 5.0 feet.

Boring performed on Stadium Boulevard - STA 101+65, 7' R of CL

CTI and Associates, Inc.

BORING NUMBER SB-10

CLIENT Northwest Consultants, Inc.

PROJECT NAME Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 11/12/14 **COMPLETED** 11/12/14

GROUND ELEVATION 890.85 ft +/-

DRILLING CONTRACTOR Brax Drilling

GROUND WATER LEVELS:

DRILLING METHOD Hand Auger

DURING DRILLING None

LOGGED BY R. Rajan **CHECKED BY** T. Marsik

AFTER DRILLING None

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60; PL MC LL 10 20 30 40; □ FINES CONTENT (%) □ 20 40 60 80
0		6 inches of ASPHALT PAVEMENT						
		6 inches of SAND and GRAVEL FILL						
		SILTY SAND (SM) - brown, fine, trace gravel, moist	HA 1	100				
		SAND (SP-SM) - brown, fine to medium, some silt, traces of gravel, very moist						
5			HA 2	100				

Bottom of borehole at 5.0 feet.

Boring performed on S. Main Street - STA 543+15, 15' L of CL

BORING NUMBER SB-11

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.

PROJECT NAME Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 11/12/14 **COMPLETED** 11/12/14

GROUND ELEVATION 890.77 ft +/-

DRILLING CONTRACTOR Brax Drilling

GROUND WATER LEVELS:

DRILLING METHOD 2-1/4 inch Solid Stem Auger

DURING DRILLING None

LOGGED BY R. Rajan **CHECKED BY** T. Marsik

AFTER DRILLING None

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / □ FINES CONTENT (%) □ 20 40 60 80
0		6 inches of ASPHALT PAVEMENT						
		6 inches of SAND and GRAVEL FILL						
		SAND (SP-SM) - brown, fine to medium, some silt, trace gravel, medium dense, moist	SS 1	83	12-12-9 (21)			
5		CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, occasional silt partings, very stiff, moist	SS 2	94	4-4-7 (11)	3.5	14	

Bottom of borehole at 5.0 feet.

Boring performed on S. Main Street - STA 544+18, 13' R of CL

BORING NUMBER SB-12

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/12/14 **COMPLETED** 11/12/14
GROUND ELEVATION 886.58 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 2-1/4 inch Solid Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60; PL MC LL 10 20 30 40; □ FINES CONTENT (%) □ 20 40 60 80
0		6 inches of ASPHALT PAVEMENT						
		12 inches of SAND and GRAVEL FILL						
		SAND (SP-SM) - brown, fine, some silt, trace gravel, medium dense, moist	SS 1	89	15-7-5 (12)			
5		CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, occasional silt partings, hard, moist	SS 2	56	5-5-7 (12)	4.5+	15	

Bottom of borehole at 5.0 feet.

Boring performed on S. Main Street - STA 545+50, at CL

BORING NUMBER SB-13

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.

PROJECT NAME Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 11/12/14 **COMPLETED** 11/12/14

GROUND ELEVATION 883.43 ft +/-

DRILLING CONTRACTOR Brax Drilling

GROUND WATER LEVELS:

DRILLING METHOD 2-1/4 inch Solid Stem Auger

DURING DRILLING None

LOGGED BY R. Rajan **CHECKED BY** T. Marsik

AFTER DRILLING None

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / □ FINES CONTENT (%) □ 20 40 60 80
0		6 inches of ASPHALT PAVEMENT						
		SAND (SP-SM) - brown, fine, some silt, trace gravel, medium dense, moist	SS 1	78	16-17-12 (29)			
5		CLAY (CL) - brown, with silt, traces of sand and gravel, hard, moist	SS 2	78	3-5-8 (13)	4.5+	15	

Bottom of borehole at 5.0 feet.

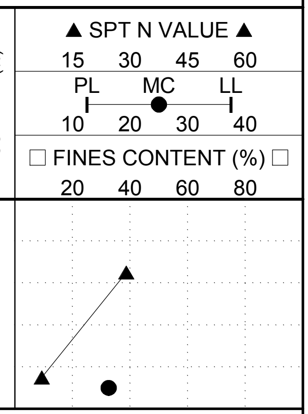
Boring performed on S. Main Street - STA 546+17, 12' R of CL

CTI and Associates, Inc.

BORING NUMBER SB-14

CLIENT	Northwest Consultants, Inc.	**PROJECT NAME**	Stadium Boulevard Reconstruction
PROJECT NUMBER	3142040052	**PROJECT LOCATION**	Ann Arbor, Michigan
DATE STARTED	11/12/14 **COMPLETED** 11/12/14	**GROUND ELEVATION**	887.17 ft +/-
DRILLING CONTRACTOR	Brax Drilling	**GROUND WATER LEVELS:**	
DRILLING METHOD	2-1/4 inch Solid Stem Auger	**DURING DRILLING**	None
LOGGED BY	R. Rajan **CHECKED BY** T. Marsik	**AFTER DRILLING**	None
NOTES	Boring backfilled with auger cuttings and patched	**COLLAPSE DEPTH**	None

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0	6 inches of ASPHALT PAVEMENT					
	SAND (SP-SM) - brown, fine to medium, some silt, trace gravel, medium dense, moist	SS 1	100	14-17-12 (29)		
	CLAY (CL) - brown, with silt, traces of sand and gravel, very stiff, moist	SS 2	67	3-3-4 (7)	2.5	16
5						



Bottom of borehole at 5.0 feet.

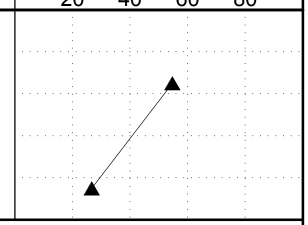
Boring performed on S. Main Street - STA 541+34, 24' L of CL

BORING NUMBER SB-15

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/12/14 **COMPLETED** 11/12/14
GROUND ELEVATION 886.07 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 2-1/4 inch Solid Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / □ FINES CONTENT (%) □ 20 40 60 80
0		8 inches of ASPHALT PAVEMENT						
		SAND (SP-SM) - brown, fine, some silt, trace gravel, dense to medium dense, moist	SS 1	89	14-21-20 (41)			
5			SS 2	78	7-10-10 (20)			



Bottom of borehole at 5.0 feet.

Boring performed on S. Main Street - STA 540+95, 12' R of CL

BORING NUMBER SB-16

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.

PROJECT NAME Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 11/12/14 **COMPLETED** 11/12/14

GROUND ELEVATION 882.69 ft +/-

DRILLING CONTRACTOR Brax Drilling

GROUND WATER LEVELS:

DRILLING METHOD 2-1/4 inch Solid Stem Auger

DURING DRILLING None

LOGGED BY R. Rajan **CHECKED BY** T. Marsik

AFTER DRILLING None

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ (15 30 45 60); PL MC LL (10 20 30 40); □ FINES CONTENT (%) □ (20 40 60 80)
0		6 inches of ASPHALT PAVEMENT						
		6 inches of SAND and GRAVEL FILL						
		SAND FILL (SM-FILL) - brown, fine, with silt, trace gravel, moist	SS 1	78	11-12-12 (24)			
		CLAY FILL (CL-FILL) - mottled brown and dark brown; with silt; traces of sand, gravel and organics; occasional pieces of glass; moist	SS 2	89	5-4-3 (7)		14	
5								

Bottom of borehole at 5.0 feet.

Boring performed on S. Main Street - STA 539+92, 8' L of CL

BORING NUMBER SB-17

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.

PROJECT NAME Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 11/12/14 **COMPLETED** 11/12/14

GROUND ELEVATION 881.05 ft +/-

DRILLING CONTRACTOR Brax Drilling

GROUND WATER LEVELS:

DRILLING METHOD 2-1/4 inch Solid Stem Auger

DURING DRILLING None

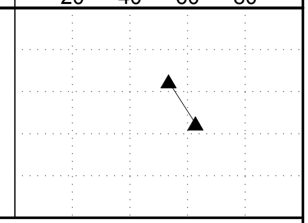
LOGGED BY R. Rajan **CHECKED BY** T. Marsik

AFTER DRILLING None

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
0		8 inches of ASPHALT PAVEMENT						
		10 inches of SAND and GRAVEL FILL						
		SAND FILL (SP-SM-FILL) - brown, fine to medium, some silt, trace gravel, moist	SS 1	100	18-21-19 (40)			
			SS 2	89	14-15-32 (47)			
5		SILTY SAND FILL (SM-FILL) - dark brown, fine, some gravel, occasional clay seams, moist						
		CLAY (CL) - gray, with silt, traces of sand and gravel, moist						



Bottom of borehole at 5.0 feet.

Boring performed on S. Main Street - STA 539+04, 23' R of CL

BORING NUMBER SB-18

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/12/14 **COMPLETED** 11/12/14
GROUND ELEVATION 911.14 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 2-1/4 inch Solid Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / □ FINES CONTENT (%) □ 20 40 60 80
0		6 inches of ASPHALT PAVEMENT						
		12 inches of SAND and GRAVEL FILL						
		CLAY (CL) - brown, with silt, traces of sand and gravel, occasional silt partings, very stiff to hard, moist	SS 1	67	3-5-7 (12)	3.25	13	
5			SS 2	72	6-9-15 (24)	4.5+	13	

Bottom of borehole at 5.0 feet.

Boring performed on Potter Avenue - STA 303+81, 8' R of CL

BORING NUMBER SB-19

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/12/14 **COMPLETED** 11/12/14
GROUND ELEVATION 911.69 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 2-1/4 inch Solid Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / □ FINES CONTENT (%) □ 20 40 60 80
0		5 inches of ASPHALT PAVEMENT						
		7 inches of SAND and GRAVEL FILL						
		CLAY FILL (CL-FILL) - dark brown, with silt, traces of sand and organics, moist Loss-on-Ignition (organic content) = 3.9%	SS 1	83	5-3-4 (7)		22	
5		CLAY (CL) - mottled brown and gray, with silt, some sand, trace gravel, medium stiff, very moist	SS 2	89	3-3-3 (6)	1.0	20	

Bottom of borehole at 5.0 feet.

Boring performed on Potter Avenue - STA 305+70, 8' R of CL

BORING NUMBER SB-20

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/12/14 **COMPLETED** 11/12/14
GROUND ELEVATION 912.38 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 2-1/4 inch Solid Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / □ FINES CONTENT (%) □ 20 40 60 80
0		6 inches of ASPHALT PAVEMENT						
		6 inches of SAND and GRAVEL FILL						
		CLAY FILL (CL-FILL) - mottled dark brown and dark gray, with silt, some organics, traces of sand, moist	SS 1	83	3-3-4 (7)		16	
5		CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, occasional silt partings, stiff, moist	SS 2	100	3-3-4 (7)	1.5	19	

Bottom of borehole at 5.0 feet.

Boring performed on Potter Avenue - STA 307+62, 5' R of CL

BORING NUMBER SB-21

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/12/14 **COMPLETED** 11/12/14
GROUND ELEVATION 916.08 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 2-1/4 inch Solid Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / □ FINES CONTENT (%) □ 20 40 60 80
0		6 inches of ASPHALT PAVEMENT						
		18 inches of SAND and GRAVEL FILL	SS 1	61	5-4-7 (11)	4.0	18	
		CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, occasional silt partings, very stiff, moist						
5			SS 2	50	2-3-7 (10)	2.25	18	

Bottom of borehole at 5.0 feet.

Boring performed on Potter Avenue - STA 309+60, 9' L of CL

CTI and Associates, Inc.

BORING NUMBER SB-22

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/12/14 **COMPLETED** 11/12/14
GROUND ELEVATION 919.28 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 2-1/4 inch Solid Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
0		5 inches of ASPHALT PAVEMENT						
		7 inches of SAND and GRAVEL FILL						
		CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, occasional silt partings, hard, moist	SS 1	61	3-5-7 (12)	4.25	16	
5			SS 2	89	5-8-12 (20)	4.5+	13	

Bottom of borehole at 5.0 feet.

Boring performed on Potter Avenue - STA 311+18, 7' L of CL

CTI and Associates, Inc.

BORING NUMBER SB-23

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/12/14 **COMPLETED** 11/12/14
GROUND ELEVATION 918.43 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 2-1/4 inch Solid Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH None

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / □ FINES CONTENT (%) □ 20 40 60 80
0		6 inches of ASPHALT PAVEMENT						
		6 inches of SAND and GRAVEL FILL						
		CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, occasional silt partings, very stiff to hard, moist	SS 1	89	3-5-7 (12)	3.0	14	
5			SS 2	72	7-11-15 (26)	4.5+	13	

Bottom of borehole at 5.0 feet.

Boring performed on Potter Avenue - STA 312+58, 8' L of CL

BORING NUMBER SB-24

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.

PROJECT NAME Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 11/10/14 **COMPLETED** 11/10/14

GROUND ELEVATION 909.82 ft +/-

DRILLING CONTRACTOR Brax Drilling

GROUND WATER LEVELS:

DRILLING METHOD 2-1/4 inch Solid Stem Auger

DURING DRILLING None

LOGGED BY D. Kent **CHECKED BY** T. Marsik

AFTER DRILLING None

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH 4' 1"

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / □ FINES CONTENT (%) □ 20 40 60 80
0		4 inches of ASPHALT PAVEMENT						
		4 inches of GRAVEL FILL						
		CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, occasional silt partings, very stiff, moist	SS 1	83	3-4-5 (9)	2.0	11	
		CLAY (CL) - brown, with silt, some sand, trace gravel, occasional very moist sand partings, very stiff, moist	SS 2	100	3-5-6 (11)	3.0	12	
5								

Bottom of borehole at 5.0 feet.

Boring performed on Prescott Avenue - STA 200+92, 7' L of CL

BORING NUMBER SB-25

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/10/14 **COMPLETED** 11/10/14
GROUND ELEVATION 904.78 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 2-1/4 inch Solid Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH 3' 8"

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / □ FINES CONTENT (%) □ 20 40 60 80
0	4 inches of ASPHALT PAVEMENT						
	6 inches of SAND and GRAVEL FILL						
	CLAY (CL) - reddish-brown, with silt, trace sand, very stiff, moist	SS 1	67	2-2-4 (6)	2.0	17	
	SILTY SAND (SM) - brown, fine, some gravel, loose, moist						
5		SS 2	67	2-3-5 (8)			

Bottom of borehole at 5.0 feet.

Boring performed on Prescott Avenue - STA 202+65, 3' L of CL

BORING NUMBER SB-26

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.

PROJECT NAME Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052

PROJECT LOCATION Ann Arbor, Michigan

DATE STARTED 11/11/14 **COMPLETED** 11/11/14

GROUND ELEVATION 896.62 ft +/-

DRILLING CONTRACTOR Brax Drilling

GROUND WATER LEVELS:

DRILLING METHOD 2-1/4 inch Solid Stem Auger

DURING DRILLING None

LOGGED BY R. Rajan **CHECKED BY** T. Marsik

AFTER DRILLING None

NOTES Boring backfilled with auger cuttings and patched

COLLAPSE DEPTH 4' 8"

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / □ FINES CONTENT (%) □ 20 40 60 80
0		5 inches of ASPHALT PAVEMENT						
		7 inches of SAND and GRAVEL FILL						
		SANDY CLAY FILL (CL-FILL) - brown, with silt, trace gravel, frequent sand partings, moist	SS 1	67	3-2-4 (6)		12	
		CLAY FILL (CL-FILL) - dark brown, with silt, some organics, trace sand, moist Loss-on-Ignition (organic content) = 5.4%	SS 2	89	2-2-4 (6)		24	
5								

Bottom of borehole at 5.0 feet.

Boring performed on Prescott Avenue - STA 204+41, 5' L of CL

BORING NUMBER SB-27

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/11/14 **COMPLETED** 11/11/14
GROUND ELEVATION 903.59 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 2-1/4 inch Solid Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH 3' 4"

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60 / PL MC LL 10 20 30 40 / □ FINES CONTENT (%) □ 20 40 60 80
0		5 inches of ASPHALT PAVEMENT						
		SILTY SAND FILL (SM-FILL) - dark brown, fine, some gravel, trace organics, moist	SS 1	33	3-5-4 (9)			
		CLAY (CL) - brown, with silt, traces of sand and gravel, hard, moist	SS 2	100	2-7-13 (20)	4.5+	15	
5								

Bottom of borehole at 5.0 feet.

Boring performed on Prescott Avenue - STA 206+55, 5' L of CL

BORING NUMBER SB-28

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.

PROJECT NUMBER 3142040052

DATE STARTED 11/11/14 **COMPLETED** 11/11/14

DRILLING CONTRACTOR Brax Drilling

DRILLING METHOD 2-1/4 inch Solid Stem Auger

LOGGED BY R. Rajan **CHECKED BY** T. Marsik

NOTES Boring backfilled with auger cuttings and patched

PROJECT NAME Stadium Boulevard Reconstruction

PROJECT LOCATION Ann Arbor, Michigan

GROUND ELEVATION 913.32 ft +/-

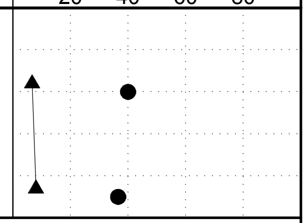
GROUND WATER LEVELS:

DURING DRILLING None

AFTER DRILLING None

COLLAPSE DEPTH 4' 6"

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60; PL MC LL 10 20 30 40; ☐ FINES CONTENT (%) ☐ 20 40 60 80
0		4 inches of ASPHALT PAVEMENT						
		14 inches of SAND and GRAVEL FILL						
		CLAY FILL (CL-FILL) - dark brown, with silt, traces of sand and organics, moist Loss-on-Ignition (organic content) = 4.0%	SS 1	56	3-2-3 (5)		20	
5		CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, occasional sand partings, stiff, moist	SS 2	100	2-2-4 (6)	1.5	18	



Bottom of borehole at 5.0 feet.

Boring performed on Prescott Avenue - STA 208+52, 8' L of CL

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan
DATE STARTED 11/14/14 **COMPLETED** 11/14/14
GROUND ELEVATION 905.71 ft +/-
DRILLING CONTRACTOR Brax Drilling
GROUND WATER LEVELS:
DRILLING METHOD 3-1/4 inch Hollow Stem Auger
DURING DRILLING None
LOGGED BY R. Rajan **CHECKED BY** T. Marsik
AFTER DRILLING None
NOTES Boring backfilled with auger cuttings and patched
COLLAPSE DEPTH 4' 6"

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲ 15 30 45 60; PL MC LL 10 20 30 40; □ FINES CONTENT (%) □ 20 40 60 80
0		6 inches of ASPHALT PAVEMENT						
		SAND FILL (SP-SM-FILL) - mottled brown and dark brown, fine to medium, some gravel, occasional pieces of asphalt, moist	SS 1	44	4-6-4 (10)			
5		CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel, very stiff, moist	SS 2	100	4-6-7 (13)	3.0	15	

Bottom of borehole at 5.0 feet.

Boring performed on Edgewood Avenue - 250' N of Snyder Avenue CL, 8' E of Edgewood CL

CTI and Associates, Inc.

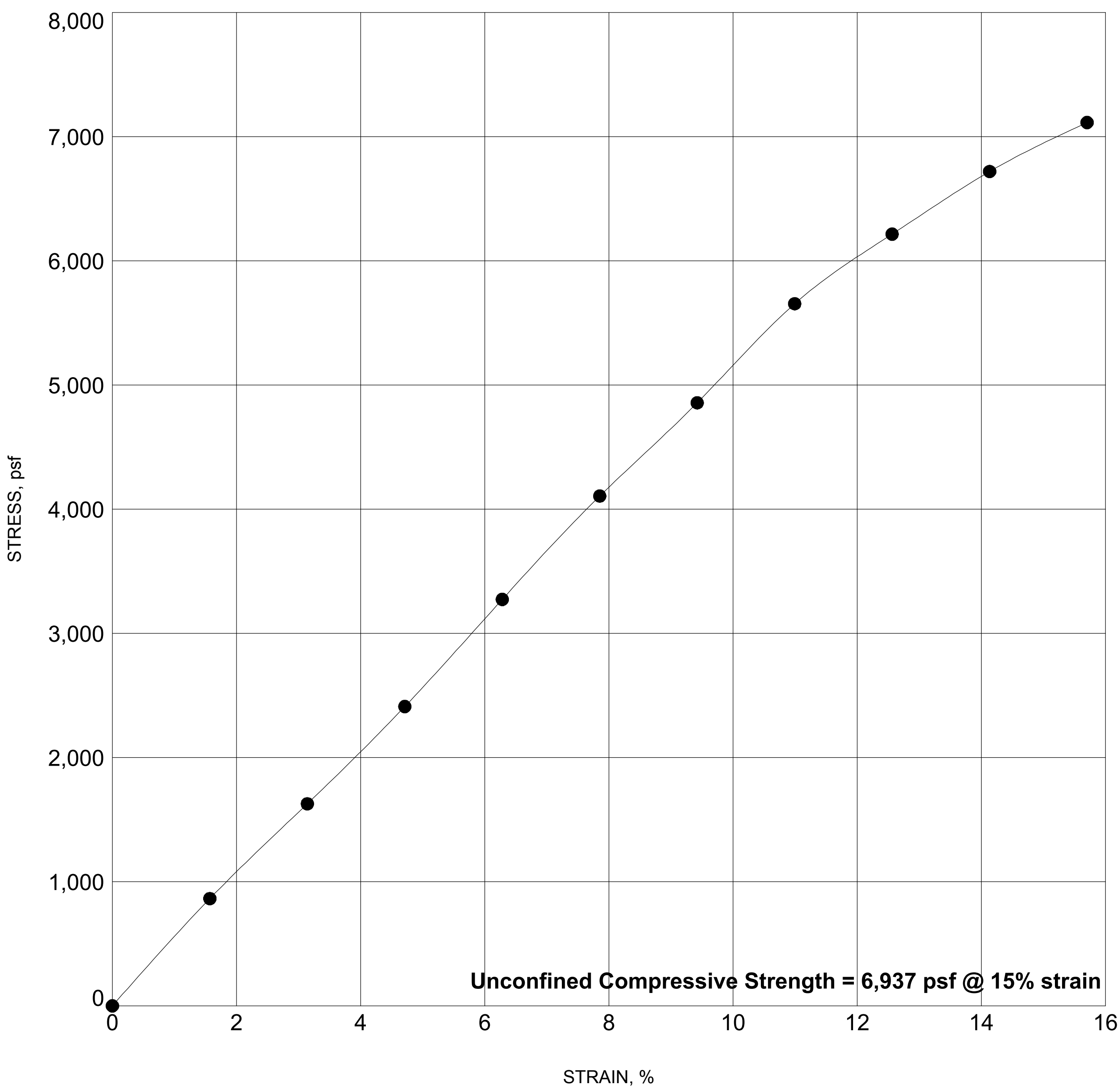
Laboratory Test Reports
and
Summary of Laboratory Results

UNCONFINED COMPRESSION TEST

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc. **PROJECT NAME** Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052 **PROJECT LOCATION** Ann Arbor, Michigan



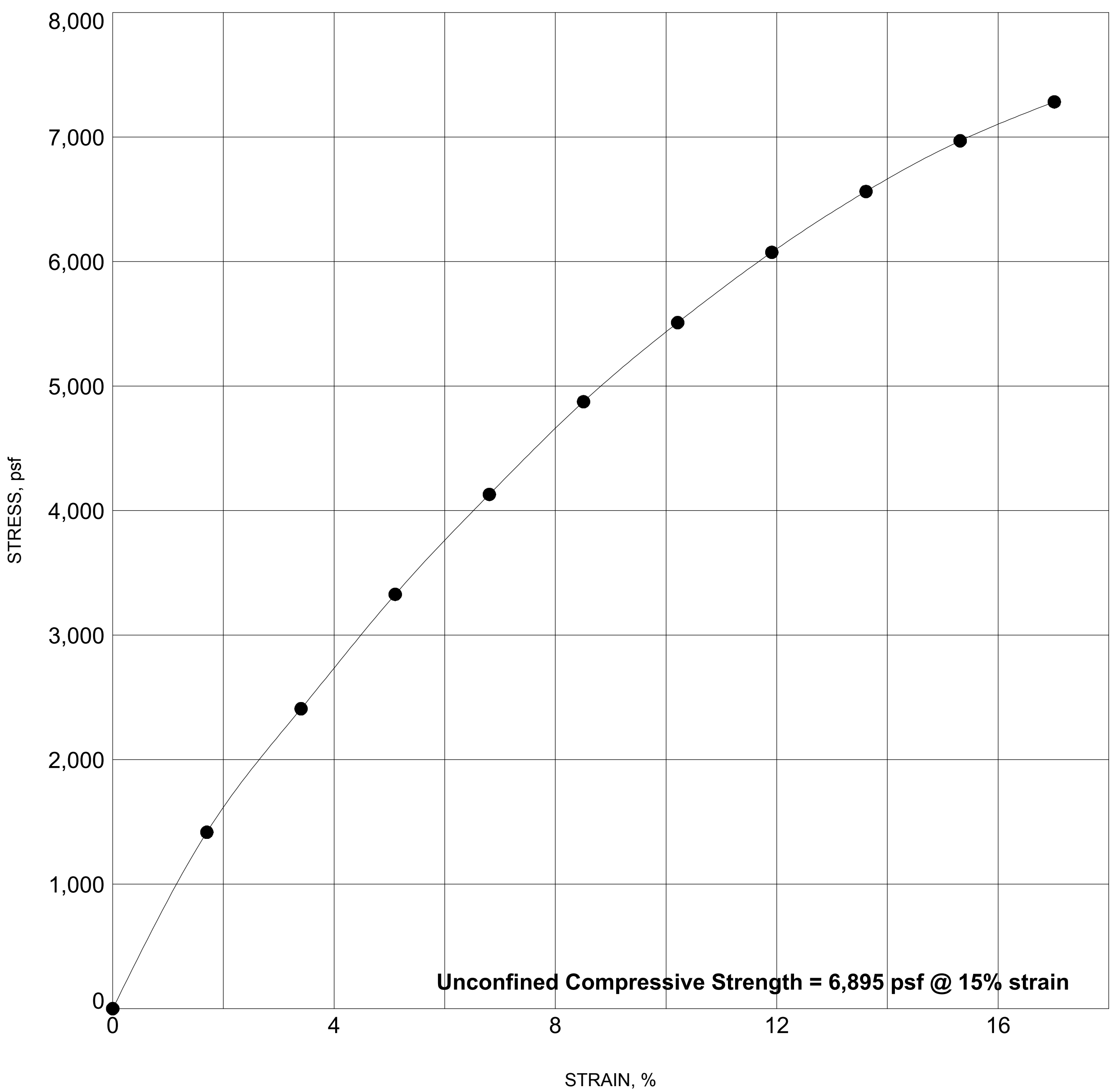
	BOREHOLE	DEPTH	Classification	γ_w	MC%
●	**FFSB-01**	**10.0**	**CLAY (CL) - brown, with silt, traces of sand and gravel, occasional silt seams**	**134.6**	**16**

UNCONFINED COMPRESSION TEST

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc. **PROJECT NAME** Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052 **PROJECT LOCATION** Ann Arbor, Michigan



	BOREHOLE	DEPTH	Classification	γ_w	MC%
●	**RWFF-01**	**5.0**	**CLAY (CL) - gray, with silt, traces of sand and gravel**	**137.1**	**14**

UNCONFINED COMPRESSION TEST

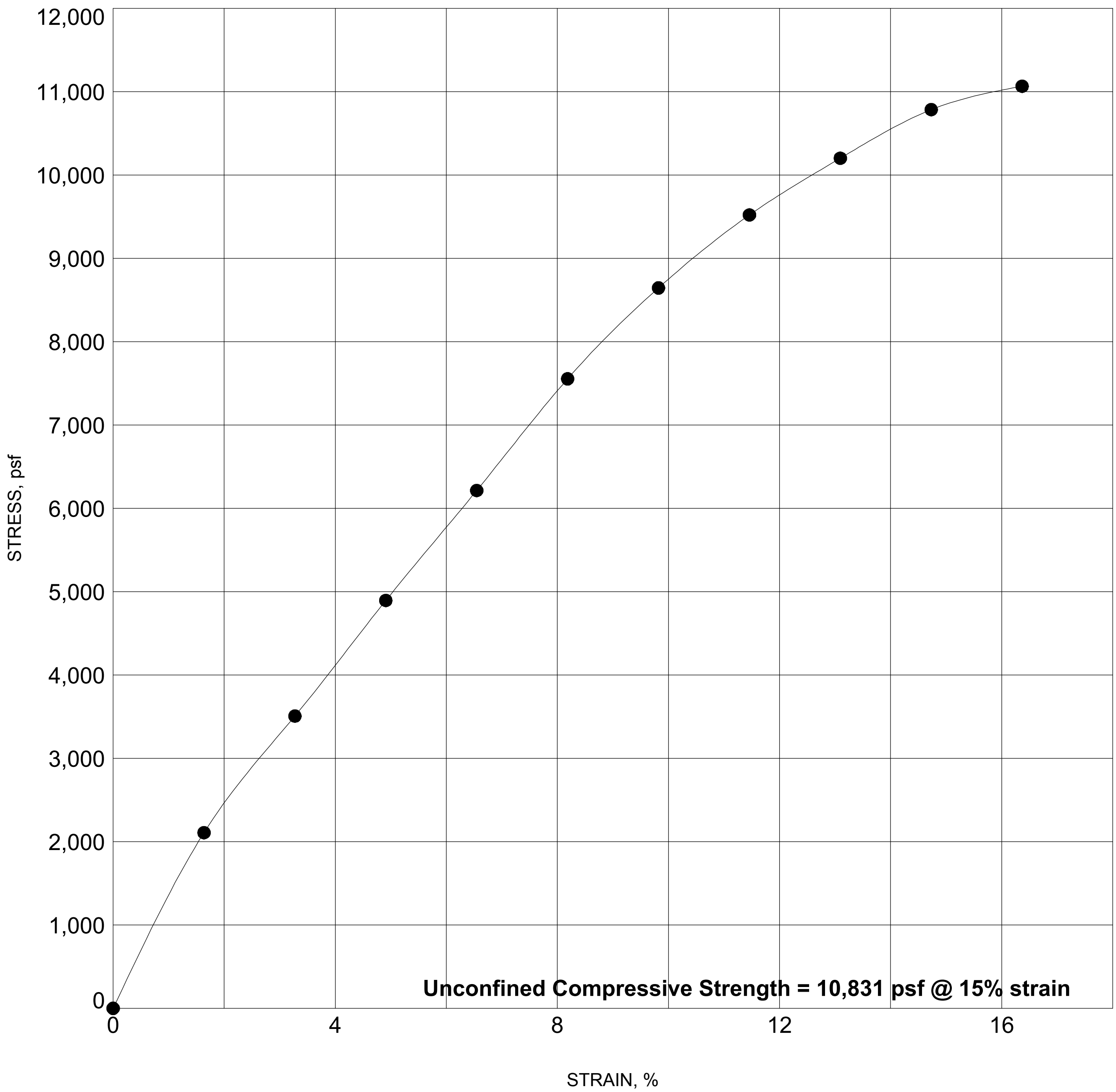
CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.

PROJECT NAME Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052

PROJECT LOCATION Ann Arbor, Michigan

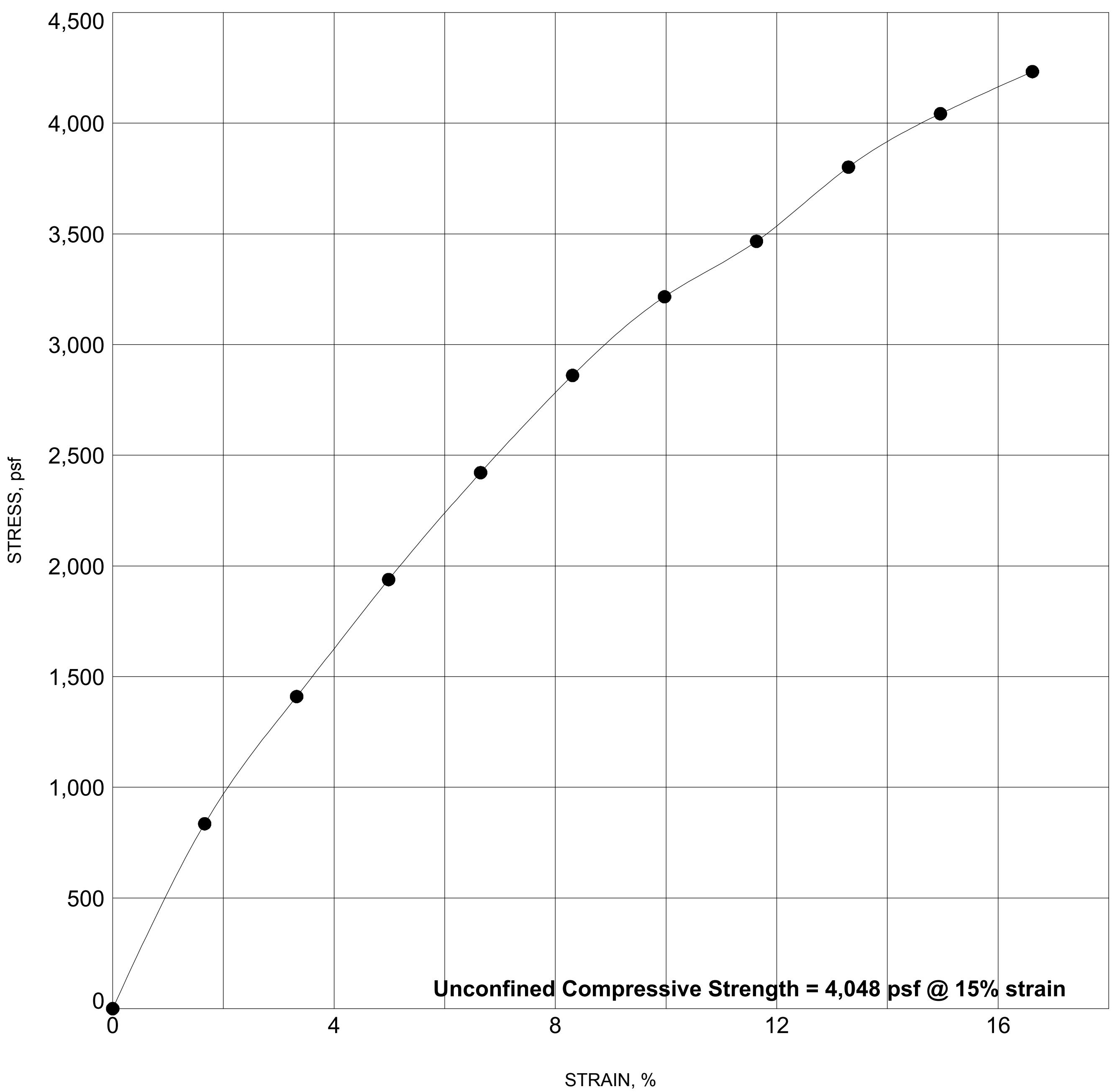


	BOREHOLE	DEPTH	Classification	γ_w	MC%
●	**RWFF-02**	**5.0**	**CLAY (CL) - mottled brown and gray, with silt, traces of sand and gravel**	**138.0**	**15**

UNCONFINED COMPRESSION TEST

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan



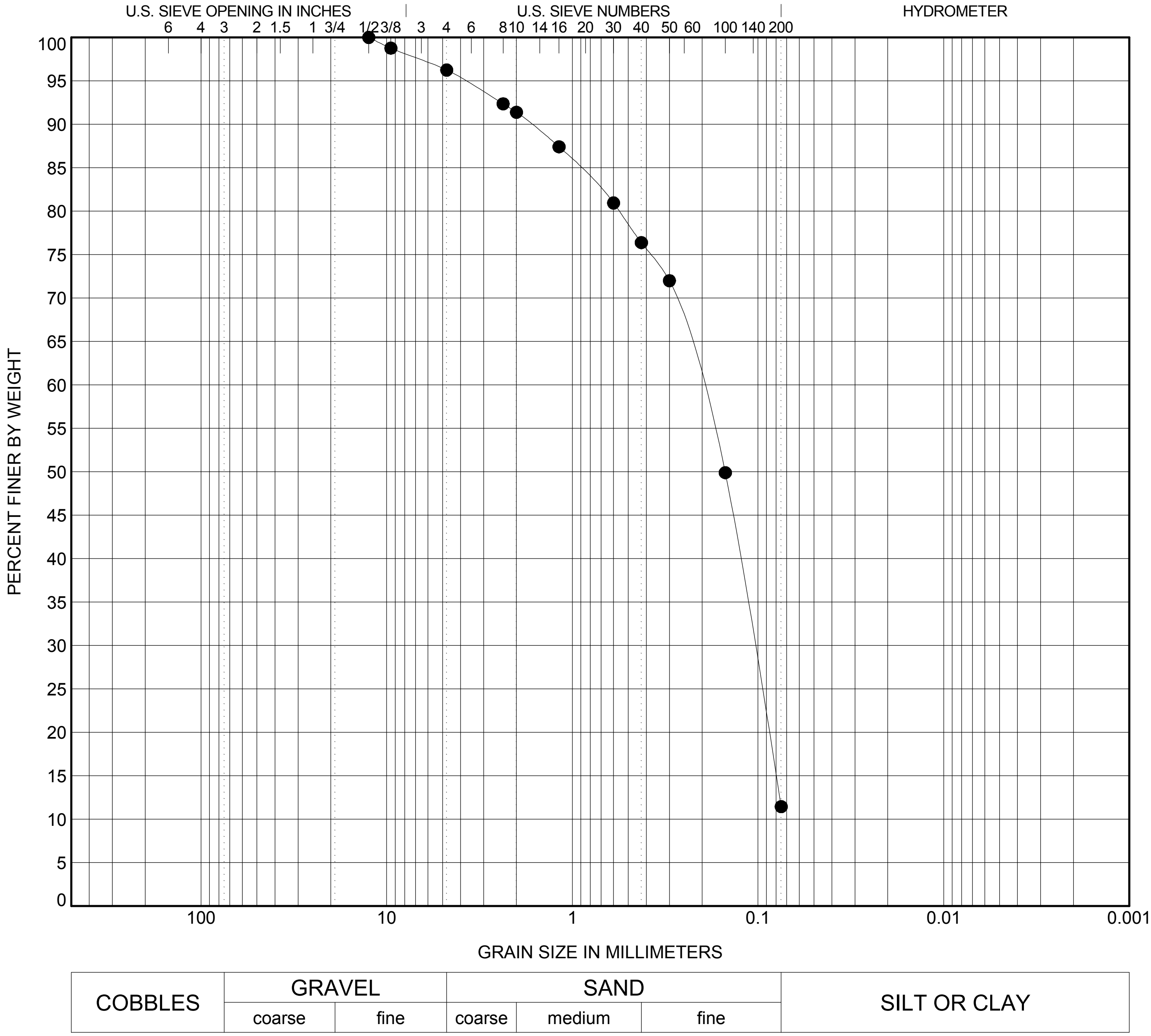
	BOREHOLE	DEPTH	Classification	γ_w	MC%
●	**RWFF-02**	**15.0**	**CLAY (CL) - gray, with silt, traces of sand and gravel**	**130.4**	**16**

GRAIN SIZE DISTRIBUTION

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc. **PROJECT NAME** Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052 **PROJECT LOCATION** Ann Arbor, Michigan



	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**FF-02**	**3 - 5**	**SAND (SP-SM) - brown, fine to medium, some silt, trace gravel**				**0.73**	**2.82**

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**FF-02**	**3 - 5**	**12.5**	**0.206**	**0.105**		**3.8**	**84.8**	**11.4**	

CTI and Associates, Inc.

FALLING HEAD PERMEABILITY OF GRANULAR MATERIALS

Project Name	Stadium Boulevard Reconstruction	Sample Number	FF-02
Project Number	3142040052	Sample Depth	3' - 5'
Tested By	DRC	Test Date	12/18/2014
Sample Description	SAND (SP-SM) - brown, fine to medium, some silt, trace gravel		

Maximum Material Particle Size between 2.00-mm (No. 10) and 9.5-mm (3/8 in.) ☑ NO ☐ YES

Maximum Material Particle Size between 9.5-mm (3/8 in.) and 19.00-mm (3/4 in.) ☑ NO ☐ YES

Total weight of sample for sieve analysis, grams	460.6	% of Total sample retained on 9.5-mm (3/8 in.) sieve	1.2%
% of Total sample retained on 2.00-mm (No.10) sieve	8.6%	% of Total sample retained on 19.00-mm (3/4 in.) sieve	0.0%

Permeant	Tap Water				
Diameter (D), cm	11.40	Speciman Area (A), cm^2	102.07	Moisture Content (%)	5.2
Length (L), cm	11.40	Area of Burette (a), cm^2	0.17	Dry Density (pcf)	110.1
Length to Bottom, L_1	19.90	Weight Before, W_1	3400.6	Specific Gravity (assumed)	2.65
Length to Top, L_2	2.50	Weight After, W_2	103.6	Void Ratio, e	0.5017
Net Length, L (cm)	17.40	Weight Net, grams	3297.0		

Test Number	Manometers		Difference in Head (delta h) cm	Test Duration (t) sec	Temperature of Water (T) °C	Volume of Water (V) cm^3	Calculated K (cm/sec)	Corrected K @ 20°C (cm/sec)
	h_1, cm	h_2, cm						
1	182.5	82.5	100.0	60.00	22.0	35.0	7.90E-04	7.53E-04
2	182.5	82.5	100.0	60.00	22.0	36.0	8.12E-04	7.75E-04
3	182.5	82.5	100.0	60.00	22.0	35.0	7.90E-04	7.53E-04
4	182.5	82.5	100.0	60.00	22.0	35.0	7.90E-04	7.53E-04
5	182.5	82.5	100.0	60.00	22.0	36.0	8.12E-04	7.75E-04
6	182.5	82.5	100.0	60.00	22.0	36.0	8.12E-04	7.75E-04
							AVERAGE K_{20}	**7.64E-04**

NOTE: Sample overcompacted in lab. In-situ dry density was approximately 105 pcf. Therefore, in-situ conditions may have a higher permeability rate

GRAIN SIZE DISTRIBUTION

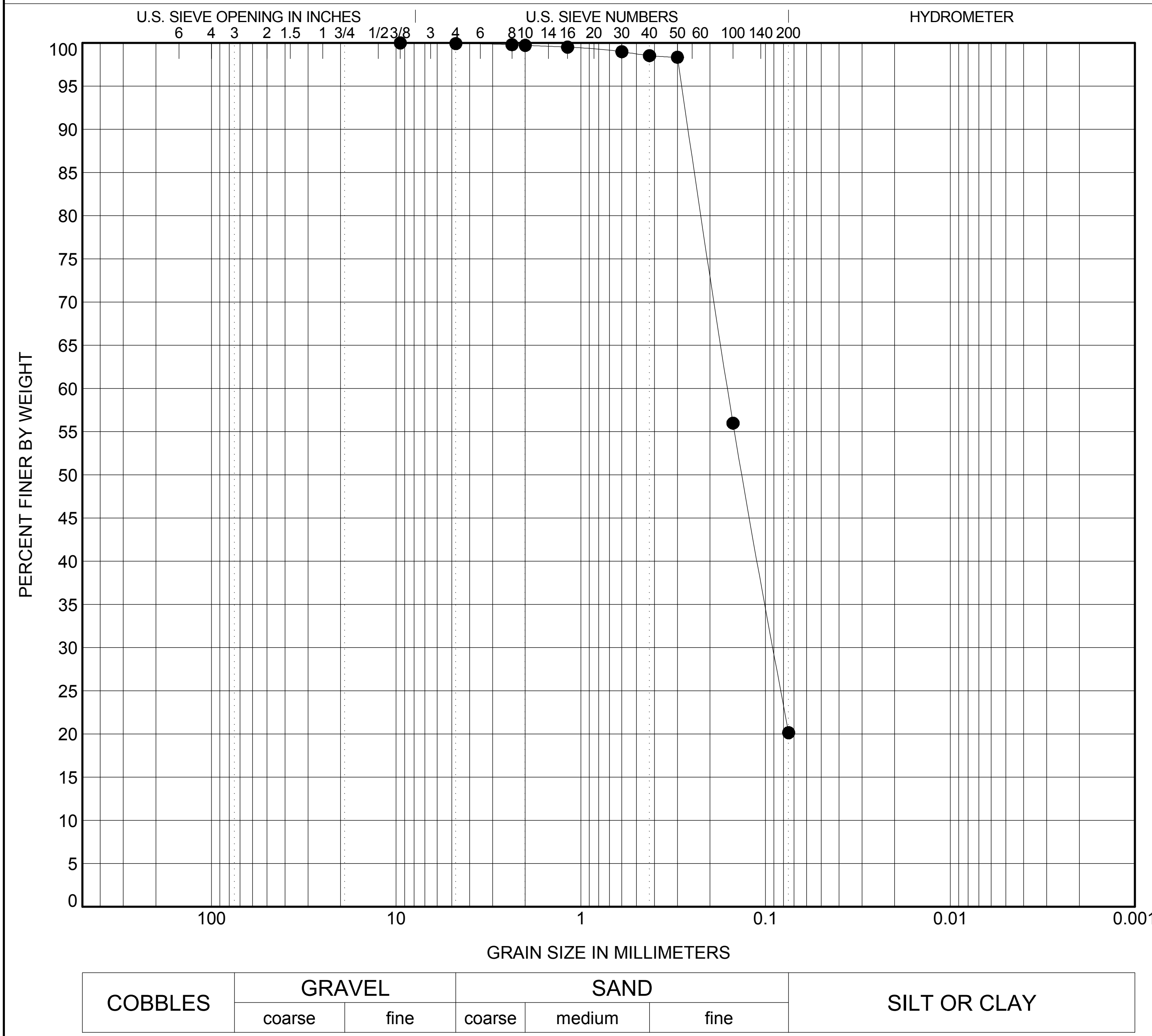
CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.

PROJECT NAME Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052

PROJECT LOCATION Ann Arbor, Michigan



BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● **FFSB-01**	**15.5 - 18.5**	**SAND (SM) - brown, fine, with silt, traces of clay and gravel**					

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **FFSB-01**	**15.5 - 18.5**	**9.5**	**0.16**	**0.091**		**0.1**	**79.8**	**20.1**	

CTI and Associates, Inc.

FALLING HEAD PERMEABILITY OF GRANULAR MATERIALS

Project Name	Stadium Boulevard Reconstruction	Sample Number	FFSB-01
Project Number	3142040052	Sample Depth	15.5' - 18.5'
Tested By	DRC	Test Date	12/18/2014
Sample Description	SAND (SM) - brown, fine, with silt, traces of clay and gravel		

Maximum Material Particle Size between 2.00-mm (No. 10) and 9.5-mm (3/8 in.) ☐ NO ☑ YES

Maximum Material Particle Size between 9.5-mm (3/8 in.) and 19.00-mm (3/4 in.) ☑ NO ☐ YES

Total weight of sample for sieve analysis, grams	577.7	% of Total sample retained on 9.5-mm (3/8 in.) sieve	0.0%
% of Total sample retained on 2.00-mm (No.10) sieve	0.3%	% of Total sample retained on 19.00-mm (3/4 in.) sieve	0.0%

Permeant	Tap Water				
Diameter (D), cm	11.40	Speciman Area (A), cm^2	102.07	Moisture Content (%)	14.1
Length (L), cm	11.40	Area of Burette (a), cm^2	0.17	Dry Density (pcf)	110.7
Length to Bottom, L_1	19.90	Weight Before, W_1	3825.5	Specific Gravity (assumed)	2.65
Length to Top, L_2	2.07	Weight After, W_2	140.1	Void Ratio, e	0.4931
Net Length, L (cm)	17.83	Weight Net, grams	3685.4		

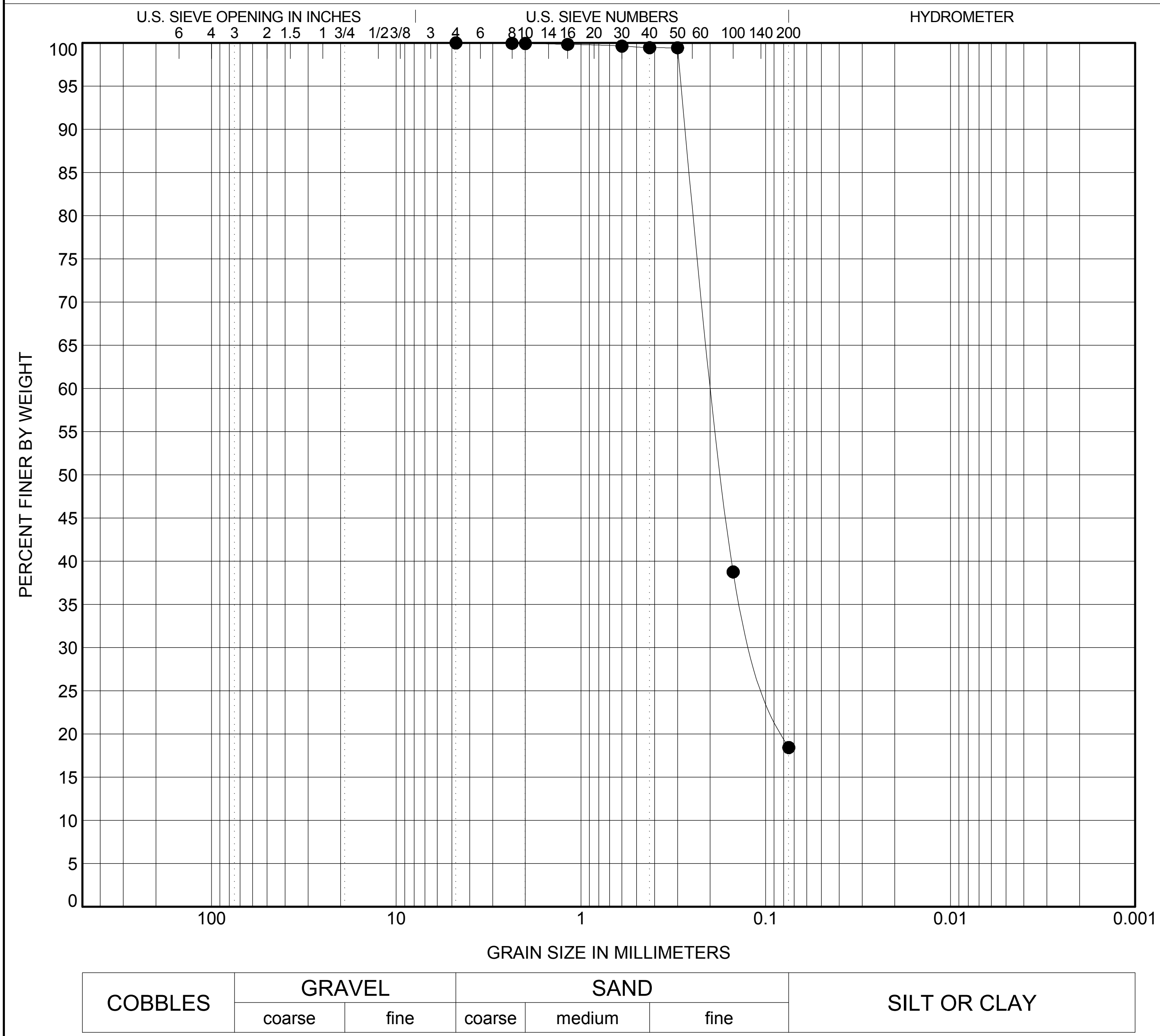
Test Number	Manometers		Difference in Head (delta h) cm	Test Duration (t) sec	Temperature of Water (T) °C	Volume of Water (V) cm^3	Calculated K (cm/sec)	Corrected K @ 20°C (cm/sec)
	h_1, cm	h_2, cm						
1	182.5	82.5	100.0	60.00	21.2	19.0	4.39E-04	4.27E-04
2	182.5	82.5	100.0	60.00	21.2	20.0	4.62E-04	4.50E-04
3	182.5	82.5	100.0	60.00	21.2	19.0	4.39E-04	4.27E-04
4	182.5	82.5	100.0	60.00	21.2	20.0	4.62E-04	4.50E-04
5	182.5	82.5	100.0	60.00	21.2	20.0	4.62E-04	4.50E-04
6	182.5	82.5	100.0	60.00	21.2	19.0	4.39E-04	4.27E-04
							AVERAGE K_{20}	**4.38E-04**

NOTE:

GRAIN SIZE DISTRIBUTION

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan



	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**FFSB-02**	**15 - 17**	**SAND (SM) - brown, fine, with silt**					

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**FFSB-02**	**15 - 17**	**4.75**	**0.191**	**0.111**		**0.0**	**81.6**	**18.4**	

CTI and Associates, Inc.

FALLING HEAD PERMEABILITY OF GRANULAR MATERIALS

Project Name	Stadium Boulevard Reconstruction	Sample Number	FFSB-02
Project Number	3142040052	Sample Depth	15' - 17'
Tested By	DRC	Test Date	12/18/2014
Sample Description	SAND (SM) - brown, fine, with silt		

Maximum Material Particle Size between 2.00-mm (No. 10) and 9.5-mm (3/8 in.) ☐ NO ☑ YES

Maximum Material Particle Size between 9.5-mm (3/8 in.) and 19.00-mm (3/4 in.) ☑ NO ☐ YES

Total weight of sample for sieve analysis, grams	656.6	% of Total sample retained on 9.5-mm (3/8 in.) sieve	0.0%
% of Total sample retained on 2.00-mm (No.10) sieve	0.1%	% of Total sample retained on 19.00-mm (3/4 in.) sieve	0.0%

Permeant	Tap Water				
Diameter (D), cm	11.40	Speciman Area (A), cm^2	102.07	Moisture Content (%)	11.7
Length (L), cm	11.40	Area of Burette (a), cm^2	0.17	Dry Density (pcf)	95.2
Length to Bottom, L_1	19.90	Weight Before, W_1	3089.5	Specific Gravity (assumed)	2.65
Length to Top, L_2	2.29	Weight After, W_2	25.7	Void Ratio, e	0.7366
Net Length, L (cm)	17.61	Weight Net, grams	3063.8		

Test Number	Manometers		Difference in Head (delta h) cm	Test Duration (t) sec	Temperature of Water (T) °C	Volume of Water (V) cm^3	Calculated K (cm/sec)	Corrected K @ 20°C (cm/sec)
	h_1, cm	h_2, cm						
1	182.5	82.5	100.0	75.00	21.2	17.0	3.11E-04	3.02E-04
2	182.5	82.5	100.0	75.00	21.2	18.0	3.29E-04	3.20E-04
3	182.5	82.5	100.0	75.00	21.2	17.0	3.11E-04	3.02E-04
4	182.5	82.5	100.0	75.00	21.2	19.0	3.47E-04	3.38E-04
5	182.5	82.5	100.0	75.00	21.2	18.0	3.29E-04	3.20E-04
6	182.5	82.5	100.0	75.00	21.2	19.0	3.47E-04	3.38E-04
							AVERAGE K_{20}	**3.20E-04**

NOTE:

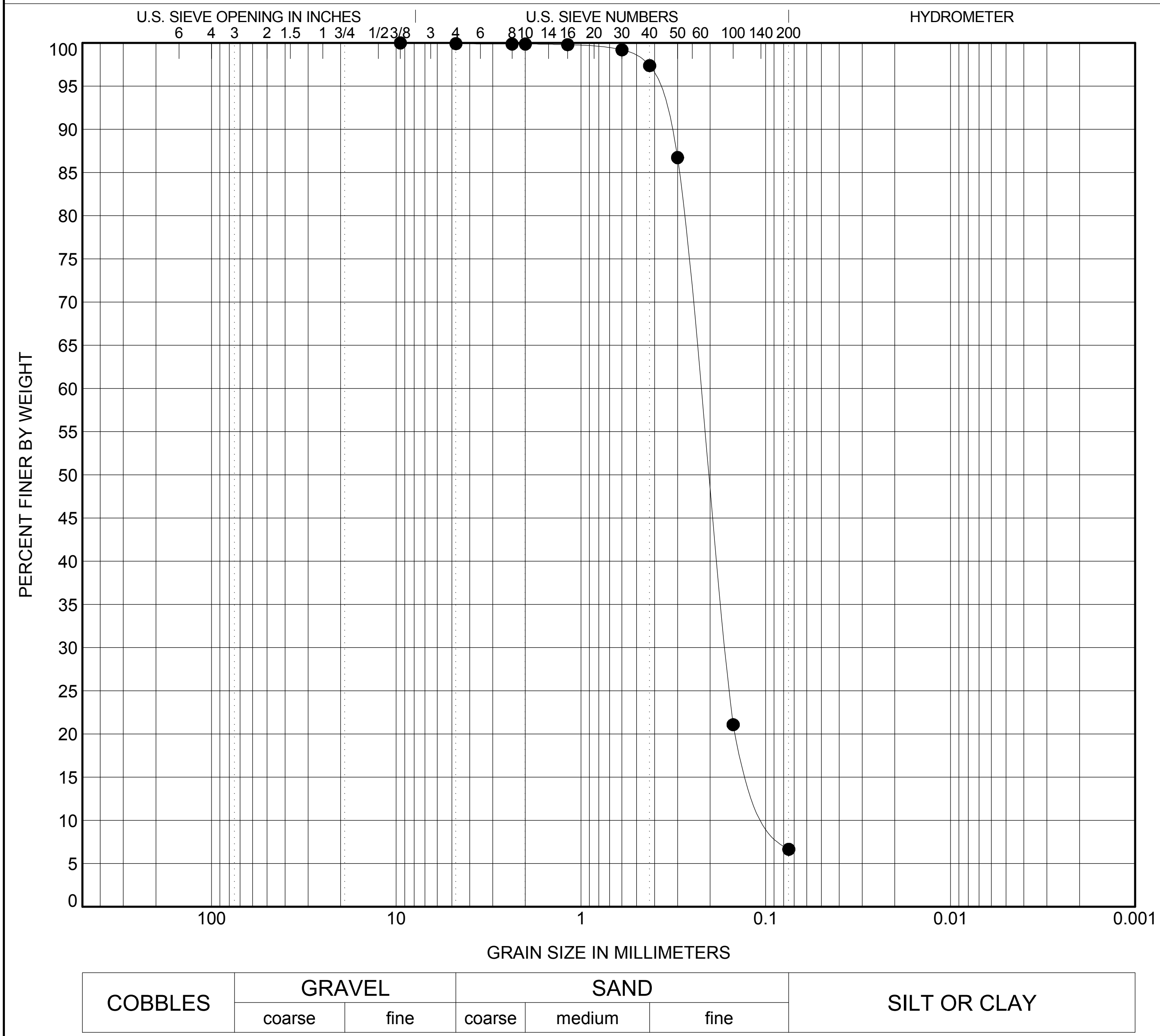
Corporate Office: 51331 W. Pontiac Trail, Wixom, MI 48393 | phone: 248.486.5100 | fax: 248.486.5050

GRAIN SIZE DISTRIBUTION

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc. **PROJECT NAME** Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052 **PROJECT LOCATION** Ann Arbor, Michigan



BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● **FFSB-03**	**13 - 16**	**SAND (SP-SC) - brown, fine, some clay, trace gravel**				**1.36**	**2.57**

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **FFSB-03**	**13 - 16**	**9.5**	**0.226**	**0.165**	**0.088**	**0.1**	**93.3**	**6.6**	

CTI and Associates, Inc.

CONSTANT HEAD PERMEABILITY OF GRANULAR MATERIALS

Project Name	Stadium Boulevard Reconstruction	Sample Number	FFSB-03
Project Number	3142040052	Sample Location	13' - 16'
Tested By	D. Cook	Test Date	12/18/2014
Sample Description	SAND (SP-SC) - brown, fine, some clay, trace gravel		

Maximum Material Particle Size between 2.00-mm (No. 10) and 9.5-mm (3/8 in.) ☐ NO ☑ YES

Maximum Material Particle Size between 9.5-mm (3/8 in.) and 19.00-mm (3/4 in.) ☑ NO ☐ YES

Total weight of sample for sieve analysis, grams	482.9	% of Total sample retained on 9.5-mm (3/8 in.) sieve	0.00%
% of Total sample retained on 2.00-mm (No.10) sieve	0.10%	% of Total sample retained on 19.00-mm (3/4 in.) sieve	0.00%

Permeant	Tap Water				
Diameter (D), cm	11.40	Area (A), cm^2	102.07	Moisture Content (%)	10.1
Length (L), cm	11.40			Dry Density (pcf)	96.5
Height Before, H_1	19.90	Weight Before, W_1	3190.0	Specific Gravity (assumed)	2.65
Height After, H_2	2.15	Weight After, W_2	105.0	Void Ratio, e	0.7135
Net Height, cm	17.75	Weight Net, grams	3085.0		

Test Number	Manometers		Head (h) cm	Flow (Q) mL	Time (t) sec.	Temp (T) °C	Q/At	h/L	Calculated K (cm/sec)	Corrected K @ 20°C (cm/sec)
	Top, cm	Bottom, cm								
1	81.5	81.0	0.5	6	90	22.0	0.001	0.04	1.49E-02	1.42E-02
	81.5	81.0	0.5	6	90	22.0	0.001	0.04	1.49E-02	1.42E-02
2	81.1	80.1	1.0	11	90	22.0	0.001	0.09	1.37E-02	1.30E-02
	81.1	80.1	1.0	11	90	22.0	0.001	0.09	1.37E-02	1.30E-02
3	80.9	79.4	1.5	18	90	22.0	0.002	0.13	1.49E-02	1.42E-02
	80.9	79.4	1.5	18	90	22.0	0.002	0.13	1.49E-02	1.42E-02
4	80.5	78.5	2.0	22	90	22.0	0.002	0.18	1.37E-02	1.30E-02
	80.5	78.5	2.0	22	90	22.0	0.002	0.18	1.37E-02	1.30E-02
5	80.1	77.6	2.5	31	90	22.0	0.003	0.22	1.54E-02	1.47E-02
	80.1	77.6	2.5	31	90	22.0	0.003	0.22	1.54E-02	1.47E-02
									AVERAGE K	**1.38E-02**

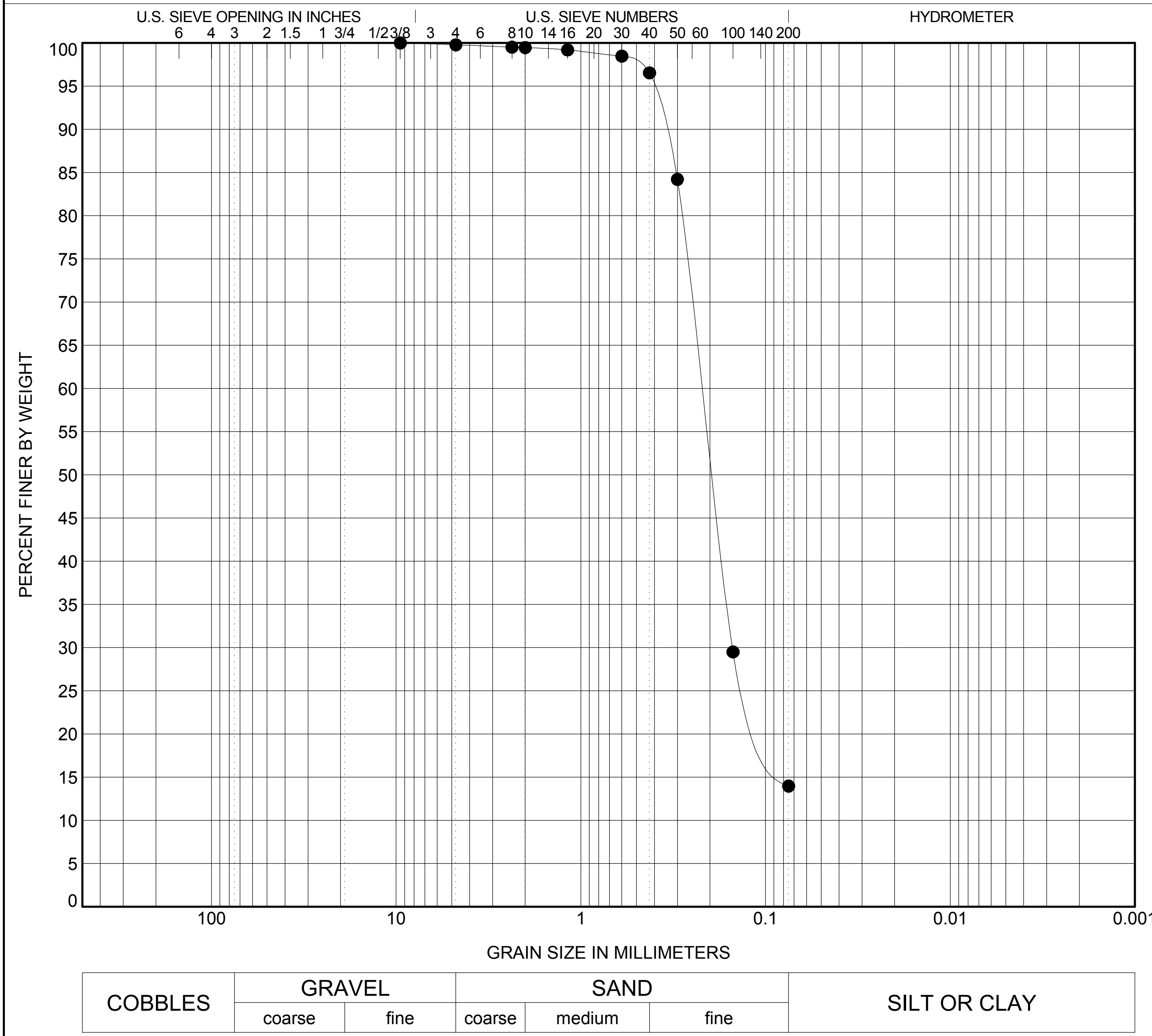
NOTE:

GRAIN SIZE DISTRIBUTION

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc. **PROJECT NAME** Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052 **PROJECT LOCATION** Ann Arbor, Michigan



BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● **FFSB-06**	**8 - 12**	**SAND (SP-SM) - brown, fine, some silt, traces of gravel and clay**					

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **FFSB-06**	**8 - 12**	**9.5**	**0.221**	**0.151**		**0.2**	**85.8**	**14.0**	

CTI and Associates, Inc.

FALLING HEAD PERMEABILITY OF GRANULAR MATERIALS

Project Name	Stadium Boulevard Reconstruction	Sample Number	FFSB-06
Project Number	3142040052	Sample Depth	8' - 12'
Tested By	DRC	Test Date	12/18/2014
Sample Description	SAND (SP-SM) - brown, fine, some silt, traces of gravel and clay		

Maximum Material Particle Size between 2.00-mm (No. 10) and 9.5-mm (3/8 in.) ☐ NO ☑ YES

Maximum Material Particle Size between 9.5-mm (3/8 in.) and 19.00-mm (3/4 in.) ☑ NO ☐ YES

Total weight of sample for sieve analysis, grams	554.0	% of Total sample retained on 9.5-mm (3/8 in.) sieve	0.0%
% of Total sample retained on 2.00-mm (No.10) sieve	0.5%	% of Total sample retained on 19.00-mm (3/4 in.) sieve	0.0%

Permeant	Tap Water				
Diameter (D), cm	11.40	Speciman Area (A), cm^2	102.07	Moisture Content (%)	3.3
Length (L), cm	11.40	Area of Burette (a), cm^2	0.17	Dry Density (pcf)	107.4
Length to Bottom, L_1	19.90	Weight Before, W_1	3513.2	Specific Gravity (assumed)	2.65
Length to Top, L_2	2.38	Weight After, W_2	334.2	Void Ratio, e	0.5399
Net Length, L (cm)	17.52	Weight Net, grams	3179.0		

Test Number	Manometers		Difference in Head (delta h) cm	Test Duration (t) sec	Temperature of Water (T) °C	Volume of Water (V) cm^3	Calculated K (cm/sec)	Corrected K @ 20°C (cm/sec)
	h_1, cm	h_2, cm						
1	182.5	82.5	100.0	60.00	21.5	32.0	7.27E-04	7.02E-04
2	182.5	82.5	100.0	60.00	21.5	32.0	7.27E-04	7.02E-04
3	182.5	82.5	100.0	60.00	21.5	31.0	7.04E-04	6.80E-04
4	182.5	82.5	100.0	60.00	21.5	32.0	7.27E-04	7.02E-04
5	182.5	82.5	100.0	60.00	21.5	32.0	7.27E-04	7.02E-04
6	182.5	82.5	100.0	60.00	21.5	33.0	7.50E-04	7.24E-04
							AVERAGE K_{20}	**7.02E-04**

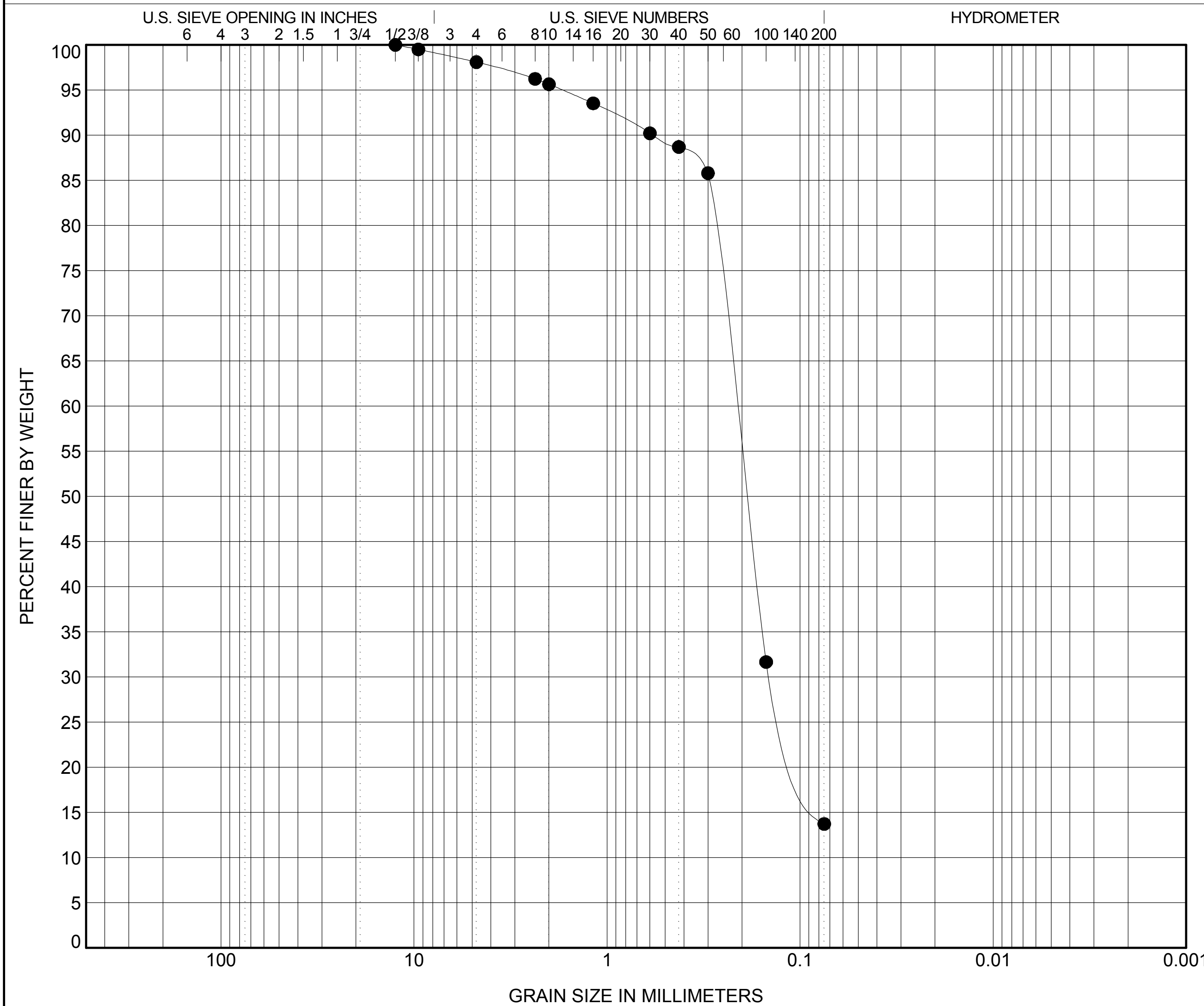
NOTE: Sample overcompacted in lab. In-situ dry density was approximately 96 pcf. Therefore, in-situ conditions may have a higher permeability rate

GRAIN SIZE DISTRIBUTION

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc. **PROJECT NAME** Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052 **PROJECT LOCATION** Ann Arbor, Michigan



	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**RWFF-03**	**10 - 13**	**SAND (SM) - brown, fine, with silt, trace gravel**					

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**RWFF-03**	**10 - 13**	**12.5**	**0.216**	**0.141**		**1.9**	**84.4**	**13.7**	

CTI and Associates, Inc.

CONSTANT HEAD PERMEABILITY OF GRANULAR MATERIALS

Project Name	Stadium Boulevard Reconstruction	Sample Number	RWFF-03
Project Number	3142040052	Sample Location	10' - 13'
Tested By	D. Cook	Test Date	12/18/2014
Sample Description	SAND (SM) - brown, fine, with silt, trace gravel		

Maximum Material Particle Size between 2.00-mm (No. 10) and 9.5-mm (3/8 in.) ☑ NO ☐ YES

Maximum Material Particle Size between 9.5-mm (3/8 in.) and 19.00-mm (3/4 in.) ☑ NO ☐ YES

Total weight of sample for sieve analysis, grams	534.2	% of Total sample retained on 9.5-mm (3/8 in.) sieve	0.50%
% of Total sample retained on 2.00-mm (No.10) sieve	4.40%	% of Total sample retained on 19.00-mm (3/4 in.) sieve	0.00%

Permeant	Tap Water				
Diameter (D), cm	11.40	Area (A), cm^2	102.07	Moisture Content (%)	5.7
Length (L), cm	11.40			Dry Density (pcf)	95.6
Height Before, H_1	19.90	Weight Before, W_1	3300.9	Specific Gravity (assumed)	2.65
Height After, H_2	2.05	Weight After, W_2	352.0	Void Ratio, e	0.7306
Net Height, cm	17.85	Weight Net, grams	2948.9		

Test Number	Manometers		Head (h) cm	Flow (Q) mL	Time (t) sec.	Temp (T) °C	Q/At	h/L	Calculated K (cm/sec)	Corrected K @ 20°C (cm/sec)
	Top, cm	Bottom, cm								
1	70.5	70.0	0.5	4	90	21.8	0.000	0.04	9.93E-03	9.52E-03
	70.5	70.0	0.5	4	90	21.8	0.000	0.04	9.93E-03	9.52E-03
2	70.4	69.4	1.0	9	90	21.8	0.001	0.09	1.12E-02	1.07E-02
	70.4	69.4	1.0	9	90	21.8	0.001	0.09	1.12E-02	1.07E-02
3	70.2	68.7	1.5	15	90	21.8	0.002	0.13	1.24E-02	1.19E-02
	70.2	68.7	1.5	15	90	21.8	0.002	0.13	1.24E-02	1.19E-02
4	70.1	68.1	2.0	19	90	21.8	0.002	0.18	1.18E-02	1.13E-02
	70.1	68.1	2.0	19	90	21.8	0.002	0.18	1.18E-02	1.13E-02
5	70.0	67.5	2.5	27	90	21.8	0.003	0.22	1.34E-02	1.28E-02
	70.0	67.5	2.5	27	90	21.8	0.003	0.22	1.34E-02	1.28E-02
								AVERAGE K		**1.13E-02**

NOTE:

SUMMARY OF LABORATORY RESULTS

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc. **PROJECT NAME** Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052 **PROJECT LOCATION** Ann Arbor, Michigan

Borehole	Depth	Classification	Maximum Size (mm)	%<#200 Sieve	Loss-on-Ignition (%)	Permeability (cm/sec)	Water Content (%)	Natural Density (pcf)	Dry Density (pcf)	Hand Penetrometer (tsf)	Unc. Compressive Strength (psf)
FF-01	2.5	FILL					11				
FF-01	5.0	FILL			3.4		20				
FF-01	7.5	CL					14			4.0	
FF-01	10.0	CL					13			4.5+	
FF-01	12.5	CL					15			4.5+	
FF-01	15.0	CL					17			4.5+	
FF-02	2.5	CL					14			1.5	
FF-02	5.0	SP-SM	12.5	11		7[illegible]64[illegible]	5	[illegible]0[illegible]6	105.1		
FFSB-01	2.5	FILL					17				
FFSB-01	5.0	CL					15			3.25	
FFSB-01	7.5	CL					14			2.0	
FFSB-01	10.0	CL					16	134.6	116.0	4.0	6937
FFSB-01	12.5	CL					17			2.0	
FFSB-01	15.0	CL					8			3.5	
FFSB-01	18.5	SM	9.5	20		4[illegible]38[illegible]					
FFSB-01	25.0	CL					8			2.5	
FFSB-02	2.5	SM					13				
FFSB-02	6.5	OL			2.5		17				
FFSB-02	7.5	CL					18			1.25	
FFSB-02	10.0	CL					18			3.0	
FFSB-02	12.5	SM					23			3.0	
FFSB-02	15.0	SM	4.75	18		3[illegible]20[illegible]	12	[illegible]0[illegible]	94.7		
FFSB-02	20.0	CL					9				
FFSB-02	25.0	CL					11			1.5	
FFSB-03	2.5	FILL			2.2		16				
FFSB-03	5.0	CL					23			2.75	
FFSB-03	7.5	CL					27			4.25	
FFSB-03	10.0	CL					18			4.5+	
FFSB-03	12.5	SP-SC					6				
FFSB-03	15.0	SP-SC	9.5	7		1[illegible]38[illegible]	10	[illegible]0[illegible]	95.2		
FFSB-03	20.0	SM					6				
FFSB-04	2.5	CL					14			2.5	
FFSB-04	5.0	CL					15			1.5	
FFSB-04	7.5	CL					13			4.5+	
FFSB-04	10.0	CL					17			4.5+	
FFSB-04	15.0	CL					15			1.5	
FFSB-04	20.0	CL					13			1.5	
FFSB-04	25.0	CL					14			1.5	
FFSB-05	2.5	FILL			2.1		12				
FFSB-05	5.0	CL					17			2.5	
FFSB-05	7.5	CL					14			4.5+	
FFSB-05	10.0	SP-SM					23				
FFSB-05	12.5	CL					17			2.0	

SUMMARY OF LABORATORY RESULTS

CTI and Associates, Inc.

CLIENT Northwest Consultants, Inc. **PROJECT NAME** Stadium Boulevard Reconstruction

PROJECT NUMBER 3142040052 **PROJECT LOCATION** Ann Arbor, Michigan

Borehole	Depth	Classification	Maximum Size (mm)	%<#200 Sieve	Loss-on-Ignition (%)	Permeability (cm/sec)	Water Content (%)	Natural Density (pcf)	Dry Density (pcf)	Hand Penetrometer (tsf)	Unc. Compressive Strength (psf)
FFSB-05	15.0	CL					15			2.0	
FFSB-05	20.0	CL					18			2.0	
FFSB-05	25.0	CL					16			1.5	
FFSB-06	2.5	FILL					14				
FFSB-06	5.0	OL			4.6		22				
FFSB-06	10.0	SP-SM	9.5	14		[illegible]7[illegible]02[illegible]	3	[illegible]	96.2		
FFSB-06	24.5	CL					18			3.25	
RWFF-01	2.5	FILL					18			4.0	
RWFF-01	5.0	CL					14	137.1	119.9	4.0	6895
RWFF-01	7.5	CL					15			2.25	
RWFF-01	10.0	CL					16			4.0	
RWFF-01	12.5	CL					15			2.5	
RWFF-01	15.0	CL					14			2.0	
RWFF-01	20.0	CL					17			1.5	
RWFF-01	25.0	CL					17			1.5	
RWFF-01	30.0	CL					17			1.5	
RWFF-02	2.5	CL					14			4.5+	
RWFF-02	5.0	CL					14	138.0	120.2	4.5+	10831
RWFF-02	7.5	CL					16			4.5+	
RWFF-02	10.0	CL					15			4.5+	
RWFF-02	12.5	CL								1.5	
RWFF-02	15.0	CL					15	130.4	112.4	1.5	4048
RWFF-02	20.0	CL					16			1.75	
RWFF-02	25.0	CL					18			1.75	
RWFF-02	30.0	CL					17			2.0	
RWFF-03	10.0	SM	12.5	14		1[illegible]13[illegible]	6	[illegible]00[illegible]	94.9		
RWFF-03	20.0	SM					22				
RWFF-03	25.0	SM					21				
SB-01	2.5	CL					15			4.0	
SB-01	5.0	CL					12			4.5+	
SB-02	2.5	FILL			3.8		16				
SB-02	5.0	CL			2.3		16			0.5	
SB-03	2.5	FILL					24				
SB-03	5.0	CL					22			3.5	
SB-04	2.5	FILL			2.9		6				
SB-04	5.0	CL					17			0.5	
SB-05	5.0	SC					19				
SB-06	2.5	CL					15			4.5+	
SB-06	5.0	CL					15			4.5+	
SB-07	2.5	CL					12			2.5	
SB-07	5.0	CL					14			4.5+	
SB-09	2.5	CL					23			3.5	
SB-09	5.0	CL					20				

SUMMARY OF LABORATORY RESULTS

CLIENT Northwest Consultants, Inc.
PROJECT NAME Stadium Boulevard Reconstruction
PROJECT NUMBER 3142040052
PROJECT LOCATION Ann Arbor, Michigan

Borehole	Depth	Classification	Maximum Size (mm)	%<#200 Sieve	Loss-on-Ignition (%)	Permeability (cm/sec)	Water Content (%)	Natural Density (pcf)	Dry Density (pcf)	Hand Penetrometer (tsf)	Unc. Compressive Strength (psf)
SB-11	5.0	CL					14			3.5	
SB-12	5.0	CL					15			4.5+	
SB-13	5.0	CL					15			4.5+	
SB-14	5.0	CL					16			2.5	
SB-16	5.0	CL					14				
SB-18	2.5	CL					13			3.25	
SB-18	5.0	CL					13			4.5+	
SB-19	2.5	FILL			3.9		22				
SB-19	5.0	CL					20			1.0	
SB-20	2.5	FILL					16				
SB-20	5.0	CL					19			1.5	
SB-21	2.5	CL					18			4.0	
SB-21	5.0	CL					18			2.25	
SB-22	2.5	CL					16			4.25	
SB-22	5.0	CL					13			4.5+	
SB-23	2.5	CL					14			3.0	
SB-23	5.0	CL					13			4.5+	
SB-24	2.5	CL					11			2.0	
SB-24	5.0	CL					12			3.0	
SB-25	2.5	CL					17			2.0	
SB-26	2.5	FILL					12				
SB-26	5.0	FILL			5.4		24				
SB-27	5.0	CL					15			4.5+	
SB-28	2.5	FILL			4.0		20				
SB-28	5.0	CL					18			1.5	
SB-29	5.0	CL					15			3.0	

CTI and Associates, Inc.

Analytical Laboratory Test Report
and
Summary Tables

SUMMARY OF ANALYTICAL TEST RESULTS FOR MICHIGAN 10 METALS

Stadium Boulevard Reconstruction

Ann Arbor, Michigan

CTI Project Number 3142040052

MDEQ - Soil: Non-Residential. PART 201 GENERIC CLEANUP CRITERIA AND SCREENING LEVELS/PART 213 RISK-BASED SCREENING LEVELS

SB-01 - 2'			Groundwater Protection			Indoor Air	Ambient Air (Y) (C)				Contact	Csat
Parameter (Metals)	Result (ug/Kg)	Statewide Default Background Levels	Residential Drinking Water Protection Criteria	Nonresidential Drinking Water Protection Criteria	Groundwater Surface Water Interface Protection Criteria	Soil Volatilization to Indoor Air Inhalation Criteria	Infinite Source Volatile Soil Inhalation Criteria (VSIC)	Finite VSIC for 5 Meter Source Thickness	Finite VSIC for 2 Meter Source Thickness	Particulate Soil Inhalation Criteria	Direct Contact Criteria	Soil Saturation Concentration Screening Levels
Arsenic	7200	5,800	4,600	4,600	4,600	NLV	NLV	NLV	NLV	9.10E+05	37,000	NA
Barium (B)	95000	75,000	1.30E+06	1.30E+06	(G)	NLV	NLV	NLV	NLV	1.50E+08	1.30E+08	NA
Cadmium (B)	480	1,200	6,000	6,000	(G,X)	NLV	NLV	NLV	NLV	2.20E+06	2.10E+06	NA
Chromium	20000	18,000 (total)	30,000	30,000	3,300	NLV	NLV	NLV	NLV	2.40E+05	9.20E+06	NA
Copper (B)	23000	32,000	5.80E+06	5.80E+06	(G)	NLV	NLV	NLV	NLV	5.90E+07	7.30E+07	NA
Lead (B)	11000	21,000	7.00E+05	7.00E+05	(G,X)	NLV	NLV	NLV	NLV	4.40E+07	9.0E+5 (DD)	NA
Mercury (B,Z)	U	130	1,700	1,700	50 (M); 1.2	89,000	62,000	62,000	62,000	8.80E+06	5.80E+05	NA
Selenium (B)	250	410	4,000	4,000	400	NLV	NLV	NLV	NLV	5.90E+07	9.60E+06	NA
Silver (B)	U	1,000	4,500	13,000	100 (M); 27	NLV	NLV	NLV	NLV	2.90E+06	9.00E+06	NA
Zinc (B)	61000	47,000	2.40E+06	5.00E+06	(G)	NLV	NLV	NLV	NLV	ID	6.30E+08	NA

MDEQ - Soil: Non-Residential. PART 201 GENERIC CLEANUP CRITERIA AND SCREENING LEVELS/PART 213 RISK-BASED SCREENING LEVELS

SB-05 - 4.5'			Groundwater Protection			Indoor Air	Ambient Air (Y) (C)				Contact	Csat
Parameter (Metals)	Result (ug/Kg)	Statewide Default Background Levels	Residential Drinking Water Protection Criteria	Nonresidential Drinking Water Protection Criteria	Groundwater Surface Water Interface Protection Criteria	Soil Volatilization to Indoor Air Inhalation Criteria	Infinite Source Volatile Soil Inhalation Criteria (VSIC)	Finite VSIC for 5 Meter Source Thickness	Finite VSIC for 2 Meter Source Thickness	Particulate Soil Inhalation Criteria	Direct Contact Criteria	Soil Saturation Concentration Screening Levels
Arsenic	3900	5,800	4,600	4,600	4,600	NLV	NLV	NLV	NLV	9.10E+05	37,000	NA
Barium (B)	12000	75,000	1.30E+06	1.30E+06	(G)	NLV	NLV	NLV	NLV	1.50E+08	1.30E+08	NA
Cadmium (B)	160	1,200	6,000	6,000	(G,X)	NLV	NLV	NLV	NLV	2.20E+06	2.10E+06	NA
Chromium	5100	18,000 (total)	30,000	30,000	3,300	NLV	NLV	NLV	NLV	2.40E+05	9.20E+06	NA
Copper (B)	8400	32,000	5.80E+06	5.80E+06	(G)	NLV	NLV	NLV	NLV	5.90E+07	7.30E+07	NA
Lead (B)	8600	21,000	7.00E+05	7.00E+05	(G,X)	NLV	NLV	NLV	NLV	4.40E+07	9.0E+5 (DD)	NA
Mercury (B,Z)	U	130	1,700	1,700	50 (M); 1.2	89,000	62,000	62,000	62,000	8.80E+06	5.80E+05	NA
Selenium (B)	U	410	4,000	4,000	400	NLV	NLV	NLV	NLV	5.90E+07	9.60E+06	NA
Silver (B)	U	1,000	4,500	13,000	100 (M); 27	NLV	NLV	NLV	NLV	2.90E+06	9.00E+06	NA
Zinc (B)	25000	47,000	2.40E+06	5.00E+06	(G)	NLV	NLV	NLV	NLV	ID	6.30E+08	NA

MDEQ - Soil: Non-Residential. PART 201 GENERIC CLEANUP CRITERIA AND SCREENING LEVELS/PART 213 RISK-BASED SCREENING LEVELS

SB-08 - 4.5'			Groundwater Protection			Indoor Air	Ambient Air (Y) (C)				Contact	Csat
Parameter (Metals)	Result (ug/Kg)	Statewide Default Background Levels	Residential Drinking Water Protection Criteria	Nonresidential Drinking Water Protection Criteria	Groundwater Surface Water Interface Protection Criteria	Soil Volatilization to Indoor Air Inhalation Criteria	Infinite Source Volatile Soil Inhalation Criteria (VSIC)	Finite VSIC for 5 Meter Source Thickness	Finite VSIC for 2 Meter Source Thickness	Particulate Soil Inhalation Criteria	Direct Contact Criteria	Soil Saturation Concentration Screening Levels
Arsenic	5200	5,800	4,600	4,600	4,600	NLV	NLV	NLV	NLV	9.10E+05	37,000	NA
Barium (B)	21000	75,000	1.30E+06	1.30E+06	(G)	NLV	NLV	NLV	NLV	1.50E+08	1.30E+08	NA
Cadmium (B)	150	1,200	6,000	6,000	(G,X)	NLV	NLV	NLV	NLV	2.20E+06	2.10E+06	NA
Chromium	6100	18,000 (total)	30,000	30,000	3,300	NLV	NLV	NLV	NLV	2.40E+05	9.20E+06	NA
Copper (B)	15000	32,000	5.80E+06	5.80E+06	(G)	NLV	NLV	NLV	NLV	5.90E+07	7.30E+07	NA
Lead (B)	7000	21,000	7.00E+05	7.00E+05	(G,X)	NLV	NLV	NLV	NLV	4.40E+07	9.0E+5 (DD)	NA
Mercury (B,Z)	U	130	1,700	1,700	50 (M); 1.2	89,000	62,000	62,000	62,000	8.80E+06	5.80E+05	NA
Selenium (B)	290	410	4,000	4,000	400	NLV	NLV	NLV	NLV	5.90E+07	9.60E+06	NA
Silver (B)	U	1,000	4,500	13,000	100 (M); 27	NLV	NLV	NLV	NLV	2.90E+06	9.00E+06	NA
Zinc (B)	38000	47,000	2.40E+06	5.00E+06	(G)	NLV	NLV	NLV	NLV	ID	6.30E+08	NA

SUMMARY OF ANALYTICAL TEST RESULTS FOR MICHIGAN 10 METALS

Stadium Boulevard Reconstruction

Ann Arbor, Michigan

CTI Project Number 3142040052

MDEQ - Soil: Non-Residential. PART 201 GENERIC CLEANUP CRITERIA AND SCREENING LEVELS/PART 213 RISK-BASED SCREENING LEVELS

RWFF-01 - 2'			Groundwater Protection			Indoor Air	Ambient Air (Y) (C)				Contact	Csat
Parameter (Metals)	Result (ug/Kg)	Statewide Default Background Levels	Residential Drinking Water Protection Criteria	Nonresidential Drinking Water Protection Criteria	Groundwater Surface Water Interface Protection Criteria	Soil Volatilization to Indoor Air Inhalation Criteria	Infinite Source Volatile Soil Inhalation Criteria (VSIC)	Finite VSIC for 5 Meter Source Thickness	Finite VSIC for 2 Meter Source Thickness	Particulate Soil Inhalation Criteria	Direct Contact Criteria	Soil Saturation Concentration Screening Levels
Arsenic	8800	5,800	4,600	4,600	4,600	NLV	NLV	NLV	NLV	9.10E+05	37,000	NA
Barium (B)	18000	75,000	1.30E+06	1.30E+06	(G)	NLV	NLV	NLV	NLV	1.50E+08	1.30E+08	NA
Cadmium (B)	280	1,200	6,000	6,000	(G,X)	NLV	NLV	NLV	NLV	2.20E+06	2.10E+06	NA
Chromium	7600	18,000 (total)	30,000	30,000	3,300	NLV	NLV	NLV	NLV	2.40E+05	9.20E+06	NA
Copper (B)	19000	32,000	5.80E+06	5.80E+06	(G)	NLV	NLV	NLV	NLV	5.90E+07	7.30E+07	NA
Lead (B)	11000	21,000	7.00E+05	7.00E+05	(G,X)	NLV	NLV	NLV	NLV	4.40E+07	9.0E+5 (DD)	NA
Mercury (B,Z)	U	130	1,700	1,700	50 (M); 1.2	89,000	62,000	62,000	62,000	8.80E+06	5.80E+05	NA
Selenium (B)	230	410	4,000	4,000	400	NLV	NLV	NLV	NLV	5.90E+07	9.60E+06	NA
Silver (B)	U	1,000	4,500	13,000	100 (M); 27	NLV	NLV	NLV	NLV	2.90E+06	9.00E+06	NA
Zinc (B)	59000	47,000	2.40E+06	5.00E+06	(G)	NLV	NLV	NLV	NLV	ID	6.30E+08	NA

MDEQ - Soil: Non-Residential. PART 201 GENERIC CLEANUP CRITERIA AND SCREENING LEVELS/PART 213 RISK-BASED SCREENING LEVELS

FF-02 - 12.5'			Groundwater Protection			Indoor Air	Ambient Air (Y) (C)				Contact	Csat
Parameter (Metals)	Result (ug/Kg)	Statewide Default Background Levels	Residential Drinking Water Protection Criteria	Nonresidential Drinking Water Protection Criteria	Groundwater Surface Water Interface Protection Criteria	Soil Volatilization to Indoor Air Inhalation Criteria	Infinite Source Volatile Soil Inhalation Criteria (VSIC)	Finite VSIC for 5 Meter Source Thickness	Finite VSIC for 2 Meter Source Thickness	Particulate Soil Inhalation Criteria	Direct Contact Criteria	Soil Saturation Concentration Screening Levels
Arsenic	2200	5,800	4,600	4,600	4,600	NLV	NLV	NLV	NLV	9.10E+05	37,000	NA
Barium (B)	7700	75,000	1.30E+06	1.30E+06	(G)	NLV	NLV	NLV	NLV	1.50E+08	1.30E+08	NA
Cadmium (B)	180	1,200	6,000	6,000	(G,X)	NLV	NLV	NLV	NLV	2.20E+06	2.10E+06	NA
Chromium	3700	18,000 (total)	30,000	30,000	3,300	NLV	NLV	NLV	NLV	2.40E+05	9.20E+06	NA
Copper (B)	10000	32,000	5.80E+06	5.80E+06	(G)	NLV	NLV	NLV	NLV	5.90E+07	7.30E+07	NA
Lead (B)	3300	21,000	7.00E+05	7.00E+05	(G,X)	NLV	NLV	NLV	NLV	4.40E+07	9.0E+5 (DD)	NA
Mercury (B,Z)	U	130	1,700	1,700	50 (M); 1.2	89,000	62,000	62,000	62,000	8.80E+06	5.80E+05	NA
Selenium (B)	U	410	4,000	4,000	400	NLV	NLV	NLV	NLV	5.90E+07	9.60E+06	NA
Silver (B)	U	1,000	4,500	13,000	100 (M); 27	NLV	NLV	NLV	NLV	2.90E+06	9.00E+06	NA
Zinc (B)	32000	47,000	2.40E+06	5.00E+06	(G)	NLV	NLV	NLV	NLV	ID	6.30E+08	NA

MDEQ - Soil: Non-Residential. PART 201 GENERIC CLEANUP CRITERIA AND SCREENING LEVELS/PART 213 RISK-BASED SCREENING LEVELS

SB-14 - 2'			Groundwater Protection			Indoor Air	Ambient Air (Y) (C)				Contact	Csat
Parameter (Metals)	Result (ug/Kg)	Statewide Default Background Levels	Residential Drinking Water Protection Criteria	Nonresidential Drinking Water Protection Criteria	Groundwater Surface Water Interface Protection Criteria	Soil Volatilization to Indoor Air Inhalation Criteria	Infinite Source Volatile Soil Inhalation Criteria (VSIC)	Finite VSIC for 5 Meter Source Thickness	Finite VSIC for 2 Meter Source Thickness	Particulate Soil Inhalation Criteria	Direct Contact Criteria	Soil Saturation Concentration Screening Levels
Arsenic	3000	5,800	4,600	4,600	4,600	NLV	NLV	NLV	NLV	9.10E+05	37,000	NA
Barium (B)	8500	75,000	1.30E+06	1.30E+06	(G)	NLV	NLV	NLV	NLV	1.50E+08	1.30E+08	NA
Cadmium (B)	91	1,200	6,000	6,000	(G,X)	NLV	NLV	NLV	NLV	2.20E+06	2.10E+06	NA
Chromium	2900	18,000 (total)	30,000	30,000	3,300	NLV	NLV	NLV	NLV	2.40E+05	9.20E+06	NA
Copper (B)	5700	32,000	5.80E+06	5.80E+06	(G)	NLV	NLV	NLV	NLV	5.90E+07	7.30E+07	NA
Lead (B)	2600	21,000	7.00E+05	7.00E+05	(G,X)	NLV	NLV	NLV	NLV	4.40E+07	9.0E+5 (DD)	NA
Mercury (B,Z)	U	130	1,700	1,700	50 (M); 1.2	89,000	62,000	62,000	62,000	8.80E+06	5.80E+05	NA
Selenium (B)	U	410	4,000	4,000	400	NLV	NLV	NLV	NLV	5.90E+07	9.60E+06	NA
Silver (B)	U	1,000	4,500	13,000	100 (M); 27	NLV	NLV	NLV	NLV	2.90E+06	9.00E+06	NA
Zinc (B)	18000	47,000	2.40E+06	5.00E+06	(G)	NLV	NLV	NLV	NLV	ID	6.30E+08	NA

SUMMARY OF ANALYTICAL TEST RESULTS FOR MICHIGAN 10 METALS

Stadium Boulevard Reconstruction

Ann Arbor, Michigan

CTI Project Number 3142040052

MDEQ - Soil: Non-Residential. PART 201 GENERIC CLEANUP CRITERIA AND SCREENING LEVELS/PART 213 RISK-BASED SCREENING LEVELS

SB-16 - 4'			Groundwater Protection			Indoor Air	Ambient Air (Y) (C)				Contact	Csat
Parameter (Metals)	Result (ug/Kg)	Statewide Default Background Levels	Residential Drinking Water Protection Criteria	Nonresidential Drinking Water Protection Criteria	Groundwater Surface Water Interface Protection Criteria	Soil Volatilization to Indoor Air Inhalation Criteria	Infinite Source Volatile Soil Inhalation Criteria (VSIC)	Finite VSIC for 5 Meter Source Thickness	Finite VSIC for 2 Meter Source Thickness	Particulate Soil Inhalation Criteria	Direct Contact Criteria	Soil Saturation Concentration Screening Levels
Arsenic	5800	5,800	4,600	4,600	4,600	NLV	NLV	NLV	NLV	9.10E+05	37,000	NA
Barium (B)	28000	75,000	1.30E+06	1.30E+06	(G)	NLV	NLV	NLV	NLV	1.50E+08	1.30E+08	NA
Cadmium (B)	330	1,200	6,000	6,000	(G,X)	NLV	NLV	NLV	NLV	2.20E+06	2.10E+06	NA
Chromium	5800	18,000 (total)	30,000	30,000	3,300	NLV	NLV	NLV	NLV	2.40E+05	9.20E+06	NA
Copper (B)	16000	32,000	5.80E+06	5.80E+06	(G)	NLV	NLV	NLV	NLV	5.90E+07	7.30E+07	NA
Lead (B)	130000	21,000	7.00E+05	7.00E+05	(G,X)	NLV	NLV	NLV	NLV	4.40E+07	9.0E+5 (DD)	NA
Mercury (B,Z)	U	130	1,700	1,700	50 (M); 1.2	89,000	62,000	62,000	62,000	8.80E+06	5.80E+05	NA
Selenium (B)	220	410	4,000	4,000	400	NLV	NLV	NLV	NLV	5.90E+07	9.60E+06	NA
Silver (B)	U	1,000	4,500	13,000	100 (M); 27	NLV	NLV	NLV	NLV	2.90E+06	9.00E+06	NA
Zinc (B)	76000	47,000	2.40E+06	5.00E+06	(G)	NLV	NLV	NLV	NLV	ID	6.30E+08	NA

MDEQ - Soil: Non-Residential. PART 201 GENERIC CLEANUP CRITERIA AND SCREENING LEVELS/PART 213 RISK-BASED SCREENING LEVELS

SB-10 - 5'			Groundwater Protection			Indoor Air	Ambient Air (Y) (C)				Contact	Csat
Parameter (Metals)	Result (ug/Kg)	Statewide Default Background Levels	Residential Drinking Water Protection Criteria	Nonresidential Drinking Water Protection Criteria	Groundwater Surface Water Interface Protection Criteria	Soil Volatilization to Indoor Air Inhalation Criteria	Infinite Source Volatile Soil Inhalation Criteria (VSIC)	Finite VSIC for 5 Meter Source Thickness	Finite VSIC for 2 Meter Source Thickness	Particulate Soil Inhalation Criteria	Direct Contact Criteria	Soil Saturation Concentration Screening Levels
Arsenic	4700	5,800	4,600	4,600	4,600	NLV	NLV	NLV	NLV	9.10E+05	37,000	NA
Barium (B)	11000	75,000	1.30E+06	1.30E+06	(G)	NLV	NLV	NLV	NLV	1.50E+08	1.30E+08	NA
Cadmium (B)	120	1,200	6,000	6,000	(G,X)	NLV	NLV	NLV	NLV	2.20E+06	2.10E+06	NA
Chromium	3900	18,000 (total)	30,000	30,000	3,300	NLV	NLV	NLV	NLV	2.40E+05	9.20E+06	NA
Copper (B)	8300	32,000	5.80E+06	5.80E+06	(G)	NLV	NLV	NLV	NLV	5.90E+07	7.30E+07	NA
Lead (B)	4500	21,000	7.00E+05	7.00E+05	(G,X)	NLV	NLV	NLV	NLV	4.40E+07	9.0E+5 (DD)	NA
Mercury (B,Z)	U	130	1,700	1,700	50 (M); 1.2	89,000	62,000	62,000	62,000	8.80E+06	5.80E+05	NA
Selenium (B)	210	410	4,000	4,000	400	NLV	NLV	NLV	NLV	5.90E+07	9.60E+06	NA
Silver (B)	U	1,000	4,500	13,000	100 (M); 27	NLV	NLV	NLV	NLV	2.90E+06	9.00E+06	NA
Zinc (B)	26000	47,000	2.40E+06	5.00E+06	(G)	NLV	NLV	NLV	NLV	ID	6.30E+08	NA

MDEQ - Soil: Non-Residential. PART 201 GENERIC CLEANUP CRITERIA AND SCREENING LEVELS/PART 213 RISK-BASED SCREENING LEVELS

SB-19 - 2'			Groundwater Protection			Indoor Air	Ambient Air (Y) (C)				Contact	Csat
Parameter (Metals)	Result (ug/Kg)	Statewide Default Background Levels	Residential Drinking Water Protection Criteria	Nonresidential Drinking Water Protection Criteria	Groundwater Surface Water Interface Protection Criteria	Soil Volatilization to Indoor Air Inhalation Criteria	Infinite Source Volatile Soil Inhalation Criteria (VSIC)	Finite VSIC for 5 Meter Source Thickness	Finite VSIC for 2 Meter Source Thickness	Particulate Soil Inhalation Criteria	Direct Contact Criteria	Soil Saturation Concentration Screening Levels
Arsenic	2800	5,800	4,600	4,600	4,600	NLV	NLV	NLV	NLV	9.10E+05	37,000	NA
Barium (B)	88000	75,000	1.30E+06	1.30E+06	(G)	NLV	NLV	NLV	NLV	1.50E+08	1.30E+08	NA
Cadmium (B)	360	1,200	6,000	6,000	(G,X)	NLV	NLV	NLV	NLV	2.20E+06	2.10E+06	NA
Chromium	10000	18,000 (total)	30,000	30,000	3,300	NLV	NLV	NLV	NLV	2.40E+05	9.20E+06	NA
Copper (B)	11000	32,000	5.80E+06	5.80E+06	(G)	NLV	NLV	NLV	NLV	5.90E+07	7.30E+07	NA
Lead (B)	10000	21,000	7.00E+05	7.00E+05	(G,X)	NLV	NLV	NLV	NLV	4.40E+07	9.0E+5 (DD)	NA
Mercury (B,Z)	U	130	1,700	1,700	50 (M); 1.2	89,000	62,000	62,000	62,000	8.80E+06	5.80E+05	NA
Selenium (B)	390	410	4,000	4,000	400	NLV	NLV	NLV	NLV	5.90E+07	9.60E+06	NA
Silver (B)	U	1,000	4,500	13,000	100 (M); 27	NLV	NLV	NLV	NLV	2.90E+06	9.00E+06	NA
Zinc (B)	32000	47,000	2.40E+06	5.00E+06	(G)	NLV	NLV	NLV	NLV	ID	6.30E+08	NA

SUMMARY OF ANALYTICAL TEST RESULTS FOR MICHIGAN 10 METALS

Stadium Boulevard Reconstruction

Ann Arbor, Michigan

CTI Project Number 3142040052

MDEQ - Soil: Non-Residential. PART 201 GENERIC CLEANUP CRITERIA AND SCREENING LEVELS/PART 213 RISK-BASED SCREENING LEVELS

SB-28 - 4.5'			Groundwater Protection			Indoor Air	Ambient Air (Y) (C)				Contact	Csat
Parameter (Metals)	Result (ug/Kg)	Statewide Default Background Levels	Residential Drinking Water Protection Criteria	Nonresidential Drinking Water Protection Criteria	Groundwater Surface Water Interface Protection Criteria	Soil Volatilization to Indoor Air Inhalation Criteria	Infinite Source Volatile Soil Inhalation Criteria (VSIC)	Finite VSIC for 5 Meter Source Thickness	Finite VSIC for 2 Meter Source Thickness	Particulate Soil Inhalation Criteria	Direct Contact Criteria	Soil Saturation Concentration Screening Levels
Arsenic	5300	5,800	4,600	4,600	4,600	NLV	NLV	NLV	NLV	9.10E+05	37,000	NA
Barium (B)	72000	75,000	1.30E+06	1.30E+06	(G)	NLV	NLV	NLV	NLV	1.50E+08	1.30E+08	NA
Cadmium (B)	300	1,200	6,000	6,000	(G,X)	NLV	NLV	NLV	NLV	2.20E+06	2.10E+06	NA
Chromium	16000	18,000 (total)	30,000	30,000	3,300	NLV	NLV	NLV	NLV	2.40E+05	9.20E+06	NA
Copper (B)	16000	32,000	5.80E+06	5.80E+06	(G)	NLV	NLV	NLV	NLV	5.90E+07	7.30E+07	NA
Lead (B)	9300	21,000	7.00E+05	7.00E+05	(G,X)	NLV	NLV	NLV	NLV	4.40E+07	9.0E+5 (DD)	NA
Mercury (B,Z)	U	130	1,700	1,700	50 (M); 1.2	89,000	62,000	62,000	62,000	8.80E+06	5.80E+05	NA
Selenium (B)	260	410	4,000	4,000	400	NLV	NLV	NLV	NLV	5.90E+07	9.60E+06	NA
Silver (B)	U	1,000	4,500	13,000	100 (M); 27	NLV	NLV	NLV	NLV	2.90E+06	9.00E+06	NA
Zinc (B)	49000	47,000	2.40E+06	5.00E+06	(G)	NLV	NLV	NLV	NLV	ID	6.30E+08	NA

U The analyte was not detected at or above the reporting limit

B Background, as defined in R 299.1(b), may be substituted if higher than the calculated cleanup criterion. Background levels may be less than criteria for some inorganic compounds

D Calculated criterion exceeds 100 percent, hence it is reduced to 100 percent or 1.0E+9 parts per billion (ppb)

G Groundwater surface water interface (GSI) criterion depends on the pH or water hardness, or both, of the receiving surface water. The final chronic value (FCV) for the protection of aquatic life shall be calculated based on the pH or hardness of the receiving surface water. Where water hardness exceeds 400 mg CaCO3/L, use 400 mg CaCO3/L for the FCV calculation. The FCV formula provides values in units of ug/L or ppb. The generic GSI criterion is the lesser of the calculated FCV, the wildlife value (WV), and the surface water human non-drinking water value (HNDV). The soil GSI protection criteria for these hazardous substances are the greater of the 20 times the GSI criterion or the GSI soil-water partition values using the GSI criteria developed with the procedure described in this footnote

H Valence-specific chromium data (Cr III and Cr VI) shall be compared to the corresponding valence-specific cleanup criteria. If both Cr III and Cr VI are present in groundwater, the total concentration of both cannot exceed the drinking water criterion of 100 ug/L. If analytical data are provided for total chromium only, they shall be compared to the cleanup criteria for Cr VI. Cr III soil cleanup criterion for protection of drinking water can only be used at sites where groundwater is prevented from being used as a public water supply, currently and in the future, through an approved land or resource use restriction

M Calculated criterion is below the analytical target detection limit, therefore, the criterion defaults to the target detection limit

X The GSI criterion shown in the generic cleanup criteria tables is not protective for surface water that is used as a drinking water source. For a groundwater discharge to the Great Lakes and their connecting waters or discharge in close proximity to a water supply intake in inland surface waters, the generic GSI criterion shall be the surface water human drinking water value (HDV) listed in the table in this footnote, except for those HDV indicated with an asterisk. For HDV with an asterisk, the generic GSI criterion shall be the lowest of the HDV, the WV, and the calculated FCV. See formulas in footnote (G). Soil protection criteria based on the HDV shall be as listed in the table in this footnote, except for those values with an asterisk. Soil GSI protection criteria based on the HDV shall be as listed in the table in this footnote, except for those values with an asterisk. Soil GSI protection criteria for compounds with an asterisk shall be the greater of 20 times the GSI criterion or the GSI soil-water partition values using the GSI criteria developed with the procedure described in this footnote

Z Mercury is typically measured as total mercury. The generic cleanup criteria, however, are based on data for different species of mercury. Specifically, data for elemental mercury, chemical abstract service (CAS) number 7439976, serve as the basis for the soil volatilization to indoor air criteria, groundwater volatilization to indoor air, and soil inhalation criteria. Data for methyl mercury, CAS number 22967926, serve as the basis for the GSI criterion; and data for mercuric chloride, CAS number 7487947, serve as the basis for the drinking water, groundwater contact, soil direct contact, and the groundwater protection criteria. Comparison to criteria shall be based on species-specific analytical data only if sufficient facility characterization has been conducted to rule out the presence of other species of mercury

DD Hazardous substance causes developmental effects. Residential direct contact criteria are protective of both prenatal and postnatal exposure. Nonresidential direct contact criteria are protective for a pregnant adult receptor

"NA" a criterion or value is not available or, in the case of background and CAS numbers, not applicable

"ID" insufficient data to develop criterion

"NLV" hazardous substance is not likely to volatilize under most conditions

SUMMARY OF ANALYTICAL TEST RESULTS FOR POLYNUCLEAR AROMATIC HYDROCARBONS (PNAs)

Stadium Boulevard Reconstruction

Ann Arbor, Michigan

CTI Project Number 3142040052

MDEQ - Soil: Non-Residential. PART 201 GENERIC CLEANUP CRITERIA AND SCREENING LEVELS/PART 213 RISK-BASED SCREENING LEVELS

SB-05 - 4.5'			Groundwater Protection			Indoor Air	Ambient Air (Y) (C)				Contact	Csat
Parameter (PNAs)	Result (ug/Kg)	Statewide Default Background Levels	Residential Drinking Water Protection Criteria	Nonresidential Drinking Water Protection Criteria	Groundwater Surface Water Interface Protection Criteria	Soil Volatilization to Indoor Air Inhalation Criteria	Infinite Source Volatile Soil Inhalation Criteria (VSIC)	Finite VSIC for 5 Meter Source Thickness	Finite VSIC for 2 Meter Source Thickness	Particulate Soil Inhalation Criteria	Direct Contact Criteria	Soil Saturation Concentration Screening Levels
Acenaphthene	U	NA	3.00E+05	8.80E+05	8,700	3.50E+08	9.70E+07	9.70E+07	9.70E+07	6.20E+09	1.30E+08	NA
Acenaphthylene	U	NA	5,900	17,000	ID	3.00E+06	2.70E+06	2.70E+06	2.70E+06	1.00E+09	5.20E+06	NA
Anthracene	340	NA	41,000	41,000	ID	1.0E+9 (D)	1.60E+09	1.60E+09	1.60E+09	2.90E+10	7.30E+08	NA
Benzo(a)anthracene (Q)	770	NA	NLL	NLL	NLL	NLV	NLV	NLV	NLV	ID	80,000	NA
Benzo(a)pyrene (Q)	740	NA	NLL	NLL	NLL	NLV	NLV	NLV	NLV	1.90E+06	8,000	NA
Benzo(b)fluoranthene (Q)	990	NA	NLL	NLL	NLL	ID	ID	ID	ID	ID	80,000	NA
Benzo(g,h,i)perylene	490	NA	NLL	NLL	NLL	NLV	NLV	NLV	NLV	3.50E+08	7.00E+06	NA
Benzo(k)fluoranthene (Q)	U	NA	NLL	NLL	NLL	NLV	NLV	NLV	NLV	ID	8.00E+05	NA
Chrysene (Q)	920	NA	NLL	NLL	NLL	ID	ID	ID	ID	ID	8.00E+06	NA
Dibenzo(a,h)anthracene (Q)	U	NA	NLL	NLL	NLL	NLV	NLV	NLV	NLV	ID	8,000	NA
Fluoranthene	2300	NA	7.30E+05	7.30E+05	5,500	1.0E+9 (D)	8.90E+08	8.80E+08	8.80E+08	4.10E+09	1.30E+08	NA
Fluorene	U	NA	3.90E+05	8.90E+05	5,300	1.0E+9 (D)	1.50E+08	1.50E+08	1.50E+08	4.10E+09	8.70E+07	NA
Indeno(1,2,3-cd)pyrene (Q)	500	NA	NLL	NLL	NLL	NLV	NLV	NLV	NLV	ID	80,000	NA
Phenanthrene	1000	NA	56,000	1.60E+05	2,100	5.10E+06	1.90E+05	1.90E+05	1.90E+05	2.90E+06	5.20E+06	NA
Pyrene	1600	NA	4.80E+05	4.80E+05	ID	1.0E+9 (D)	7.80E+08	7.80E+08	7.80E+08	2.90E+09	8.40E+07	NA

MDEQ - Soil: Non-Residential. PART 201 GENERIC CLEANUP CRITERIA AND SCREENING LEVELS/PART 213 RISK-BASED SCREENING LEVELS

SB-016 - 4'			Groundwater Protection			Indoor Air	Ambient Air (Y) (C)				Contact	Csat
Parameter (PNAs)	Result (ug/Kg)	Statewide Default Background Levels	Residential Drinking Water Protection Criteria	Nonresidential Drinking Water Protection Criteria	Groundwater Surface Water Interface Protection Criteria	Soil Volatilization to Indoor Air Inhalation Criteria	Infinite Source Volatile Soil Inhalation Criteria (VSIC)	Finite VSIC for 5 Meter Source Thickness	Finite VSIC for 2 Meter Source Thickness	Particulate Soil Inhalation Criteria	Direct Contact Criteria	Soil Saturation Concentration Screening Levels
Acenaphthene	40000	NA	3.00E+05	8.80E+05	8,700	3.50E+08	9.70E+07	9.70E+07	9.70E+07	6.20E+09	1.30E+08	NA
Acenaphthylene	84000	NA	5,900	17,000	ID	3.00E+06	2.70E+06	2.70E+06	2.70E+06	1.00E+09	5.20E+06	NA
Anthracene	200000	NA	41,000	41,000	ID	1.0E+9 (D)	1.60E+09	1.60E+09	1.60E+09	2.90E+10	7.30E+08	NA
Benzo(a)anthracene (Q)	330000	NA	NLL	NLL	NLL	NLV	NLV	NLV	NLV	ID	80,000	NA
Benzo(a)pyrene (Q)	300000	NA	NLL	NLL	NLL	NLV	NLV	NLV	NLV	1.90E+06	8,000	NA
Benzo(b)fluoranthene (Q)	350000	NA	NLL	NLL	NLL	ID	ID	ID	ID	ID	80,000	NA
Benzo(g,h,i)perylene	170000	NA	NLL	NLL	NLL	NLV	NLV	NLV	NLV	3.50E+08	7.00E+06	NA
Benzo(k)fluoranthene (Q)	110000	NA	NLL	NLL	NLL	NLV	NLV	NLV	NLV	ID	8.00E+05	NA
Chrysene (Q)	390000	NA	NLL	NLL	NLL	ID	ID	ID	ID	ID	8.00E+06	NA
Dibenzo(a,h)anthracene (Q)	43000	NA	NLL	NLL	NLL	NLV	NLV	NLV	NLV	ID	8,000	NA
Fluoranthene	910000	NA	7.30E+05	7.30E+05	5,500	1.0E+9 (D)	8.90E+08	8.80E+08	8.80E+08	4.10E+09	1.30E+08	NA
Fluorene	150000	NA	3.90E+05	8.90E+05	5,300	1.0E+9 (D)	1.50E+08	1.50E+08	1.50E+08	4.10E+09	8.70E+07	NA
Indeno(1,2,3-cd)pyrene (Q)	170000	NA	NLL	NLL	NLL	NLV	NLV	NLV	NLV	ID	80,000	NA
Phenanthrene	850000	NA	56,000	1.60E+05	2,100	5.10E+06	1.90E+05	1.90E+05	1.90E+05	2.90E+06	5.20E+06	NA
Pyrene	770000	NA	4.80E+05	4.80E+05	ID	1.0E+9 (D)	7.80E+08	7.80E+08	7.80E+08	2.90E+09	8.40E+07	NA

U	The analyte was not detected at or above the reporting limit
Q	Criteria for carcinogenic polycyclic aromatic hydrocarbons were developed using relative potential potencies to benzo(a)pyrene
"NA"	a criterion or value is not available or, in the case of background and CAS numbers, not applicable
"NLL"	hazardous substance is not likely to leach under most soil conditions
"ID"	insufficient data to develop criterion
"NLV"	hazardous substance is not likely to volatilize under most conditions

Fibertec environmental services

Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-001

[illegible]

[illegible]	**CTI & Associates, Inc.**	[illegible]	**Brown Clay**	[illegible]	
[illegible]	**Stadium Blvd Reconstruction (3142040052)**	[illegible]	**B1-2' (SB-01)**	[illegible]	**11/13/14**
[illegible]	**3142040052**	[illegible]	**Soil/Solid**	[illegible]	**10:15**

[illegible] **Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**

[illegible]

Dry Weight Determination (ASTM D 2974-87) — **Aliquot ID: 65442-001** — **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**17**	[illegible]		0[illegible]	[illegible]0	[illegible]6[illegible]	M[illegible]6	[illegible]	M[illegible]6	[illegible]M[illegible]

Michigan 10 Elements by ICP/MS (EPA 0200.2-M/EPA 6020A) — **Aliquot ID: 65442-001** — **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**7200**		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**95000**		[illegible]	[illegible]000	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**480**		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**20000**		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**23000**		[illegible]	[illegible]000	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6[illegible]d	**11000**		[illegible]	[illegible]000	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**250**		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**61000**		[illegible]	[illegible]000	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Mercury by CVAAS (EPA 7471B) — **Aliquot ID: 65442-001** — **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]M[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]	[illegible]	[illegible]M[illegible]	[illegible]	M6[illegible]	[illegible]

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) — **Aliquot ID: 65442-001A** — **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]000	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6[illegible]	[illegible]		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]0[illegible]	[illegible]		[illegible]	60	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-001

[illegible] 6[illegible]
[illegible]
[illegible]0[illegible]

[illegible]	**CTI & Associates, Inc.**	[illegible]	**Brown Clay**	[illegible]	
[illegible]	**Stadium Blvd Reconstruction (3142040052)**	[illegible]	**B1-2' (SB-01)**	[illegible]	**11/13/14**
[illegible]	**3142040052**	[illegible]	**Soil/Solid**	[illegible]	**10:15**
[illegible]	**Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**				
[illegible]	[illegible]				

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) **Aliquot ID: 65442-001A** **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	60	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-001

[illegible]	**CTI & Associates, Inc.**	[illegible]	**Brown Clay**	[illegible]	
[illegible]	**Stadium Blvd Reconstruction (3142040052)**	[illegible]	**B1-2' (SB-01)**	[illegible]	**11/13/14**
[illegible]	**3142040052**	[illegible]	**Soil/Solid**	[illegible]	**10:15**
[illegible]	**Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**				
[illegible]	[illegible]				

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) **Aliquot ID: 65442-001A** **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Polynuclear Aromatic Hydrocarbons (PNAs) (EPA 3546/EPA 8270C) **Aliquot ID: 65442-001** **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-002

[illegible]

[illegible]	**CTI & Associates, Inc.**	[illegible]	**Dark Gray Clay**	[illegible]	
[illegible]	**Stadium Blvd Reconstruction (3142040052)**	[illegible]	**B7-4.5' (SB-05)**	[illegible]	**11/12/14**
[illegible]	**3142040052**	[illegible]	**Soil/Solid**	[illegible]	**14:10**

[illegible] **Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**

[illegible]

Dry Weight Determination (ASTM D 2974-87) — Aliquot ID: 65442-002 — Matrix: Soil/Solid

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**16**	[illegible]	[illegible]	0[illegible]	[illegible]0	[illegible]6[illegible]	M[illegible]6	[illegible]	M[illegible]6	[illegible]M[illegible]

Michigan 10 Elements by ICP/MS (EPA 0200.2-M/EPA 6020A) — Aliquot ID: 65442-002 — Matrix: Soil/Solid

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**3900**		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**12000**		[illegible]	[illegible]000	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**160**		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**5100**		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**8400**		[illegible]	[illegible]000	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6[illegible]d	**8600**		[illegible]	[illegible]000	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**25000**		[illegible]	[illegible]000	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Mercury by CVAAS (EPA 7471B) — Aliquot ID: 65442-002 — Matrix: Soil/Solid

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]M[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]M[illegible]	[illegible]	M6[illegible]	[illegible]

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) — Aliquot ID: 65442-002A — Matrix: Soil/Solid

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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6[illegible]	[illegible]		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]0[illegible]	[illegible]		[illegible]	60	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-002

[illegible] 6[illegible]
[illegible] 6[illegible]
[illegible] [illegible]0[illegible]

[illegible]	CTI & Associates, Inc.	[illegible]	Dark Gray Clay	[illegible]	
[illegible]	Stadium Blvd Reconstruction (3142040052)	[illegible]	B7-4.5' (SB-05)	[illegible]	11/12/14
[illegible]	3142040052	[illegible]	Soil/Solid	[illegible]	14:10

[illegible] **Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**

[illegible]

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) **Aliquot ID: 65442-002A** **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		
						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible] [illegible]	[illegible]		[illegible]	60	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	60	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]		[illegible]	60	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-002

[illegible]	**CTI & Associates, Inc.**	[illegible]	**Dark Gray Clay**	[illegible]	
[illegible]	**Stadium Blvd Reconstruction (3142040052)**	[illegible]	**B7-4.5' (SB-05)**	[illegible]	**11/12/14**
[illegible]	**3142040052**	[illegible]	**Soil/Solid**	[illegible]	**14:10**

[illegible] **Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**

[illegible]

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) **Aliquot ID: 65442-002A** **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Polynuclear Aromatic Hydrocarbons (PNAs) (EPA 3546/EPA 8270C) **Aliquot ID: 65442-002** **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**340**		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**770**		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**740**		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**990**		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**490**		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	**920**		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**2300**		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**500**		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**1000**		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**1600**		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-003

[illegible]	CTI & Associates, Inc.	[illegible]	Brown Wet Sand	[illegible]	
[illegible]	Stadium Blvd Reconstruction (3142040052)	[illegible]	B12-4.5' (SB-08)	[illegible]	11/12/14
[illegible]	3142040052	[illegible]	Soil/Solid	[illegible]	13:40
[illegible]	Soil results have been calculated and reported on a dry weight basis unless otherwise noted.				

Dry Weight Determination (ASTM D 2974-87) Aliquot ID: 65442-003 Matrix: Soil/Solid

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	8.5	[illegible]	[illegible]	0[illegible]	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Michigan 10 Elements by ICP/MS (EPA 0200.2-M/EPA 6020A) Aliquot ID: 65442-003 Matrix: Soil/Solid

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	5200		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	21000		[illegible]	[illegible]000	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	15000		[illegible]	[illegible]000	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Mercury by CVAAS (EPA 7471B) Aliquot ID: 65442-003 Matrix: Soil/Solid

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) Aliquot ID: 65442-003A Matrix: Soil/Solid

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]000	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]		[illegible]	[illegible]	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-003

[illegible] 6[illegible]
[illegible] [illegible]
[illegible] [illegible]0[illegible]

[illegible]	**CTI & Associates, Inc.**	[illegible]	**Brown Wet Sand**	[illegible]	
[illegible]	**Stadium Blvd Reconstruction (3142040052)**	[illegible]	**B12-4.5' (SB-08)**	[illegible]	**11/12/14**
[illegible]	**3142040052**	[illegible]	**Soil/Solid**	[illegible]	**13:40**

[illegible] **Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**

[illegible] [illegible] [illegible] [illegible]

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) **Aliquot ID: 65442-003A** **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		
						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]6[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-003

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[illegible] [illegible]0[illegible]

[illegible]	**CTI & Associates, Inc.**	[illegible]	**Brown Wet Sand**	[illegible]	
[illegible]	**Stadium Blvd Reconstruction (3142040052)**	[illegible]	**B12-4.5' (SB-08)**	[illegible]	**11/12/14**
[illegible]	**3142040052**	[illegible]	**Soil/Solid**	[illegible]	**13:40**
[illegible]	**Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**				
[illegible]	[illegible]	[illegible]	[illegible]		

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) — **Aliquot ID: 65442-003A** — **Matrix: Soil/Solid**

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Polynuclear Aromatic Hydrocarbons (PNAs) (EPA 3546/EPA 8270C) — **Aliquot ID: 65442-003** — **Matrix: Soil/Solid**

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						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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6[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-004

[illegible]	CTI & Associates, Inc.	[illegible]	Mottled Brown and Gray Clay	[illegible]	
[illegible]	Stadium Blvd Reconstruction (3142040052)	[illegible]	B15-2' (RWFF-01)	[illegible]	11/13/14
[illegible]	3142040052	[illegible]	Soil/Solid	[illegible]	12:10

[illegible] Soil results have been calculated and reported on a dry weight basis unless otherwise noted.

Dry Weight Determination (ASTM D 2974-87) Aliquot ID: 65442-004 Matrix: Soil/Solid

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	7.4	[illegible]	[illegible]	0□	□0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Michigan 10 Elements by ICP/MS (EPA 0200.2-M/EPA 6020A) Aliquot ID: 65442-004 Matrix: Soil/Solid

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	8800		[illegible]	□00	□0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	18000		[illegible]	□000	□0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	230		[illegible]	□00	□0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	59000		[illegible]	□000	□0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Mercury by CVAAS (EPA 7471B) Aliquot ID: 65442-004 Matrix: Soil/Solid

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Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) Aliquot ID: 65442-004A Matrix: Soil/Solid

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[illegible]	[illegible]		[illegible]	□0	□0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	□00	□0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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1914 Holloway Drive, Holt, MI 48842, T: (517) 699-0345, F: (517) 699-0388
11766 E. Grand River, Brighton, MI 48116, T: (810) 220-3300, F: (810) 220-3311
8660 S. Mackinaw Trail, Cadillac, MI 49601, T: (231) 775-8368, F: (231) 775-8584
lab@fibertec.us

[illegible]	**CTI & Associates, Inc.**	[illegible]	**Mottled Brown and Gray Clay**	[illegible]	
[illegible]	**Stadium Blvd Reconstruction (3142040052)**	[illegible]	**B15-2' (RWFF-01)**	[illegible]	**11/13/14**
[illegible]	**3142040052**	[illegible]	**Soil/Solid**	[illegible]	**12:10**

[illegible] **Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**

[illegible]

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) **Aliquot ID: 65442-004A** **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-004

[illegible]	**CTI & Associates, Inc.**	[illegible]	**Mottled Brown and Gray Clay**	[illegible]	
[illegible]	**Stadium Blvd Reconstruction (3142040052)**	[illegible]	**B15-2' (RWFF-01)**	[illegible]	**11/13/14**
[illegible]	**3142040052**	[illegible]	**Soil/Solid**	[illegible]	**12:10**
[illegible]	**Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**				
[illegible]	[illegible]	[illegible]	[illegible]		

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) — **Aliquot ID: 65442-004A** — **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Polynuclear Aromatic Hydrocarbons (PNAs) (EPA 3546/EPA 8270C) — **Aliquot ID: 65442-004** — **Matrix: Soil/Solid**

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[illegible]M[illegible]M[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]6[illegible]	[illegible]
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[illegible]6[illegible]M[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]6[illegible]	[illegible]

Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-005

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[illegible]	CTI & Associates, Inc.	[illegible]	Brown Silty Sand	[illegible]	
[illegible]	Stadium Blvd Reconstruction (3142040052)	[illegible]	B19-12.5' (FF-02)	[illegible]	11/11/14
[illegible]	3142040052	[illegible]	Soil/Solid	[illegible]	10:05
[illegible]	Soil results have been calculated and reported on a dry weight basis unless otherwise noted.				
[illegible]	[illegible]	[illegible]	[illegible]		

Dry Weight Determination (ASTM D 2974-87) Aliquot ID: 65442-005 Matrix: Soil/Solid

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	10	[illegible]		0[illegible]	[illegible]0	[illegible]6[illegible]	M[illegible]6	[illegible]	M[illegible]6	[illegible]M[illegible]

Michigan 10 Elements by ICP/MS (EPA 0200.2-M/EPA 6020A) Aliquot ID: 65442-005 Matrix: Soil/Solid

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	2200		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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6[illegible]d	3300		[illegible]	[illegible]000	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	32000		[illegible]	[illegible]000	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Mercury by CVAAS (EPA 7471B) Aliquot ID: 65442-005 Matrix: Soil/Solid

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Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) Aliquot ID: 65442-005A Matrix: Soil/Solid

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[illegible]	[illegible]		[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-005

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[illegible]	CTI & Associates, Inc.	[illegible]	Brown Silty Sand	[illegible]	
[illegible]	Stadium Blvd Reconstruction (3142040052)	[illegible]	B19-12.5' (FF-02)	[illegible]	11/11/14
[illegible]	3142040052	[illegible]	Soil/Solid	[illegible]	10:05
[illegible]	Soil results have been calculated and reported on a dry weight basis unless otherwise noted.				
[illegible]	[illegible]				

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) **Aliquot ID: 65442-005A** **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-005

[illegible]

[illegible]	CTI & Associates, Inc.	[illegible]	Brown Silty Sand	[illegible]	
[illegible]	Stadium Blvd Reconstruction (3142040052)	[illegible]	B19-12.5' (FF-02)	[illegible]	11/11/14
[illegible]	3142040052	[illegible]	Soil/Solid	[illegible]	10:05

[illegible] **Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**

[illegible]

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) — **Aliquot ID: 65442-005A** — **Matrix: Soil/Solid**

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Polynuclear Aromatic Hydrocarbons (PNAs) (EPA 3546/EPA 8270C) — **Aliquot ID: 65442-005** — **Matrix: Soil/Solid**

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Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-006

[illegible]	**CTI & Associates, Inc.**	[illegible]	**Brown Clay**	[illegible]	
[illegible]	**Stadium Blvd Reconstruction (3142040052)**	[illegible]	**B21-4' (SB-16)**	[illegible]	**11/12/14**
[illegible]	**3142040052**	[illegible]	**Soil/Solid**	[illegible]	**12:50**
[illegible]	**Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**				

Dry Weight Determination (ASTM D 2974-87) — **Aliquot ID: 65442-006** — **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**5.4**	[illegible]	[illegible]	0[illegible]	[illegible]0	[illegible]6[illegible]	M[illegible]6	[illegible]	M[illegible]6	[illegible]M[illegible]

Michigan 10 Elements by ICP/MS (EPA 0200.2-M/EPA 6020A) — **Aliquot ID: 65442-006** — **Matrix: Soil/Solid**

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[illegible]	**5800**		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	**5800**		[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**16000**		[illegible]	[illegible]000	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	**220**	[illegible]	[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Mercury by CVAAS (EPA 7471B) — **Aliquot ID: 65442-006** — **Matrix: Soil/Solid**

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Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) — **Aliquot ID: 65442-006A** — **Matrix: Soil/Solid**

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Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-006

[illegible]	CTI & Associates, Inc.	[illegible]	Brown Clay	[illegible]	
[illegible]	Stadium Blvd Reconstruction (3142040052)	[illegible]	B21-4' (SB-16)	[illegible]	11/12/14
[illegible]	3142040052	[illegible]	Soil/Solid	[illegible]	12:50
[illegible]	Soil results have been calculated and reported on a dry weight basis unless otherwise noted.				
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Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) Aliquot ID: 65442-006A Matrix: Soil/Solid

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Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-006

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[illegible]	CTI & Associates, Inc.	[illegible]	Brown Clay	[illegible]	
[illegible]	Stadium Blvd Reconstruction (3142040052)	[illegible]	B21-4' (SB-16)	[illegible]	11/12/14
[illegible]	3142040052	[illegible]	Soil/Solid	[illegible]	12:50
[illegible]	Soil results have been calculated and reported on a dry weight basis unless otherwise noted.				
[illegible]	[illegible]				

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) Aliquot ID: 65442-006A Matrix: Soil/Solid

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Polynuclear Aromatic Hydrocarbons (PNAs) (EPA 3546/EPA 8270C) Aliquot ID: 65442-006 Matrix: Soil/Solid

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	**84000**	[illegible]	[illegible]	[illegible]00	[illegible]00	[illegible]	[illegible]	[illegible]6[illegible]	[illegible]6[illegible]	[illegible]
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Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-007

[illegible]	CTI & Associates, Inc.	[illegible]	Brown Sand	[illegible]	
[illegible]	Stadium Blvd Reconstruction (3142040052)	[illegible]	B23-2' (SB-14)	[illegible]	11/12/14
[illegible]	3142040052	[illegible]	Soil/Solid	[illegible]	11:45
[illegible]	Soil results have been calculated and reported on a dry weight basis unless otherwise noted.				

Dry Weight Determination (ASTM D 2974-87) Aliquot ID: 65442-007 Matrix: Soil/Solid

Parameter	Result	Q	Units	Reporting Limit	Dilution	Prep Date	Prep By	Analysis Date	Analysis By	Init
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Michigan 10 Elements by ICP/MS (EPA 0200.2-M/EPA 6020A) Aliquot ID: 65442-007 Matrix: Soil/Solid

Parameter	Result	Q	Units	Reporting Limit	Dilution	Prep Date	Prep By	Analysis Date	Analysis By	Init
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Mercury by CVAAS (EPA 7471B) Aliquot ID: 65442-007 Matrix: Soil/Solid

Parameter	Result	Q	Units	Reporting Limit	Dilution	Prep Date	Prep By	Analysis Date	Analysis By	Init
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) Aliquot ID: 65442-007A Matrix: Soil/Solid

Parameter	Result	Q	Units	Reporting Limit	Dilution	Prep Date	Prep By	Analysis Date	Analysis By	Init
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Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-007

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[illegible]	CTI & Associates, Inc.	[illegible]	Brown Sand	[illegible]	
[illegible]	Stadium Blvd Reconstruction (3142040052)	[illegible]	B23-2' (SB-14)	[illegible]	11/12/14
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[illegible]	Soil results have been calculated and reported on a dry weight basis unless otherwise noted.				
[illegible]	[illegible]				

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) Aliquot ID: 65442-007A Matrix: Soil/Solid

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[illegible]	CTI & Associates, Inc.	[illegible]	Brown Sand	[illegible]	
[illegible]	Stadium Blvd Reconstruction (3142040052)	[illegible]	B23-2' (SB-14)	[illegible]	11/12/14
[illegible]	3142040052	[illegible]	Soil/Solid	[illegible]	11:45
[illegible]	Soil results have been calculated and reported on a dry weight basis unless otherwise noted.				
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Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) Aliquot ID: 65442-007A Matrix: Soil/Solid

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Polynuclear Aromatic Hydrocarbons (PNAs) (EPA 3546/EPA 8270C) Aliquot ID: 65442-007 Matrix: Soil/Solid

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Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-008

[illegible]	[illegible]
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[illegible]	[illegible]

[illegible]	**CTI & Associates, Inc.**	[illegible]	**Brown Sand**	[illegible]	
[illegible]	**Stadium Blvd Reconstruction (3142040052)**	[illegible]	**B24-5' (SB-10)**	[illegible]	**11/12/14**
[illegible]	**3142040052**	[illegible]	**Soil/Solid**	[illegible]	**11:20**

[illegible] **Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**

[illegible]

Dry Weight Determination (ASTM D 2974-87) — **Aliquot ID: 65442-008** — **Matrix: Soil/Solid**

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Michigan 10 Elements by ICP/MS (EPA 0200.2-M/EPA 6020A) — **Aliquot ID: 65442-008** — **Matrix: Soil/Solid**

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Mercury by CVAAS (EPA 7471B) — **Aliquot ID: 65442-008** — **Matrix: Soil/Solid**

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Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) — **Aliquot ID: 65442-008A** — **Matrix: Soil/Solid**

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Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-008

[illegible]	**CTI & Associates, Inc.**	[illegible]	**Brown Sand**	[illegible]	
[illegible]	**Stadium Blvd Reconstruction (3142040052)**	[illegible]	**B24-5' (SB-10)**	[illegible]	**11/12/14**
[illegible]	**3142040052**	[illegible]	**Soil/Solid**	[illegible]	**11:20**
[illegible]	**Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**				

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) **Aliquot ID: 65442-008A** **Matrix: Soil/Solid**

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Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-008

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[illegible]	**CTI & Associates, Inc.**	[illegible]	**Brown Sand**	[illegible]	
[illegible]	**Stadium Blvd Reconstruction (3142040052)**	[illegible]	**B24-5' (SB-10)**	[illegible]	**11/12/14**
[illegible]	**3142040052**	[illegible]	**Soil/Solid**	[illegible]	**11:20**
[illegible]	**Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**				
[illegible]	[illegible]				

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) — **Aliquot ID: 65442-008A** — **Matrix: Soil/Solid**

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Polynuclear Aromatic Hydrocarbons (PNAs) (EPA 3546/EPA 8270C) — **Aliquot ID: 65442-008** — **Matrix: Soil/Solid**

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Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-009

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[illegible] [illegible]
[illegible] [illegible]

[illegible]	**CTI & Associates, Inc.**	[illegible]	**Dark Gray Clay**	[illegible]	
[illegible]	**Stadium Blvd Reconstruction (3142040052)**	[illegible]	**B29-2' (SB-19)**	[illegible]	**11/12/14**
[illegible]	**3142040052**	[illegible]	**Soil/Solid**	[illegible]	**16:40**

[illegible] **Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**

[illegible]

Dry Weight Determination (ASTM D 2974-87) **Aliquot ID: 65442-009** **Matrix: Soil/Solid**

[illegible]	16	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Michigan 10 Elements by ICP/MS (EPA 0200.2-M/EPA 6020A) **Aliquot ID: 65442-009** **Matrix: Soil/Solid**

[illegible]	2800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	88000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Mercury by CVAAS (EPA 7471B) **Aliquot ID: 65442-009** **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) **Aliquot ID: 65442-009A** **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-009

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]	CTI & Associates, Inc.	[illegible]	Dark Gray Clay	[illegible]	
[illegible]	Stadium Blvd Reconstruction (3142040052)	[illegible]	B29-2' (SB-19)	[illegible]	11/12/14
[illegible]	3142040052	[illegible]	Soil/Solid	[illegible]	16:40

[illegible] **Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**

[illegible]

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) **Aliquot ID: 65442-009A** **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Prepared [illegible]		Analyzed [illegible]		
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[illegible]	[illegible]	[illegible]	[illegible]	60	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-009

[illegible]

[illegible]	CTI & Associates, Inc.	[illegible]	Dark Gray Clay	[illegible]	
[illegible]	Stadium Blvd Reconstruction (3142040052)	[illegible]	B29-2' (SB-19)	[illegible]	11/12/14
[illegible]	3142040052	[illegible]	Soil/Solid	[illegible]	16:40

[illegible] **Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**

[illegible]

Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) Aliquot ID: 65442-009A Matrix: Soil/Solid

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]6[illegible]	[illegible]	[illegible]	[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]00	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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6[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Polynuclear Aromatic Hydrocarbons (PNAs) (EPA 3546/EPA 8270C) Aliquot ID: 65442-009 Matrix: Soil/Solid

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]0[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-010

[illegible]	6[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]	**CTI & Associates, Inc.**	[illegible]	**Mottled Brown and Gray Clay**	[illegible]	
[illegible]	**Stadium Blvd Reconstruction (3142040052)**	[illegible]	**B38-4.5' (SB-28)**	[illegible]	**11/11/14**
[illegible]	**3142040052**	[illegible]	**Soil/Solid**	[illegible]	**15:45**

[illegible] **Soil results have been calculated and reported on a dry weight basis unless otherwise noted.**

[illegible]

Dry Weight Determination (ASTM D 2974-87) — **Aliquot ID: 65442-010** — **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	**17**	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Michigan 10 Elements by ICP/MS (EPA 0200.2-M/EPA 6020A) — **Aliquot ID: 65442-010** — **Matrix: Soil/Solid**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	**300**		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Mercury by CVAAS (EPA 7471B) — **Aliquot ID: 65442-010** — **Matrix: Soil/Solid**

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Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) — **Aliquot ID: 65442-010A** — **Matrix: Soil/Solid**

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Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-010

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[illegible]	**CTI & Associates, Inc.**	[illegible]	**Mottled Brown and Gray Clay**	[illegible]	
[illegible]	**Stadium Blvd Reconstruction (3142040052)**	[illegible]	**B38-4.5' (SB-28)**	[illegible]	**11/11/14**
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Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) **Aliquot ID: 65442-010A** **Matrix: Soil/Solid**

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Analytical Laboratory Report
Laboratory Project Number: 65442
Laboratory Sample Number: 65442-010

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Volatile Organic Compounds (VOCs) by GC/MS, 5035 (EPA 5035A/EPA 8260B) Aliquot ID: 65442-010A Matrix: Soil/Solid

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Fibertec environmental services

Analytical Laboratory Report
Laboratory Project Number: 65442

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CTI and Associates, Inc.

Falling Weight Deflectometer Report

December 31, 2014

Theresa Marsik
CTI and Associates, Inc.
51331 W. Pontiac Trail
Wixom, MI 48393
(248) 486-5100 tel
tmarsik@cticompanies.com

Subject: **Falling Weight Deflectometer (FWD) Testing Report for Stadium Boulevard, Ann Arbor. ARA Project No. 002390.**

Dear Ms. Marsik:

Applied Research Associates (ARA), Inc., is pleased to submit the FWD testing report for the above referenced project.

If you have any questions or need additional information, please do not hesitate to contact us.

Sincerely,

Douglas A. Steele, PE
Senior Engineer

William R. Vavrik, PhD, PE
Vice-President, Principal Engineer

BACKGROUND

ARA performed FWD testing for CTI and Associates, Inc. (CTI) on five streets near Stadium Boulevard in Ann Arbor as part of a CTI pavement evaluation and design project. The pavement structures consist primarily of asphalt concrete (AC) with no reported base, with the exception of Stadium Boulevard, which has a portland cement concrete (PCC) base. The other roads included in the study are Main St., Potter Ave., Prescott Ave., and Edgewood Ave. ARA performed FWD testing at 40 locations selected by CTI, corresponding to bore holes. CTI determined the pavement layer thicknesses for us in data analysis. The following report summarizes our data collection, analysis, and results.

FWD TESTING

ARA tested with a JILS 20-T truck-mounted FWD on November 6, 2014. The FWD was configured with nine deflection sensors spaced a 0, 8, 12, 18, 24, 36, 48, 60, and -12 in from the load center and a 12-in diameter load plate. The FWD performed an unrecorded seating drop and three test drops at 6, 9, and 12 kip target loads at 40 test locations selected by CTI, corresponding to bore hole locations. In addition to the load and deflection data, the FWD automatically recorded the station, GPS coordinates, air temperature, and pavement surface temperature at each test point.

Figure 1. The JILS truck-mounted FWD configured with nine deflection sensors.

DATA ANALYSIS AND RESULTS

The following sections describe the FWD data analysis procedures and results. Appendix A (attached electronically) presents the point-by-point results.

Normalization of Maximum Deflections

ARA normalized the maximum deflection at each test location to 9,000 lbf using a linear extrapolation of the measured load and deflection data. Normalization is used to remove small variations in the actual load at each test point due to variations in pavement stiffness and to allow comparison of all maximum deflections at a single load level. In addition, we normalized the deflections to a standard temperature of 68 °F to account for the temperature susceptibility of AC pavement deflections. Figure 2 presents the normalized deflection results by road and boring number. It shows the deflections ranged from 4 to 55 mils, with lower deflections on Stadium Blvd. and Main St., and higher deflections on the other three roads.

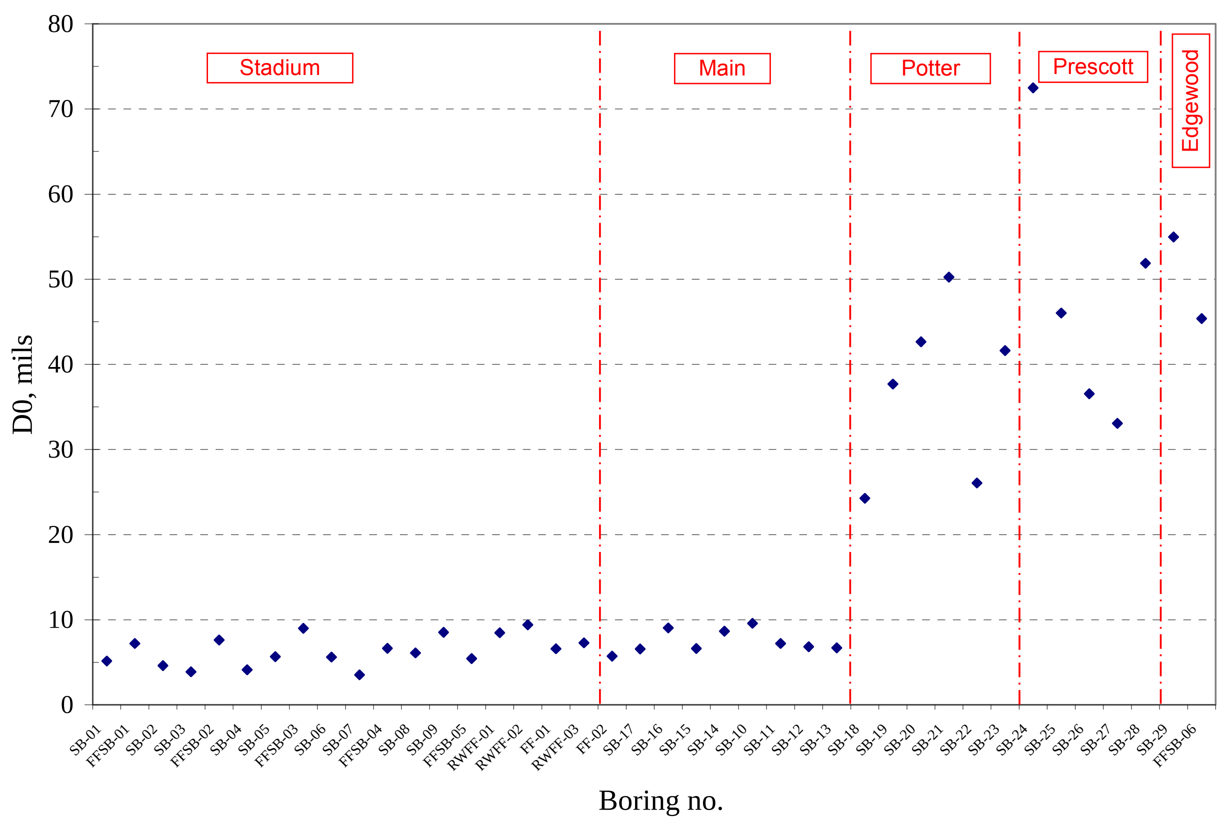


Figure 2. Maximum deflections at 9,000 lbf and 68 °F.

Flexible Pavement Backcalculation – AASHTO 1993 Method

ARA analyzed the pavements using two methods—the 1993 AASHTO backcalculation procedure and the MODULUS backcalculation program. In the case of flexible pavements, the AASHTO method models the pavement as a two-layer system—the combination of all layers above the subgrade, and the subgrade layer. It determines a composite pavement modulus (Ep), effective structural number (SNeff), and the subgrade resilient modulus (Mr). The subgrade modulus is the backcalculated subgrade elastic modulus multiplied by a C-factor to convert it to an equivalent laboratory Mr value. In the case of fine-grained soils, AASHTO recommends a C-factor of 0.33. Figures 3 through 5 present the results for Ep, SNeff, and Mr, respectively, and the point-by-point results are presented in Appendix A.

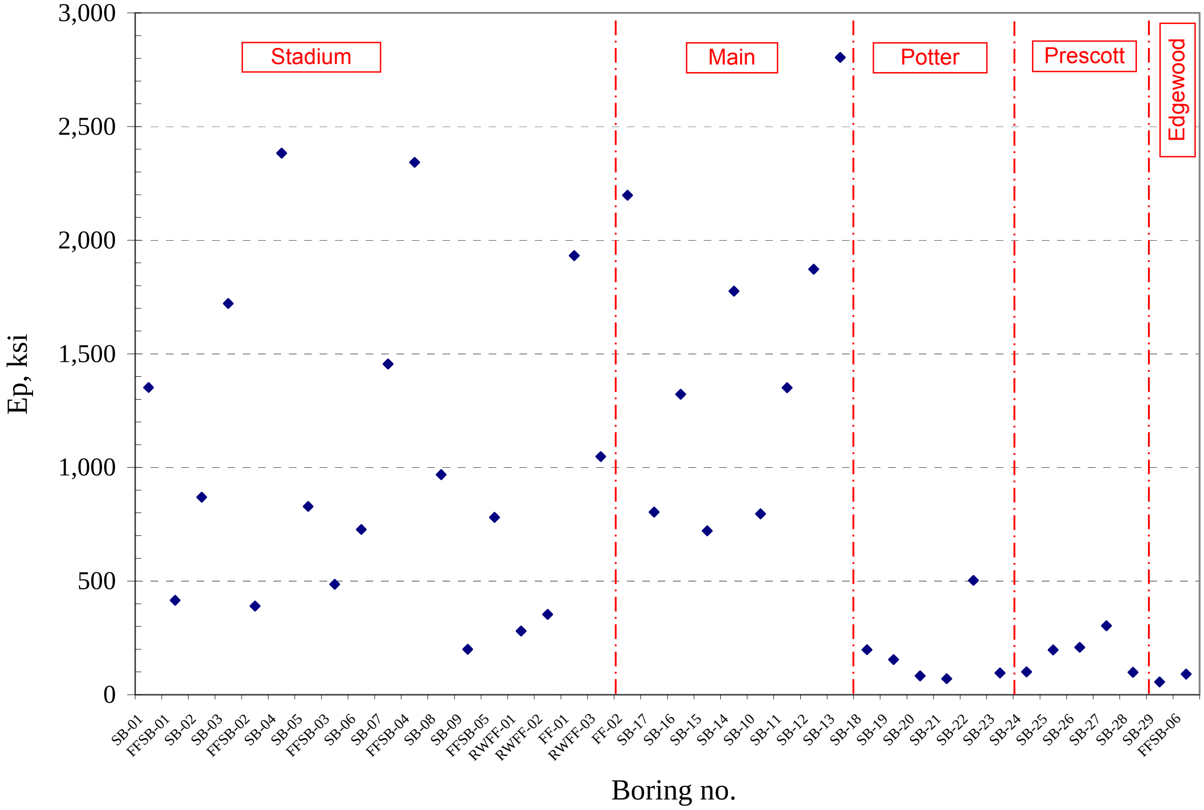


Figure 3. Pavement composite moduli – AASHTO method.

The Ep results show higher values for Stadium and Main. This is expected for Stadium, as it has a PCC base, which increases Ep significantly. The cause of the higher values on Main is not immediately clear, as the borings did not report a PCC or stabilized base for this road. Ep values for Potter, Prescott, and Edgewood are low and typical of thin- to medium-thick AC pavements.

The SNeff values show a similar trend as Ep, ranging from 0.8 to 8 in, with higher values on Stadium and Main, and lower values on the others. It should be noted that the backcalculated Ep values, and therefore SNeff values, are determined based on deflections normalized to 68 °F. Therefore, the Ep and SNeff values presented can be considered normalized to a standard temperature of 68 °F.

The subgrade Mr values are significantly higher on Stadium and Main, ranging from 4 to 10 ksi, relative to the other roads, which ranged from 2 to 3.5 ksi. One explanation for the difference in values can be due to the stress-sensitivity of the subgrade soils, which react with a lower effective modulus when subjected to higher stresses due to the absence of the rigid base present on Stadium.

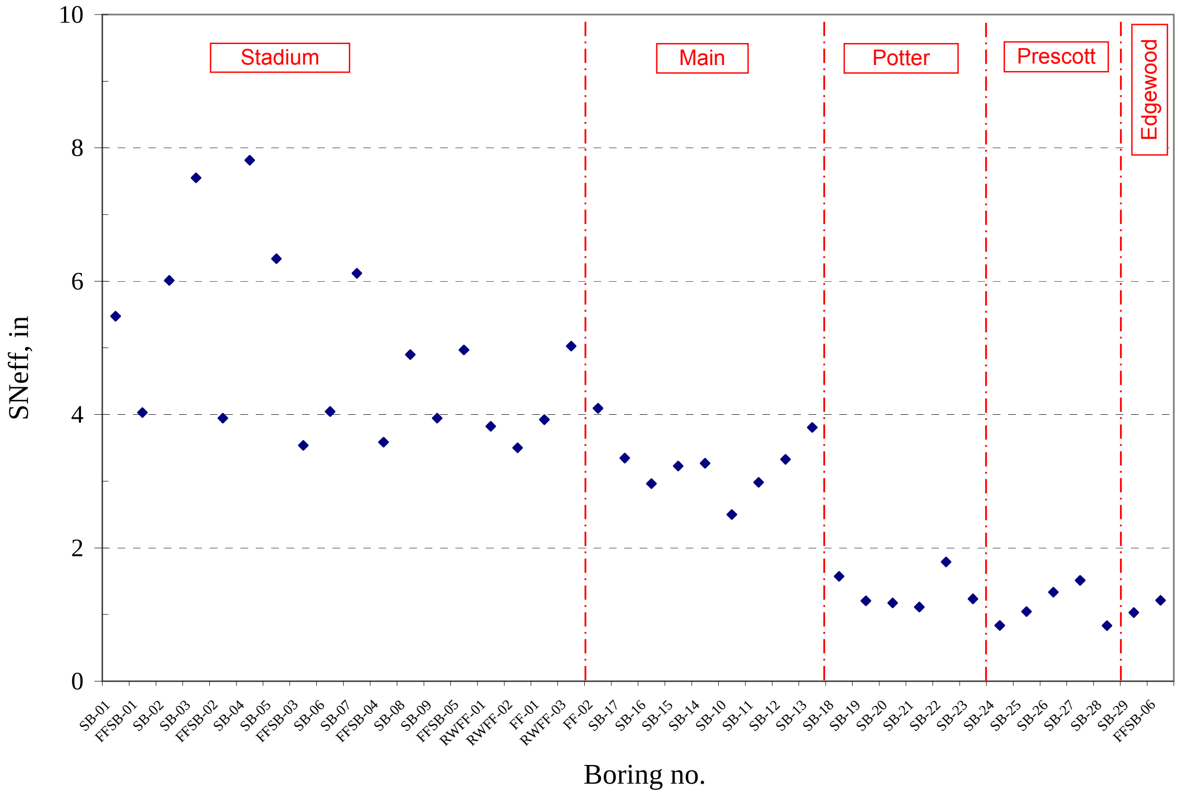


Figure 4. Effective structural number – AASHTO method.

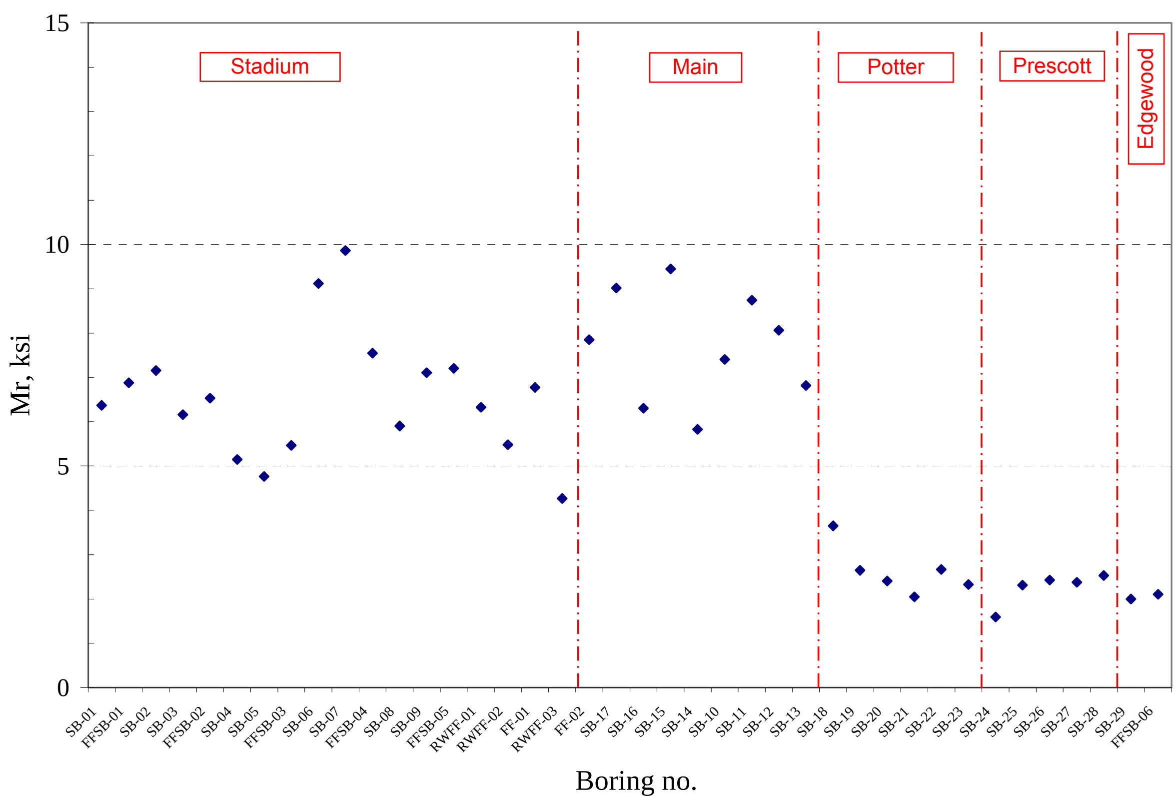


Figure 5. Subgrade resilient modulus – AASHTO method.

Flexible Pavement Backcalculation – Multi-Layer Backcalculation

ARA analyzed all five pavements using the MODULUS backcalculation program. MODULUS models the pavement as multiple elastic layers over an elastic solid foundation. It also has the option to predict and incorporate a rigid subsurface layer, such as shallow bedrock. MODULUS sets realistic upper and lower limits for the pavement layer moduli based on the AC temperature at the time of testing. The program searches for the combination of pavement and subgrade layer moduli that gives the best fit between theoretical and FWD-measured deflection basins, within the constraints of these limits.

Figure 6 presents the backcalculated Eac values using thicknesses determined from pavement coring and the estimated AC temperature at the time of testing. ARA also normalized the AC moduli to a standard temperature of 70 °F using the Asphalt Institute's equation for relating the modulus of AC mixes to temperature based on typical mix properties (e.g., AC content, percent voids, percent fines, and viscosity) and loading frequency. They range from approximately 100 to 1,600 ksi, with the highest values occurring on Main and lower values on the remaining roads.

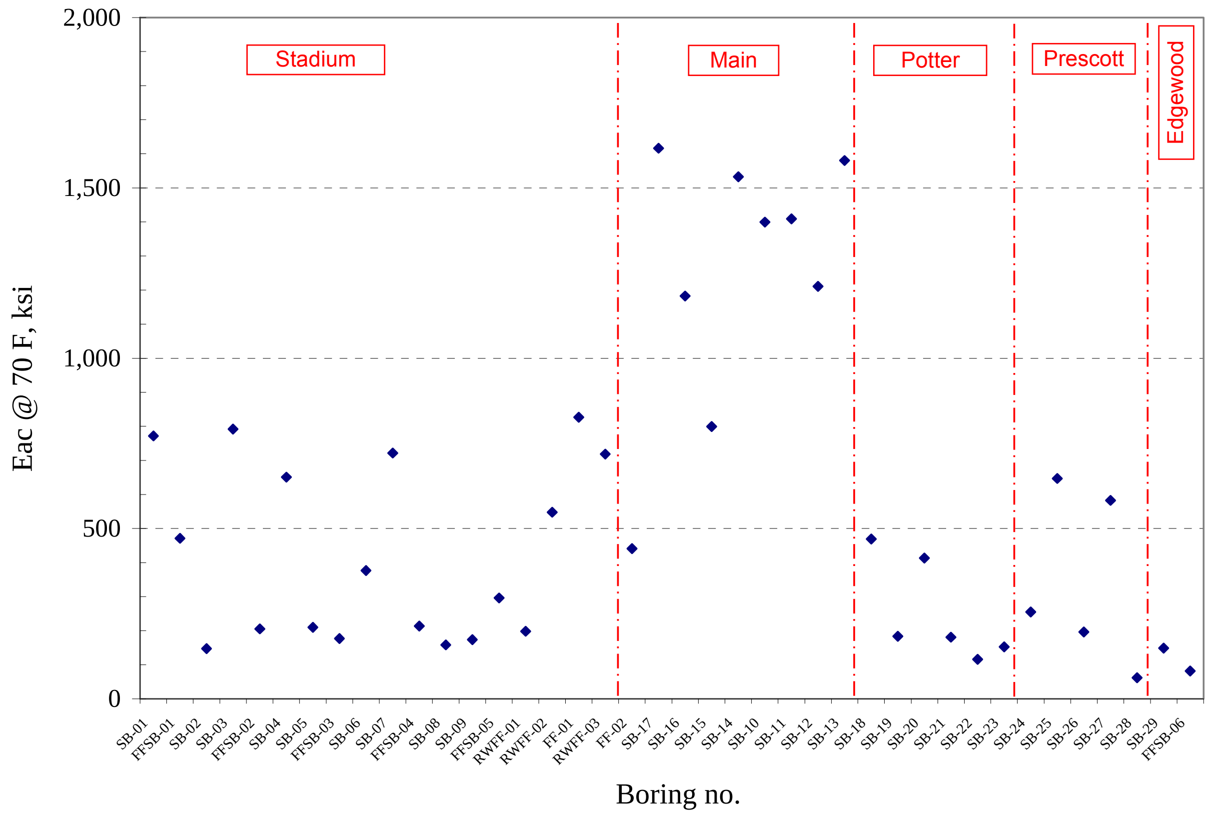


Figure 6. AC moduli normalized to 70 °F.

ARA backcalculated using the depth-to-bedrock option in MODULUS, which produced a better fit between field and theoretical basins than the semi-infinite subgrade option. This option results in lower Mr values when compared to semi-infinite results, such as the AASHTO method, due to the incorporation of a bedrock layer that contributes to the foundation stiffness. Figure 7 shows the Mr values determined from MODULUS.

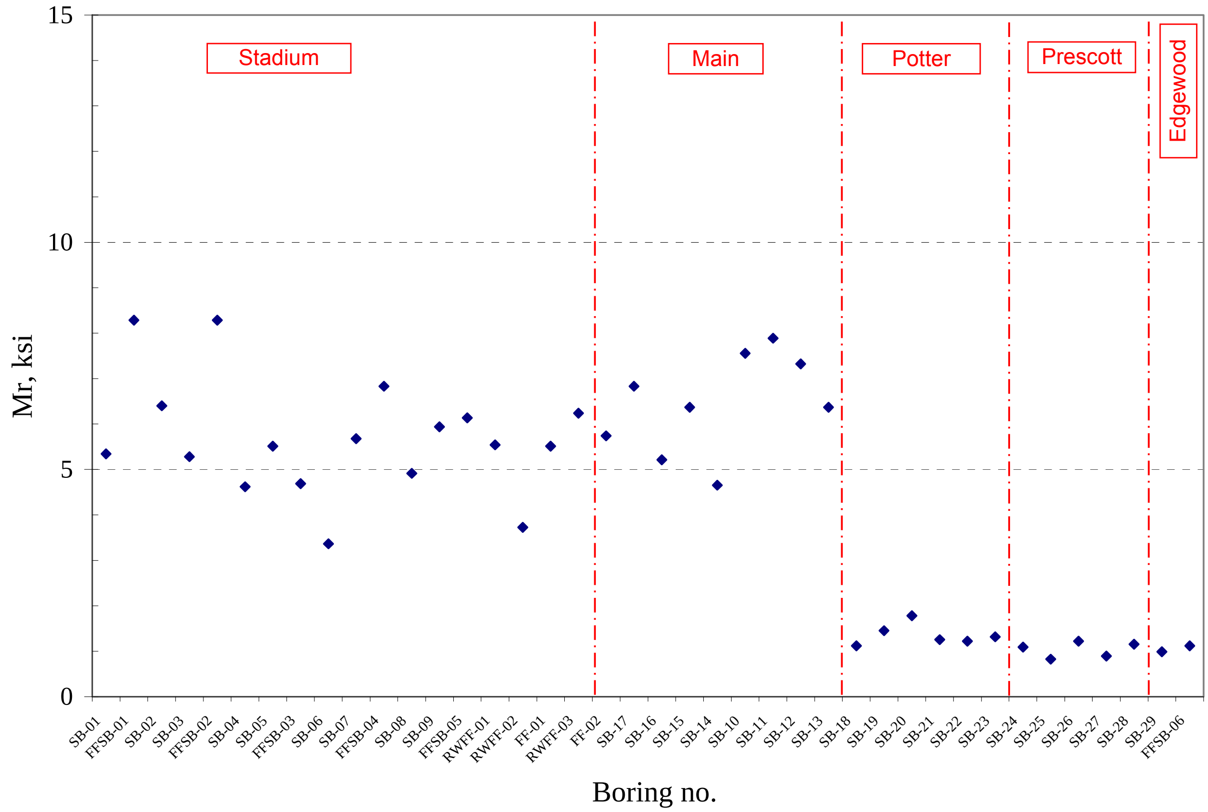


Figure 7. Subgrade resilient moduli – MODULUS depth-to-bedrock option.

Rigid Pavement Backcalculation – AREA Method

ARA backcalculated the composite pavement (i.e., AC/PCC) on Stadium Blvd. as a rigid pavement, using a modification of the AREA method from the 1993 AASHTO guide. The benefit of modeling this road as a rigid pavement is that it characterizes the subgrade as a dense liquid, determining a subgrade modulus of reaction (i.e., k-value) for the soil, which is typically used for rehabilitation design of rigid and composite pavements. Figure 8 presents the dynamic backcalculated k-values converted to equivalent k-values determined through static plate load testing (i.e., k static) using a conversion factor of 0.5, as recommended by the AASHTO guide.

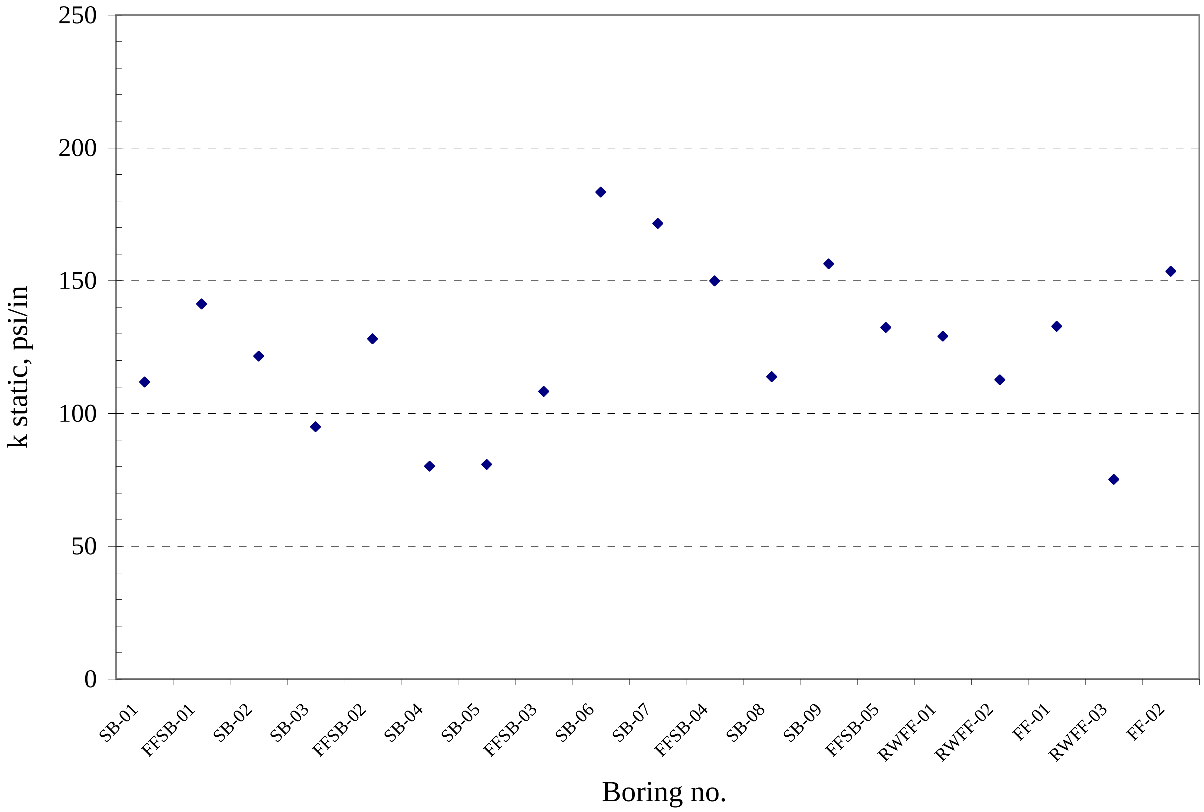


Figure 8. Subgrade static k-values for Stadium Boulevard – AREA method.

APPENDIX A

FWD RESULTS

(attached electronically)

							AASHTO - Flexible			MODULUS						AREA					
Street Name	**Boring Number**	**Traffic Direction**	**Hac (in)**	**Hpcc (in)**	**AC Temp (F)**	**D0 @ 9k/68F (mil)**	**Mr (ksi)**	**Ep (ksi)**	**SNeff (in)**	**Hac (in)**	**Hpcc (in)**	**Mr (ksi)**	**Eac (ksi)**	**Eac@70F (ksi)**	**Epcc (ksi)**	**Eac (ksi)**	**Eac@70F (ksi)**	**Epcc (ksi)**	**Kstatic (psi/in)**	**Latitude (dd.ddddd)**	**Longitude (dd.ddddd)**
Stadium	SB-01	EB	3.0	8.0	48.8	5.15	6.4	1351.8	5.5	5.0	7.0	5.3	1619.4	772.0	4,887.0	967.0	461.0	6769.3	111.9	42.26401	-83.75587
Stadium	FFSB-01	WB	7.0	5.0	50.9	7.21	6.9	415.5	4.0	5.0	7.0	8.3	927.9	471.5	8,000.0	420.4	213.6	2942.5	141.3	42.26410	-83.75554
Stadium	SB-02	EB	6.0	8.0	47.1	4.62	7.2	868.6	6.0	5.0	7.0	6.4	324.5	147.2	1,007.6	1341.0	608.3	9387.0	121.6	42.26407	-83.75513
Stadium	SB-03	WB	6.0	8.0	50.1	3.88	6.2	1721.5	7.6	5.0	7.0	5.3	1600.4	791.8	4,810.2	2639.1	1305.7	18473.4	95.1	42.26414	-83.75480
Stadium	FFSB-02	WB	6.0	6.0	51.5	7.63	6.5	390.1	3.9	5.0	7.0	8.3	397.3	205.5	2,587.4	459.9	237.9	3219.3	128.2	42.26413	-83.75445
Stadium	SB-04	EB	4.0	9.0	49.9	4.13	5.1	2382.8	7.8	5.0	7.0	4.6	1320.0	650.7	3,757.3	3141.4	1548.6	21989.6	80.2	42.26406	-83.75404
Stadium	SB-05	WB	3.0	12.0	52.2	5.67	4.8	828.0	6.3	5.0	7.0	5.5	396.9	210.1	1,000.0	1278.8	677.1	8951.4	80.9	42.26418	-83.75371
Stadium	FFSB-03	WB	6.0	4.0	51.3	9.00	5.5	485.9	3.5	5.0	7.0	4.7	344.5	177.2	1,000.0	397.0	204.2	2779.0	108.3	42.26416	-83.75334
Stadium	SB-06	EB	4.0	6.0	48.5	5.62	9.1	726.9	4.0	5.0	7.0	3.4	796.7	376.3	3,370.4	617.6	291.7	4323.0	183.4	42.26412	-83.75291
Stadium	SB-07	EB	3.0	9.0	46.8	3.53	9.9	1455.5	6.1	5.0	7.0	5.7	1608.3	721.9	1,617.5	1700.9	763.4	11906.3	171.6	42.26410	-83.75255
Stadium	FFSB-04	WB	6.0		51.7	6.64	7.5	2342.2	3.6	5.0	7.0	6.8	410.6	213.9	1,762.6	521.1	271.4	3647.8	149.9	42.26419	-83.75221
Stadium	SB-08	WB	3.0	8.0	51.4	6.11	5.9	968.4	4.9	5.0	7.0	4.9	307.2	158.7	1,389.5	802.5	414.5	5617.7	113.9	42.26423	-83.75185
Stadium	SB-09	EB	7.0	8.0	45.9	8.53	7.1	199.9	3.9	5.0	7.0	5.9	397.5	174.1	1,347.7	321.7	140.9	2252.2	156.4	42.26412	-83.75139
Stadium	FFSB-05	WB	6.0	6.0	51.1	5.45	7.2	780.1	5.0	5.0	7.0	6.1	579.6	295.9	1,000.0	778.7	397.5	5451.0	132.4	42.26422	-83.75110
Stadium	RWFF-01	EB	6.0	7.0	49.1	8.46	6.3	279.6	3.8	5.0	7.0	5.5	412.8	198.3	3,862.9	340.3	163.5	2382.3	129.1	42.26417	-83.74963
Stadium	RWFF-02	EB	4.0	7.0	49.3	9.41	5.5	353.8	3.5	5.0	7.0	3.7	1133.0	547.8	4,692.2	296.2	143.2	2073.2	112.7	42.26421	-83.74886
Stadium	FF-01	WB	3.0	4.0	50.1	6.60	6.8	1931.7	3.9	5.0	7.0	5.5	1668.6	826.3	6,014.9	486.1	240.7	3402.6	132.9	42.26434	-83.74803
Stadium	RWFF-03	EB	4.0	7.0	48.3	7.29	4.3	1047.8	5.0	5.0	7.0	6.2	1529.9	718.7	1,000.0	840.0	394.6	5880.2	75.2	42.26414	-83.74708
Stadium	FF-02	WB	7.0		51.0	5.73	7.8	2197.7	4.1	5.0	7.0	5.7	865.2	441.3	1,000.0	538.4	274.6	3769.0	153.6	42.26412	-83.74583
Main	SB-17	NB	8.0		52.8	6.56	9.0	803.1	3.3	6.5	0.0	6.8	3000.0	1616.6						42.26328	-83.75015
Main	SB-16	SB	6.0		52.3	9.04	6.3	1322.0	3.0	6.5	0.0	5.2	2231.3	1182.4						42.26350	-83.75029
Main	SB-15	NB	8.0		52.5	6.61	9.4	721.4	3.2	6.5	0.0	6.4	1495.6	799.6						42.26380	-83.75018
Main	SB-14	SB	6.0		51.2	8.65	5.8	1775.8	3.3	6.5	0.0	4.7	2986.8	1532.6						42.26390	-83.75034
Main	SB-10	SB	6.0		50.0	9.58	7.4	795.2	2.5	6.5	0.0	7.6	2837.0	1399.4						42.26440	-83.75033
Main	SB-11	NB	6.0		52.2	7.21	8.7	1350.9	3.0	6.5	0.0	7.9	2662.8	1409.3						42.26472	-83.75017
Main	SB-12	SB	6.0		50.4	6.83	8.1	1872.5	3.3	6.5	0.0	7.3	2420.9	1211.0						42.26502	-83.75029
Main	SB-13	NB	6.0		52.1	6.70	6.8	2804.3	3.8	6.5	0.0	6.4	3000.0	1580.1						42.26517	-83.75018
Potter	SB-18	EB	6.0		49.4	24.26	3.7	197.7	1.6	5.5	0.0	1.1	968.2	469.0						42.26660	-83.75805
Potter	SB-19	WB	5.0		51.3	37.67	2.6	154.8	1.2	5.5	0.0	1.5	356.8	183.3						42.26667	-83.75736
Potter	SB-20	EB	6.0		51.3	42.66	2.4	82.6	1.2	5.5	0.0	1.8	802.8	413.2						42.26659	-83.75662
Potter	SB-21	EB	6.0		49.8	50.25	2.0	70.0	1.1	5.5	0.0	1.3	367.5	180.6						42.26660	-83.75589
Potter	SB-22	WB	5.0		50.8	26.06	2.7	502.9	1.8	5.5	0.0	1.2	228.7	115.6						42.26667	-83.75537
Potter	SB-23	EB	6.0		49.7	41.61	2.3	95.9	1.2	5.5	0.0	1.3	311.6	152.4						42.26662	-83.75478
Prescott	SB-24	SB	4.0		52.2	72.48	1.6	100.7	0.8	4.5	0.0	1.1	481.9	254.9						42.26430	-83.75577
Prescott	SB-25	NB	4.0		51.0	46.03	2.3	196.8	1.0	4.5	0.0	0.8	1271.8	646.9						42.26481	-83.75569
Prescott	SB-26	SB	5.0		50.1	36.54	2.4	208.5	1.3	4.5	0.0	1.2	396.0	196.3						42.26531	-83.75580
Prescott	SB-27	NB	5.0		51.9	33.07	2.4	303.3	1.5	4.5	0.0	0.9	1112.5	582.4						42.26589	-83.75572
Prescott	SB-28	SB	4.0		50.7	51.87	2.5	98.8	0.8	4.5	0.0	1.2	122.4	61.8						42.26641	-83.75583
Edgewood	SB-29	NB	6.0		50.1	54.97	2.0	55.5	1.0	6.0	0.0	1.0	300.4	149.0						42.26555	-83.75460
Edgewood	FFSB-06	SB	6.0		50.7	45.37	2.1	90.6	1.2	6.0	0.0	1.1	162.3	82.0						42.26505	-83.75465

CTI and Associates, Inc.

ESAL Calculation and Pavement Designs

CTI ESAL CALCULATION WORKSHEET

Stadium Boulevard Reconstruction (CTI Project Number 3142040052)

	NB & SB Main St		EB & WB West Stadium		EB & WB East Stadium		Seventh at Stadium		
Start	10-8-14 and 10-16-14		3/24/2015 0:00		3/10/2015 0:00		converted to 1 day		
End	10-9-14 and 10-17-14		3/25/2015 0:00		3/11/2015 0:00		9/30-10/3 and 10/7-10/9		
# of Days	1.00		1.00		1.00		1.00		
Class		ESAL		ESAL		ESAL		ESAL	LEF*
1 & 2	20543	245,797.74	15364	183,830.82	20104	245,884.31	4913.3	73,485.46	0.004
3	881	10,541.20	1604	19,191.92	618	7,558.52	1204.8	18,019.91	0.004
4	53	90,365.94	85	144,926.50	48	83,657.41	74.132	157,996.52	0.570
5	216	484,583.98	271	607,973.42	159	364,625.25	137.47	385,499.11	0.750
6	120	594,064.06	32	158,417.08	56	283,383.38	13.368	82,721.32	1.655
7	9	55,834.84	3	18,611.61	7	44,391.02	0.3692	2,863.33	2.074
8	71	522,665.70	123	905,463.11	52	391,294.10	44.097	405,771.73	2.461
9	41	353,330.52	20	172,356.35	21	184,991.13	4.7925	51,625.73	2.881
10	8	73,776.41	10	92,220.52	0	-	2.9388	33,876.93	3.083
11	5	50,701.84	11	111,544.05	0	-	1.3488	17,096.95	3.390
12	2	24,354.83	2	24,354.83	2	24,895.42	0	-	4.071
13	13	176,155.25	4	54,201.62	5	69,255.86	0.4898	8,296.17	4.530
TOTAL	21962	**2,682,172.31**	17529	**2,493,091.83**	21072	**1,699,936.40**	6397	**1,237,253.14**	

Directional Factor	0.5	
Analysis Period	20 yrs	
Lane Distribution Factor	0.8	[1]
Growth Rate	0.253 %	[3]
Flexible Pavement	Y	
Rigid Pavement	N	
p_t	2.5	[2]
SN	5	[2]
Growth Factor	20.488	

Note: for Seventh, Lane Distribution Factor = 1

Growth Rate for E. Stadium = 0.482%

*References - [1], [4], [5], [6], [7]

Note: assumes "unclassified" vehicles are in Class 1 or 2

ESALs = (vehicle count/recording days)*(365 days/year)*(analysis period years)*(directional Factor)*(lane distribution factor)*(growth factor)*(LEF)

SpectraPave4 PRO™
Pavement Optimization Design Analysis
West Stadium Boulevard - Seventh Street to Main Street

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 95	Initial Serviceability	= 4.5
Standard Normal Deviate	= -1.645	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

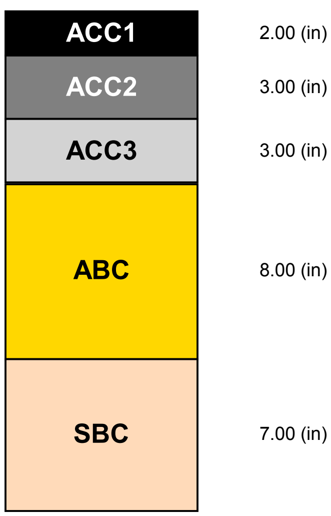
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course		0.440	N/A
ACC2	Dense-graded Asphalt Course		0.440	N/A
ACC3	Dense-graded Asphalt Course		0.360	N/A
ABC	Aggregate Base Course		0.140	0.7
SBC	Subbase Course		0.100	0.7

Stabilized Section Material Properties

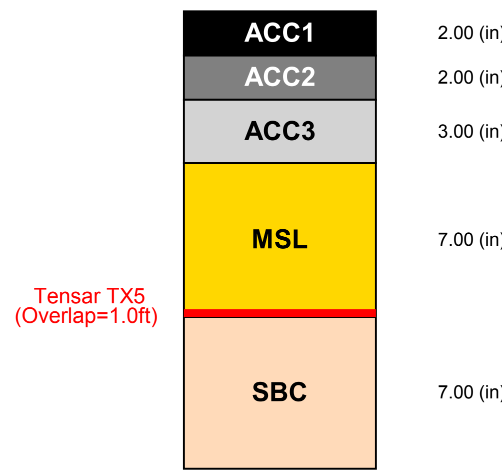
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course		0.440	N/A
ACC2	Dense-graded Asphalt Course		0.440	N/A
ACC3	Dense-graded Asphalt Course		0.360	N/A
MSL	Mechanically Stabilized Base Cour		0.250	0.7
SBC	Subbase Course		0.100	0.7

Unstabilized Pavement



Subgrade Modulus = 6,000 (psi)
Structural Number = 4.554
Calculated Traffic (ESALs) = 2,511,000

Stabilized Pavement



Subgrade Modulus = 6,000 (psi)
Structural Number = 4.555
Calculated Traffic (ESALs) = 2,514,000

Project Name	Stadium Boulevard - CTI Project 3142040052		
Company Name	CTI and Associates, Inc.		
Designer	T. Marsik	Date	5-11-15

SpectraPave4 PRO™
Pavement Optimization Design Analysis
East Stadium Boulevard - Main Street to Kipke Drive

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 95	Initial Serviceability	= 4.5
Standard Normal Deviate	= -1.645	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

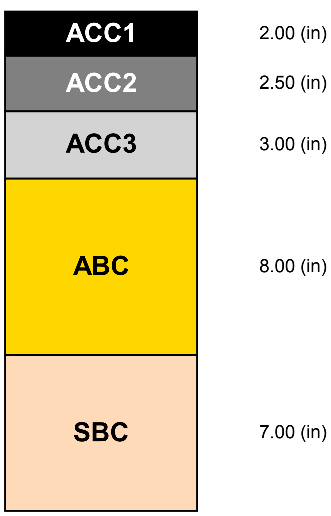
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course		0.440	N/A
ACC2	Dense-graded Asphalt Course		0.440	N/A
ACC3	Dense-graded Asphalt Course		0.360	N/A
ABC	Aggregate Base Course		0.140	0.7
SBC	Subbase Course		0.100	0.7

Stabilized Section Material Properties

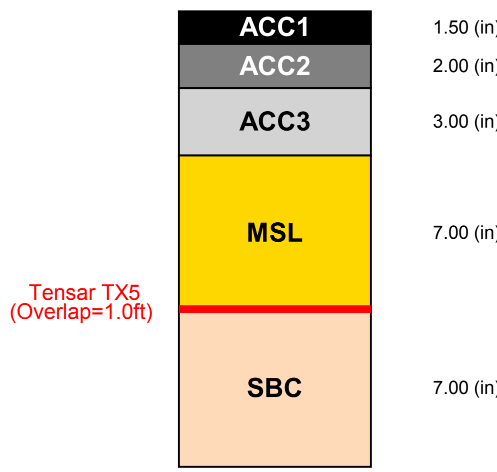
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course		0.440	N/A
ACC2	Dense-graded Asphalt Course		0.440	N/A
ACC3	Dense-graded Asphalt Course		0.360	N/A
MSL	Mechanically Stabilized Base Cour		0.250	0.7
SBC	Subbase Course		0.100	0.7

Unstabilized Pavement



Subgrade Modulus = 5,500 (psi)
Structural Number = 4.334
Calculated Traffic (ESALs) = 1,777,000

Stabilized Pavement



Subgrade Modulus = 5,500 (psi)
Structural Number = 4.335
Calculated Traffic (ESALs) = 1,780,000

Project Name	Stadium Boulevard - CTI Project N□□3142040052		
Company Name	CTI and Associates, Inc.		
Designer	T. Marsik	Date	5-11-15

SpectraPave4 PRO™
Pavement Optimization Design Analysis
Stadium Boulevard and Seventh Street Intersection

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 95	Initial Serviceability	= 4.5
Standard Normal Deviate	= -1.645	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

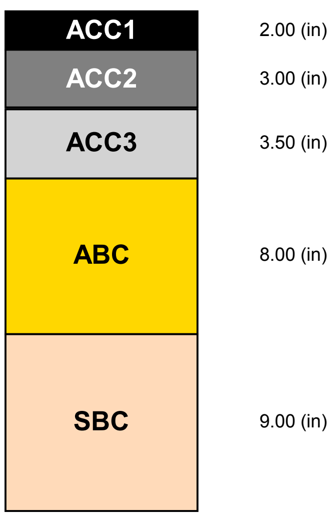
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ACC2	Dense-graded Asphalt Course	70	0.440	N/A
ACC3	Dense-graded Asphalt Course	70	0.360	N/A
ABC	Aggregate Base Course	20	0.140	0.7
SBC	Subbase Course	16	0.100	0.7

Stabilized Section Material Properties

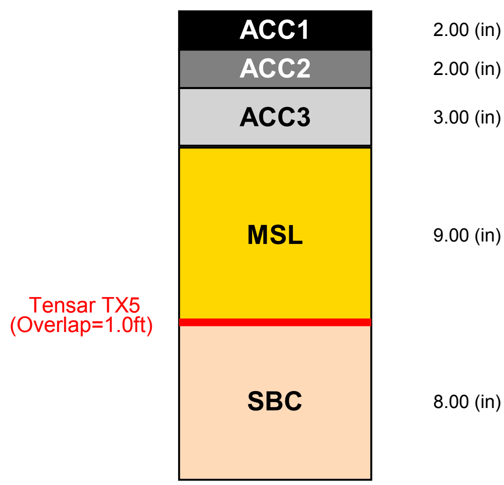
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ACC2	Dense-graded Asphalt Course	70	0.440	N/A
ACC3	Dense-graded Asphalt Course	70	0.360	N/A
MSL	Mechanically Stabilized Base Cour	20	0.230	0.7
SBC	Subbase Course	16	0.100	0.7

Unstabilized Pavement



Subgrade Modulus = 6,000 (psi)
Structural Number = 4.874
Calculated Traffic (ESALs) = 4,074,000

Stabilized Pavement



Subgrade Modulus = 6,000 (psi)
Structural Number = 4.849
Calculated Traffic (ESALs) = 3,926,000

Project Name	Stadium Boulevard - CTI Project No. 3142040052		
Company Name	CTI and Associates, Inc.		
Designer	T. Marsik	Date	5-11-15

SpectraPave4 PRO™
Pavement Optimization Design Analysis
Seventh Street - Stadium Boulevard to Potter Avenue

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 95	Initial Serviceability	= 4.5
Standard Normal Deviate	= -1.645	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

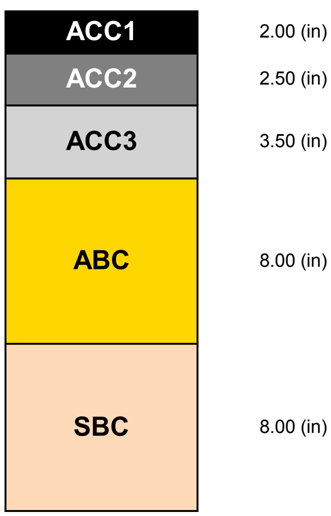
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course		0.440	N/A
ACC2	Dense-graded Asphalt Course		0.440	N/A
ACC3	Dense-graded Asphalt Course		0.360	N/A
ABC	Aggregate Base Course		0.140	0.7
SBC	Subbase Course		0.100	0.7

Stabilized Section Material Properties

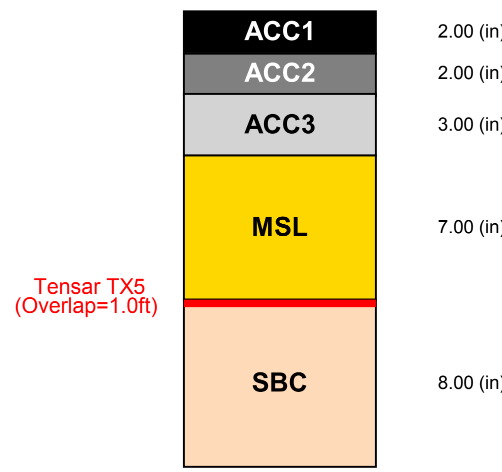
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course		0.440	N/A
ACC2	Dense-graded Asphalt Course		0.440	N/A
ACC3	Dense-graded Asphalt Course		0.360	N/A
MSL	Mechanically Stabilized Base Cour		0.250	0.7
SBC	Subbase Course		0.100	0.7

Unstabilized Pavement



Subgrade Modulus = 4,000 (psi)
Structural Number = 4.584
Calculated Traffic (ESALs) = 1,256,000

Stabilized Pavement



Subgrade Modulus = 4,000 (psi)
Structural Number = 4.625
Calculated Traffic (ESALs) = 1,338,000

Project Name	Stadium Boulevard - CTI Project No. 3142040052		
Company Name	CTI and Associates, Inc.		
Designer	T. Marsik	Date	5-11-15

SpectraPave4 PRO™
Pavement Optimization Design Analysis
Seventh Street and Potter Avenue Intersection

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 95	Initial Serviceability	= 4.5
Standard Normal Deviate	= -1.645	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

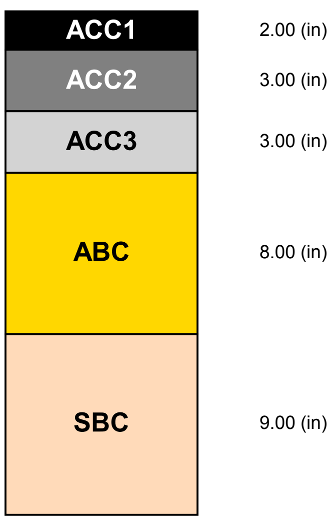
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course		0.440	N/A
ACC2	Dense-graded Asphalt Course		0.440	N/A
ACC3	Dense-graded Asphalt Course		0.360	N/A
ABC	Aggregate Base Course		0.140	0.7
SBC	Subbase Course		0.100	0.7

Stabilized Section Material Properties

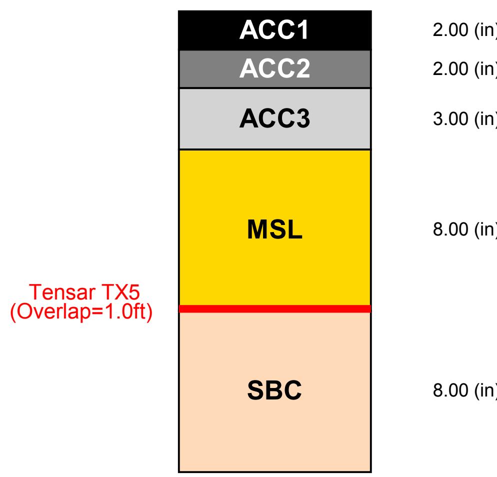
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course		0.440	N/A
ACC2	Dense-graded Asphalt Course		0.440	N/A
ACC3	Dense-graded Asphalt Course		0.360	N/A
MSL	Mechanically Stabilized Base Cour		0.238	0.7
SBC	Subbase Course		0.100	0.7

Unstabilized Pavement



Subgrade Modulus = 4,000 (psi)
Structural Number = 4.694
Calculated Traffic (ESALs) = 1,486,000

Stabilized Pavement



Subgrade Modulus = 4,000 (psi)
Structural Number = 4.733
Calculated Traffic (ESALs) = 1,576,000

Project Name	Stadium Boulevard - CTI Project No. 3142040052		
Company Name	CTI and Associates, Inc.		
Designer	T. Marsik	Date	5-11-15

This document was prepared using SpectraPave4 PRO™ Software Version 4.6.1
Developed by Tensar International Corporation

SpectraPave4 PRO™
Pavement Optimization Design Analysis
Potter Avenue-Prescott Avenue-Edgewood Avenue

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 95	Initial Serviceability	= 4.5
Standard Normal Deviate	= -1.645	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

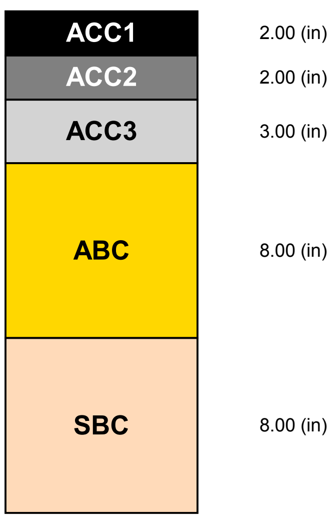
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course		0.440	N/A
ACC2	Dense-graded Asphalt Course		0.440	N/A
ACC3	Dense-graded Asphalt Course		0.360	N/A
ABC	Aggregate Base Course		0.140	0.7
SBC	Subbase Course		0.100	0.7

Stabilized Section Material Properties

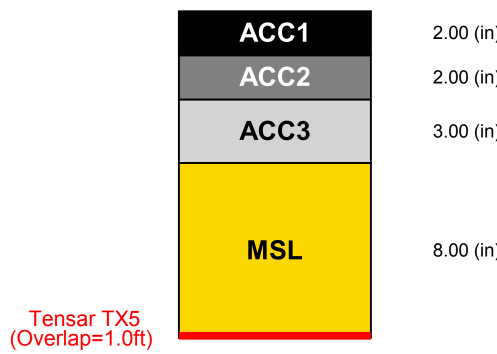
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course		0.440	N/A
ACC2	Dense-graded Asphalt Course		0.440	N/A
ACC3	Dense-graded Asphalt Course		0.360	N/A
MSL	Mechanically Stabilized Base Cour		0.247	0.7
None	Subbase Course		0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 2,500 (psi)
Structural Number = 4.184
Calculated Traffic (ESALs) = 224,000

Stabilized Pavement



Subgrade Modulus = 2,500 (psi)
Structural Number = 4.223
Calculated Traffic (ESALs) = 239,000

Project Name	Stadium Boulevard - CTI Project No. 3142040052		
Company Name	CTI and Associates, Inc.		
Designer	T. Marsik	Date	5-11-15

1993 AASHTO Empirical Equation for Rigid Pavements

Equation Solver | **Variable Descriptions and Typical Values** | **Precautions**

Type in data in the grey boxes and click the calculate button to see the output. To make additional calculations, change the desired input data and click the calculate button again. Click on the text descriptions of the input or output variables for more information.

INPUT

1. Loading

Total Design ESALs (W_{18}):	2493092

2. Reliability

Reliability Level in percent (R):	95
Combined Standard Error (S_0):	0.34

3. Serviceability

Initial Serviceability Index (p_i):	4.5
Terminal Serviceability Index (p_t):	2.5

4. Portland Cement Concrete Parameters

Elastic Modulus (E_c) in psi:	3600000
Modulus of Rupture (S'_c) in psi:	670

5. Other Design Parameters

Drainage Factor (C_d):	0.7
Load Transfer Coefficient (J):	3.2
Mod. of Subgrade Reaction (k) in pci:	130

OUTPUT

1. Calculation Parameters

Standard Normal Deviate (z_R):	-1.645
ΔPSI:	2
Calculated Slab Thickness (inches):	10

2. Slab Thickness (to the nearst 1/2 inch)

Design Slab Thickness (inches):	10

Comments

West Stadium Boulevard - Seventh to Main

CTI Project No. 3142040052
Stadium Boulevard Reconstruction Project

Calculate

1993 AASHTO Empirical Equation for Rigid Pavements

Equation Solver | **Variable Descriptions and Typical Values** | **Precautions**

Type in data in the grey boxes and click the calculate button to see the output. To make additional calculations, change the desired input data and click the calculate button again. Click on the text descriptions of the input or output variables for more information.

INPUT

1. Loading

Total Design ESALs (W_{18}):	1699936

2. Reliability

Reliability Level in percent (R):	95
Combined Standard Error (S_0):	0.34

3. Serviceability

Initial Serviceability Index (p_i):	4.5
Terminal Serviceability Index (p_t):	2.5

4. Portland Cement Concrete Parameters

Elastic Modulus (E_c) in psi:	3600000
Modulus of Rupture (S'_c) in psi:	670

5. Other Design Parameters

Drainage Factor (C_d):	0.7
Load Transfer Coefficient (J):	3.2
Mod. of Subgrade Reaction (k) in pci:	130

OUTPUT

1. Calculation Parameters

Standard Normal Deviate (z_R):	-1.645
ΔPSI:	2
Calculated Slab Thickness (inches):	9.745

2. Slab Thickness (to the nearst 1/2 inch)

Design Slab Thickness (inches):	10

Comments

East Stadium Boulevard - Main to Kipke

CTI Project No. 3142040052
Stadium Boulevard Reconstruction Project

Calculate

1993 AASHTO Empirical Equation for Rigid Pavements

Equation Solver | **Variable Descriptions and Typical Values** | **Precautions**

Type in data in the grey boxes and click the calculate button to see the output. To make additional calculations, change the desired input data and click the calculate button again. Click on the text descriptions of the input or output variables for more information.

INPUT

1. Loading

Total Design ESALs (W_{18}):	2682172

2. Reliability

Reliability Level in percent (R):	95
Combined Standard Error (S_0):	0.34

3. Serviceability

Initial Serviceability Index (p_i):	4.5
Terminal Serviceability Index (p_t):	2.5

4. Portland Cement Concrete Parameters

Elastic Modulus (E_c) in psi:	3600000
Modulus of Rupture (S'_c) in psi:	670

5. Other Design Parameters

Drainage Factor (C_d):	0.72
Load Transfer Coefficient (J):	3.2
Mod. of Subgrade Reaction (k) in pci:	140

OUTPUT

1. Calculation Parameters

Standard Normal Deviate (z_R):	-1.645
ΔPSI:	2
Calculated Slab Thickness (inches):	9.995

2. Slab Thickness (to the nearst 1/2 inch)

Design Slab Thickness (inches):	10

Comments

Main Street at Stadium Boulevard

CTI Project No. 3142040052
Stadium Boulevard Reconstruction Project

Calculate

1993 AASHTO Empirical Equation for Rigid Pavements

Equation Solver | **Variable Descriptions and Typical Values** | **Precautions**

Type in data in the grey boxes and click the calculate button to see the output. To make additional calculations, change the desired input data and click the calculate button again. Click on the text descriptions of the input or output variables for more information.

INPUT

1. Loading

Total Design ESALs (W_{18}):	5175264

2. Reliability

Reliability Level in percent (R):	95
Combined Standard Error (S_0):	0.34

3. Serviceability

Initial Serviceability Index (p_i):	4.5
Terminal Serviceability Index (p_t):	2.5

4. Portland Cement Concrete Parameters

Elastic Modulus (E_c) in psi:	3600000
Modulus of Rupture (S'_c) in psi:	670

5. Other Design Parameters

Drainage Factor (C_d):	0.72
Load Transfer Coefficient (J):	3.2
Mod. of Subgrade Reaction (k) in pci:	140

OUTPUT

1. Calculation Parameters

Standard Normal Deviate (z_R):	-1.645
ΔPSI:	2
Calculated Slab Thickness (inches):	10.905

2. Slab Thickness (to the nearst 1/2 inch)

Design Slab Thickness (inches):	11

Comments

Main Street and Stadium Boulevard Intersection

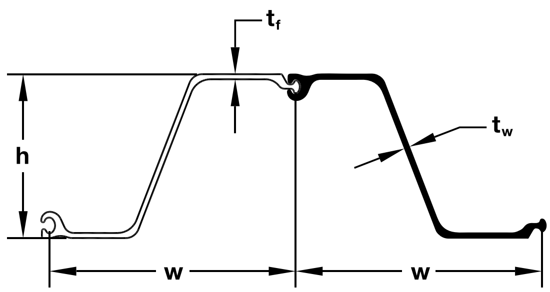
CTI Project No. 3142040052
Stadium Boulevard Reconstruction Project

Calculate

CTI and Associates, Inc.

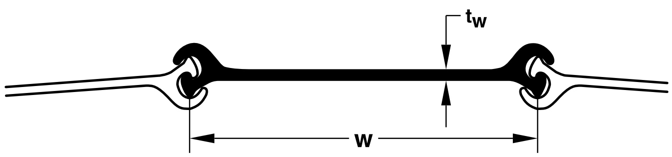
Skyline Steel Corporation
Sheet Pile and H-Pile Specifications

PZ/PS Hot Rolled Steel Sheet Pile



PZ

SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS Flange (t_f) in (mm)	THICKNESS Wall (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² of wall (m²/m²)
PZ 22	22.0 559	9.0 229	0.375 9.50	0.375 9.50	6.47 136.9	40.3 60.0	22.0 107.4	18.1 973	21.79 1171.4	84.38 11500	4.48 1.37	1.22 1.22
PZ 27	18.0 457	12.0 305	0.375 9.50	0.375 9.50	7.94 168.1	40.5 60.3	27.0 131.8	30.2 1620	36.49 1961.9	184.20 25200	4.48 1.37	1.49 1.49
PZ 35	22.6 575	14.9 378	0.600 15.21	0.500 12.67	10.29 217.8	66.0 98.2	35.0 170.9	48.5 2608	57.17 3073.5	361.22 49300	5.37 1.64	1.42 1.42
PZ 40	19.7 500	16.1 409	0.600 15.21	0.500 12.67	11.77 249.1	65.6 97.6	40.0 195.3	60.7 3263	71.92 3866.7	490.85 67000	5.37 1.64	1.64 1.64



PS

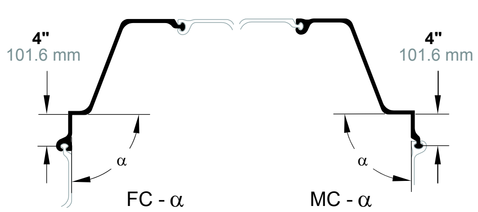
SECTION	Width (w) in (mm)	Web (t_W) in (mm)	Maximum Interlock Strength k/in (kN/m)	Minimum Cell Diameter* ft (m)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	Elastic Section Modulus in³/sheet (cm³/sheet)	Moment of Inertia in⁴/sheet (cm⁴/sheet)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² of wall (m²/m²)
PS 27.5	19.69 500	0.4 10.2	20 3500	30 9.14	8.09 171.2	45.1 67.1	27.5 134.3	3.3 54	5.3 221	3.65 1.11	1.11 1.11
PS 31	19.69 500	0.5 12.7	20 3500	30 9.14	9.12 193.0	50.9 75.7	31.0 151.4	3.3 54	5.3 221	3.65 1.11	1.11 1.11

* Minimum cell diameter cannot be guaranteed for piles over 65 feet (19.81 m) in length, or if piles are spliced. 58 piles are needed to make a 30 foot diameter cell.

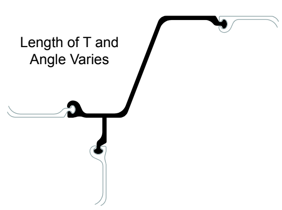
PZ/PS Hot Rolled Steel Sheet Pile

Available Steel Grades						
ASTM	PZ		PS			
	YIELD STRENGTH		YIELD STRENGTH		INTERLOCK STRENGTH	
	(ksi)	(MPa)	(ksi)	(MPa)	(k/in)	(kN/m)
A 328	39	270	39	270	16	2800
A 572 Grade 50	50	345	50	345	20	3500
A 572 Grade 60	60	415	-	-	-	-
A 588	50	345	50	345	20	3500
A 690	50	345	50	345	20	3500

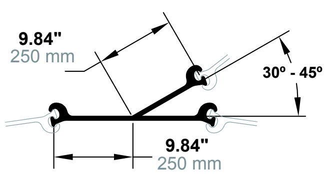
Corner and Junction Piles



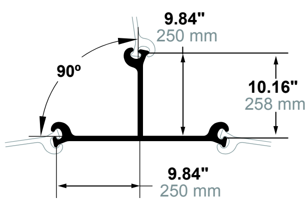
Female or Male Corner



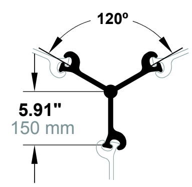
T Pile



30° Y Pile



90° T Pile



120° Y Pile

Delivery Conditions & Tolerances

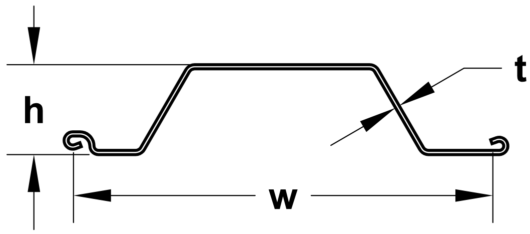
	ASTM A 6	
Mass	± 2.5%	
Length	+ 5 inches	– 0 inches

Maximum Rolled Lengths*

PZ	85 feet for singles, 70 feet for pairs	(25.9 m, 21.3 m)
PS	65 feet	(19.8 m)

* Longer lengths may be possible upon request.

SKL/SKS Cold Formed Steel Sheet Pile



					WEIGHT		SECTION MODULUS			COATING AREA	
SECTION	Width (w) in (mm)	Height (h) in (mm)	Thickness (t) in (mm)	Cross Sectional Area in^2/ft (cm^2/m)	Pile lb/ft (kg/m)	Wall lb/ft^2 (kg/m^2)	Elastic in^3/ft (cm^3/m)	Plastic in^3/ft (cm^3/m)	Moment of Inertia in^4/ft (cm^4/m)	Both Sides ft^2/ft (m^2/m)	Coating Area ft^2/ft^2 (m^2/m^2)
SKL 9	21.65 550	3.54 90	0.157 4.0	2.53 53.50	15.52 23.10	8.60 42.00	2.55 137	3.28 176.43	4.50 615	4.23 1.29	1.17 1.17
SKL 10	21.65 550	3.54 90	0.177 4.5	2.83 59.90	17.40 25.90	9.63 47.00	2.88 155	3.67 197.23	5.09 695	4.23 1.29	1.17 1.17
SKL 12	21.65 550	3.54 90	0.217 5.5	3.43 72.60	21.10 31.40	11.67 57.00	3.53 190	4.42 237.66	6.22 850	4.23 1.29	1.17 1.17
SKS 11	27.56 700	5.91 150	0.197 5.0	3.29 69.60	25.69 38.23	11.26 55.00	6.34 341	7.54 405.36	18.67 2550	5.87 1.79	1.28 1.28
SKS 13	27.56 700	5.91 150	0.217 5.5	3.61 76.40	28.22 42.00	12.29 60.00	6.98 375	8.44 454.03	20.48 2810	5.87 1.79	1.28 1.28
SKS 14	27.56 700	5.91 150	0.250 6.4	4.17 88.20	32.58 48.49	14.19 69.27	8.05 433	9.48 509.87	23.78 3247	5.87 1.79	1.28 1.28
SKS 16	27.56 700	5.91 150	0.276 7.0	4.57 96.70	35.61 53.00	15.57 76.00	8.89 478	10.40 559.20	26.25 3585	5.87 1.79	1.28 1.28

Interlock Compatibility

	SKL 9	SKL 10	SKL 12	SKS 11	SKS 13	SKS 14	SKS 16
SKL 9	●	●	●	●	●	●	●
SKL 10	●	●	●	●	●	●	●
SKL 12	●	●	●	●	●	●	●
SKS 11	●	●	●	●	●	●	●
SKS 13	●	●	●	●	●	●	●
SKS 14	●	●	●	●	●	●	●
SKS 16	●	●	●	●	●	●	●

● Interlock compatible   ○ Interlock not compatible

SKL/SKS

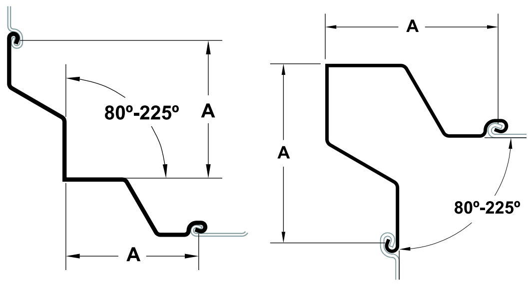
SKL/SKS Cold Formed Steel Sheet Pile

Available Steel Grades					
ASTM	YIELD STRENGTH		ASTM	YIELD STRENGTH	
	(ksi)	(MPa)		(ksi)	(MPa)
A 572 Grade 50	50	345	A 572 Grade 65 (Mod)**	80	555
A 572 Grade 55	55	380	A 588	50	345
A 572 Grade 60	60	415	A 690	50	345
A 572 Grade 65*	65	450			

*Not available for thicknesses ≥ 0.375" (9.525mm). **Not available for thicknesses > 0.276" (7.0mm).

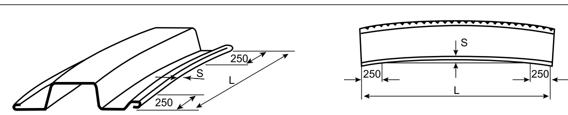
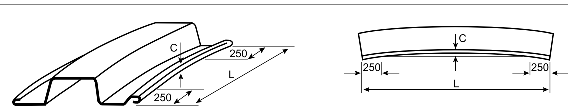
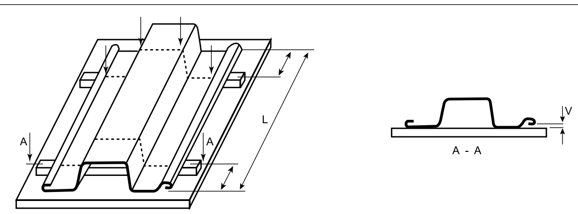
Corner Piles

D1 Corner Piles **D3 Corner Piles**



SKL 9-12: A = 10.8 inches (275.0 mm)
SKS 11-16: A = 13.8 inches (350.0 mm)

Delivery Conditions & Tolerances

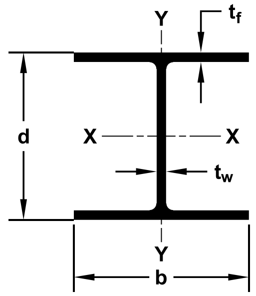
	ASTM A6		EN 10249-2	
Mass	± 2.5%		± 7%	
Length	+ 5 inches	– 0 inches	± 50 mm	
Straightness				
Bending (S)			0.25% of the length	
Curving (C)			0.25% of the length	
Twisting (V)			2% of the length	

Standard Rolled Lengths*

SKL, SKS	70 feet	(21.3 m)

* Longer lengths may be possible upon request.

Steel H-Pile



SECTION	Weight	Area	Depth d	Flange Width b	THICKNESS		Coating Area	PROPERTIES							
					Flange (t_f)	Web (t_w)		AXIS X-X				AXIS Y-Y			
								I	S	Z	r	I	S	Z	r
	lb/ft (kg/m)	in^2 (cm^2)	in (mm)	in (mm)	in (mm)	in (mm)	ft^2/ft (m^2/m)	in^4 (cm^4)	in^3 (cm^3)	in^3 (cm^3)	in (cm)	in^4 (cm^4)	in^3 (cm^3)	in^3 (cm^3)	in (cm)
HP 8 HP 200	36 54	10.6 68.4	8.02 204	8.16 207	0.445 11.3	0.445 11.3	3.92 1.19	119 4953	29.8 488	33.6 550.6	3.36 8.53	40.3 1677	9.88 162	15.2 249.1	1.95 4.95
HP 10 HP 250	42 63	12.4 80.0	9.70 246	10.10 257	0.420 10.7	0.415 10.5	4.83 1.47	210 8741	43.4 711	48.3 791.5	4.13 10.5	71.7 2984	14.2 233	21.8 357.2	2.41 6.12
	57 85	16.7 108	9.99 254	10.20 259	0.565 14.4	0.565 14.4	4.91 1.50	294 12237	58.8 964	66.5 1089.7	4.18 10.6	101 4204	19.7 323	30.3 496.5	2.45 6.22
HP 12 HP 310	53 79	15.5 100	11.80 300	12.00 305	0.435 11.0	0.435 11.0	5.82 1.77	393 16358	66.7 1093	74.0 1212.6	5.03 12.8	127 5286	21.1 346	32.2 527.7	2.86 7.26
	63 94	18.4 119	11.90 302	12.10 307	0.515 13.1	0.515 13.1	5.86 1.79	472 19646	79.1 1296	88.3 1447.0	5.06 12.9	153 6368	25.3 415	38.7 634.2	2.88 7.32
	74 110	21.8 141	12.10 307	12.20 310	0.610 15.5	0.605 15.4	5.91 1.80	569 23683	93.8 1537	105 1720.6	5.11 13.0	186 7742	30.4 498	46.6 763.6	2.92 7.42
	84 125	24.6 159	12.30 312	12.30 312	0.685 17.4	0.685 17.4	5.97 1.82	650 27055	106 1737	120 1966.4	5.14 13.1	213 8866	34.6 567	53.2 871.8	2.94 7.47
	89 132	25.9 167	12.36 314	12.32 313	0.720 18.3	0.720 18.3	6.04 1.84	689 28700	111.6 1830	126.3 2070	5.16 13.1	225 9370	36.5 599	56.2 922	2.94 7.48
	102 152	29.9 193	12.56 319	12.64 321	0.819 20.8	0.819 20.8	6.17 1.88	811 33800	129.3 2120	147.6 2420	5.20 13.2	276 11500	43.7 716	67.1 1100	3.04 7.71
	117 174	34.4 222	12.76 324	12.87 327	0.929 23.6	0.929 23.6	6.26 1.91	946 39400	148.2 2430	170.8 2800	5.24 13.3	331 13800	51.4 843	79.3 1300	3.11 7.89
HP 14 HP 360	73 109	21.4 138	13.60 345	14.60 371	0.505 12.8	0.505 12.8	6.96 2.12	729 30343	107 1753	118 1933.7	5.84 14.8	261 10864	35.8 587	54.6 894.7	3.49 8.86
	89 132	26.1 168	13.80 351	14.70 373	0.615 15.6	0.615 15.6	7.02 2.14	904 37627	131 2147	146 2392.5	5.88 14.9	326 13569	44.3 726	67.7 1109.4	3.53 8.97
	102 152	30.1 194	14.00 356	14.80 376	0.705 17.9	0.705 17.9	7.06 2.15	1050 43704	150 2458	169 2769.4	5.92 15.0	380 15817	51.4 842	78.8 1291.3	3.56 9.04
	117 174	34.4 222	14.20 361	14.90 378	0.805 20.4	0.805 20.4	7.12 2.34	1220 50780	172 2819	194 3179.1	5.96 15.1	443 18439	59.5 975	91.4 1497.8	3.59 9.12
HP 16 HP 410	88 131	25.8 167	15.30 389	15.70 399	0.540 13.7	0.540 13.7	7.52 2.29	1110 46201	145 2376	161 2638.3	6.56 16.7	349 14526	44.5 729	68.2 1117.6	3.68 9.35
	101 150	29.9 193	15.50 394	15.80 401	0.625 15.9	0.625 15.9	7.56 2.30	1300 54110	168 2753	187 3064.4	6.59 16.7	412 17149	52.2 855	80.1 1312.6	3.71 9.42
	121 180	35.8 231	15.80 401	15.90 404	0.750 19.1	0.750 19.1	7.62 2.32	1590 66180	201 3294	226 3703.5	6.66 16.9	504 20978	63.4 1039	97.6 1599.4	3.75 9.53
	141 210	41.7 269	16.00 406	16.00 406	0.875 22.2	0.875 22.2	7.69 2.34	1870 77835	234 3835	264 4326.2	6.70 17.0	599 24932	74.9 1227	116 1900.9	3.79 9.63
	162 241	47.7 308	16.30 414	16.10 409	1.000 25.4	1.000 25.4	7.75 2.36	2190 91154	269 4408	306 5014.4	6.78 17.2	697 29011	86.6 1419	134 2195.9	3.82 9.70
	183 272	54.1 349	16.50 419	16.30 414	1.130 28.7	1.130 28.7	7.81 2.38	2510 104473	304 4982	349 5719.1	6.81 17.3	818 34047	100.0 1639	156 2556.4	3.89 9.88
HP 18 HP 460	135 201	39.9 257	17.50 445	17.80 452	0.750 19.1	0.750 19.1	8.54 2.60	2200 91570	251 4113	281 4604.7	7.43 18.9	706 29386	79.3 1299	122 1999.2	4.21 10.7
	157 234	46.2 298	17.70 450	17.90 455	0.870 22.1	0.870 22.1	8.60 2.62	2570 106971	290 4752	327 5358.5	7.46 18.9	833 34672	93.1 1526	143 2343.3	4.25 10.8
	181 269	53.2 343	18.00 457	18.00 457	1.000 25.4	1.000 25.4	8.66 2.64	3020 125701	336 5506	379 6210.7	7.53 19.1	974 40541	108.0 1770	167 2736.6	4.28 10.9
	204 304	60.2 388	18.30 465	18.10 460	1.130 28.7	1.130 28.7	8.73 2.66	3480 144847	380 6227	433 7095.6	7.60 19.3	1120 46618	124.0 2032	191 3129.9	4.31 11.0

HP

Steel H-Pile

Available Steel Grades								
AMERICAN			CANADIAN			EUROPEAN**		
ASTM	YIELD STRENGTH		CSA G40.21	YIELD STRENGTH		EN 10034	YIELD STRENGTH	
	(ksi)	(MPa)		(ksi)	(MPa)		(ksi)	(MPa)
A 36	36	250	**Grade 300 W**	44	300	**HISTAR 355**	51	355
A 572 Grade 50*	50	345	**Grade 350 W**	50	350	**HISTAR 420**	61	420
A 588	50	345				**HISTAR 460**	67	460
A 690	50	345						
A 709	50	345						

* Standard grade for H-Pile.

**HISTAR only available in some sizes.

Splicer and H-Pile Point

Splicer

H-Pile Point

Delivery Conditions & Tolerances

	ASTM A 6	
Mass	± 2.5%	
Length[§]		
30 Feet and Under	± 0.375 inches	
Over 30 Feet	+ (0.375 inches + (length - 30)/80)	– 0.375 inches
Depth	± 0.125 inches	– 0.1875 inches
Flange Width	+ 0.25 inches	
Flanges out of Square		
HP 8 x 42 - HP 12 x 84	≤ 0.25 inches	
HP 14 x 73 - HP 14 x 117	≤ 0.3125 inches	
Web off Center	≤ 0.1875 inches	
Greatest Depth over Theoretical	≤ 0.25 inches	
Camber and Sweep***		
45 Feet and Under	(0.125")(Length in feet/10) but not over 0.375"	
Over 45 Feet	(0.375") + (0.125" (Length in feet - 45)/10)	

[§] For HP ordered as bearing piles, length tolerances are +5 in. and -0 in.

***For the HP 10 x 42, 12 x 53, 12 x 63, 14 x 73, and 14 x 89 ordered as columns, tolerances are subject to negotiation with manufacturer.

Maximum Rolled Lengths[†]

HP	100 ‘	30.5 m

[†] Longer lengths may be possible upon request.

CTI and Associates, Inc.

General Notes for Soil Classification

CTI and Associates, Inc.

GENERAL NOTES FOR SOIL CLASSIFICATION

51331 W. Pontiac Trail Wixom, MI 48393 248.486.5100 Main 248.486.5050 Fax

STANDARD PENETRATION TEST: Driving a 2” outside diameter, 1-3/8” inside diameter sampler a distance of 18 inches into undisturbed soil with a 140 pound hammer free falling a distance of 30 inches. The sampler is driven three successive 6-inch increments. The number of blows required for the last 12 inches of penetration is termed the Standard Penetration Resistance (N).

GROUNDWATER: Observations are made at the times indicated on logs. Porosity of soil strata, weather conditions and site topography may cause changes in the water levels.

SOIL CLASSIFICATION PROCEDURE: Classification on the logs is generally made by visual inspection. For fine-grained soils (silt, clay and combinations thereof), the classification is primarily based upon plasticity. For coarse-grained soils (sand and gravel), the classification is based upon particle size distribution. Minor soil constituents are reported as “trace” (0-5%), “some” (5-12%) and “with” (15-29%). Where the minor constituents are in excess of 29%, an adjective is used preceding the major constituent name (i.e. for sands containing 35% silt, the soil is classified as silty sand).

PARTICLE SIZE DISTRIBUTION

Boulders	-	Greater than 12 inches average diameter
Cobbles	-	3 inches to 12 inches
Gravel –		
Coarse	-	¾ inches to 3 inches
Fine	-	No. 4 (4.75mm) to ¾ inches
Sand –		
Coarse	-	No. 10 (2.00mm) to No. 4 (4.75mm)
Medium	-	No. 40 (0.425mm) to No. 10 (2.00mm)
Fine	-	No. 200 (0.075mm) to No. 40 (0.425mm)
Silt and Clay	-	Less than 0.075mm, Classification based upon plasticity. Generally silt particles size ranges from 0.005mm to 0.075mm and clay particle size is less than 0.005mm.

CONSISTENCY OF FINE GRAINED SOILS IN TERMS OF UNCONFINED COMPRESSIVE STRENGTH AND N-VALUES

Consistency	Unconfined Compressive Strength (Tons per square foot)	Approximate range of N
Very Soft	Less than 0.25	0 - 2
Soft	0.25 to 0.5	3 - 4
Medium Stiff	0.5 to 1.0	5 - 8
Stiff	1.0 to 2.0	9 - 15
Very Stiff	2.0 to 4.0	16 - 30
Hard	over 4.0	over 31

RELATIVE DENSITY OF COARSE GRAINED SOILS ACCORDING TO N-VALUES

Density Classification	Relative Density, %	Approximate Range of N
Very Loose	0 – 15	0 – 4
Loose	16 – 35	5 – 10
Medium Dense	36 - 65	11 - 30
Dense	66 - 85	31 – 50
Very Dense	86 – 100	over 50

Relative density of cohesionless soils is based upon an evaluation of the Standard Penetration Resistance (N), modified as required for overburden pressure.

Information To Build On
Engineering • Consulting • Testing

November 8, 2010

Mr. Jon Drummond, P.E.
Northwest Consultants, Inc.
3220 Central Park West
Toledo, Ohio 43617

RE: Geotechnical Exploration and Engineering Report
Proposed East Stadium Boulevard
Structure Replacement Project
City of Ann Arbor, Washtenaw County, Michigan
PSI Project No. **381-65050**

Dear Mr. Drummond:

This letter certifies that the "Draft" copies of Professional Service Industries, Inc. (PSI) geotechnical engineering reports for the proposed "*East Stadium Boulevard Structure Replacement Project Roadway Reconstruction, MSE Retaining Walls and Pedestrian Tunnel*", PSI Report No. 381-65050, dated January 31, 2007 and the "*East Stadium Boulevard Structure Replacement Project Over the Ann Arbor Railroad and Over State Street*", PSI Report No. 381-65050, dated January 31, 2007 previously transmitted may be considered final (unless subsequently amended or supplemented).

If you have any questions concerning this letter or the reports submitted or we may be of further service, please feel free to contact the undersigned at (734) 453-7900 or fax us at (734) 453-0724.

Respectfully submitted,
PROFESSIONAL SERVICE INDUSTRIES, INC.

STATE OF MICHIGAN
JEFFREY D. HESTWOOD
ENGINEER
No. 41701
LICENSED PROFESSIONAL ENGINEER

Jeffrey D. Hestwood, P.E.
Senior Project Engineer

Mahmound El-Gamal, Ph.D., P.E.
Chief Engineer/District Manager

3 pc: Encl.

GEOTECHNICAL EXPLORATION
AND ENGINEERING REPORT

FOR THE PROPOSED:

EAST STADIUM BOULEVARD
STRUCTURE REPLACEMENT PROJECT
ROADWAY RECONSTRUCTION, MSE
RETAINING WALLS AND TUNNEL
CITY OF ANN ARBOR, MICHIGAN

GEOTECHNICAL EXPLORATION
AND
ENGINEERING REPORT

FOR THE PROPOSED:

EAST STADIUM BOULEVARD
STRUCTURE REPLACEMENT PROJECT
ROADWAY RECONSTRUCTION, MSE
RETAINING WALLS AND TUNNEL
CITY OF ANN ARBOR, MICHIGAN

PREPARED FOR:

NORTHWEST CONSULTANTS, INC.
3220 CENTRAL PARK WEST
TOLEDO, OHIO 43617

BY:

PROFESSIONAL SERVICE INDUSTRIES, INC.
45749 HELM STREET
PLYMOUTH, MICHIGAN 48170
(734) 453-7900

JANUARY 31, 2007

PSI PROJECT NO. 381-65050

January 31, 2007

Mr. Jon Drummond, P.E.
Northwest Consultants, Inc.
3220 Central Park West
Toledo, Ohio 43617

RE: Geotechnical Exploration and Engineering Report
Proposed East Stadium Boulevard
Structure Replacement Project
Roadway Reconstruction, MSE Retaining Walls
and Pedestrian Tunnel
City of Ann Arbor, Washtenaw County, Michigan
PSI Project No. ***381-65050***

Dear Mr. Drummond:

PSI has completed a geotechnical exploration and engineering report for the proposed East Stadium Boulevard structure replacement project in the city of Ann Arbor, Washtenaw County, Michigan. This report presents the results of our observations and analysis and our recommendations for the proposed East Stadium Boulevard roadway reconstruction and the MSE retaining wall and pedestrian tunnel design and construction.

PSI appreciates the opportunity to perform this geotechnical study and to assist you and the design team on this project. If you have any questions regarding this report, or if we may be of further service, please contact our office.

Respectfully,

PROFESSIONAL SERVICE INDUSTRIES, INC.,

Jeffrey D. Hestwood, P.E.
Senior Project Engineer

Mahmoud E. El-Gamal, Ph.D., P.E.
Geotechnical Services Manager

3 pc: Enc.

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GEOTECHNICAL EXPLORATION AND ENGINEERING REPORT
PROPOSED EAST STADIUM BOULEVARD STRUCTURE REPLACEMENT PROJECT
CITY OF ANN ARBOR, WASHTENAW COUNTY, MICHIGAN

EXECUTIVE SUMMARY

PSI has completed the geotechnical exploration and engineering report for the proposed East Stadium Boulevard structure replacement project in the city of Ann Arbor, Washtenaw County, Michigan. This report presents the results of our observations and analysis and our recommendations for the proposed East Stadium Boulevard roadway reconstruction and the MSE retaining wall and pedestrian tunnel design and construction. A total of eighty (80) soil borings were drilled within the proposed development area for these structures and selected samples were tested in the laboratory.

The pavement section encountered at the boring locations performed through the existing East Stadium Boulevard roadway surface was variable. The pavement section encountered at the boring locations performed within the middle lanes of the existing 5 and 6-lane portions of the East Stadium Boulevard alignment from the west project limit to approximate Station 126+50, identified as lanes No. 3, 5 and 6, consisted of approximately 3 to 6 inches of asphalt pavement underlain by approximately 6 to 9 inches of concrete pavement. The two northern most west bound lanes and the southern most east bound lanes within the existing 6-lane portion of East Stadium Boulevard from approximate Station 105+50 to 126+50, identified as lanes No. 1, 2 and 4, consisted of approximately 10 to 12 inches of asphalt pavement. The asphalt section was underlain by approximately 0 to 13 inches of aggregate base. The pavement section encountered at the boring locations performed within each of the lanes of the existing 4-lane portions of the East Stadium Boulevard alignment from approximate Station 126+50 to 136+50, identified as lanes No. 1, 3, 4 and 6, consisted of approximately 2 to 4 inches of asphalt pavement underlain by approximately 7 to 9 inches of concrete pavement. Each of the lanes within the existing 5-lane portion of East Stadium Boulevard, from approximate Station 136+50 to the east project limit consisted of approximately 5 to 6 inches of asphalt pavement underlain by approximately 10 to 15 inches of aggregate base.

The soil borings indicate that the subgrade soils below the proposed East Stadium Boulevard roadway and adjacent sidewalk and bike paths may consist predominately of mottled brown silty clay from the beginning of the project at Station 103+00 through approximate Station 120+00. These soils should provide adequate support for the proposed pavement surfaces, provided they are stable at the time of construction. However, the pavement section was underlain by a layer of possibly native soils or uncontrolled fill material consisting predominately of dark brown and dark gray to mottled dark blueish gray and grayish brown sandy clay and silty clay with sand and variable percentages of organics at several locations. Loss-on-ignition (organic content) values of the tested soil samples from the apparent fill and discolored native soils ranged from approximately 3.0 to 5.2 percent. These soils should be undercut in their entirety throughout the pavement areas and backfilled with clean-engineered fill.

From approximate Station 120+00 through 136+00, the soil borings indicate that the subgrade soils below the proposed East Stadium Boulevard roadway and adjacent sidewalk and bike paths may consist of existing embankment fill materials comprised predominately of brown to reddish brown fine to medium sand with variable percentages of silt, gravel and coarse sand seams to layers of clayey sand. From approximate Station 136+00 through the end of the project at Station 145+50, the soil borings indicate that the subgrade soils below the proposed East Stadium Boulevard roadway and adjacent sidewalk and bike paths may consist predominately of native brown and light brown fine to coarse sand with variable percentages of silt and gravel. These soils should provide adequate support for the proposed pavement surfaces, provided they are stable at the time of construction. Significant undercut or subgrade improvement below the existing roadway alignment is generally not anticipated for these portions of the project, based on the borings performed.

20-year flexible and rigid pavement designs have been determined utilizing the DARWin Pavement Design and Analysis System and are presented in the following report. The 2007 and projected 2027 average daily traffic to be used for design was provided by Northwest Consultants, Inc. Specific commercial traffic volume or vehicle breakdowns were not provided. The number of heavy trucks using a pavement significantly affects the 18-kip ESAL value over the design life of the pavement. PSI recommends that the City of Ann Arbor or their design representative review the assumed commercial traffic percentage to verify that the following pavement designs recommendations submitted by PSI are based on an appropriate number of 18-kip ESAL's.

Mechanically stabilized earth (MSE) retaining walls will be constructed along portions of the proposed East Stadium Boulevard alignment. The soil borings performed along the segment of retaining wall from Station 105+50 to 114+00 (RW-1 through RW-4) indicate that the foundation soils may consist predominately of stiff to hard mottled brown silty clay. The soil borings performed along the segments of retaining wall from Station 119+50 to 135+50 and Station 122+50 to 135+75 (RW-5 through RW-21) indicate that the foundation soils may consist predominately of native moderately compact brown and light brown fine to medium or fine to coarse sand with variable percentages of silt and gravel. These soils should provide adequate support for the proposed retaining walls, provided they are stable at the time of construction. PSI estimates that the soil below the proposed MSE retaining wall may be loaded to a maximum ultimate soil bearing pressure of approximately 15,000 to 20,000 psf, where the leveling pad and reinforced fill zone are extended through the existing roadway embankment fill and any buried native organic soils and constructed directly on the underlying native soils. The required soil bearing pressure as calculated by the wall supplier should be checked against the ultimate soil bearing capacity outlined above. The resulting factor of safety against bearing capacity failure should be equal to or greater than 2.5.

An external global or rotational stability analysis was performed for the proposed MSE retaining wall embankment using the computer program PCSTABLE5M by Purdue University. The results of this analysis indicate a minimum factor of safety of 1.972 against rotational failure. A minimum factor of safety of 1.5 is generally required by the Geotechnical industry. The internal stability of the MSE wall system is the responsibility of the wall supplier.

The existing pedestrian tunnel located beneath East Stadium Boulevard at approximate Station 124+65 will be extended. Soil borings T-1 and T-2, which were performed adjacent to the existing pedestrian tunnel indicate that the foundation soils may consist predominately of native moderately compact to compact brown and light brown fine to coarse sand with variable percentages of silt and gravel. These soils should provide adequate support for the proposed pedestrian tunnel, provided they are stable at the time of construction. PSI estimates that the soil below the proposed tunnel foundations may be loaded to a maximum allowable soil bearing pressure of up to 5,000 psf, where the pedestrian tunnel foundations are extended through the existing roadway embankment fill and any buried native organic soils and constructed directly on the underlying native sand soils.

Groundwater or perched water was encountered during drilling in roadway Borings B-2, B-14, B-18 and B-33 through B-49 at depths ranging from approximately 5 to 9 feet below the existing East Stadium Boulevard, State Street, White Street or Rose Street pavement surfaces or an elevation typically ranging from approximately 823 to 833 feet. Groundwater or perched water was encountered during drilling in pedestrian tunnel Borings T-1 and T-2 and retaining wall Borings RW-1, RW-3 and RW-7 through RW-21 at depths ranging from approximately 5 to 34 feet below the existing East Stadium Boulevard pavement or ground surface or an elevation typically ranging from approximately 830 to 838 feet. It is possible for the groundwater table to vary within the depths explored during other times of the year, depending upon climatic and rainfall conditions (seasonal fluctuation).

Therefore, difficulty with groundwater seepage or presence of perched water is anticipated during construction of the MSE retaining walls on this site. Difficulty with groundwater seepage is generally not anticipated during earthwork operations associated with the proposed roadway reconstruction. PSI recommends that the Contractor verify the actual groundwater and seepage conditions at the time of the construction activities and, if necessary, proposes his groundwater control methods for the Engineer's approval, including the disposal of discharge of water.

This executive summary should not be considered separately from the entire text of this report with all the conclusions and qualifications mentioned herein. Details of our analysis and recommendations are given in the following sections of this report.

1.0 PROJECT INFORMATION

1.1 Project Authorization

Professional Service Industries, Inc. (PSI) has completed a geotechnical exploration and engineering report of the subsurface soil conditions for the proposed East Stadium Boulevard structure replacement project in the city of Ann Arbor, Washtenaw County, Michigan. This report presents the results of our observations and analysis and our recommendations for the proposed East Stadium Boulevard roadway reconstruction and the MSE retaining wall and pedestrian tunnel design and construction. This work was authorized by Mr. Ernest Er-Li Ch'ang, President of Northwest Consultants, Inc. and was performed in general accordance with PSI Proposal No. 381-6061R, initially dated March 20, 2006 and revised May 1, 2006.

1.2 Project Description

Initial project information was provided by Mr. Jon Drummond, P.E. of Northwest Consultants, Inc. during a meeting on March 9, 2006. Additional initial project and structure information was obtained by PSI from the set of plan sheets titled "E. Stadium Blvd. Structure Replacement Study", Sheets 1 through 19 prepared by Northwest Consultants, Inc., with an original issue date of October 12, 2005. Updated project information including current project stationing and soil boring and ground surface elevation information was obtained from Drawings 2006045-B1 through 2006045-B5, dated January 10, 2007.

PSI understands that the project includes the reconstruction of the existing East Stadium Boulevard roadway from South Main Street to South Industrial Highway, approximate Station Number 103+00 to 145+50, in the city of Ann Arbor, Washtenaw County, Michigan. The reconstruction will include the addition of turning lanes at the South Main Street intersection, a 5-foot wide bike path and an 8 to 12-foot wide concrete sidewalk along each side of East Stadium Boulevard, construction of mechanically stabilized earth (MSE) retaining walls along portions of the East Stadium Boulevard alignment and the extension of the existing pedestrian tunnel beneath East Stadium Boulevard located at approximate Station 124+65.

The geotechnical recommendations presented in this report are based on the available project information, and the results of our geotechnical exploration described in this report. If any of the noted information is considered incorrect or is changed, please inform PSI in writing so that we may amend the recommendations presented in this report if appropriate and if desired by the client. PSI will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

1.3 Purpose and Scope of Services

The purpose of this study was to explore the subsurface conditions at the site to enable an evaluation of the subgrade conditions and pavement designs for the proposed roadway, bike bath and sidewalk construction and an evaluation of acceptable foundation systems for the proposed MSE retaining walls and pedestrian tunnel. Our scope of services included drilling a total of eighty (80) soil test borings within the proposed development areas, laboratory testing of selected samples, an engineering evaluation of the data generated, and the preparation of a geotechnical report. The geotechnical exploration was performed in general accordance with the "MDOT Requirements for Geotechnical Investigations and Analysis," dated June, 1991.

This report presents available project information, briefly outlines the testing procedures, describes the site and supplementary subsurface conditions, and provides recommendations regarding the following:

- Earthwork considerations for site development including undercutting requirements, placement and the compaction of fill soils
- Flexible and rigid pavement designs using the DARWin pavement design and analysis system.
- MSE retaining wall subgrade preparation, support and estimated settlement
- Foundation type, depth of embedment and estimates of potential settlement for the proposed pedestrian tunnel extension.
- Earth pressure coefficients for use in the design of below grade walls and retaining walls.
- Comments regarding geotechnical factors that may impact earthwork, foundation construction, subgrade preparation, and performance of the proposed roadway, MSE retaining walls and pedestrian tunnel

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

PSI did not provide any service to investigate or detect the presence of moisture, mold or other biological contaminates in or around any structure within the proposed development area, or any service that was designed or intended to prevent or lower the risk of the occurrence of the amplification of the same. Northwest Consultants, Inc. acknowledges that mold is ubiquitous to the environment with mold amplification occurring when building materials are impacted by moisture. Northwest Consultants, Inc. further acknowledges that site conditions are outside of PSI's control, and that mold amplification will likely occur, or continue to occur, in the presence of moisture. As such, PSI cannot and shall not be held responsible for the occurrence or recurrence of mold amplification.

2.0 SITE AND SUBSURFACE CONDITIONS

2.1 Site Location and Description

The project site is located along East Stadium Boulevard in the city of Ann Arbor, Washtenaw County, Michigan. The general site location is shown on the "Site Vicinity Map" in the Appendix as Figure No. 1.

East Stadium Boulevard consisted of a four to six-lane bituminous roadway in fair to poor condition with concrete curb and gutter. Metal guard rails were present in the area of the Ann Arbor Railroad and State Street bridge structures. A concrete sidewalk was present outside of the guard rail adjacent to the west bound lanes. The existing embankment slopes in the area of the bridge structures consisted of grass and weeds with moderate tree cover. The ground surface within the remaining portions of the existing right-of-way consisted predominately of landscaped grass with a few trees. An existing stacked stone wall and fence was present along the south side of East Stadium adjacent to the University of Michigan Golf Course property.

2.2 Regional Geology

The general geomorphology and near surface geology of the site area is associated with glaciation, de-glaciation and retreat of the Wisconsin Glacier during the Wisconsinan Stage of the Pleistocene Series glacial episode as well as post glacial alluvium. The near surface soils are expected to consist predominately of well-drained, non-sorted glacial debris consisting of loamy and sandy textured gravelly sand occurring on ground moraines.

The United States Department of Agriculture (USDA) Soil Conservation Service (SCS) maps the near surface soils as belonging to the Boyer-Fox-Sebewa association. The major soil series within the proposed development area are the Fox sandy loam and the Miami loam, with adjacent deposits of the Matherton sandy loam. The SCS map for the project site area is included as Figure No. 3A and 3B in Section No. 1 of the Appendix †.

2.3 Field Exploration

The field exploration program consisted of drilling a total of eighty (80) soil borings within the proposed development areas. Forty (40) borings were drilled through the existing East Stadium Boulevard pavement surface to a depth of approximately 10 feet below the existing roadway surface. A total of nine (9) borings were drilled through the existing State Street, White Street and Rose Street pavement surfaces to a depth of approximately 10 feet below the existing roadway surfaces. The borings were staggered between the existing lanes of

† Soil Survey of Washtenaw County Michigan; United States Department of Agriculture Soil Conservation Service, Issued June, 1977
Quaternary Geology of Southern Michigan; Michigan Department of Natural Resources, Geological Survey Division, W.R. Farrand, Compiler. (1982)

traffic along the limits of the proposed roadway reconstruction. Twenty-one (21) borings were drilled along or near the proposed MSE retaining wall alignments. The borings were extended to depths ranging from approximately 15 to 45 feet below the existing roadway or ground surfaces or approximately 15 feet below the anticipated MSE retaining wall leveling pad elevation. One (1) boring was drilled at each end of the existing pedestrian tunnel. The pedestrian tunnel borings were performed through the existing east Stadium Boulevard roadway surface to a depth of approximately 25 feet below the existing roadway surface or approximately 10 feet below the existing tunnel floor elevation.

PSI staked the boring locations in the field by measuring from know reference points indicated on Sheet Nos. 4, 5 and 6 of the previously referenced original set of plan sheets provided by Northwest Consultants, Inc. The elevation of the ground surface at the boring locations performed was provided on the previously referenced updated plan sheets, dated January 10, 2007. PSI estimated the station number and lateral offset from the project centerline indicated on the current plan sheets provided. The boring locations are indicated on the Boring Location Diagrams, which were reproduced from the previously referenced current plan sheets, drawings 2006045-B1 through 2006045-B5 and are included as Figure No. 4A through 4E in Section No. 1 of the Appendix.

The drilling operations were performed between November 22 and January 3, 2007. A truck-mounted rotary drilling rig was used to perform the borings utilizing 3¼ -inch diameter continuous flight hollow-stem augers to advance the boreholes. Split spoon samplers were used to obtain soil samples by the Standard Penetration Test (SPT) method in general accordance with ASTM Standard D1586. In the Standard Penetration Test, the number of blows required to drive the sampler 12 inches, after an initial seating of 6 inches, with a 130 lb hammer falling 30 inches is termed the Standard Penetration Resistance, N-value. The drill crew maintained a log of the subsurface conditions, including changes in stratigraphy and observed groundwater levels. A graphical representation of the N-values is given on the boring logs.

After completion of the drilling operations, the borings were backfilled with auger cuttings and the pavement surfaces were patched with a bituminous cold patch material.

2.4 <u>FWD Testing</u>

PSI subcontracted SME to perform Falling Weight Deflectometer (FWD) testing in the field along the existing East Stadium Boulevard alignment. The field-testing was performed on October 31, 2006. The results of this analysis are presented in a report identified as SME Project Number PP54180, dated January 16, 2007, which is included in Section No. 3 of the Appendix. Please note that the project stationing referenced in this report is based on the original project stationing indicated on the original October 12, 2005 plan sheets. In addition, the boring locations and lane designations were based on preliminary information provided to SME by PSI and may not accurately reflect the actual location of the borings performed due to boring offsets performed in the field by the drill crew.

Following completion of the FWD testing, PSI performed a total of eight (8) additional soil borings, identified as F-1 through F-8. The borings were performed at the locations identified by the initial FWD test results as having the weakest subgrade resilient modulus. The borings were drilled through the existing pavement surface and were extended to a depth of approximately 10 feet below the existing pavement surface.

2.5 Laboratory Testing

The soil samples obtained during the field exploration were placed in sealed containers in the field and brought to the laboratory for testing and supplemental visual engineering classification. An experienced geotechnical engineer classified the samples in general conformance with the MDOT Modified Unified Soil Classification System.

Laboratory testing on the subsurface soil samples obtained during the field exploration, included natural moisture content, loss-on-ignition (organic content), Atterberg Limits, mechanical grain size analyses, unit weight, estimating the unconfined compressive strength with a calibrated hand penetrometer and performance of unconfined compression tests on intact split-spoon samples. In addition, Modified Proctor and California Bearing Ratio (CBR) tests were performed on composite samples of the subgrade soils encountered at the boring locations performed within the existing East Stadium Boulevard roadway for use in determining the pavement designs for this project.

With a calibrated hand penetrometer, the unconfined compressive strength (Qu) of the soil sample is estimated by measuring the resistance of the soil sample to penetration of a small, calibrated spring-loaded cylinder. The penetrometer can measure a maximum compressive strength of up to 4½ tsf. In the unconfined compression test, a sample of soil is axially loaded at a slow constant rate of strain until failure is obtained. During the performance of unconfined compression tests, deformation-stress curves were determined for the current ASTM Standard D2166, in which the failure is defined as the peak compressive stress in the sample, or the stress at a maximum strain of 15 percent.

The results of the grain size analyses, unconfined compression, CBR and moisture-density relationship tests are presented in Section No. 2 of the Appendix. The unconfined compressive strength values, Atterberg limits, as well as the moisture content and organic content test results are indicated on the boring logs at the depths the samples were obtained.

The unused portions of the soil samples will be placed in storage at PSI's Plymouth Township facility until our geotechnical engineering report has been reviewed and accepted by the City of Ann Arbor Engineering Division and MDOT, at which time, we will dispose of them. If you desire to retain the samples, please notify us.

2.6 Existing Pavement Conditions

A summary of the existing pavement sections, based on the results of the borings performed through the existing roadway surfaces, are presented on Table No. 1 in Section No. 1 of the Appendix. The thicknesses in the table represent the pavement section only at the individual boring locations. Other locations along the existing alignments may have pavement sections significantly different from that indicated in the table.

Based on a review of Table No. 1, the pavement section encountered at the boring locations performed was variable. The pavement section encountered at the boring locations performed within the middle lanes of the existing 5 and 6-lane portions of the East Stadium Boulevard alignment from the west project limit to approximate Station 126+50, identified as lanes No. 3, 5 and 6, consisted of approximately 3 to 6 inches of asphalt pavement underlain by approximately 6 to 9 inches of concrete pavement. The two northern most west bound lanes and the southern most east bound lanes within the existing 6-lane portion of East Stadium Boulevard from approximate Station 105+50 to 126+50, identified as lanes No. 1, 2 and 4, consisted of approximately 10 to 12 inches of asphalt pavement. The asphalt section was underlain by approximately 0 to 13 inches of aggregate base. The pavement section encountered at the boring locations performed within each of the lanes of the existing 4-lane portions of the East Stadium Boulevard alignment from approximate Station 126+50 to 136+50, identified as lanes No. 1, 3, 4 and 6, consisted of approximately 2 to 4 inches of asphalt pavement underlain by approximately 7 to 9 inches of concrete pavement. Each of the lanes within the existing 5-lane portion of East Stadium Boulevard, from approximate Station 136+50 to the east project limit consisted of approximately 5 to 6 inches of asphalt pavement underlain by approximately 10 to 15 inches of aggregate base.

2.7 Subsurface Conditions

2.7.1 East Stadium Boulevard

Borings B-1 through B-40 and Borings F-1 through F-8 were drilled through the existing East Stadium Boulevard roadway surface. A generalized soil description encountered at the boring locations, beginning below the pavement section and proceeding downward, is as follows:

Stratum 1: Organic Soil/ Embankment Fill. The pavement section was underlain by a layer of possibly native soils or uncontrolled fill material consisting predominately of dark brown and dark gray to mottled dark blueish gray and grayish brown sandy clay and silty clay with sand and variable percentages of organics in Borings B-4, B-6, B-7, B-9, B-12 through B-18, F-1 and F-3 through F-6. Black cinders and slag was encountered within the fill in Boring B-9. The discolored, organic sandy to silty clay extended to depths ranging from approximately 2.5 to 4 feet below the existing roadway surface. Loss-on-ignition (organic content) values of the tested soil samples from this stratum ranged from approximately 3.0 to 5.2 percent.

Roadway embankment fill consisting predominately of brown to reddish brown fine to medium sand with variable percentages of silt, gravel and coarse sand and occasional seams and layers of clayey sand and dark brown to dark gray organics was encountered below the East Stadium Boulevard pavement section in Borings B-20 through B-32, F-7 and F-8. The embankment fill extended to depths ranging from approximately 6.5 to 9 feet below the existing roadway surface in Borings B-20 through B-22 and B-29 through B-32. The fill extended through the explored depth of approximately 10 feet in Borings B-23 through B-28, F-7 and F-8. ASTM Standard Penetration Resistance (N) values typically ranged from 4 to 24 blows per foot (N-MDOT values of 3 to 22 blows per foot) with a maximum of 36 (N-MDOT value of 18). The moisture contents of the tested soil samples from the embankment fill typically ranged from 4 to 15 percent, indicating a moist condition. While the embankment fill was generally free of organic materials, loss-on-ignition (organic content) values of the tested organic soil seams encountered within the fill ranged from approximately 3.1 to 4.5 percent.

Stratum 2: Silty Clay. A stratum of native mottled yellowish brown and gray to brown and grayish brown silty clay with some sand and few gravel was encountered below Stratum No. 1 and below the existing pavement section in Borings B-1 through B-11, B-13 through B-16, B-18 and F-1 through F-5. The color changed to gray in Borings B-3, B-5, B-6, B-10 and F-4 at depths ranging from approximately 2.5 to 9 feet below the existing roadway surface. The mottled brown to gray silty clay extended through the explored depth of approximately 10 feet in Borings B-1 through B-10, B-13, B-14, F-1, F-4 and F-5 and to depths ranging from approximately 4 to 9 feet in Borings B-11, B-15, B-16, B-18, F-2 and F-3. ASTM Standard Penetration Resistance (N) values typically ranged from 4 to 22 blows per foot (N-MDOT values of 5 to 12 blows per foot). The unconfined compressive strength typically ranged from approximately 2.0 to greater than 4.5 tsf, indicating consistencies of firm to hard. The moisture content of the tested soil samples from the silty clay strata typically ranged from 13 to 22 percent.

Atterberg limit tests performed on representative composite samples of this stratum indicates the soil to be moderate in plasticity with a liquid limit ranging from 27 to 36 percent and a plastic limit ranging from 14 to 16 percent.

Stratum 3: Sand. A stratum of native reddish brown clayey sand to brown and light brown fine to medium and fine to coarse sand with varying percentages of silt and gravel was encountered below the silty clay in Borings B-11, B-15, B-16, F-2 and F-3; below the embankment fill in Borings B-20 through B-22 and B-29 through B-32; and below the existing pavement section in Borings B-19 and B-33 through B-40. The brown sand extended through the explored depth of the borings of approximately 10 feet. Inter-bedded layers of light brown, grayish brown and yellowish brown fine silty sand were encountered within the fine to coarse sand stratum at some locations. ASTM Standard Penetration Resistance (N) values typically ranged from 5 to 27 blows per foot (N-MDOT values of 4 to 21 blows per foot), with a maximum of 39 (N-MDOT value of 21), indicating consistencies of loose to compact. The moisture content of the tested soil samples from the sand and silty sand strata ranged from 2 to 18 percent, indicating a moist to wet condition.

2.7.2 MSE Retaining Walls

Borings RW-1 through RW-21 were drilled at or near the proposed MSE retaining wall locations. The majority of the borings were performed through the existing East Stadium Boulevard roadway surface. Borings RW-1, RW-6 through RW-9 and RW-18 through RW-21 were performed outside of the existing roadway surface. A generalized soil description encountered at the boring locations, beginning below the pavement section or surficial topsoil and proceeding downward, is as follows:

Stratum 1: Organic Soil/ Fill. A layer of possibly native soils or uncontrolled fill material consisting predominately of mottled olive brown and grayish brown silty clay with sand and variable percentages of organics was encountered below the pavement surface at the locations of RW-2 through RW-4. The discolored silty clay with organics extended to depths ranging from approximately 1.5 to 3 feet below the existing roadway surface. Fill or apparent fill consisting predominately of black, dark gray to dark brown silty sand with variable percentages of organics was encountered below the surficial topsoil in Borings RW-6 through RW-8 and RW-19 through RW-21. Concrete, wood and brick debris was encountered within the fill in Borings RW-7 and RW-8. The fill or apparent fill extended to depths ranging from approximately 4 to 9 feet below the existing ground surface. Loss-on-ignition (organic content) values of the tested soil samples from the apparent fill and discolored native soils ranged from approximately 3.2 to 5.0 percent.

Roadway embankment fill consisting predominately of brown to reddish brown fine to medium sand with variable percentages of silt, gravel and coarse sand and occasional seams and layers of clayey sand and dark brown to dark gray organics was encountered below the East Stadium Boulevard pavement section in Borings RW-10 through RW-17. Cinder, slag and brick debris was encountered near the bottom of the fill in Borings RW-12 and RW-13. The embankment fill extended to depths ranging from approximately 19 to 29 feet below the existing roadway surface. ASTM Standard Penetration Resistance (N) values typically ranged from 4 to 15 blows per foot (N-MDOT values of 3 to 11 blows per foot) with a maximum of 19 (N-MDOT value of 14). The moisture contents of the tested soil samples from the embankment fill ranged from 5 to 16 percent, indicating a moist condition. While the embankment fill was generally free of organic materials, loss-on-ignition (organic content) values of the tested organic soil seams encountered within the fill ranged from approximately 2.3 to 5.7 percent.

Stratum 2: Silty Clay. A stratum of native mottled yellowish brown and gray to brown and grayish brown silty clay with some sand and few gravel was encountered below the near-surface native discolored organic silty clay soils and fill in Borings RW-1 through RW-4. The color changed to gray in Borings RW-1 through RW-3 at depths ranging from approximately 6 to 14 feet below the existing ground or roadway surface. The mottled brown to gray silty clay stratum extended through the explored depth of approximately 15 feet at each boring location. ASTM Standard Penetration Resistance (N) values ranged from 8 to 19 blows per foot (bpf) (N-MDOT values of 4 to 14 blows per foot) with a maximum of 27 (N-MDOT value of 22). The unconfined compressive strength of the tested soil samples typically ranged from approximately 2.0 to greater than 4.5 tsf, indicating consistencies of firm to hard. The moisture content of the tested soil samples from the silty clay stratum ranged from 13 to 18 percent.

Stratum 3: Sand. A stratum of native reddish brown clayey sand to brown and light brown fine to medium and fine to coarse sand with varying percentages of silt and gravel was encountered below the pavement section and embankment fill in Borings RW-5 through RW-21. ASTM Standard Penetration Resistance (N) values typically ranged from 8 to 25 blows per foot (N-MDOT values of 6 to 23 blows per foot), with a maximum of 38 (N-MDOT value of 14), indicating consistencies of loose to compact. The moisture content of the tested soil samples from the sand stratum typically ranged from 4 to 17 percent, indicating a moist to wet condition.

2.7.3 <u>Pedestrian Tunnel</u>

Borings T-1 and T-2 were drilled adjacent to the existing pedestrian tunnel located below the East Stadium Boulevard roadway surface at approximate Station 124+65. A generalized soil description encountered at the boring locations, beginning below the pavement section and proceeding downward, is as follows:

Stratum 1: Embankment Fill/ Organic Soil. Roadway embankment fill consisting predominately of brown to reddish brown fine to medium sand with variable percentages of silt, gravel and coarse sand and occasional seams and layers of clayey sand and dark brown to dark gray organics was encountered below the East Stadium Boulevard pavement section in Borings T-1 and T-2. The embankment fill extended to depths ranging from approximately 14 to 15 feet below the existing roadway surface. ASTM Standard Penetration Resistance (N) values ranged from 4 to 18 blows per foot (N-MDOT values of 3 to 16 blows per foot). The moisture contents of the tested soil samples from the embankment fill ranged from 6 to 16 percent, indicating a moist condition.

A layer of possible native organic soil or uncontrolled fill consisting of dark gray silty, clayey sand was encountered below the embankment fill in Boring T-2. The loss-on-ignition (organic content) value of the tested soil sample from this stratum was 3.3 percent.

Stratum 2: Sand. A stratum of native brown and light brown fine to coarse sand with varying percentages of silt and gravel was encountered below the fill and possible buried native organic soil at each boring location. The brown sand extended through the explored depth of the borings of approximately 25 feet below the existing roadway surface or approximately 10 feet below the pedestrian tunnel slab elevation. ASTM Standard Penetration Resistance (N) values ranged from 22 to 43 blows per foot (N-MDOT values of 19 to 29 blows per foot), indicating consistencies of moderately compact to compact. The moisture content of the tested soil samples from the native fine to coarse sand stratum ranged from 6 to 14 percent, indicating a moist to wet condition.

The above subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs should be reviewed for specific information at individual boring locations. These records include soil descriptions, stratification, penetration resistance, location of the samples, and laboratory test data. The soil boring logs are presented in Section No. 2 of the Appendix and have been forwarded previously via E-mail in AutoCADD format.

The stratification shown on the boring logs represent the conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. The stratification represents the approximate boundary between subsurface materials; however, the actual transition may be gradual. Water level information obtained during field operations is also shown on the boring logs. The boring logs were prepared on the basis of the laboratory testing and supplemental visual engineering classification, as well as the field logs of the soil conditions encountered.

2.8 Groundwater Information

The driller looked for indications of groundwater seepage both during and after the drilling operations. Groundwater or perched water was encountered during drilling in roadway Borings B-2, B-14, B-18 and B-33 through B-49 at depths ranging from approximately 5 to 9 feet below the existing East Stadium Boulevard, State Street, White Street or Rose Street pavement surfaces or an elevation typically ranging from approximately 823 to 833 feet. Groundwater or perched water was encountered during drilling in pedestrian tunnel Borings T-1 and T-2 and retaining wall Borings RW-1, RW-3 and RW-7 through RW-21 at depths ranging from approximately 5 to 34 feet below the existing East Stadium Boulevard pavement or ground surface or an elevation typically ranging from approximately 830 to 838 feet.

It is possible for the groundwater table to vary within the depths explored during other times of the year, depending upon climatic and rainfall conditions (seasonal fluctuation). In granular soils, the indicated water levels are usually relatively accurate indications of the groundwater level at the time the work was performed. Groundwater monitoring wells are required to accurately define the position and fluctuation of the groundwater table, especially if a boring is drilled in cohesive soil, where several days or weeks may be required for the groundwater to reach a static level. However, the installation of such monitoring wells was not included in the scope of services for this project.

2.9 Site Seismic Classification

Washtenaw County in Michigan lies in the Central Stable Tectonic Region and in the Seismic Zone 1 of probable seismic activity of the Building Officials Congress of America (BOCA), National Building Code (1993), and the Uniform Building Code (UBC). This zone indicates that minor damages due to occasional earthquakes might be expected in this area.

In the 2003 Michigan Building Code (MBC), the State of Michigan has adopted the provisions of the 2000 International Building Code (IBC). The Site Class is based on a weighted average of known or estimated soil properties for the uppermost 100 feet of the subsurface profile. Soil borings at the project site extended to a maximum depth of approximately 120 feet below the existing ground surface. Based on the weighted average of the soil properties encountered within the upper 100 feet of the subsurface soil profile, including the Standard Penetration Test (SPT) N-values and soil shear strength, PSI estimates that the seismic design for this project would be Site Class D.

The 2002 USGS NEHRP probabilistic ground motion values of the proposed site, which is located near latitude 42.26450 and longitude -83.74619 are as follows, based on Site Class D:

Period (seconds)	2% Probability of Event in 50 years* (%g)	Site Coefficient F_a	Site Coefficient F_v
PGA	5.68	Na	Na
0.2 (S_a)	12.22	1.60	Na
1.0 (S_1)	4.56	Na	2.40

*At the nearest grid point (lat: 42.26450, long: -83.74619)

The site coefficients F_a and F_v were interpolated from IBC Tables 1615.1.2(1) and 1615.1.2(2) as a function of the site classification and the mapped spectral response acceleration at the short (S_a) and 1 second (S_1) periods.

The development of shear strains tending to cause liquefaction of sand deposits is governed by the character of the ground motion (i.e. acceleration and frequency), soil type, groundwater level and in-situ stress conditions. Very loose to loose sands and sands below the water table are more likely to liquefy than dense sands and sands above the water table. PSI believes the risk of liquefaction occurring at this site is low based on the site being located in a low seismic activity area.

3.0 EVALUATION AND RECOMMENDATIONS

Based on the available soil and project information, the site appears to be suitable for support of the proposed pavements, MSE retaining walls and pedestrian tunnel extension. The proposed structures may be supported on the native sand and gravel stratum or on properly placed and compacted engineered fill materials. Some subgrade preparation will be necessary to remove and replace the discolored native organic soils or uncontrolled fills from below the proposed pavements and structures at some locations.

PSI has made our analysis based on the information developed during this exploration. The resulting recommendations are given in the following sections. If our estimations or understandings of the project are considered incorrect or if conditions during construction are significantly different from those described in this report, please contact PSI immediately in writing so that we may amend our recommendations presented in this report if appropriate and if desired by the client.

3.1 Site and Subgrade Preparation and Fill Placement

PSI anticipates that site preparation and earthwork activities will generally consist of the removal of the existing pavement surfaces followed by reconstruction and widening of the existing roadways to include additional turning lanes, sidewalks and bike paths adjacent to the existing roadway alignments and construction of new MSE retaining walls. PSI recommends that all earthwork operations be performed under current MDOT and City of Ann Arbor specifications and be properly monitored in the field.

At the start of the earthwork operations, existing or previously abandoned underground utilities and other buried structures in reconstruction or roadway-widening areas should be re-routed and/or removed from within the proposed construction areas. Resulting excavations extending below the proposed grades should be backfilled with engineered fill or specified materials, such as lean concrete or flowable fill, to the final design grade. Existing utilities that are not re-routed or abandoned should be adequately marked and protected to minimize the potential for damage during construction.

Existing pavement materials, topsoil and surface vegetation in roadway, sidewalk and bike path widening areas and below the MSE retaining wall reinforced zone, as well as unsuitable materials encountered below the pavement subgrades, should be removed in their entirety from the proposed construction areas.

Following removal of the existing pavements, surficial topsoil, vegetation and any unsuitable materials, the exposed subgrade should be prepared in accordance with Section 205.03.A of the MDOT "2003 Standard Specifications for Construction". Loose, soft, or unstable areas revealed during proof-rolling should be stabilized by aeration, drying, and additional compaction, or be removed and replaced with engineered fill as outlined in Section 205.03E and 205.03F. Engineered fill should be placed at or near the optimum moisture content. Adequate compaction will not be achieved if the fill is in a saturated condition.

The soil borings indicate that the subgrade soils below the proposed East Stadium Boulevard roadway and adjacent sidewalk and bike paths may consist predominately of mottled brown silty clay from the beginning of the project at Station 103+00 through approximate Station 120+00. These soils should provide adequate support for the proposed pavement surface, provided they are stable at the time of construction. However, the pavement section was underlain by a layer of possibly native soils or uncontrolled fill material consisting predominately of dark brown and dark gray to mottled dark blueish gray and grayish brown sandy clay and silty clay with sand and variable percentages of organics in Borings B-4, B-6, B-7, B-9, B-12 through B-18, F-1 and F-3 through F-6. Black cinders and slag was encountered within the fill in Boring B-9. The discolored, organic sandy to silty clay extended to depths ranging from approximately 2.5 to 4 feet below the existing roadway surface. Loss-on-ignition (organic content) values of the tested soil samples from this stratum ranged from approximately 3.0 to 5.2 percent. It would not be unusual for the thickness, composition and organic contents of the discolored native soils and engineered fill to vary within the site area from that encountered at the individual boring locations. In addition, it is possible that organic native soils or uncontrolled fills may be present at other locations within the proposed roadway, sidewalk and bike path alignment that were not disclosed by the borings.

The most critical portion of the subgrade is the upper 3-foot section. This zone provides the primary strength needed for support of the pavement section. Therefore, where organic soils or uncontrolled fills are exposed during site grading operations at and below the designed subgrade elevation within this critical 3-foot zone, PSI generally recommends that these soils be undercut in their entirety throughout the pavement areas and backfilled with clean-engineered fill. The exact depth and need for undercutting should be determined in the field at the time of construction. Moderately organic soils present at depth below the pavement section and critical 3-foot zone, exclusive of peat, marl or other highly organic and compressive soils, may be left in place at the discretion of the MDOT or City of Ann Arbor engineer, provided a sufficient thickness of high quality, stable engineered fill is placed over the organic or otherwise unsuitable subgrade soils.

From approximate Station 120+00 through 136+00, the soil borings indicate that the subgrade soils below the proposed East Stadium Boulevard roadway and adjacent sidewalk and bike paths may consist of existing embankment fill materials comprised predominately of brown to reddish brown fine to medium sand with variable percentages of silt, gravel and coarse sand seams to layers of clayey sand. These soils should provide adequate support for the proposed pavement surfaces, provided they are stable at the time of construction. Significant undercut or subgrade improvement below the existing roadway alignment is generally not anticipated for this portion of the project, based on the borings performed. However, occasional seams of dark brown to dark gray organics were noted within the fill at some locations. The need for localized undercutting and replacement of organic materials within the existing, relatively clean embankment fill should be addressed in the field at the time of construction.

From approximate Station 136+00 through the end of the project at Station 145+50, the soil borings indicate that the subgrade soils below the proposed East Stadium Boulevard roadway and adjacent sidewalk and bike paths may consist predominately of native brown and light brown fine to coarse sand with variable percentages of silt and gravel. These soils should provide adequate support for the proposed pavement surfaces, provided they are stable at the time of construction. Significant undercut or subgrade improvement below the existing roadway alignment is generally not anticipated for this portion of the project, based on the borings performed.

The soil borings indicate that the subgrade soils below the proposed State Street, White Street and Rose Street roadways may consist predominately of native brown to reddish brown clayey sand and brown and light brown fine to coarse sand with variable percentages of silt and gravel. These soils should provide adequate support for the proposed pavement surfaces, provided they are stable at the time of construction. Significant undercut or subgrade improvement below the existing roadway alignments are generally not anticipated for this portion of the project, based on the borings performed. However, a layer of black to dark gray organic silt and sandy clay was encountered in State Street Boring B-41 and Rose Street Boring B-48. Organic and unsuitable subgrade soils should be undercut and replaced as outlined previously in this section of the report.

Based on the plan and profile sheets provided, PSI understands that the proposed roadways will be reconstructed near the existing pavement elevations. Adjustments to the vertical alignments are generally anticipated to be on the order of 1 foot or less, with the exception of the portion of the alignment between the proposed Ann Arbor Railroad and State Street bridge replacement structures. In this portion of the project, the East Stadium Boulevard vertical alignment will be increased approximately 2 to 3 feet. PSI recommends that engineered fill required to establish the finished subgrade elevation consist of MDOT Class II granular material. Frozen material should not be used as engineered fill, nor should fill be placed on frozen subgrade. Engineered fill should be spread in level lifts not exceeding the specified thickness and compacted to the specified minimum density as outlined in Section 205 of the MDOT 2003 Standard Specifications. Engineered fill should be placed at or near the optimum moisture content. Adequate compaction will not be achieved if the fill is in a saturated condition.

To minimize settlement, it is imperative that the engineered fill placed in subgrade undercut areas and general embankment fills be placed and compacted in accordance with a strict quality control program to minimize internal consolidation and to moderate external consolidation. Special attention should be given to the interface area between bridge abutment backfill, pedestrian tunnel backfill and the MSE wall backfill and the roadway embankment or subgrade fill.

3.2 <u>Pavement Design Recommendations</u>

Based on the available subgrade and subsurface conditions obtained at the soil boring locations performed and the traffic information provided, 20-year flexible and rigid pavement designs have been determined utilizing the DARWin Pavement Design and Analysis System. This program embodies the methodology of the 1993 AASHTO Guide for the Design of Pavement Structures.

The 2007 and projected 2027 average daily traffic to be used for design was provided by Northwest Consultants, Inc. A 2007 and 2027 ADT value of 26,500 vehicles and 29,330 vehicles, respectively, was provided for East Stadium Boulevard at the Ann Arbor Railroad bridge structure. 2007 and 2027 ADT values of 20,040 vehicles and 22,730 vehicles, respectively were provided for State Street at the Granger Road intersection. Specific commercial traffic volume or vehicle breakdowns were not provided. For the purposes of PSI's pavement design, PSI has used a value of 2% commercial traffic for this project.

For the projected 2007 and 2027 ADT values provided and commercial traffic percentages estimated by PSI, DARWin calculated a total of 2,710,155 and 2,999,579 ESAL's, respectively over the 20-year design period for East Stadium Boulevard based on a 4-lane roadway with 80 percent of the trucks traveling in the design lane. Similarly, DARWin calculated a total of 2,561,864 and 2,905,746 ESAL's, respectively over the 20-year design period for State Street based on a 2-lane roadway with 100 percent of the trucks traveling in the design lane. These models represent the most concentrated application of the anticipated traffic loads within the proposed alignments. The proposed 5 and 6-lane portions of East Stadium Boulevard will likely have a slightly different truck distribution across the various traffic lanes resulting, in theory, in a lower ESAL value for design.

3.2.1 Flexible Pavement Design Recommendations

Flexible pavement designs have been prepared based on the 18-kip ESAL's over the 20-year design period outlined above. The number of heavy trucks using a pavement significantly affects the 18-kip ESAL value over the design life of the pavement. PSI recommends that the City of Ann Arbor or their design representative review the assumed commercial traffic percentage to verify that the following pavement designs recommendations submitted by PSI are based on an appropriate number of 18-kip ESAL's. PSI can review and adjust as necessary the recommended pavement sections based on actual traffic data and vehicle breakdowns or the number of ESAL's provided by the City of Ann Arbor or their design representative.

CBR values of approximately 3.4 to 6.1 were determined on composite samples of the existing subgrade soils taken from within the proposed pavement areas. The back calculated subgrade modulus determined by the FWD tests typically ranged from approximately 3,500 to 4,800 psi, which is equivalent to a CBR value in the range of 2.5 to 4.0. Based on the CBR and FWD tests, an effective roadbed soil resilient modulus of 5,000 psi was used in the pavement designs. Other design parameters used in the pavement design for this project include a terminal serviceability of 2.5, an initial serviceability of 4.5, reliability of 90%, subgrade drainage coefficient of 0.7, and a standard deviation of 0.49. The DARWin pavement design inputs above are consistent with the parameters recommended in Division II of the City of Ann Arbor Standard Specifications, dated 1/94 and the MDOT Pavement Design and Selection Manual, updated March 2005.

For the soil conditions and anticipated traffic loads, DARWin has calculated minimum required flexible design structural numbers of 4.58 and 4.65 for East Stadium Boulevard, based on the 2007 and 2027 ADT values, respectively. Similarly, DARWin has calculated minimum required flexible design structural numbers of 4.54 and 4.63 for State Street, based on the 2007 and 2027 ADT values, respectively. Since the calculated structural numbers are similar for the 2007 and 2027 ADT values provided, PSI has provided one pavement design recommendation based on the structural number corresponding to the 2027 ADT value. Copies of the DARWin Flexible Pavement Design inputs and outputs are included in the Appendix. Based on these outputs, PSI recommends the following pavement sections:

Flexible Pavement Section East Stadium Boulevard				
Pavement Material	**Section Thickness (inches)**	**Structural Layer Coefficient**	**Drainage Coefficient**	**Structural Number**
HMA Surface Course MDOT 4C	2.0	0.44	1.0	0.88
HMA Leveling Course MDOT 3C	2.5	0.44	1.0	1.10
HMA Base Course MDOT 2C	3.5	0.36	1.0	1.26
Aggregate Base Course MDOT 21AA	16.0	0.14	0.70	1.57
			Total SN = 4.81>4.65	

Flexible Pavement Section State Street				
Pavement Material	**Section Thickness (inches)**	**Structural Layer Coefficient**	**Drainage Coefficient**	**Structural Number**
HMA Surface Course MDOT 4C	2.0	0.44	1.0	0.88
HMA Leveling Course MDOT 3C	2.5	0.44	1.0	1.10
HMA Base Course MDOT 2C	4.0	0.36	1.0	1.26
Aggregate Base Course MDOT 21AA	16.0	0.14	0.70	1.57
			Total SN = 4.81>4.63	

ADT values were not provided for White Street and Rose Street. PSI recommends that the pavement section for these roadways meet or exceed the minimum pavement design criteria outlined by the City of Ann Arbor for minor local and residential collector roadways as outlined in Division II of the current edition of the City of Ann Arbor Standard Specifications.

The flexible pavement design above assumes a high quality, high stability plant mix with design properties and aggregate gradation meeting or exceeding the requirements of MDOT 2C/3C/4C as outlined in Section 5.01 of the 2003 MDOT Standard Specifications. The HMA should be placed as outlined in Section 5.02 of the 2003 MDOT Standard Specifications. The HMA base layer may be replaced with additional MDOT 4C, 3C and 21AA pavement materials if desired, provided the minimum structural number required is met or exceeded.

It should be recognized that all pavements require regular maintenance and occasional repairs to keep the pavements in a serviceable condition. Of particular value, is a timely sealing of joints and cracks, which if left un-repaired, can serve to permit water to enter the pavement section and cause rapid deterioration of the pavement during freeze-thaw cycles. The need for such maintenance and repair is not necessarily indicative of premature pavement failure. However, if appropriate maintenance and repairs are not performed on a timely basis, the serviceable life of the pavement can be reduced significantly.

The pavement surface should be adequately sloped to promote good surface drainage and to reduce water infiltration into the base course. Water should not be allowed to pond behind curbs and saturate the pavement base stone. Where open grade base course is used, an edge drain system will be required to remove water infiltration within the base course

3.2.2 Rigid Pavement Design Recommendations

Heavy-duty rigid pavement designs have also been determined utilizing the "AASHTO Guide for Rigid Pavement Design." Parameters used include a concrete modulus of elasticity of 4.2 x 10^6 psi, a concrete modulus of rupture of 670 psi and a mean effective k value of 138 psi/in. Copies of the DARWin Rigid Pavement Design inputs and outputs are included in the Appendix. The results are shown on the following table:

Rigid Pavement Section East Stadium Boulevard and State Street	
Pavement Material	**Section Thickness (inches)**
Portland Cement Concrete Class A	8.5
MDOT 21AA Aggregate Base Course	6.0

The concrete mix design should consist of a minimum 5-bag, normal weight concrete with a minimum 28-day compressive strength of 3,500 psi when tested in accordance with ASTM C39. The concrete should contain an air entrainment mixture to resist the effects of freezing and thawing. The pavement should contain a wire mesh reinforcement in the bottom third of the pavement section and should be suitably doweled at construction joints to permit the proper transfer of loads.

3.2.3 Bike Path and Sidewalk Recommendations

The proposed project includes the construction of a 5-foot wide bike path and an 8 to 12-foot wide concrete sidewalk along each side of East Stadium Boulevard. PSI recommends that the proposed bike path and sidewalk pavement sections meet or exceed the minimum pavement design criteria outlined in Division II of the current edition of the City of Ann Arbor Standard Specifications as outlined below:

Flexible Pavement Section Bike Paths	
Pavement Material	**Section Thickness (inches)**
HMA – MDOT 1100T	3.0
MDOT 21AA Aggregate Base	6.0

Rigid Pavement Section Sidewalks	
Pavement Material	**Section Thickness (inches)**
Portland Cement Concrete Class A	4.0
Class II Granular Material	4.0

3.3 MSE Retaining Wall Recommendations

Mechanically stabilized earth (MSE) retaining walls will be constructed along portions of the proposed East Stadium Boulevard alignment. A low retaining wall will be provided on the south side of East Stadium Boulevard from approximate Station 105+50 to 114+00. The retained height within this segment of wall is anticipated to be less than 10 feet. A retaining wall will be provided on the north side of East Stadium Boulevard from approximate Station 119+50 to 135+50. The retained height within this segment of wall is anticipated to range from less than 10 feet at the beginning and end of the run to as much as 25 to 30 feet between the Ann Arbor Railroad and State Street bridge structures and roadway approach sections immediately adjacent to the bridges. A retaining wall will also be provided on the south side of East Stadium Boulevard from approximate Station 122+50 to 135+75. The retained height within this segment of wall is anticipated to range from less than 10 feet at the beginning and end of the run to as much as 25 to 30 feet between the Ann Arbor Railroad and State Street bridge structures and roadway approach sections immediately adjacent to the bridges.

The soil borings performed along the segment of retaining wall from Station 105+50 to 114+00 (RW-1 through RW-4) indicate that the foundation soils may consist predominately of stiff to hard mottled brown silty clay. These soils should provide adequate support for the proposed retaining wall, provided they are stable at the time of construction. Based on a review of the available subsurface soil conditions, PSI estimates that the soil below the proposed MSE retaining wall may be loaded to a maximum ultimate soil bearing pressure of up to 15,000 psf, where the leveling pad and reinforced fill zone are extended through the near-surface discolored organic soils and constructed directly on the stiff to hard mottled silty clay soils. The MSE wall leveling pad should be located at a minimum depth of 42 inches below the finished grade adjacent to the face of the proposed MSE retaining walls for proper protection against frost.

The soil borings performed along the segments of retaining wall from Station 119+50 to 135+50 and Station 122+50 to 135+75 (RW-5 through RW-21) indicate that the foundation soils may consist predominately of native moderately compact brown and light brown fine to medium or fine to coarse sand with variable percentages of silt and gravel. These soils should provide adequate support for the proposed retaining walls, provided they are stable at the time of construction. Based on a review of the available subsurface soil conditions, PSI estimates that the soil below the proposed MSE retaining wall may be loaded to a maximum ultimate soil bearing pressure of up to 20,000 psf, where the leveling pad and reinforced fill zone are extended through the existing roadway embankment fill and any buried native organic soils and constructed directly on the underlying native moderately compact sand soils. The MSE wall leveling pad should be located at a minimum depth of 42 inches below the finished grade adjacent to the face of the proposed MSE retaining walls for proper protection against frost.

The required bearing pressure below each section of the MSE wall due to the weight of the MSE wall fill, surcharge loads and overturning considerations should be supplied by the MSE wall designer as part of their standard submittal. The required soil bearing pressure as calculated by the wall supplier should be checked against the ultimate soil bearing capacity outlined above. The resulting factor of safety against bearing capacity failure should be equal to or greater than 2.5. Where unsatisfactory safety factors are present, subgrade improvement consisting of undercutting and replacement of the unsuitable foundation soils or in-place densification methods such as vibro-compaction may be required.

Settlement of the native silty clay soils beneath the proposed segment of low retaining wall from Station 105+50 to 114+00 has been estimated using the Terzaghi equation and empirical correlations between the recompression and virgin compression ratios RR=Cr/(1+eo) and CR=Cc/(1+eo). The estimated settlement is also based on empirical correlations, standard to the geotechnical industry, relating to natural moisture content, void ratio, specific gravity and Atterberg limits. We have also assumed a maximum retained height of 10 feet and a reinforced zone width of 7 feet in our analysis. Based on the available subsurface information and anticipated loading, we estimate that total consolidation settlement of the silty clay support soils below the proposed MSE retaining wall structure may be on the order of 0.5 inches or less. Settlement within the MSE retaining wall reinforced zone should be negligible, provided the fill is constructed and compacted under a strict quality control program.

Settlement of the native fine to coarse sand soils beneath the proposed segments of retaining wall from Station 119+50 to 135+50 and Station 122+50 to 135+75 have been estimated using Schmertmann's method and elastic theory. We have also assumed a maximum retained height of 30 feet and a reinforced zone width of 20 feet in our analysis. Based on the available subsurface information and anticipated loading, we estimate that total consolidation settlement of the fine to coarse support soils and deep silty clay soils below the proposed MSE retaining wall structures may be on the order of 1.0 to1.5 inches. Settlement within the MSE retaining wall reinforced zone should be negligible, provided the fill is constructed and compacted under a strict quality control program. Due to the granular nature of the foundation soils, some of this settlement is expected to occur during placement and compaction of the MSE retaining wall and embankment fill. Post construction settlement below the MSE retaining wall and embankment fill structure may be on the order of ¾ inch or less. Settlement within the MSE retaining wall reinforced zone should be negligible, provided the fill is constructed and compacted under a strict quality control program.

An external global or rotational stability analysis was performed for the proposed MSE retaining wall embankment using the computer program PCSTABLE5M by Purdue University. Our analysis was modeled for a typical segment of retaining wall located between the Ann Arbor Railroad and State Street bridge structures and the subsurface soil conditions encountered at the retaining wall and bridge structure soil borings performed in this area of the proposed project. PSI has assumed a leveling pad elevation of approximately 840 feet, a maximum retained height of 30 feet and a reinforced zone width of approximately 0.7H or approximately 20 feet. We have also assumed that the MSE soil backfill will have a minimum internal friction angle of 34 degrees and will be compacted to a minimum density of 125 pcf. A traffic surcharge load of 250 psf was also included in our analysis. The results of this analysis indicate a minimum factor of safety of 1.972 against rotational failure. A minimum factor of safety of 1.5 is generally required by the Geotechnical industry. The results of the PCSTABLE5 stability analysis is presented in Section No. 3 of the Appendix. The internal stability of the MSE wall system is the responsibility of the wall supplier.

Existing pavement materials, embankment fill, topsoil and surface vegetation should be removed in their entirety from below the MSE retaining wall leveling pad and reinforced zone. Following site stripping, the existing soils should be excavated to the proposed leveling pad bottom elevation. The leveling pad foundation should be graded level for a width equal to the length of the steel reinforcement strips plus 3 feet. The leveling pad and reinforced soil zone bottom should be inspected and compacted according to the requirements of Section 206 of the MDOT "2003 Standard Specifications for Construction". Native discolored organic soils or uncontrolled fill materials were encountered near the anticipated MSE wall leveling pad and reinforced soil zone bottom elevation in Borings RW-2 through RW-8, RW-11, RW-13, RW-20 and RW-21. It is possible that organic native soils or uncontrolled fills may be present at other locations along the proposed MSE retaining wall alignments that were not disclosed by the borings.

Loose, soft, organic, or unsuitable areas revealed during proof-rolling and inspection should be stabilized by aeration, drying, and additional compaction or be removed and replaced with engineered fill as outlined in Section 205 of the MDOT "2003 Standard Specifications for Construction". The limits of the undercut and backfill should extend laterally from the sides of the MSE wall leveling pad and reinforced soil zone or "foundation" a distance equal to the thickness of the fill below the "foundations" for proper support of lateral loads exerted through the fill by the "foundation". The unsuitable soils undercut from below the proposed MSE wall leveling pad and reinforced soil zone should be backfilled with structural fill meeting the material and compaction requirements specified in section 206 of the MDOT Standard Specifications. Engineered fill should be placed at or near the optimum moisture content. Adequate compaction will not be achieved if the fill is in a saturated condition.

Depending on the groundwater conditions at the time of construction, it may be necessary to compact the leveling pad foundation invert with a 'static' roller if vibration causes moisture to be 'wicked' upward, resulting in subgrade instability. The use of geotextile fabric or placing stone on and into the bearing surface with a hoe-pac may also be necessary to maintain stability. Additionally, it may be necessary for the contractor to perform large scale de-watering in advance of the earthwork operations to allow subgrade preparation and leveling pad construction and fill placement to take place under relatively dry conditions. The extent of any undercut and requirements for geotextile fabric and coarse aggregate should be determined at the time of the subgrade preparation based on the condition of the exposed subgrade at the time of construction

Following subgrade preparation and stabilization as necessary, the proposed MSE wall leveling pad should be constructed as detailed on the plans. Reinforced concrete facing panels, steel reinforcement strips and structural fill should be placed in accordance with and meet the material requirements specified in the current version of the "MDOT Special Provision for Mechanically Stabilized Earth Retaining Wall/Abutment System", dated December 1, 2000 or newer. To minimize internal and external settlement of the MSE wall system, piles supporting the proposed bridge structures should be driven to the designed tip elevation prior to placement of the MSE wall leveling pad and initial lift of MSE wall fill and concrete facing panels.

MSE wall backfill should be placed near the rear and middle of the reinforcement zone and graded outward toward the wall face. Each lift should be compacted to the specified density with a large smooth-drummed roller, with the exception of within 3 feet of the back face of the wall. Fill placed within this zone and around the piles supporting the proposed bridge abutments, if exposed, should be compacted by hand with a lightweight mechanical tamper or vibratory system. The backfill should be tested for compaction prior to placement of the steel reinforcement elements.

The reinforcement strips should be placed perpendicular to the face of the concrete wall panels except where strips intercept the piles supporting the proposed bridge abutments. Reinforcement strips should be placed at angles to the wall panel as necessary to avoid the pile foundation, however, the strips should not be shortened to avoid contact with the piles or other reinforcement strips.

The roadway embankment fill placed outside the reinforced zone of the MSE wall, should conform to the requirements of Section 205 of the MDOT "2003 Standard Specifications for Construction".

3.4 Pedestrian Tunnel Foundation Recommendations

The existing pedestrian tunnel located beneath East Stadium Boulevard at approximate Station 124+65 will be extended. Specific information relative to the proposed tunnel foundation system and anticipated loads were not provided. For the purposes of our analysis, PSI estimates that the proposed tunnel and wing walls will be supported on conventional shallow spread footing foundations. PSI estimates that the soil pressure exerted by the proposed pedestrian tunnel structure including the weight of the overburden embankment fills, pavement section and surcharge loads may be on the order of 2,000 to 3,000 psf.

Existing embankment fill, topsoil and surface vegetation should be removed in their entirety from below the proposed pedestrian tunnel. Following site stripping, the existing soils should be excavated to the proposed foundation bearing elevation. The foundation bottom and tunnel floor subgrade should be inspected and compacted according to the requirements of Section 206 of the MDOT "2003 Standard Specifications for Construction". Native discolored organic soils or uncontrolled fill materials were encountered near the anticipated tunnel bottom elevation in Boring T-2. It is possible that organic native soils or uncontrolled fills may be present at other locations along the proposed tunnel that were not disclosed by the borings.

Soil borings T-1 and T-2, which were performed adjacent to the existing pedestrian tunnel indicate that the foundation soils may consist predominately of native moderately compact to compact brown and light brown fine to coarse sand with variable percentages of silt and gravel. These soils should provide adequate support for the proposed pedestrian tunnel, provided they are stable at the time of construction. Based on a review of the available subsurface soil conditions, PSI estimates that the soil below the proposed tunnel foundations may be loaded to a maximum allowable soil bearing pressure of up to 5,000 psf, where the pedestrian tunnel foundations are extended through the existing roadway embankment fill and any buried native organic soils and constructed directly on the underlying native sand soils.

Based on the available subsurface information and anticipated loading, we estimate that total consolidation settlement of the fine to coarse support soils and deep silty clay soils below the proposed MSE retaining wall structures may be on the order of 1 inch or less.

Structural backfill placed against the tunnel walls should meet the material and compaction requirements specified in sections 206.02 and 206.03B respectively. To minimize settlement, it is imperative that the structure backfill be placed and compacted in accordance with a strict quality control program to minimize internal consolidation and to moderate external consolidation. Special attention should be given to the interface area between the abutment walls and its backfill and the approach roadway embankment fill. Poor densification in this area is often caused by restricted access of standard compaction equipment. Proper densification can be achieved by optimizing the soil gradation in this area to permit maximum density with minimum compactive effort.

The pedestrian tunnel walls should be designed as retaining structures. The equivalent fluid unit weights presented below provide recommended lateral earth pressures for the design of these walls. Clean granular soil, similar to MDOT Class II sand, is recommended as the backfill material against retaining structures to minimize lateral earth pressures. Based on the use of Class II sand, an active earth pressure coefficient of 0.33 and a passive earth pressure coefficient of 3.0 may be used for free standing retaining walls (free head). For restrained walls (fixed head), an at-rest earth pressure coefficient of 0.50 may be used. The equivalent fluid unit weights presented below provide recommended lateral earth pressures for the design of these walls. The table assumes the use of hand compacted Class II sand placed on a level surface directly behind the wall and having a moist unit weight of 125 pcf and an internal friction angle of 30 degrees.

Backfill Type	Equivalent Fluid Pressure Fixed-Head Walls (pcf)	Free-Head Walls (pcf)
Granular Material With drainage	60	45
Granular Material Without drainage	90	80

The abutment walls should be designed for earth pressures that represent the support and backfill conditions. If restricted movement at the top of the walls is anticipated, at-rest earth pressure should be used. Lateral earth pressures are significantly influenced by the type and intensity of the backfill compaction. Behind the abutment walls and below the bridge approach pavement section, high compactive effort will be necessary for the required subgrade preparation. If these conditions are anticipated, a higher equivalent fluid pressure in the range of approximately 90 to 120 pounds per square foot per foot depth of the wall should be considered. The abutment walls should also be designed to resist traffic surcharge loads and loads from construction equipment located in the vicinity of the bridge structure during construction.

4.0 CONSTRUCTION CONSIDERATIONS

4.1 Drainage, Groundwater and Related Considerations

Groundwater or perched water was encountered during drilling in roadway Borings B-2, B-14, B-18 and B-33 through B-49 at depths ranging from approximately 5 to 9 feet below the existing East Stadium Boulevard, State Street, White Street or Rose Street pavement surfaces or an elevation typically ranging from approximately 823 to 833 feet. Groundwater or perched water was encountered during drilling in pedestrian tunnel Borings T-1 and T-2 and retaining wall Borings RW-1, RW-3 and RW-7 through RW-21 at depths ranging from approximately 5 to 34 feet below the existing East Stadium Boulevard pavement or ground surface or an elevation typically ranging from approximately 830 to 838 feet. It is possible for the groundwater table to vary within the depths explored during other times of the year, depending upon climatic and rainfall conditions (seasonal fluctuation).

Therefore, difficulty with groundwater seepage or presence of perched water is anticipated during construction of the MSE retaining walls on this site. Difficulty with groundwater seepage is generally not anticipated during earthwork operations associated with the proposed roadway reconstruction. PSI recommends that the Contractor verify the actual groundwater and seepage conditions at the time of the construction activities and, if necessary, proposes his groundwater control methods for the Engineer's approval, including the disposal of discharge of water.

Water should not be allowed to collect in foundation excavations or prepared roadway subgrades either during or after construction. Water accumulation should be removed from excavations by pumping. Should excessive and uncontrolled amounts of seepage occur, the geotechnical engineer should be consulted. In addition, undercut or excavated areas should be sloped toward one corner to facilitate removal of any collected rainwater, groundwater or surface runoff.

Positive site surface drainage should be provided to reduce infiltration of surface water. The grades should be sloped away from the bridge structure and prepared roadway subgrades and surface drainage should be collected and discharged.

Every effort should be made to keep the excavations and prepared roadway subgrade dry if water is encountered or if rainfall or snowmelt occurs during construction. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils that become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork and foundation construction activities during dry weather.

4.2 Excavation Safety Considerations

Typically, soils penetrated by augers can be removed with conventional earthmoving equipment (backhoe and/or trencher). However, subsurface excavation equipment varies, and field refusal conditions may vary as well. Therefore, it is possible that difficult excavation conditions may be encountered at the proposed site location between the boring locations.

Excavation near any existing structure or utility should be performed with utmost care and with supervision of geotechnical engineer representative. Locations of all underground utilities within the proposed site must be verified by the contractor prior to excavation.

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

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

All earthwork, subgrade preparation, and foundation construction operations should be conducted in accordance with the project specifications and under the supervision of the Wayne County Road Commission or MDOT resident engineer or his representative. We are providing this information solely as a service to our client. PSI does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state, and federal safety or other regulations.

5.0 REPORT LIMITATIONS

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

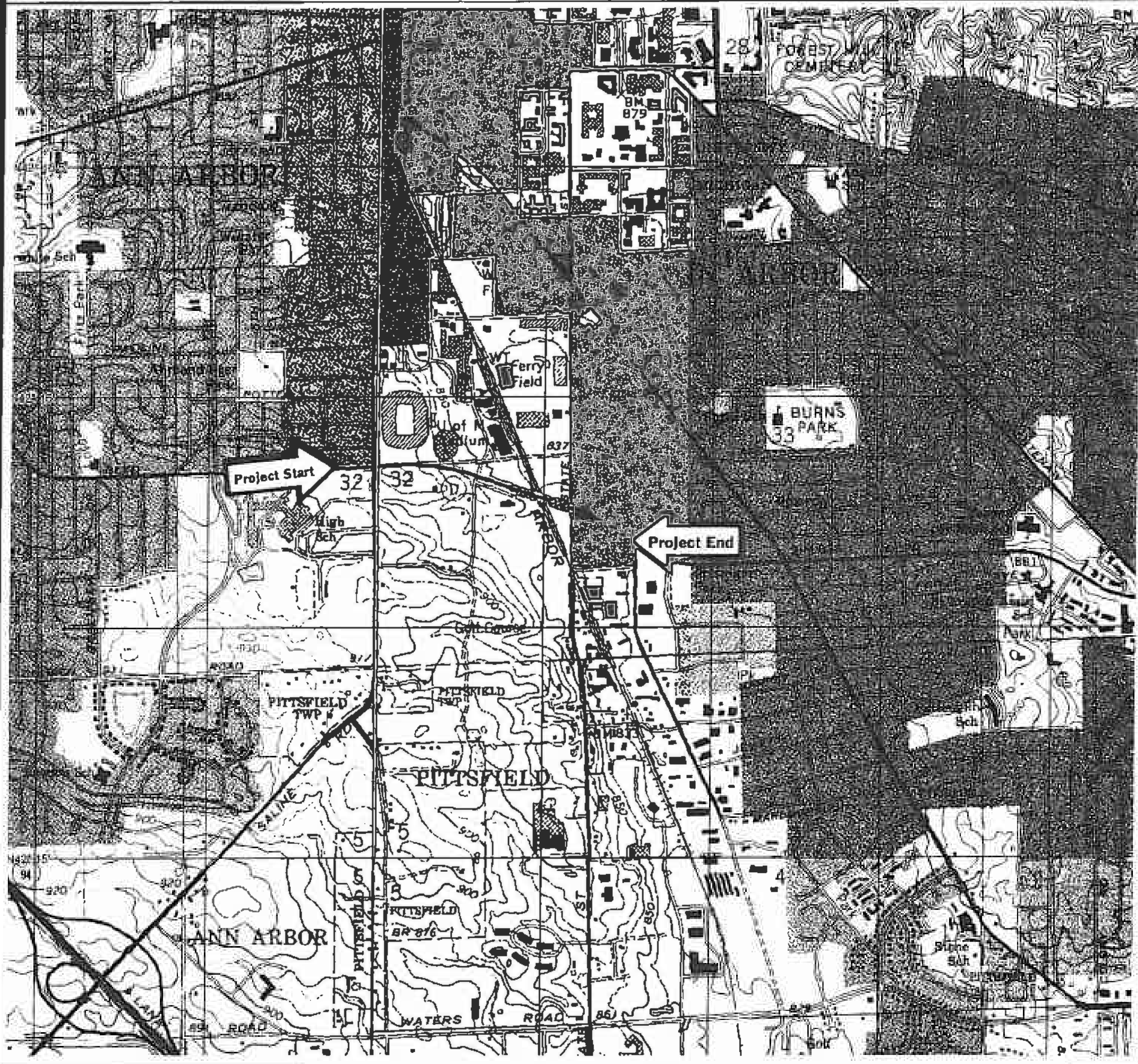
The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional engineering practices in the local area. No other warranties are implied or expressed.

This report has been prepared for the exclusive use of Northwest Consultants, Inc. and their authorized representatives. This report is intended for the specific application to the proposed East Stadium Boulevard roadway, MSE retaining wall, bike path and pedestrian tunnel design and construction portions of the proposed East Stadium Boulevard structure replacement project in the city of Ann Arbor, Washtenaw County, Michigan. .

APPENDIX
SECTION NO. 1

EAST STADIUM BOULEVARD
STRUCTURE REPLACEMENT PROJECT
CITY OF ANN ARBOR, WASHTENAW COUNTY, MICHIGAN

Figure 1
Site Vicinity Map



SCALE 1:24,000

1 ½ 0 MILES 1

PSI Project No.: 381 - 65050

psi *Information To Build On*
Engineering • Consulting • Testing

Base Map:
Ann Arbor East and West, MI
Quadrangle 7.5 Minute Series
Topographic Maps

Peak Acceleration (%g) with 10% Probability of Exceedance in 50 Years
USGS Map, Oct. 2002

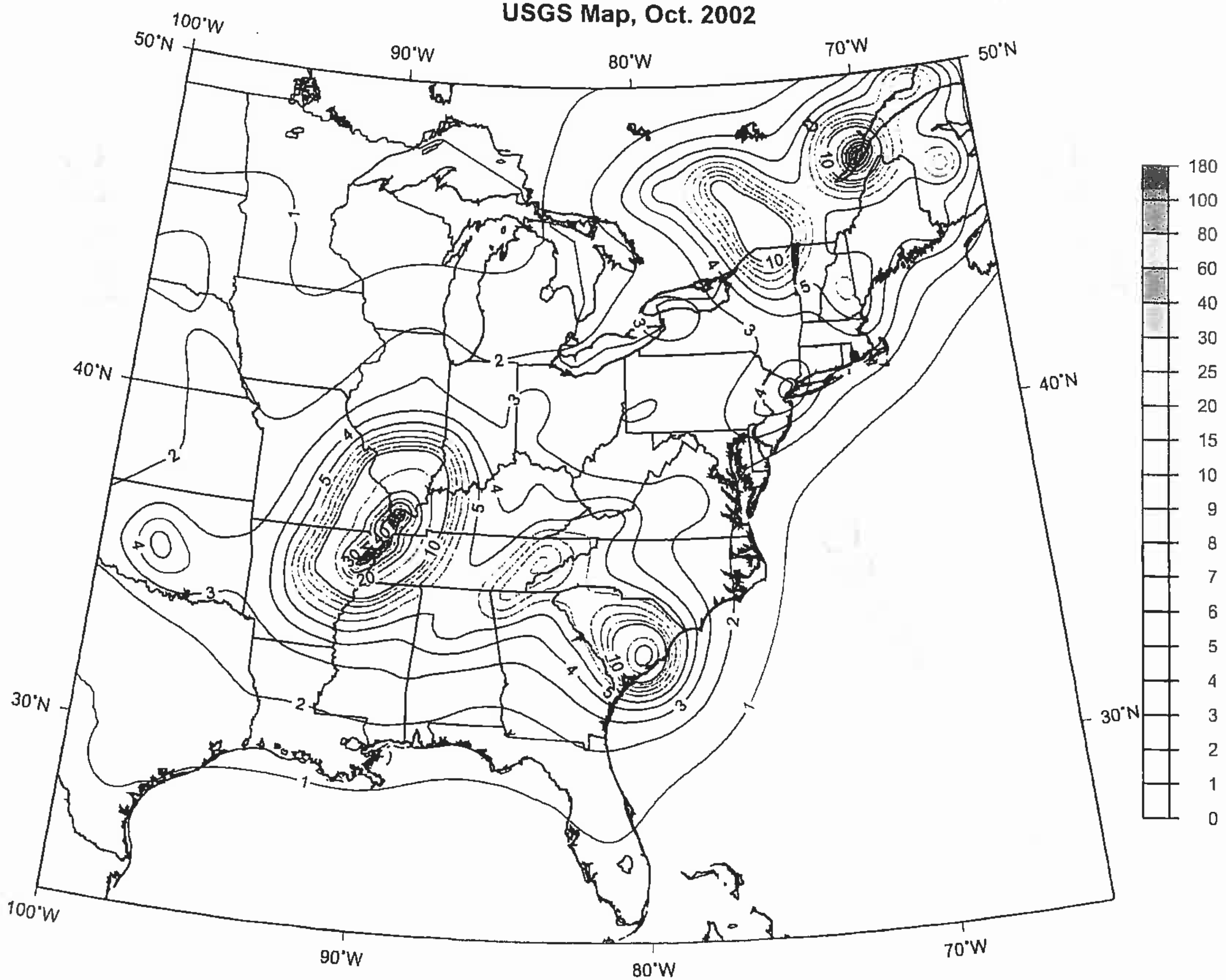


FIGURE NO. 2

Earthquake Hazard Risk Map

Source: http://earthquake.usgs.gov/hazmaps/

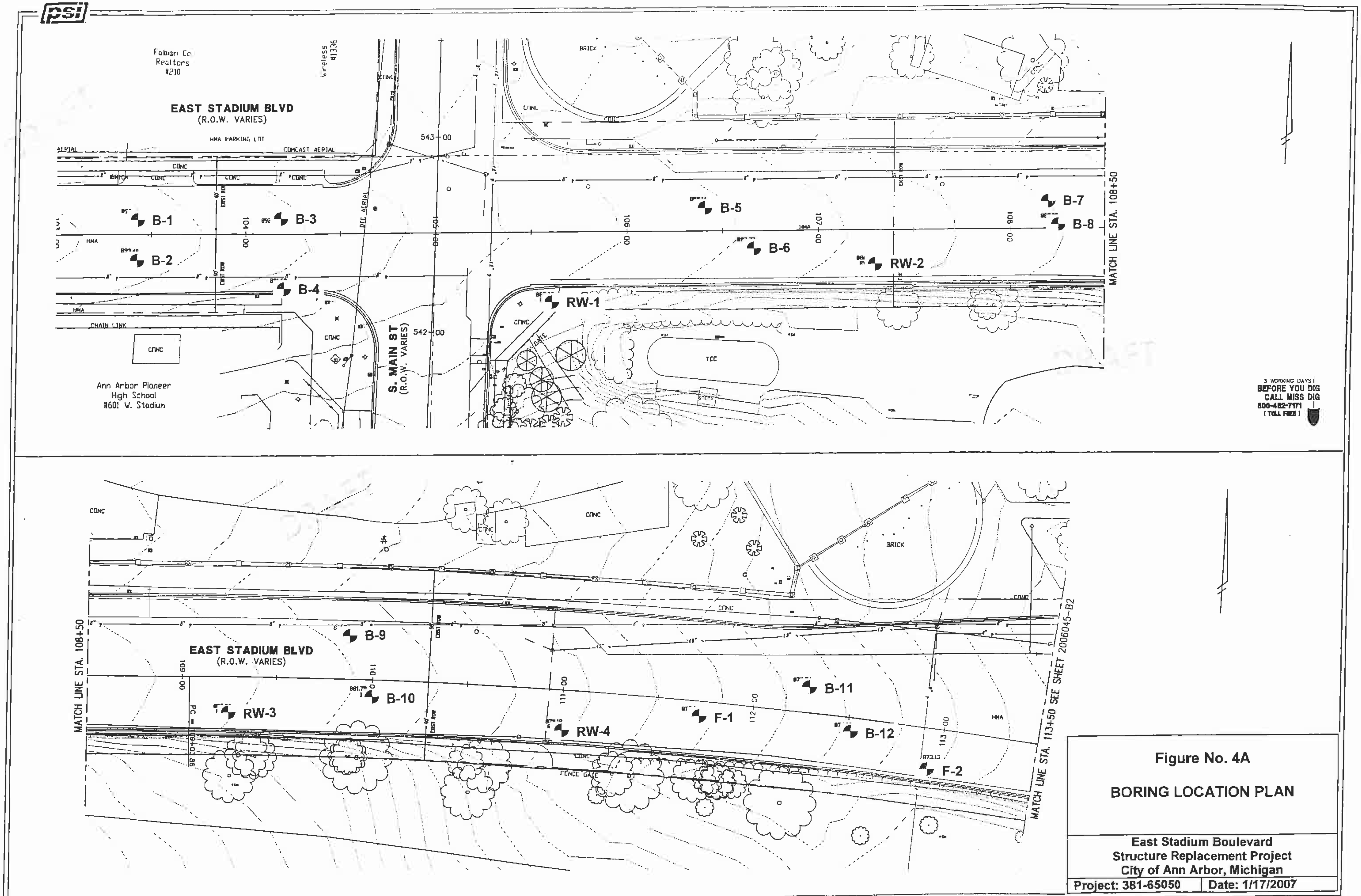
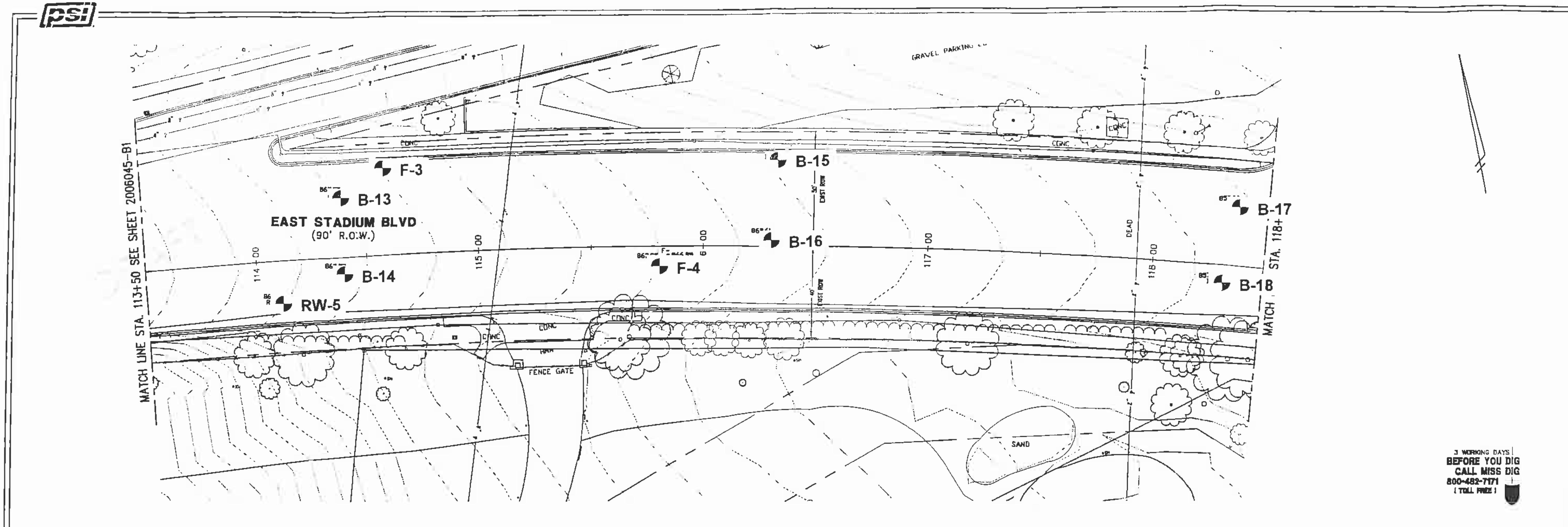


Figure No. 4A

BORING LOCATION PLAN

East Stadium Boulevard
Structure Replacement Project
City of Ann Arbor, Michigan

Project: 381-65050	Date: 1/17/2007



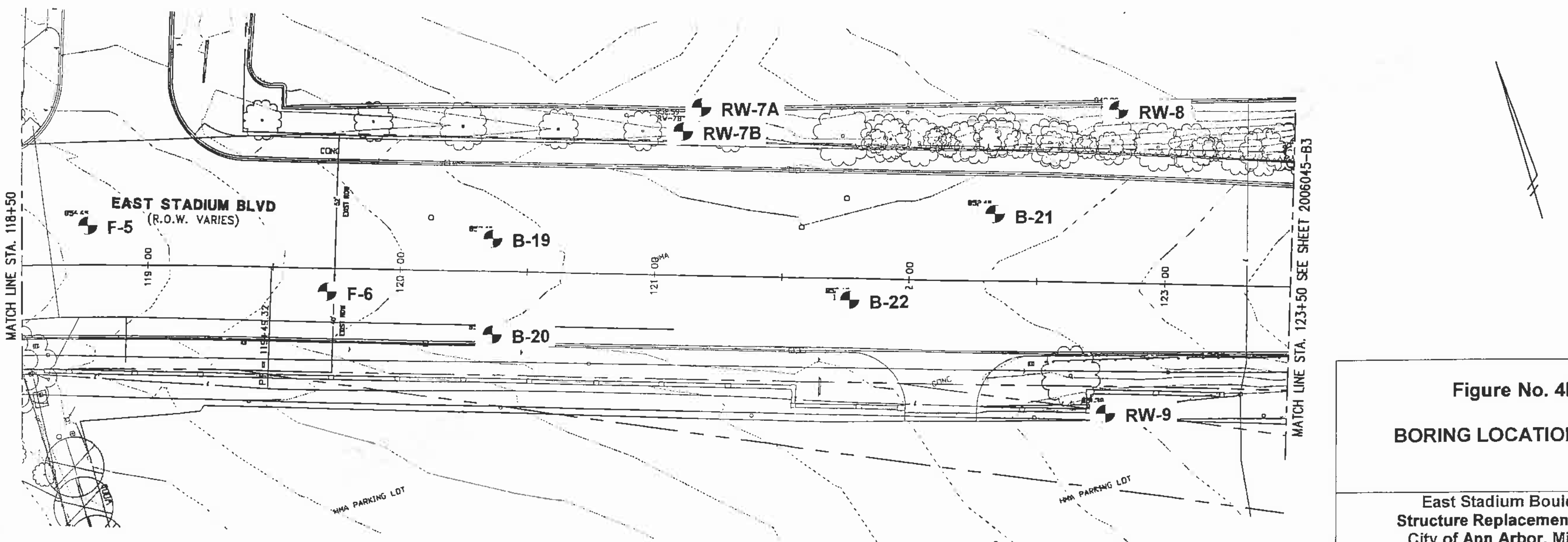


Figure No. 4B

BORING LOCATION PLAN

East Stadium Boulevard
Structure Replacement Project
City of Ann Arbor, Michigan

Project: 381-65050	Date: 1/17/2007

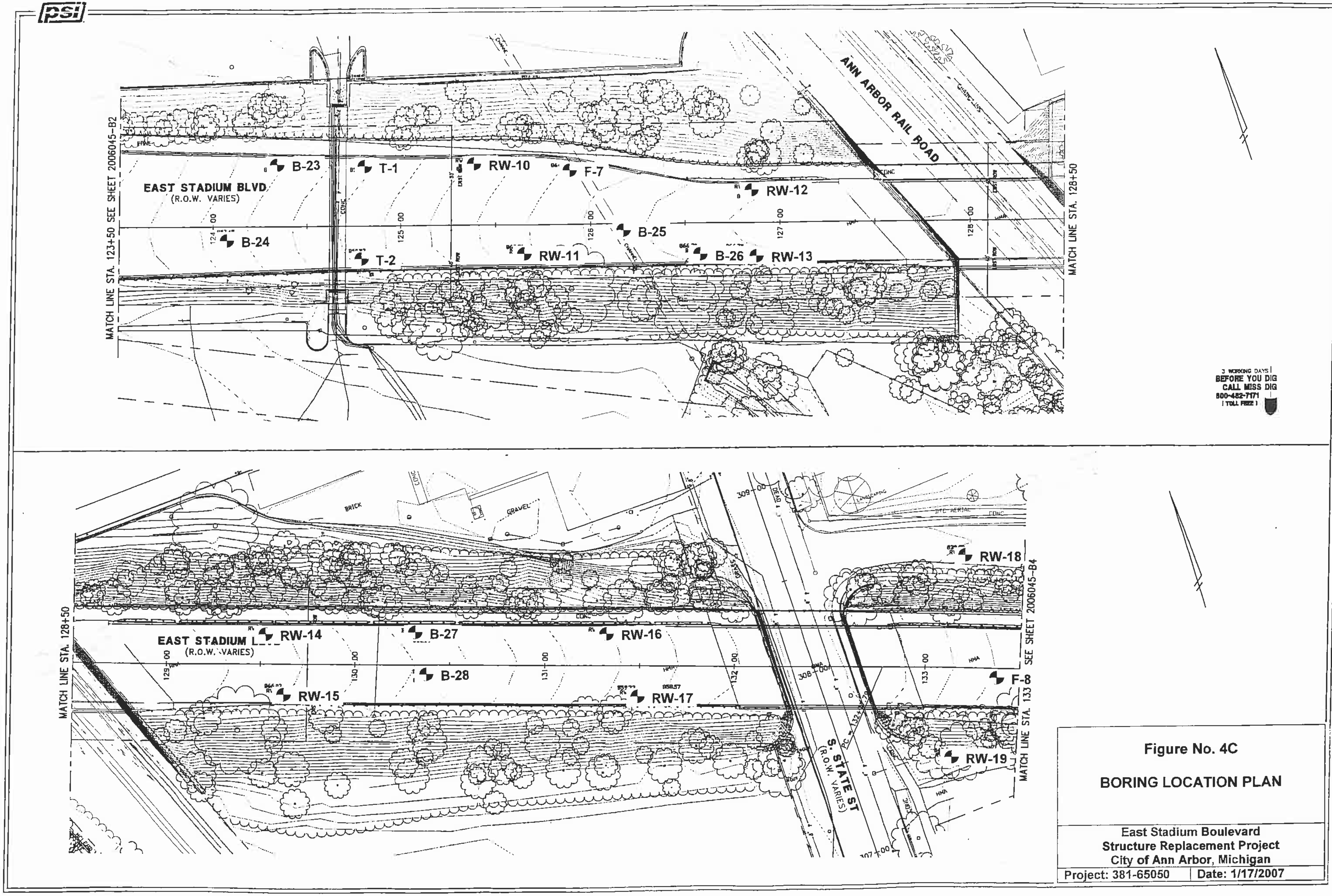


Figure No. 4C

BORING LOCATION PLAN

East Stadium Boulevard
Structure Replacement Project
City of Ann Arbor, Michigan

Project: 381-65050	Date: 1/17/2007

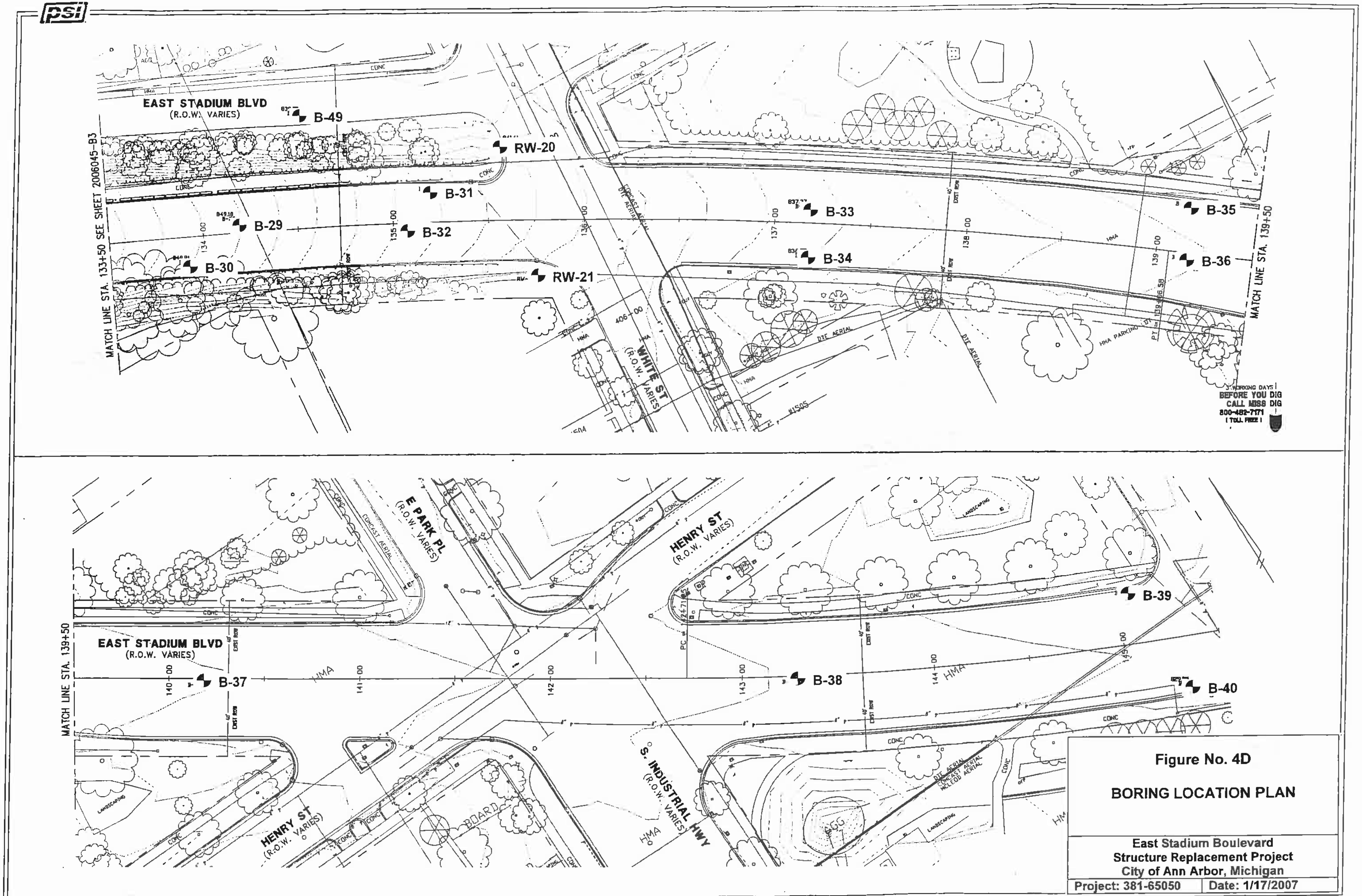


Figure No. 4D

BORING LOCATION PLAN

East Stadium Boulevard
Structure Replacement Project
City of Ann Arbor, Michigan

Project: 381-65050	Date: 1/17/2007

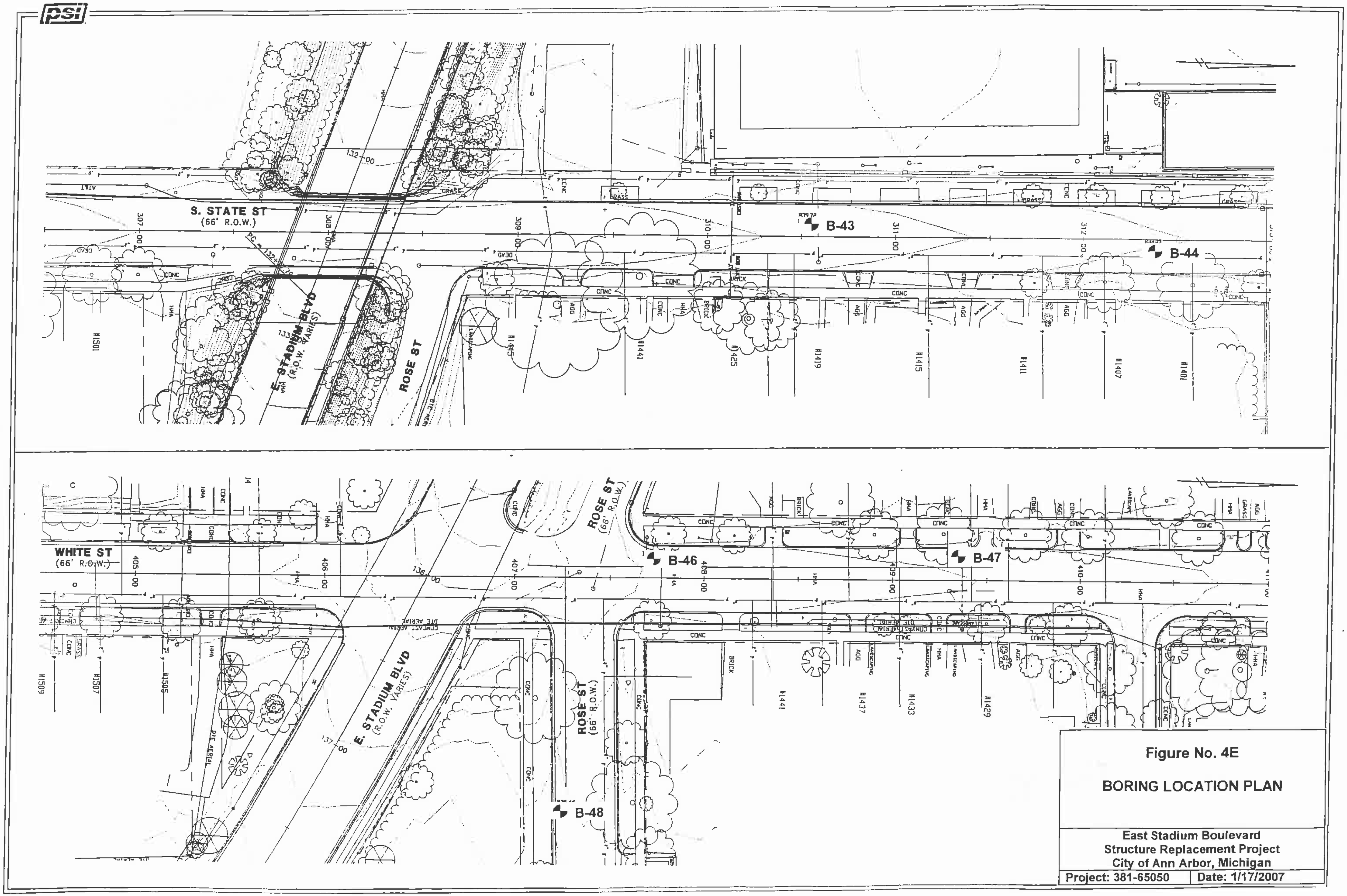


Figure No. 4E

BORING LOCATION PLAN

East Stadium Boulevard
Structure Replacement Project
City of Ann Arbor, Michigan

Project: 381-65050	Date: 1/17/2007

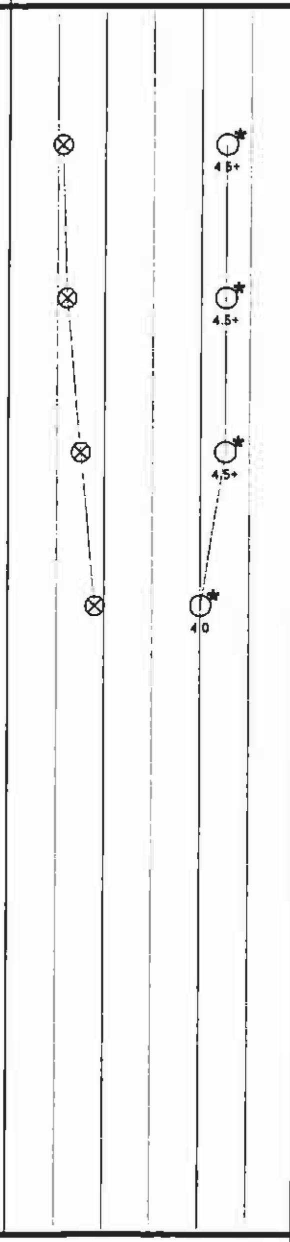
APPENDIX
SECTION NO. 2

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-1	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 103+43; 7' LT		

Surface Elevation: 893.48

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	893.0	5.5" ASPHALT PAVEMENT						
	892.4	8" CONCRETE PAVEMENT						
1SS		SILTY CLAY (CL) - with sand, trace gravel, mottled yellowish brown and gray to brown, moist, hard		11 (4,5,6)	17			
2SS	887.0		5	12 (4,5,7)	18			
3SS	884.5	SILTY CLAY (CL) - with sand, trace gravel, mottled brown and grayish brown, moist, very stiff		15 (6,7,8)	17			
4SS	883.0	SILTY CLAY (CL) - with sand, trace gravel, mottled yellowish brown and gray, moist, hard	10	18 (4,8,10)	16			
		END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)
○ Unconfined Compressive Strength (tsf)
○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)



Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling: None	Boring Started: 1/2/2007	Completed: 1/2/2007	Engineer: JDH
▼ Water Level At Completion: None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-2	PSI Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 103+42; 12' RT		

Legend: ⊗ "N" Blows Per Foot (scale 0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); ○* Calibrated Hand Penetrometer (tsf) (scale 0, 2, 4, 6)

Surface Elevation: 893.40

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Calibrated Hand Penetrometer (tsf)
	892.9	5.5" ASPHALT PAVEMENT							
	892.3	8" CONCRETE PAVEMENT							
		SILTY CLAY (CL) - with sand, trace gravel, brown, moist, stiff							
1HSA				10 (3,5,5)	15				
2HSA			5	10 (3,5,5)	14				
3SS	885.9			18 (3,5,13)	16				3.5
	884.4	SAND (SP-SM) - fine, with silt, brown and light brown, moist, moderately compact							
4SS	882.9	SILTY CLAY (CL) - with sand, trace gravel, brown and grayish brown, moist, stiff	10	14 (3,6,8)	15				4.0
		END OF BORING							

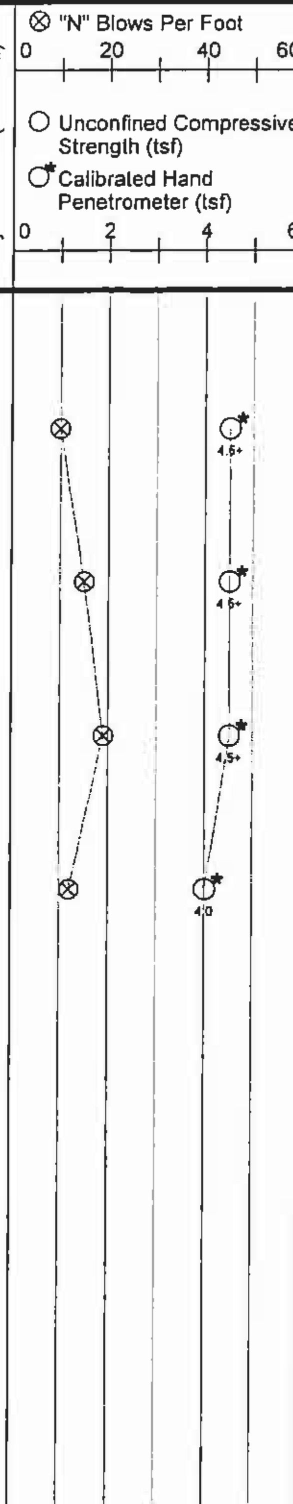
Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

∇ Water Level While Drilling 8.0'	Boring Started: 12/18/2006	Completed: 12/18/2006	Engineer: JDH
▼ Water Level At Completion 3.5'	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 3.5' After Completion	Driller: P. Cody	Drill Rig: CME-75 / Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **B-3**	**psi** *Professional Service Industries, Inc.*
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 104+18; 8' LT**		

Surface Elevation: **892.19**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Calibrated Hand Penetrometer (tsf)
	891.7	6" ASPHALT PAVEMENT							
	891.0	8" CONCRETE PAVEMENT							
1SS		SILTY CLAY (CL) - with sand, trace gravel, mottled yellowish brown and gray to brown, moist, hard		10 (4,4,6)	15				4.5+
2SS	885.7		5	15 (6,6,9)	22				4.5+
3SS	883.2	SILTY CLAY (CL) - with sand, trace gravel, grayish brown, moist, hard		19 (6,8,11)	14				4.5+
4SS	881.7	SILTY CLAY (CL) - trace sand and gravel, gray, moist, stiff	10	12 (4,5,7)	14				4.0
		END OF BORING							



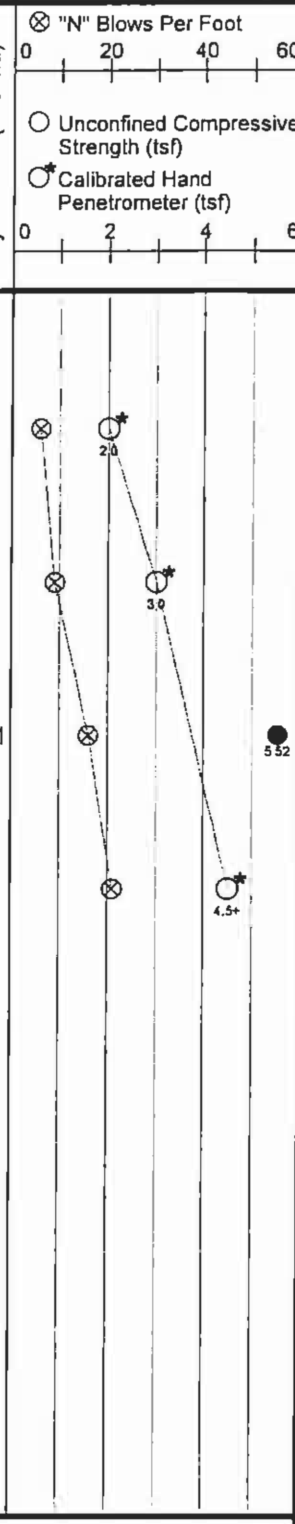
Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling None	Boring Started: 1/2/2007	Completed: 1/2/2007	Engineer: JDH
Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
________ After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 / Sheet: 1 of 1	Boring Log Number: B-4	*Professional Service Industries, Inc.*
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 104+21; 21' RT		

Surface Elevation: **891.63**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
		12" ASPHALT PAVEMENT						
1SS	890.6	SANDY CLAY (OL/CL) - trace organics, dark brown, moist L.O.I. = 3.2%		6 (2,2,4)	19			
2SS	889.1	SILTY CLAY (CL) - with sand, brown and reddish brown, moist, firm to stiff	5	9 (2,4,5)	15			
	886.6	SANDY CLAY (CL) - trace gravel and seams of sand, mottled brown, moist, stiff						
3SS	885.1	SILTY CLAY (CL) - with sand, trace gravel, brown, moist, hard		16 (3,6,10)	14			121
4SS			10	21 (3,8,13)	14			
	881.1	END OF BORING						



Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling: None	Boring Started: 12/18/2006	Completed: 12/18/2006	Engineer: JDH
Water Level At Completion: None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
____ After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved:
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-5	Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 106+41; 12' LT		

Surface Elevation: 888.14

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Calibrated Hand Penetrometer (tsf)
	887.6	6" ASPHALT PAVEMENT							
	887.0	8" CONCRETE PAVEMENT							
1SS		SILTY CLAY (CL) - with sand, trace gravel and organics, mottled olive brown and gray, moist, hard		11 (3,5,6)	17				4.5+
2SS	883.6	SILTY CLAY (CL) - trace sand and gravel, gray, moist, hard to stiff	5	12 (5,5,7)	12				4.5+
3SS				8 (5,3,5)	15				4.5+
4SS	877.6		10	8 (3,3,5)	15				4.0
		END OF BORING							

Legend: ⊗ "N" Blows Per Foot (0–60); ○ Unconfined Compressive Strength (tsf); ○* Calibrated Hand Penetrometer (tsf) (0–6)

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling: None	Boring Started: 1/2/2007	Completed: 1/2/2007	Engineer: JDH
Water Level At Completion: None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-6	PSI — Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 106+66; 9' RT		

Surface Elevation: 887.77

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Calibrated Hand Penetrometer (tsf)
	887.3	6" ASPHALT PAVEMENT							
	886.8	6" CONCRETE PAVEMENT							
1SS	885.3	SILTY CLAY (OL/CL) - with sand, trace organics, mottled blueish gray and olive, moist, stiff L.O.I. = 3.0%		11 (3,6,5)	16				4.5+
2SS		SILTY CLAY (CL) - trace sand and gravel, gray, moist, hard to stiff	5	11 (3,4,7)	13	14	27	124	6.58
3SS				9 (3,4,5)	15				3.25
4SS	877.3		10	9 (2,3,6)	15				3.0
		END OF BORING							

⊗ "N" Blows Per Foot (0–60)
○ Unconfined Compressive Strength (tsf)
Calibrated Hand Penetrometer (tsf) (0–6)

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling None
Water Level At Completion None
After Completion

Boring Started: 12/18/2006	Completed: 12/18/2006		Engineer: JDH
Drilling Method: 3.25" HSA		Office: Plymouth	Drawn By: JDH
Driller: P. Cody	Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]

Note: Boring backfilled with soil unless otherwise noted.

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-7	Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 108+19; 8' LT		

Surface Elevation: 884.97

"N" Blows Per Foot (0, 20, 40, 60); Unconfined Compressive Strength (tsf); Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Hand Penetrometer (tsf)
	884.6	5" ASPHALT PAVEMENT							
	884.0	7" CONCRETE PAVEMENT							
1SS		SILTY CLAY (OL/CL) - with sand, trace gravel and organics, mottled dark olive brown and dark grayish brown, moist, stiff to hard		9 (5,4,5)	19				4.5+
	881.0								
2SS		SILTY CLAY (CL) - with sand, trace gravel, mottled yellowish brown and gray to brown, moist, hard	5	16 (6,6,10)	13				4.5+
3SS				20 (8,9,11)	15				4.5+
	876.0								
4SS		SILTY CLAY (CL) - with sand, trace gravel, brown and grayish brown, moist, stiff	10	16 (4,7,9)	15				4.0
	874.5	END OF BORING							

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling None	Boring Started: 1/2/2007	Completed: 1/2/2007	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved:
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **B-8**	*Professional Service Industries, Inc.*
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 108+24; 2' LT**		

Surface Elevation: **885.08**

Legend: ⊗ "N" Blows Per Foot (scale 0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); ○* Calibrated Hand Penetrometer (tsf) (scale 0, 2, 4, 6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Strength (tsf)
	884.7	5" ASPHALT PAVEMENT							
	884.1	6.5" CONCRETE PAVEMENT							
		SILTY CLAY (CL) - with sand, trace gravel, mottled yellowish brown and gray, moist, stiff to hard							
1SS				7 (2,3,4)	15	15	29	122	3.28
2SS			5	17 (5,7,10)	14				4.5+
3SS				16 (4,6,10)	16				4.5+
	876.1	SILTY CLAY (CL) - with sand, trace gravel, brown and grayish brown, moist, hard							
4SS			10	16 (4,7,9)	15				4.5+
	874.6	END OF BORING							

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling None	Boring Started: 12/18/2006	Completed: 12/18/2006	Engineer: JDH
Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: MGS
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050**	Boring Log Number: **B-9**
	Sheet: **1** of **1**	
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 109+92; 22' LT**	*Professional Service Industries, Inc.*

Surface Elevation: **881.76**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Calibrated Hand Penetrometer (tsf)
	880.8	11" ASPHALT PAVEMENT							
	880.0	10" SAND AND GRAVEL BASE							
1SS	877.8	FILL - SILTY CLAY, with sand, dark grayish brown and olive, with layer of black cinders and slag, moist		12 (3,5,7)	13				
2SS	875.3	SILTY CLAY (CL) - with sand, trace gravel and organics, mottled olive brown and light grayish brown, moist, hard	5	12 (4,5,7)	14	16	36		4.5+
3SS		SILTY CLAY (CL) - with sand, trace gravel, mottled yellowish brown and gray to brown, moist, hard		17 (3,8,9)	14				4.5+
4SS	871.3		10	15 (3,6,9)	15				4.5+
		END OF BORING							

Legend: ⊗ "N" Blows Per Foot (0–60); O Unconfined Compressive Strength (tsf); O* Calibrated Hand Penetrometer (tsf) (0–6)

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling: None	Boring Started: **12/15/2006**	Completed: **12/15/2006**	Engineer: **JDH**
Water Level At Completion: None	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
______ After Completion	Driller: **P. Cody** / Drill Rig: **CME-75**	Hole Depth (ft): **10.5**	Approved:

Note: Boring backfilled with soil unless otherwise noted.

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: B-10	Professional Service Industries, Inc.
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 109+99; 10' RT		

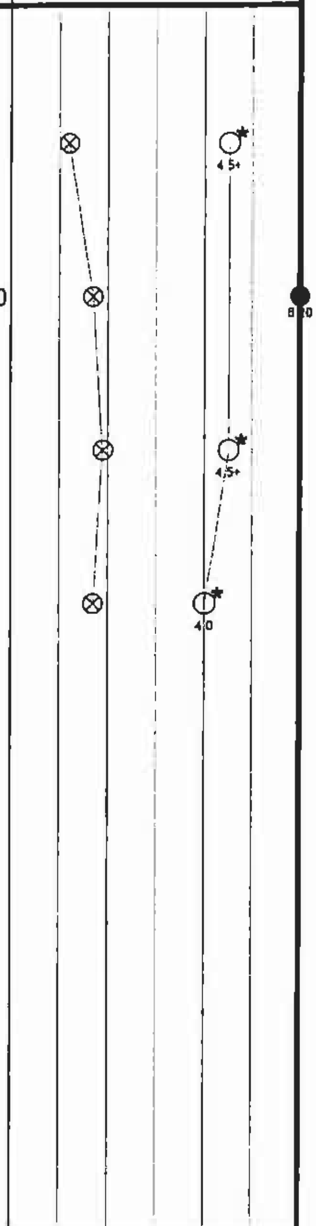
Surface Elevation: 881.79

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	881.5	4" ASPHALT PAVEMENT						
	880.6	8" CONCRETE PAVEMENT						
1SS		SILTY CLAY (CL) - with sand, trace gravel and organics, mottled brown, olive brown and grayish brown, moist, hard		12 (2,5,7)	14			
	877.8							
2SS		SILTY CLAY (CL) - with sand, trace gravel, mottled yellowish brown and gray to brown, moist, hard	5	17 (4,7,10)	14	15	29	120
3SS				19 (4,8,11)	15			
	872.8							
4SS		SILTY CLAY (CL) - trace sand and gravel, gray, moist, stiff	10	17 (4,6,11)	13			
	871.3	END OF BORING						

⊗ "N" Blows Per Foot (0 – 20 – 40 – 60)

○ Unconfined Compressive Strength (tsf)

○* Calibrated Hand Penetrometer (tsf) (0 – 2 – 4 – 6)



Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

∇ Water Level While Drilling: None	Boring Started: 12/18/2006	Completed: 12/18/2006	Engineer: JDH
▼ Water Level At Completion: None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody	Drill Rig: CME-75 / Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-11	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 112+28; 13' LT		

Surface Elevation: 875.54

Legend: ⊗ "N" Blows Per Foot (scale 0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); ○* Calibrated Hand Penetrometer (tsf) (scale 0, 2, 4, 6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Calibrated Hand Penetrometer (tsf)
	875.3	3.5" ASPHALT PAVEMENT							
	874.8	6" CONCRETE PAVEMENT							
		SANDY CLAY (CL) - mottled brown, light brown and reddish brown to brown, moist, stiff to hard							
1SS				8 (3,4,4)	17				4.5+
	871.5	SILTY CLAY (CL) - with sand, trace gravel, brown, moist, hard to stiff							
2SS			5	9 (2,3,6)	16				4.5+
3SS				12 (3,5,7)	19				3.5
	866.5	SAND (SP) - medium, trace silt and gravel, brown, moist, very loose							
4SS			10	3 (2,1,2)	8				
	865.0	END OF BORING							

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling None	Boring Started: 12/15/2006	Completed: 12/15/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050**
	Sheet: 1 of 1
Boring Log Number: **B-12**	Professional Service Industries, Inc.
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 112+51; 9' RT**

Surface Elevation: **874.90**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	874.1	10" ASPHALT PAVEMENT						
	873.5	7" SAND, GRAVEL AND CRUSHED CONCRETE BASE						
1SS	870.9	FILL - CLAYEY SAND, trace gravel, organics and seams of fine to medium sand, dark gray and gray, moist		5 (2,3,2)	12			
2SS		FILL - SAND, fine to coarse, with silt, brown, moist	5	6 (2,3,3)	6			
3SS				3 (2,2,1)	9			
4SS	864.4		10	2 (1,1,1)	11			
		END OF BORING						

⊗ "N" Blows Per Foot (0–60)

○ Unconfined Compressive Strength (tsf)

○* Calibrated Hand Penetrometer (tsf) (0–6)

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling: None	Boring Started: 12/18/2006	Completed: 12/18/2006	Engineer: JDH
Water Level At Completion: None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody	Drill Rig: CME-75; Hole Depth (ft): 10.5	Approved: [signature]

Note: Boring backfilled with soil unless otherwise noted.

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-13	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 114+29; 25' LT		

Surface Elevation: 867.88

Legend: ⊗ "N" Blows Per Foot (0–60); O Unconfined Compressive Strength (tsf); O* Calibrated Hand Penetrometer (tsf) (0–6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Calibrated Hand Penetrometer (tsf)
		12" ASPHALT PAVEMENT							
	866.9	6" SAND AND GRAVEL BASE							
1SS	866.4	SILTY CLAY (OL/CL) - with organics, dark gray to mottled dark olive and gray, moist, firm L.O.I. = 4.4%		6 (3,3,3)	22	16	36		2.0
2SS	863.9	SILTY CLAY (CL) - with sand, trace gravel, mottled yellowish brown and gray, moist, hard	5	12 (3,4,8)	13				4.5+
3SS	861.4	SILTY CLAY (CL) - with sand, trace gravel, brown, moist, hard		20 (4,8,12)	17				4.5+
4SS			10	25 (9,11,14)	15				
	857.4	END OF BORING							

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling None	Boring Started: 12/15/2006	Completed: 12/15/2006	Engineer: JDH
Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody	Drill Rig: CME-75 / Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: B-14	psi *Professional Service Industries, Inc.*
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 114+29; 9' RT		

Surface Elevation: 868.32

Legend: ⊗ "N" Blows Per Foot (scale 0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); ○* Calibrated Hand Penetrometer (tsf) (scale 0, 2, 4, 6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Strength (tsf)
	867.9	4.5" ASPHALT PAVEMENT							
	867.4	7" CONCRETE PAVEMENT							
1SS	865.3	CLAYEY SAND (OL/SC) - trace organics, dark gray to dark brown and reddish brown, moist, loose		7 (2,3,4)	14				
2SS		SILTY CLAY (CL) - with sand, trace gravel, mottled yellowish brown and gray, moist, stiff to firm	5	9 (3,4,5)	16	15	29	112	3.54
3SS	859.3	seam of wet clayey sand		9 (2,4,5)	21				1.5
4SS	857.8	SILTY CLAY (CL) - with sand, trace gravel, brown and brownish gray, moist, hard	10	22 (4,8,14)	18				4.5+
		END OF BORING							

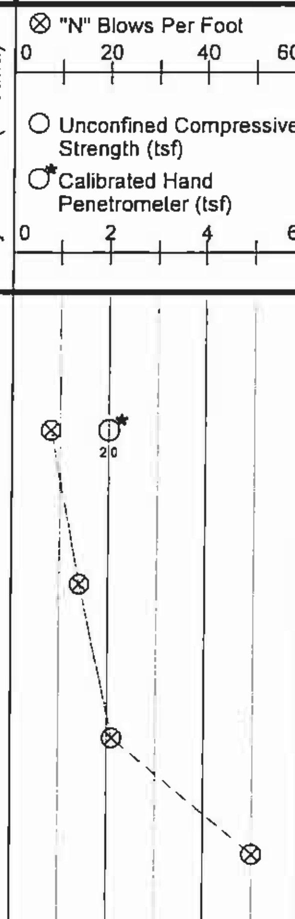
Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

∇ Water Level While Drilling 6.5'	Boring Started: 12/19/2006	Completed: 12/19/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: B-15	psi Professional Service Industries, Inc.
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 116+33; 38' LT		

Surface Elevation: 861.80

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
		10.5" ASPHALT PAVEMENT						
	860.9	SANDY CLAY (OL/CL) - with organics, mottled dark brown and dark gray, moist L.O.I. = 4.8%						
1SS	860.3	SANDY CLAY (CL) - mottled brown and yellowish brown, moist, firm		8 (2,3,5)	29			
2SS	857.8	SILTY SAND (SM) - fine, occasional seams of silt, light grayish brown, moist, moderately compact	5	14 (5,7,7)	13			
3SS	855.3	SAND (SM) - fine to coarse, with silt and gravel, brown and light brown, moist, moderately compact to very compact		21 (3,7,14)	7			
4SS	852.5	END OF BORING		50+ (30/4" Obstr.)				



Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling None	Boring Started: 11/29/2006	Completed: 11/29/2006	Engineer: JDH
Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 9.3	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-16	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 116+30; 2' LT		

Surface Elevation: **862.61**

⊗ "N" Blows Per Foot (0–60)
○ Unconfined Compressive Strength (tsf)
○* Calibrated Hand Penetrometer (tsf) (0–6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Hand Penetrometer (tsf)
	862.2	4.5" ASPHALT PAVEMENT							
	861.7	7" CONCRETE PAVEMENT							
1SS		SILTY CLAY (OL/CL) - with sand and organics, dark gray to mottled dark gray and dark olive, moist, stiff L.O.I. = 5.1%		8 (2,3,5)	25				3.0
	859.6	SILTY CLAY (CL) - with sand, trace gravel, mottled grayish brown and olive to brown, moist, stiff							
2SS			5	8 (2,3,5)	22				3.5
	856.1	SILTY SAND (SM) - fine, light brown to light yellowish brown, moist, moderately compact							
3SS				19 (5,9,10)	5				
	853.6	SAND (SP) - fine to medium, light grayish brown, moist, moderately compact							
4SS			10	24 (4,11,13)	4				
	852.1	END OF BORING							

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

∇ Water Level While Drilling None	Boring Started: 12/20/2006	Completed: 12/20/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: B-17	Professional Service Industries, Inc.
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 118+37; 25' LT		

DRAFT

Surface Elevation: 857.22

"N" Blows Per Foot (0–60); Unconfined Compressive Strength (tsf); Calibrated Hand Penetrometer (tsf) (0–6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Hand Penetrometer (tsf)
		12" ASPHALT PAVEMENT							
	856.2	6" SAND AND GRAVEL BASE							
1SS	855.7	SILTY CLAY (OL/CL) - with sand and organics, black to dark reddish brown and grayish brown, moist, firm L.O.I. = 5.0%		7 (4,3,4)	21				
2SS	853.7	SILTY SAND (SM) - fine, yellowish brown, moist, loose	5	6 (5,4,2)	6				
3SS				12 (5,6,6)	9				
	849.7	CLAYEY SAND (SC) - fine to coarse, with gravel, brown, grayish brown and red, moist, moderately compact							
4SS	848.2	SILTY CLAY (CL) - trace sand and gravel, mottled gray, moist, stiff	10	8 (2,3,5)	13				4.0
	846.7	END OF BORING							

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling: None	Boring Started: 12/15/2006	Completed: 12/15/2006	Engineer: JDH
Water Level At Completion: None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: MEG
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: B-18	psi Professional Service Industries, Inc.
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 118+30; 10' RT		

DRAFT

Surface Elevation: 857.79

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Calibrated Hand Penetrometer (tsf)
	857.5	4" ASPHALT PAVEMENT							
	856.9	7" CONCRETE PAVEMENT							
1SS	855.6	SANDY CLAY (OL/CL) - with organics, dark gray, moist L.O.I. = 3.7%		8 2,3,5	21				
	853.8	SILTY SAND (SM) - fine, olive brown and grayish brown, moist, loose							
2SS	851.3	SILTY CLAY (CL) - with sand, trace gravel, mottled yellowish brown and gray, moist, hard	5	11 3,5,6	12				4.5+
3SS	848.8	SILTY CLAY (CL) - gray, seam of wet olive silty sand, stiff		14 4,7,7	15				2.5
4SS	847.3	SANDY SILT (ML) - occasional seams of silty sand, grayish brown, wet, loose	10	6 2,2,4	17				
		END OF BORING							

⊗ "N" Blows Per Foot (0, 20, 40, 60)
○ Unconfined Compressive Strength (tsf)
Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

∇ Water Level While Drilling 7.5'	Boring Started: 12/20/2006	Completed: 12/20/2006	Engineer: JDH
▼ Water Level At Completion 8.0'	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 8.25' After Completion	Driller: P. Cody · Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved:
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: B-19	psi Professional Service Industries, Inc.
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 120+36; 12' LT		

DRAFT

Surface Elevation: 853.40

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	853.0	5" ASPHALT PAVEMENT						
	852.3	8" CONCRETE PAVEMENT						
1SS		CLAYEY SAND (SC) - some gravel, reddish brown, moist, moderately compact		12 2,5,7	10			
2SS	849.4	SAND (SP-SM) - fine to coarse, with gravel and silt, brown and light brown, moist, moderately compact	5	15 4,7,8	5			
3SS	846.9	SAND (SP-SM) - fine to medium, with silt, trace gravel, light brown to light yellowish brown, moist, moderately compact		18 9,9,9	5			
4SS			10	18 5,8,10	5			
	842.9	END OF BORING						

⊗ "N" Blows Per Foot: 0, 20, 40, 60
○ Unconfined Compressive Strength (tsf)
Calibrated Hand Penetrometer (tsf): 0, 2, 4, 6

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling: None
Water Level At Completion: None
__________ After Completion

Boring Started: 12/15/2006	Completed: 12/15/2006		Engineer: JDH
Drilling Method: 3.25" HSA		Office: Plymouth	Drawn By: JDH
Driller: P. Cody	Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
Note: Boring backfilled with soil unless otherwise noted.			

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: B-20	Professional Service Industries, Inc.
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 120+37; 26' RT		

DRAFT

Surface Elevation: 852.89

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	852.5	5" ASPHALT PAVEMENT						
	851.4	13" CRUSHED LIMESTONE BASE						
1SS		FILL - SAND, fine to medium, with silt, gravel and coarse sand, brown, moist **Sample Tested for Gradation		20 7,11,9	8			
2SS			5	3 4,2,1	9			
3SS	843.9			7 1,2,5	9			
4SS	842.4	SAND (SP-SM) - fine to medium, with silt, gravel and coarse sand, brown and light brown, moist, moderately compact	10	18 6,7,11	7			
		END OF BORING						

⊗ "N" Blows Per Foot: 0, 20, 40, 60

○ Unconfined Compressive Strength (tsf)

○* Calibrated Hand Penetrometer (tsf): 0, 2, 4, 6

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

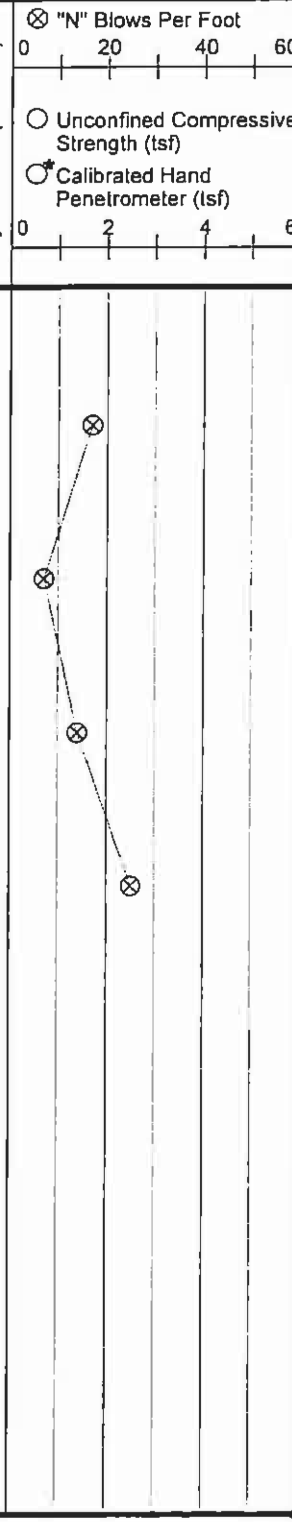
Water Level While Drilling None	Boring Started: 11/22/2006	Completed: 11/22/2006	Engineer: JDH
Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved:
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050**
	Sheet: **1** of **1**
Boring Log Number: **B-21**	*psi* Professional Service Industries, Inc.
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 122+32; 26' LT**

DRAFT

Surface Elevation: **852.42**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
		10" ASPHALT PAVEMENT						
	851.6	FILL - SAND, fine to medium, with silt, brown, moist						
1SS				17 (10,10,7)	12			
	849.9	FILL - SILTY SAND, fine to medium, trace gravel, brown and reddish brown, occasional seams of dark brown silty organics and clayey sand, moist L.O.I. = 2.4%						
2SS			5	7 (4,3,4)	7			
	845.9	SAND (SP-SM) - fine to medium, with silt, gravel and coarse sand, light brown, moist, moderately compact						
3SS				14 (4,6,8)	5			
4SS			10	25 (5,12,13)	4			
	841.9	END OF BORING						



DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling **None**	Boring Started: **11/29/2006**	Completed: **11/29/2006**	Engineer: **JDH**
Water Level At Completion **None**	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
________ After Completion	Driller: **P. Cody** Drill Rig: **CME-75**	Hole Depth (ft): **10.5**	Approved: NE
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-22	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 121+77; 10' RT		

Surface Elevation: **852.49**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	852.1	5" ASPHALT PAVEMENT						
	851.4	8" CONCRETE PAVEMENT						
1SS		FILL - SILTY SAND, fine to medium, trace clayey fines, reddish brown, moist		7 (3,4,3)	13			
2SS	848.5	FILL- SAND, fine to medium, with silt, gravel and coarse sand, trace seams of reddish brown clayey sand, moist	5	10 (1,2,8)	7			
3SS	846.0	SAND (SP-SM) - fine to coarse, with silt and gravel, light brown, moist, moderately compact		25 (4,12,13)	4			
4SS			10	21 (4,9,12)	4			
	842.0	END OF BORING						

Legend: ⊗ "N" Blows Per Foot (0–60); ○ Unconfined Compressive Strength (tsf); ○* Calibrated Hand Penetrometer (tsf) (0–6)

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling: None	Boring Started: 12/20/2006	Completed: 12/20/2006	Engineer: JDH
Water Level At Completion: None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: B-23	psi *Professional Service Industries, Inc.*
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 124+34; 33' LT		

DRAFT

Legend: ⊗ "N" Blows Per Foot (scale 0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); Calibrated Hand Penetrometer (tsf) (scale 0, 2, 4, 6)

Surface Elevation: **857.97**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
		11" ASPHALT PAVEMENT						
	857.1	FILL - SAND, fine to medium, with silt, brown, moist						
1SS				24 (9,11,13)	7			
	855.5	FILL - SILTY SAND, fine to medium, trace gravel, brown and reddish brown, occasional seams of dark brown and dark gray silty organics and clayey sand, moist						
2SS			5	12 (6,5,7)	11			
3SS				4 (2,2,2)	12			
	849.0	FILL - SILTY SAND, with clayey fines and organics, trace coarse gravel, brown and dark brown, moist L.O.I. = 4.5%						
4SS			10	7 (2,3,4)	19			
	847.5	END OF BORING						

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling: None	Boring Started: 11/27/2006	Completed: 11/27/2006	Engineer: JDH
Water Level At Completion: None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: MCL
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 / Sheet: 1 of 1	Boring Log Number: B-24	psi Professional Service Industries, Inc.
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 124+06; 7' RT		

DRAFT

Surface Elevation: 857.45

Sample No./Type	Sample Location	Sample Recovery	Graphical Log	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	"N" Blows Per Foot (0–60); Unconfined Compressive Strength (tsf); Calibrated Hand Penetrometer (tsf) (0–6)
				857 1	4.5" ASPHALT PAVEMENT							
				856 4	8" CONCRETE PAVEMENT							
1SS					FILL - SILTY SAND, with clayey fines, brown and reddish brown, moist		27 (4,13,14)	8				
				853 5								
2SS					FILL - SAND, fine to medium, with silt, trace gravel, brown, occasional seams of dark brown silty organics, moist	5	7 (4,4,3)	8				
3SS							17 (7,10,7)	6				
				848 5								
4SS					FILL - SILTY CLAY, trace gravel, brown, with lenses of dark brown silty organics, moist	10	7 (2,4,3)	4				2.0
				847 0	END OF BORING							

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling None	Boring Started: 12/20/2006	Completed: 12/20/2006	Engineer: JDH
Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: MGC
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-25	Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 126+15; 5' RT		

DRAFT

Surface Elevation: 865.56

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	865.3	3" ASPHALT PAVEMENT						
	864.7	8" CONCRETE PAVEMENT						
1SS		FILL - SILTY SAND, fine to medium, trace gravel, brown with seams of black organics, moist		6 (2,2,4)	11			
2SS	861.6	FILL - SAND, fine to coarse, trace gravel, brown and light brown, moist	5	12 (3,7,5)	6			
3SS	859.1	FILL - SILTY SAND, fine to medium, trace gravel, brown and reddish brown, occasional seams of brown silt, moist		14 (6,6,8)	9			
4SS			10	6 (3,3,3)	8			
	855.1	END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)

○ Unconfined Compressive Strength (tsf)

○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling: None	Boring Started: 12/20/2006	Completed: 12/20/2006	Engineer: JDH
Water Level At Completion: None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody	Drill Rig: CME-75 / Hole Depth (ft): 10.5	Approved:
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: B-26	Professional Service Industries, Inc.
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 126+56; 16' RT		

DRAFT

Surface Elevation: 866.30

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	866.0	4" ASPHALT PAVEMENT						
	865.2	9" CONCRETE PAVEMENT						
1SS		FILL - SAND, fine to medium, with silt, gravel and coarse sand, dark brown to brown, occasional seams of reddish brown silty sand and fine to coarse sand, moist **Sample Tested for Gradation		11 (4,4,7)	9			
2SS			5	4 (2,2,2)	9			
3SS				7 (3,4,3)	9			
4SS	855.8		10	4 (2,2,2)	9			
		END OF BORING						

⊗ "N" Blows Per Foot (0–60)
○ Unconfined Compressive Strength (tsf)
○* Calibrated Hand Penetrometer (tsf) (0–6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling: None	Boring Started: 11/28/2006	Completed: 11/28/2006	Engineer: JDH
▼ Water Level At Completion: None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: MC
	Note: Boring backfilled with soil unless otherwise noted.		

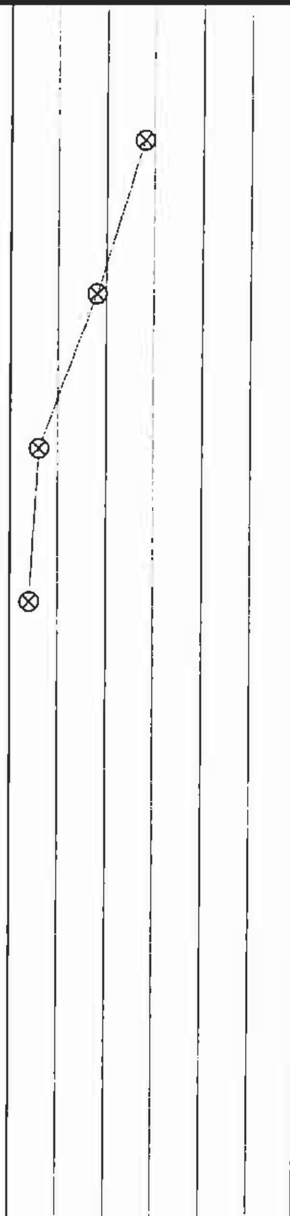
Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-27	*psi* Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 130+30; 16' LT		

DRAFT

Surface Elevation: **863.58**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	863.3	3" ASPHALT PAVEMENT						
	862.7	8" CONCRETE PAVEMENT						
		FILL - SAND, fine to medium, with silt, gravel and coarse sand, brown and light brown, moist						
1SS		**Sample Tested for Gradation		28 (8,14,14)	6			
2SS			5	18 (12,10,8)	4			
	857.1	FILL - SILTY SAND, fine to medium, trace gravel, brown and reddish brown, occasional seams of fine to coarse sand and clayey fines, moist						
3SS				6 (5,3,3)	10			
4SS			10	4 (1,2,2)	12			
	853.1	END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)
○ Unconfined Compressive Strength (tsf)
○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)



DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling: None	Boring Started: 11/27/2006	Completed: 11/27/2006	Engineer: JDH
▼ Water Level At Completion: None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

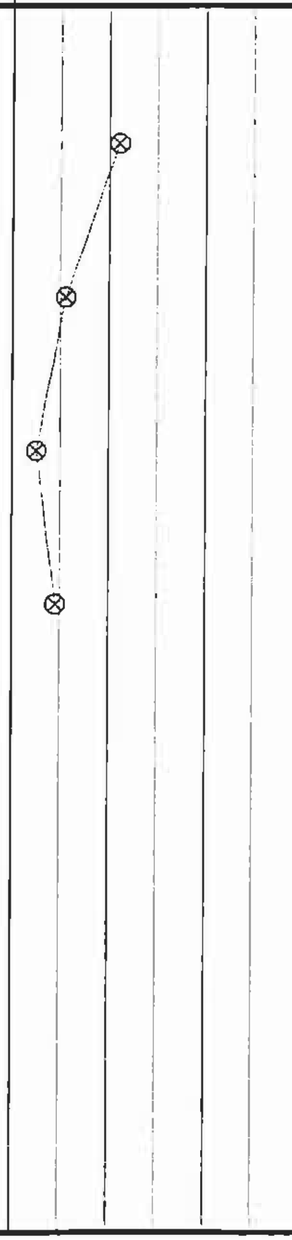
Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-28	PSI — Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 130+37; 5' RT		

DRAFT

Surface Elevation: **863.74**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	863.4	4" ASPHALT PAVEMENT						
	862.7	8" CONCRETE PAVEMENT						
1SS		FILL - SILTY SAND, fine to medium, with silt, gravel and coarse sand, brown to brown and reddish brown, moist		22 (4,9,13)	6			
2SS			5	11 (7,6,5)	8			
3SS	854.7			5 (4,2,3)	7			
4SS	853.2	FILL - SILTY SAND, with clayey fines, trace gravel, grayish brown, moist	10	9 (5,5,4)	11			
		END OF BORING						

⊗ "N" Blows Per Foot (0–60); ○ Unconfined Compressive Strength (tsf); Calibrated Hand Penetrometer (tsf) (0–6)



DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

⊻ Water Level While Drilling None	Boring Started: 12/20/2006	Completed: 12/20/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: NEC
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-29	
	Sheet: 1 of 1		**psi** Professional Service Industries, Inc
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 134+17; 5' LT		

DRAFT

Surface Elevation: 849.18

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	849.0	2" ASPHALT PAVEMENT						
	848.3	9" CONCRETE PAVEMENT						
1SS		FILL - SAND, fine to coarse, with silt and gravel, occasional seams of silty sand, brown, moist		14 (3,6,8)	5			
2SS	845.2	FILL - SILTY SAND, fine to medium, trace gravel and seams of dark gray to black sandy organics, moist	5	9 (5,4,5)	10			
3SS	842.7	FILL - CLAYEY SAND, trace gravel, dark reddish brown, moist		5 (2,2,3)	16			
4SS	840.2	SAND (SP-SM) - fine to coarse, with silt and gravel, brown and light brown, moist, compact	10	37 (24,17,20)	6			
	838.7	END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)

○ Unconfined Compressive Strength (tsf)

Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling: None	Boring Started: 12/15/2006	Completed: 12/15/2006	Engineer: JDH
Water Level At Completion: None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-30	Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 133+93; 16' RT		

DRAFT

Surface Elevation: 849.91

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	849.7	3" ASPHALT PAVEMENT						
	849.0	8" CONCRETE PAVEMENT						
		FILL - SAND, fine to coarse, with gravel, brown and light brown, moist						
1SS				12 (4,5,7)	6			
	845.9	FILL - SILTY SAND, fine to medium, trace gravel, brown and reddish brown, moist						
2SS			5	4 (3,2,2)	8			
3SS				4 (3,2,2)	15			
	840.9	SILTY SAND (OL/SM) - with organics, dark brown, moist						
4SS	840.4	SAND (SP-SM) - fine to medium, with silt, trace gravel, brown, moist, loose	10	10 (6,5,5)	16			
	839.4	END OF BORING						

Chart legend: ⊗ "N" Blows Per Foot (0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling None	Boring Started: 1/2/2007	Completed: 1/2/2007	Engineer: JDH
Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: B-31	psi *Professional Service Industries, Inc.*
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 135+20; 15' LT		

DRAFT

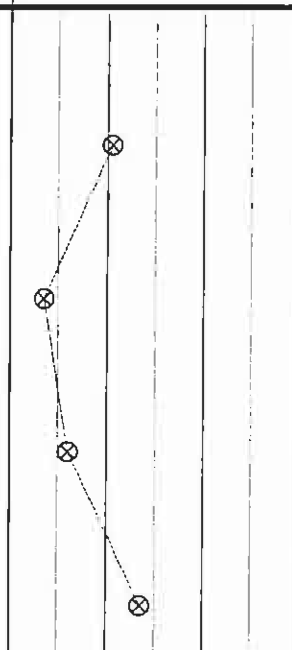
Surface Elevation: **844.17**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	843.9	3" ASPHALT PAVEMENT						
	843.4	9" CONCRETE PAVEMENT						
1SS		FILL - SILTY SAND, fine to medium, trace gravel, brown and reddish brown, occasional seams of dark gray silty organics and clayey fines, moist		21 (8,11,10)	8			
	840.2							
2SS		FILL - CLAYEY SAND, trace gravel and organics, gray and dark gray, moist L.O.I. = 3.1%	5	7 (3,3,4)	15			
	837.7							
3SS		SAND (SP-SM) - fine to coarse, with silt and gravel, light brown, moist, moderately compact		12 (2,4,8)	5			
4SS			10	27 (9,12,15)	5			
	833.7	END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)

○ Unconfined Compressive Strength (tsf)

Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)



DRAFT

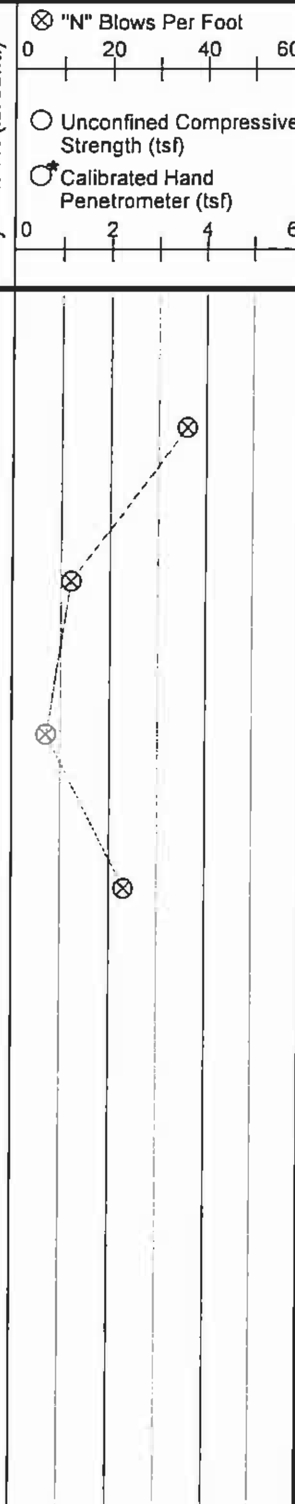
Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling: None	Boring Started: 11/27/2006	Completed: 11/27/2006	Engineer: JDH
Water Level At Completion: None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: B-32	psi Professional Service Industries, Inc.
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 135+06; 5' RT		

DRAFT

Sample No./Type	Sample Location	Sample Recovery	Graphical Log	Elevation (ft)	Description of Material (Surface Elevation: 844.75)	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
				844.4	4" ASPHALT PAVEMENT						
				843.6	8" CONCRETE PAVEMENT						
1SS					FILL - SAND, fine to medium, with silt, trace gravel, brown and reddish brown, occasional seams of coarse sand, clayey fines and dark gray organics, moist		36 (4,14,22)	7			
2SS				838.3		5	12 (10,6,6)	11			
3SS				835.8	CLAYEY SAND (SC) - trace gravel, mottled brown, moist, loose		7 (5,3,4)	13			
4SS				834.3	SAND (SP-SM) - fine to coarse, with silt and gravel, brown and light brown, moist, moderately compact	10	23 (6,10,13)	6			
					END OF BORING						



DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling None	Boring Started: 1/2/2007	Completed: 1/2/2007	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-33	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 137+17; 6' LT		

DRAFT

Surface Elevation: 837.37

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	836.9	6" ASPHALT PAVEMENT						
	836.0	11" LIMESTONE BASE						
1SS		SAND (SP-SM) - fine to coarse, with silt and gravel, brown and light brown, moist to wet, moderately compact **Sample Tested for Gradation		14 (3,7,7)	2			
2SS			5	27 (3,10,17)	4			
3SS				24 (4,10,14)	14			
4SS	826.9		10	22 (3,10,12)	10			
		END OF BORING						

Legend: ⊗ "N" Blows Per Foot (0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); ○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling 6.5'	Boring Started: 12/15/2006	Completed: 12/15/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 6.5' After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-34	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 137+17; 19' RT		

DRAFT

Surface Elevation: **836.95**

Legend: ⊗ "N" Blows Per Foot (0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
		6" ASPHALT PAVEMENT						
	836.5	12" LIMESTONE BASE						
	835.5	SAND (SP-SM) - fine to coarse, with silt, gravel and coarse sand, brown and light brown, moist to wet, moderately compact						
1SS				22 (3,9,13)	5			
2SS			5	23 (4,10,13)	7			
			▽					
3SS				25 (6,12,13)	12			
	828.0	SAND (SP-SM) - fine to medium, with silt and coarse sand, trace gravel, brown to grayish brown, wet, moderately compact						
4SS			10	15 (7,7,8)	12			
	826.5	END OF BORING						

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling 6.5'

▼ Water Level At Completion None

Collapsed @ 5.5' After Completion

Boring Started: 1/2/2007	Completed: 1/2/2007		Engineer: JDH
Drilling Method: 3.25" HSA		Office: Plymouth	Drawn By: JDH
Driller: P. Cody	Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: MSE
Note: Boring backfilled with soil unless otherwise noted.			

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050
Sheet: 1 of 1	Boring Log Number: B-35
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 139+19; 22' LT

psi *Professional Service Industries, Inc.*

DRAFT

Surface Elevation: **833.54**

⊗ "N" Blows Per Foot (0–60)
○ Unconfined Compressive Strength (tsf)
○* Calibrated Hand Penetrometer (tsf) (0–6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	833.1	5" ASPHALT PAVEMENT						
	832.0	13" CRUSHED LIMESTONE BASE						
1SS		SAND (SP-SM) - fine to coarse, with silt, gravel and coarse sand, brown and light brown, moist to wet, compact to moderately compact		39 (9,13,26)	4			
2SS			5	22 (9,11,11)	9			
	827.0							
3SS		SILTY SAND (SM) - fine to medium, trace gravel, gray, wet, moderately compact		15 (5,7,8)	17			
4SS			10	16 (2,7,9)	14			
	823.0	END OF BORING						

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

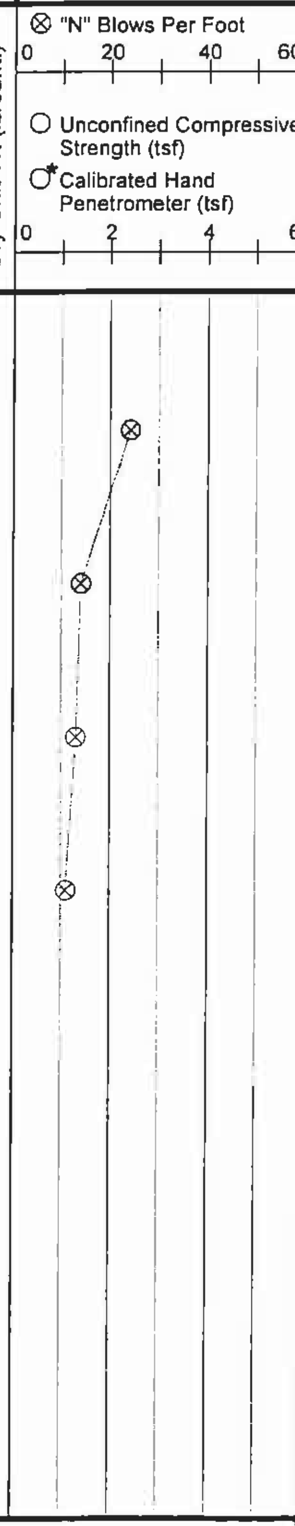
∇ Water Level While Drilling 4.5'	Boring Started: 11/27/2006 Completed: 11/27/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA Office: Plymouth	Drawn By: JDH
Collapsed @ 4.25' After Completion	Driller: P. Cody Drill Rig: CME-75 Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.	

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050**	Boring Log Number: **B-36**	*Professional Service Industries, Inc.*
	Sheet: **1** of **1**		
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 139+20; 5' RT**		

DRAFT

Surface Elevation: **834.00**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	833.5	6.5" ASPHALT PAVEMENT						
	832.5	12" LIMESTONE BASE						
1SS		SAND (SP-SM) - fine to coarse, with silt and gravel, brown, moist, moderately compact		24 (4,10,14)	2			
2SS	829.0		5	14 (4,6,8)	10			
		SAND (SP-SM) - fine to medium, with silt, gravel and coarse sand, grayish brown to gray, wet, moderately compact						
3SS				13 (4,6,7)	18			
4SS	823.5		10	11 (2,4,7)	17			
		END OF BORING						



DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling 5.0'	Boring Started: **1/2/2007**	Completed: **1/2/2007**	Engineer: **JDH**
Water Level At Completion None	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
Collapsed @ 4.25' After Completion	Driller: **P. Cody** / Drill Rig: **CME-75**	Hole Depth (ft): **10.5**	Approved:
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** / Sheet: **1** of **1**
Boring Log Number: **B-37**	**psi** Professional Service Industries, Inc.
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 140+17; 1' RT**

DRAFT

Surface Elevation: **833.11**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
		6.5" ASPHALT PAVEMENT						
	832.6	12" LIMESTONE BASE						
	831.6	SAND (SP-SM) - fine to medium, with silt, trace gravel, brown and light brown, moist, moderately compact						
1SS				16 (4,6,10)	5			
	829.1	SAND (SP-SM) - fine to medium, with silt, gravel and coarse sand, grayish brown, wet, moderately compact ▽						
2SS			5	16 (3,7,9)	10			
3SS				14 (5,7,7)	16			
4SS			10	12 (2,4,8)	15			
	822.6	END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)
○ Unconfined Compressive Strength (tsf)
○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

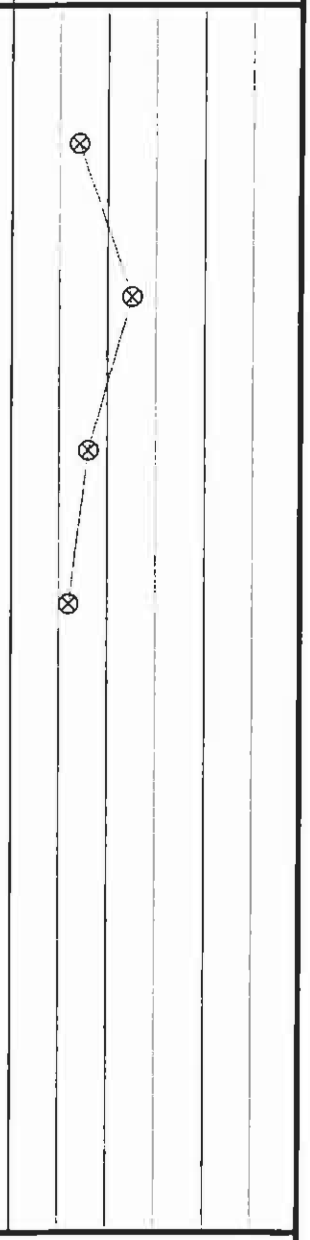
▽ Water Level While Drilling 4.5'	Boring Started: **1/3/2007**	Completed: **1/3/2007**	Engineer: **JDH**
▼ Water Level At Completion None	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
Collapsed @ 4.25' After Completion	Driller: **P. Cody** / Drill Rig: **CME-75**	Hole Depth (ft): **10.5**	Approved: MSE
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-38	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 143+29; 1' RT		

DRAFT

Surface Elevation: 830.94

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	830.5	5.5" ASPHALT PAVEMENT						
	829.2	15" LIMESTONE BASE						
1SS		SAND (SP-SM) - fine to coarse, with silt and gravel, brown and light brown, moist, moderately compact **Sample Tested for Gradation		14 (3,6,8)	2			
	826.9							
2SS		SAND (SP) - fine, trace gravel and coarse sand, light brown to light grayish white, moist, moderately compact	5	25 (4,11,14)	4			
	824.4							
3SS		SAND (SM) - fine to coarse, with silt and gravel, grayish brown to gray, wet, moderately compact		16 (4,7,9)	15			
4SS			10	12 (4,5,7)	14			
	820.4	END OF BORING						



DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

∇ Water Level While Drilling 6.5'	Boring Started: 12/15/2006	Completed: 12/15/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 6.5' After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-39	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 145+05; 25' LT		

DRAFT

Surface Elevation: 829.28

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	"N" Blows Per Foot
	828.8	6" ASPHALT PAVEMENT							
	828.0	10" LIMESTONE BASE							
1SS	825.3	SAND (SP-SM) - fine to coarse, with silt and gravel, brown, moist, moderately compact **Sample Tested for Gradation		17 4,8,9	4				17
2SS	821.8	SAND (SP) - fine to medium, trace gravel, light grayish brown, moist, moderately compact	5	17 4,8,9	6				17
3SS				15 5,7,8	16				15
4SS	818.8	SAND (SM) - fine to coarse, with silt and gravel, gray, wet, moderately compact to loose	10	9 3,4,5	15				9
		END OF BORING							

Legend: ⊗ "N" Blows Per Foot (0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling 6.5'	Boring Started: 12/15/2006	Completed: 12/15/2006	Engineer: JDH
Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 6.25' After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **B-40**	psi *Professional Service Industries, Inc.*
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 145+22; 27' RT**		

DRAFT

Surface Elevation: **829.55**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
		6" ASPHALT PAVEMENT						
	829.1	12" LIMESTONE BASE						
	828.1	SAND (SP-SM) - fine to medium, with silt, gravel and coarse sand, brown and light brown, moist, moderately compact to loose						
1SS				19 (3,8,11)	4			
2SS			5	6 (3,3,3)	4			
	823.1	SAND (SP-SM) - fine to coarse, with silt and gravel, grayish brown, wet, moderately compact						
3SS				17 (8,9,8)	13			
4SS			10	12 (5,5,7)	16			
	819.1	END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)

○ Unconfined Compressive Strength (tsf)

○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

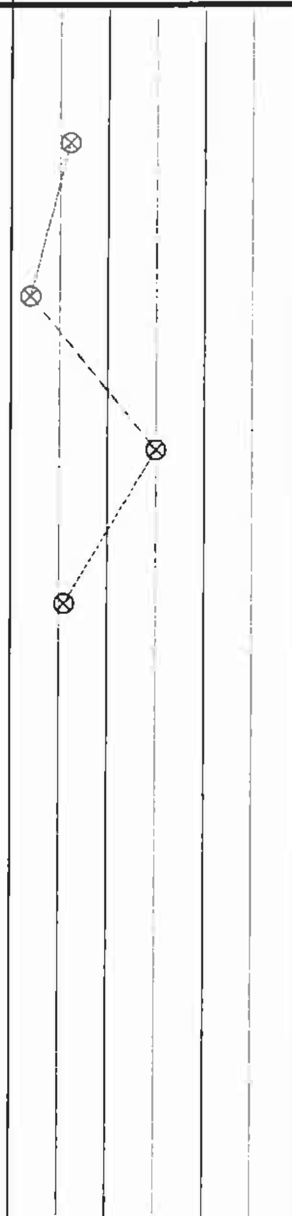
▽ Water Level While Drilling 6.5'	Boring Started: 1/3/2007	Completed: 1/3/2007	Engineer: JDH
▼ Water Level At Completion 7.0'	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 6' After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-41	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan		

DRAFT

Surface Elevation:

Sample No./Type	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	9" ASPHALT PAVEMENT						
	6" CONCRETE PAVEMENT						
1SS	FILL - SILTY SAND, fine to medium, trace gravel and clayey fines, reddish brown to brown, moist		12 (4,7,5)	7			
	SANDY SILT (OL) - with organics, dark gray to black, moist						
2SS	SAND (SP-SM) - fine to coarse, with silt and gravel, brown and light brown, moist, loose	5	4 (1,1,3)	10			
3SS	SAND (SM) - fine to coarse, with silt and gravel, brown, wet, compact to moderately compact		30 (5,15,15)	9			
4SS		10	11 (3,5,6)	15			
	END OF BORING						



DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

∇ Water Level While Drilling 9.0'

▼ Water Level At Completion 7.0'

Collapsed @ 7' After Completion

Boring Started: 1/3/2007	Completed: 1/3/2007	Engineer: JDH
Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: MEE

Note: Boring backfilled with soil unless otherwise noted.

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **B-42**	*Professional Service Industries, Inc.*
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan**		

Surface Elevation:

DRAFT

Sample No./Type	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	12" ASPHALT PAVEMENT						
1SS	SAND (SM) - fine to coarse, with silt and gravel, brown and reddish brown, moist, moderately compact		17 (4,8,9)	4			
2SS	SAND (SP-SM) - fine to coarse, with silt and gravel, brown and light brown, moist, moderately compact	5	28 (7,13,15)	7			
3SS	SAND (SM) - fine to coarse, with silt and gravel, brown, wet, moderately compact		18 (10,8,10)	10			
4SS		10	20 (8,10,10)	15			
	END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)
○ Unconfined Compressive Strength (tsf)
○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling 7.0'	Boring Started: **1/3/2007**	Completed: **1/3/2007**	Engineer: **JDH**
Water Level At Completion 7.0'	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
Collapsed @ 7' After Completion	Driller: **P. Cody** Drill Rig: **CME-75**	Hole Depth (ft): **10.5**	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

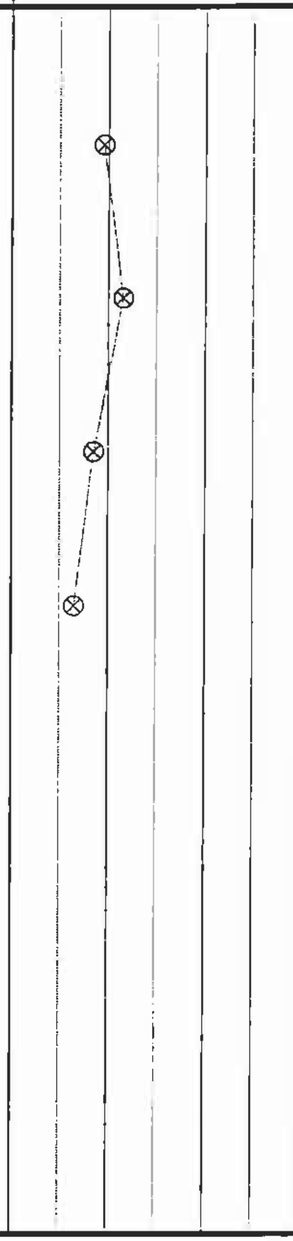
Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **B-43**	*Professional Service Industries, Inc.*
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan** **STATION 310+54; 6' LT**		

DRAFT

Surface Elevation: **839.72**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	839.1	7" ASPHALT PAVEMENT						
	838.6	6" CONCRETE PAVEMENT						
1SS		SAND (SP-SM) - fine to coarse, with silt and gravel, brown and light brown, moist, moderately compact		19 (4,8,11)	6			
2SS			5	23 (10,10,13)	7			
	833.2	SAND (SM) - fine to coarse, with silt and gravel, brown, wet, moderately compact						
3SS				17 (10,9,8)	17			
4SS	829.2		10	13 (6,6,7)	16			
		END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)
○ Unconfined Compressive Strength (tsf)
○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)



DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

∇ Water Level While Drilling 6.5'	Boring Started: 1/3/2007	Completed: 1/3/2007	Engineer: JDH
▼ Water Level At Completion 6.0'	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 6' After Completion	Driller: P. Cody — Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **B-44**	*Professional Service Industries, Inc.*
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 312+38; 6' RT**		

DRAFT

Surface Elevation: **838.05**

Legend: ⊗ "N" Blows Per Foot (0, 20, 40, 60); O Unconfined Compressive Strength (tsf); O* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	837.6	6" ASPHALT PAVEMENT						
	836.9	8" CONCRETE PAVEMENT						
1SS		SAND (SP-SM) - fine to coarse, with silt and gravel, brown and light brown, moist, loose to moderately compact		9 (4,4,5)	7			
2SS			5	15 (11,7,8)	7			
3SS	831.6	SAND (SM) - fine to coarse, with silt and gravel, brown and grayish brown, wet, moderately compact		12 (7,6,6)	18			
4SS	827.6		10	13 (5,7,6)	14			
		END OF BORING						

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling 6.5'	Boring Started: **1/3/2007**	Completed: **1/3/2007**	Engineer: **JDH**
▼ Water Level At Completion 6.0'	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
Collapsed @ 6' After Completion	Driller: **P. Cody** Drill Rig: **CME-75**	Hole Depth (ft): **10.5**	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: B-45	psi *Professional Service Industries, Inc.*
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan		

DRAFT

Sample No./Type	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	Surface Elevation:						
	5" ASPHALT PAVEMENT						
	3" SAND AND GRAVEL BASE						
	CLAYEY SAND (SC) - trace gravel, reddish brown, moist						
1SS	SAND (SP-SM) - fine to coarse, with silt and gravel, brown and light brown, moist, moderately compact **Sample Tested for Gradation		11 3,5,6	4			
2SS		5	13 6,6,7	5			
3SS	SAND (SM) - fine to coarse, with gravel, brown, wet, moderately compact		14 4,7,7	11			
4SS		10	12 2,5,7	12			
	END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)

○ Unconfined Compressive Strength (tsf)

○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling 6.5'	Boring Started: 11/3/2006	Completed: 11/3/2006	Engineer: JDH
▼ Water Level At Completion 7.0'	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 7' After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved:
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: B-46	psi *Professional Service Industries, Inc.*
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 407+72; 6' LT		

Surface Elevation: **838.74**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	838.5	3.5" ASPHALT PAVEMENT						
		CLAYEY SAND (SC) - trace gravel, brown to reddish brown, moist, moderately compact						
1SS				7 (2,3,4)	13			
	836.0	SAND (SP-SM) - fine to coarse, with silt and gravel, brown and light brown, moist to wet, moderately compact						
2SS			5	19 (4,7,12)	5			
3SS				17 (2,7,10)	15			
4SS			10	17 (4,8,9)	16			
	828.2	END OF BORING						

Legend: ⊗ "N" Blows Per Foot (scale 0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); ○* Calibrated Hand Penetrometer (tsf) (scale 0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling 7.0'	Boring Started: 12/15/2006	Completed: 12/15/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 5' After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **B-47**
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 409+33; 7' LT**	*Professional Service Industries, Inc.*

Surface Elevation: **837.59**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	837.3	4" ASPHALT PAVEMENT						
		CLAYEY SAND (SC) - trace gravel and roots, reddish brown, moist, loose						
1SS				5 (2,2,3)	12			
	833.1	SAND (SP-SM) - fine to medium, with silt, gravel and coarse sand, brown and light brown, moist to wet, moderately compact						
2SS			5	13 (4,6,7)	6			
3SS				17 (7,9,8)	14			
	828.6	SILTY SAND (SM) - fine to medium, brown, wet, moderately compact						
4SS			10	11 (5,5,6)	18			
	827.1	END OF BORING						

Chart legend: ⊗ "N" Blows Per Foot (0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); ○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling 6.5'	Boring Started: **12/20/2006**	Completed: **12/20/2006**	Engineer: **JDH**
▼ Water Level At Completion None	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
Collapsed @ 6' After Completion	Driller: **P. Cody** Drill Rig: **CME-75**	Hole Depth (ft): **10.5**	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** / Sheet: **1** of **1**	Boring Log Number: **B-48**	**psi** Professional Service Industries, Inc.
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan**		

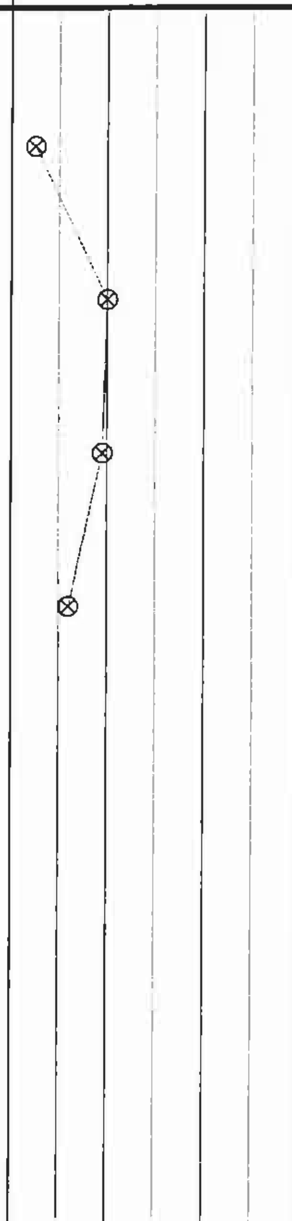
Surface Elevation: **836.44**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
		7" ASPHALT PAVEMENT						
	835.9	SANDY CLAY (OL/CL) - trace gravel and organics, dark brown, moist						
1SS	834.4	SILTY SAND (SM) - fine to medium, trace gravel, brown, moist, loose		5 (2,2,3)	12			
2SS	832.4	SAND (SP-SM) - fine to medium, with silt, gravel and coarse sand, brown and light brown, moist to wet, moderately compact	5	20 (4,9,11)	6			
3SS				19 (8,9,10)	10			
4SS			10	12 (5,6,6)	13			
	825.9	END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)

○ Unconfined Compressive Strength (tsf)

○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)



DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling 6.5'

▼ Water Level At Completion None

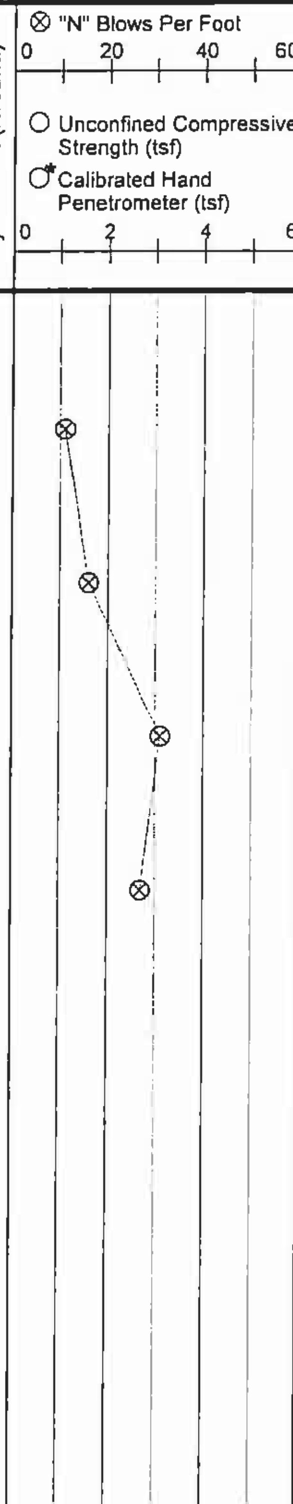
Collapsed @ 5.5' After Completion

Boring Started: **12/20/2006**	Completed: **12/20/2006**		Engineer: **JDH**
Drilling Method: **3.25" HSA**	Office: **Plymouth**		Drawn By: **JDH**
Driller: **P. Cody**	Drill Rig: **CME-75**	Hole Depth (ft): **10.5**	Approved: [signature]
Note: Boring backfilled with soil unless otherwise noted.			

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: B-49	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan		

Surface Elevation: 839.80

Sample No./Type	Sample Location	Sample Recovery	Graphical Log	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
				839.5	4" ASPHALT PAVEMENT						
					CLAYEY SAND (SC) - trace gravel, brown to reddish brown, moist, moderately compact						
1SS							11 (4,5,6)	12			
				835.8	SAND (SP-SM) - fine to coarse, with silt and gravel, brown and light brown, moist, moderately compact to compact						
2SS						5	16 (7,9,7)	5			
3SS							31 (10,14,17)	10			
				830.8	SAND (SM) - fine to coarse, with silt and gravel, brown, wet, moderately compact						
4SS						10	27 (10,12,15)	18			
				829.3	END OF BORING						



Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

∇ Water Level While Drilling 9.0'	Boring Started: 11/3/2006	Completed: 11/3/2006	Engineer: JDH
▼ Water Level At Completion 7.25'	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 7.25' After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **F-1**	*Professional Service Industries, Inc.*
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 111+72; 9' RT**		

DRAFT

Surface Elevation: **877.34**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Hand Penetrometer (tsf)
	877.0	4" ASPHALT PAVEMENT							
	876.4	7" CONCRETE PAVEMENT							
1SS	874.3	FILL - SANDY CLAY, trace gravel, grayish brown, occasional seams of dark gray sandy organics, moist L.O.I. = 3.6%		8 2,4,4	16				
2SS		SILTY CLAY (CL) - with sand, trace gravel and organics, mottled blueish gray and olive to brown and grayish brown, moist, firm to stiff	5	6 2,2,4	19	16	36	107	2.04
3SS	868.3			8 2,3,5	20				2.0
4SS	866.8	SILTY CLAY (CL) - with sand sand, brown, moist, hard	10	11 2,5,6	16				4.5+
		END OF BORING							

⊗ "N" Blows Per Foot: 0, 20, 40, 60

○ Unconfined Compressive Strength (tsf)

Calibrated Hand Penetrometer (tsf): 0, 2, 4, 6

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling: None	Boring Started: **12/18/2006**	Completed: **12/18/2006**	Engineer: **JDH**
Water Level At Completion: None	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
______ After Completion	Driller: **P. Cody** · Drill Rig: **CME-75**	Hole Depth (ft): **10.5**	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **F-2**	psi *Professional Service Industries, Inc.*
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan** **STATION 112+94; 20' RT**		

DRAFT

Surface Elevation: **873.13**

Legend: ⊗ "N" Blows Per Foot (scale 0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); ○* Calibrated Hand Penetrometer (tsf) (scale 0, 2, 4, 6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Strength (tsf)
	872.7	5" ASPHALT PAVEMENT							
	872.2	6" CONCRETE PAVEMENT							
		SILTY CLAY (CL) - with sand, trace gravel, brown, moist, firm to hard							
1SS				5 (2,2,3)	19				2.0*
2SS			5	11 (2,5,6)	15			119	6 3
	866.6	SAND (SP-SM) - trace silt, medium, brown to dark reddish brown, moist, very loose							
3SS				2 (1,1,1)	7				
4SS			10	3 (1,1,2)	8				
	862.6	END OF BORING							

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

∇ Water Level While Drilling None	Boring Started: **12/18/2006**	Completed: **12/18/2006**	Engineer: **JDH**
▼ Water Level At Completion None	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
______ After Completion	Driller: **P. Cody** / Drill Rig: **CME-75**	Hole Depth (ft): **10.5**	Approved: MLL
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**

PSI Project #: **381-65050**

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

Boring Log Number: **F-3**

Professional Service Industries, Inc.

Project: **East Stadium Boulevard Structure Replacement Project**

Location: **City of Ann Arbor, Michigan STATION 114+58; 38' LT**

DRAFT

Surface Elevation: **866.99**

⊗ "N" Blows Per Foot (0–60)
○ Unconfined Compressive Strength (tsf)
○* Calibrated Hand Penetrometer (tsf) (0–6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Hand Penetrometer / UCS (tsf)
	866.0	11.5" ASPHALT PAVEMENT							
	865.8	3" SAND AND GRAVEL BASE							
1SS	863.0	SILTY CLAY (OL/CL) - with sand, trace gravel, roots and organics, mottled olive brown and grayish brown, moist, firm to stiff L.O.I. = 3.9%		8 (2,3,5)	21	16	36		2.5
2SS		SILTY CLAY (CL) - with sand, trace gravel, mottled yellowish brown and gray, moist, hard	5	12 (3,4,8)	16				4.5+
3SS	857.5			22 (4,8,14)	14	15	29	117	5.35
4SS	856.5	SAND (SP) - fine, trace coarse gravel, light brown, moist, compact	10	31 (3,14,17)	2				
		END OF BORING							

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling: None

Water Level At Completion: None

________ After Completion

Boring Started: **11/29/2006** Completed: **11/29/2006**

Drilling Method: **3.25" HSA**

Office: **Plymouth**

Driller: **P. Cody** Drill Rig: **CME-75** Hole Depth (ft): **10.5**

Engineer: **JDH**

Drawn By: **JDH**

Approved: [signature]

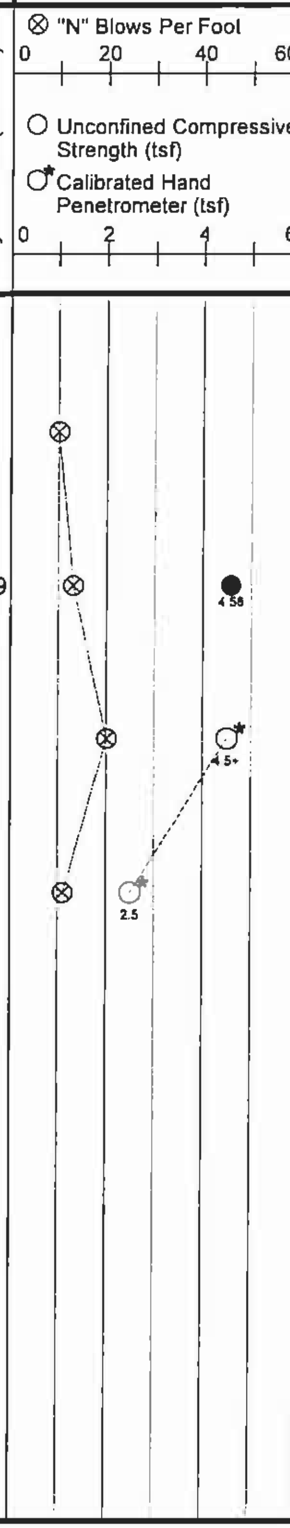
Note: Boring backfilled with soil unless otherwise noted.

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **F-4**	*Professional Service Industries, Inc.*
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 115+79; 9' RT**		

DRAFT

Surface Elevation: **863.95**

Sample No./Type	Sample Location	Sample Recovery	Graphical Log	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
				863.6	4" ASPHALT PAVEMENT						
				863.1	6" CONCRETE PAVEMENT						
1HSA					SILTY CLAY (OL/CL) - with organics, dark gray, moist L.O.I. = 5.2%		10 3,4,6	21			
				861.0	SILTY CLAY (CL) - with sand, trace gravel, mottled yellowish brown and gray, moist, hard						
2SS						5	13 4,5,8	15			119
3SS							20 5,8,12	16			
				855.0	SILTY CLAY (CL) - trace gravel, seam of fine to coarse sand, grayish brown to gray, moist, stiff						
4SS						10	11 4,5,6	10			
				853.5	END OF BORING						



DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling: None	Boring Started: **12/19/2006**	Completed: **12/19/2006**	Engineer: **JDH**
Water Level At Completion: None	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
______ After Completion	Driller: **P. Cody** Drill Rig: **CME-75**	Hole Depth (ft): **10.5**	Approved:
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: F-5	psi *Professional Service Industries, Inc.*
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 118+77; 15' LT		

DRAFT

Surface Elevation: **856.65**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	"N" Blows Per Foot / Calibrated Hand Penetrometer (tsf)
	856.3	4.5" ASPHALT PAVEMENT							
	855.8	6" CONCRETE PAVEMENT							
1SS	853.7	SILTY SAND (OL/SM) - fine, trace clayey fines and organics, black to dark reddish brown, moist, loose L.O.I. = 3.0%		4 2,2,2	16				
2SS		SILTY SAND (SM) - fine to medium, trace gravel, reddish brown to brown, moist, moderately compact	5	21 5,14,7	8				
3SS	849.7	SILTY CLAY (CL) - trace gravel, seam of medium sand, brown to brownish gray, moist, stiff		15 5,8,7	13				
4SS	846.2		10	9 3,3,6	15				3.5
		END OF BORING							

Legend: ⊗ "N" Blows Per Foot (0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling None	Boring Started: 12/15/2006	Completed: 12/15/2006		Engineer: JDH
Water Level At Completion None	Drilling Method: 3.25" HSA		Office: Plymouth	Drawn By: JDH
____ After Completion	Driller: P. Cody	Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.			

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **F-6**	*Professional Service Industries, Inc.*
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 119+71; 10' RT**		

Surface Elevation: **854.62**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	854.3	3.5" ASPHALT PAVEMENT						
	853.7	8" CONCRETE PAVEMENT						
1SS		SILTY SAND (OL/SM) - fine, trace gravel and organics, dark gray to dark brown, moist, very loose		3 (3,2,1)	10			
	851.6	SAND (SP-SM) - fine to medium, with silt, gravel and coarse sand, brown and light brown, moist, loose						
2SS			5	5 (1,2,3)	6			
3SS				7 (2,3,4)	6			
	845.6	SAND (SP-SM) - fine, with silt, light brown, moist, loose						
4SS			10	5 (2,2,3)	7			
	844.1	END OF BORING						

⊗ "N" Blows Per Foot: 0, 20, 40, 60

○ Unconfined Compressive Strength (tsf)

○* Calibrated Hand Penetrometer (tsf): 0, 2, 4, 6

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling **None**	Boring Started: **12/20/2006**	Completed: **12/20/2006**	Engineer: **JDH**
▼ Water Level At Completion **None**	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
________ After Completion	Driller: **P. Cody** / Drill Rig: **CME-75**	Hole Depth (ft): **10.5**	Approved:
	Note: Boring backfilled with soil unless otherwise noted.		

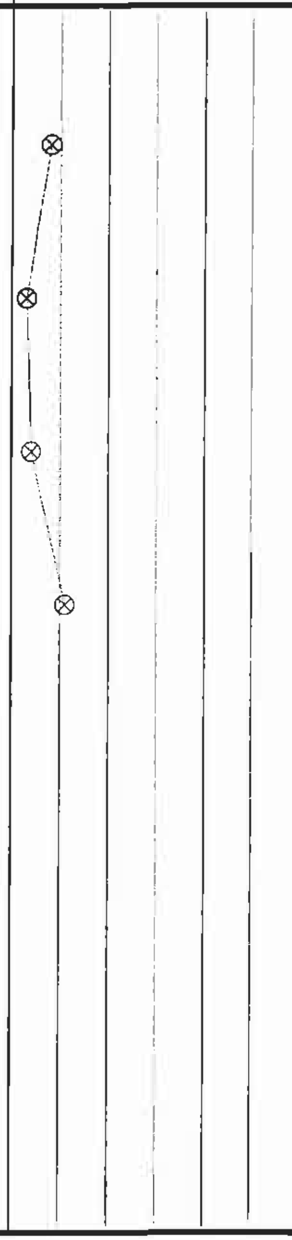
Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: F-7	psi — Professional Service Industries, Inc.
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 125+90; 29' LT		

DRAFT

Surface Elevation: 864.21

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
		10" ASPHALT PAVEMENT						
	863.4	FILL - SAND, fine to medium, trace gravel, brown and light brown, occasional seams of dark brown clayey sand, moist						
1SS				8 (7,5,3)	5			
	860.2	FILL - SILTY SAND, fine to medium, trace gravel, brown and reddish brown, occasional seams of clayey fines, moist						
2SS			5	3 (3,2,1)	8			
3SS				4 (3,2,2)	11			
	855.2	FILL - SAND, fine to coarse, with silt and gravel, brown, with seams of dark brown clayey sand moist						
4SS			10	11 (9,6,5)	7			
	853.7	END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)
○ Unconfined Compressive Strength (tsf)
Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)



DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling: None	Boring Started: 11/27/2006	Completed: 11/27/2006	Engineer: JDH
Water Level At Completion: None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
____ After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: DJH
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: F-8	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 133+37; 4' RT		

DRAFT

Surface Elevation: 852.90

⊗ "N" Blows Per Foot (0, 20, 40, 60)
○ Unconfined Compressive Strength (tsf)
Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	852.7	3" ASPHALT PAVEMENT						
	852.1	7" CONCRETE PAVEMENT						
		FILL - SILTY SAND, fine to medium, with gravel and clayey fines, brown and reddish brown, occasional seams of dark brown silty organics, moist						
1SS				12 (3,6,6)	10			
2SS			5	19 (8,8,11)	10			
3SS				11 (4,6,5)	8			
4SS			10	7 (3,3,4)	10			
	842.4	END OF BORING						

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling None	Boring Started: 1/2/2007	Completed: 1/2/2007	Engineer: JDH
Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
________ After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 10.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **RW-1**	*Professional Service Industries, Inc.*
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 105+60; 27' RT**		

DRAFT

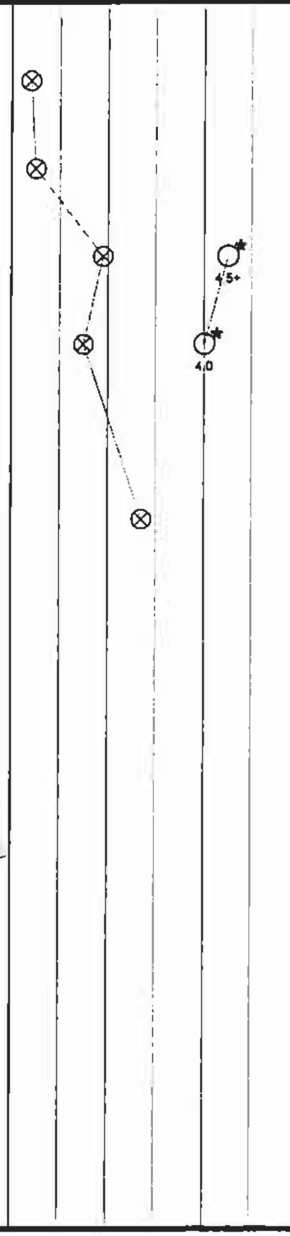
Surface Elevation: **889.68**

Sample No./Type	Sample Location	Sample Recovery	Graphical Log	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
				889.3	4.5" CONCRETE SIDEWALK PAVEMENT						
				889.2	1.25" SAND BASE						
1SS					FILL - SILTY SAND, fine to medium, trace gravel, brown, moist		4 (2,2,2)	8			
2SS				884.4		5	5 (2,3,2)	13			
3SS					SILTY CLAY (CL) - with sand, trace gravel, mottled yellowish brown and gray to brown, moist, hard		19 (6,8,11)	13			
4SS						10	15 (4,7,8)	15			
5SS				875.7	SILTY CLAY (CL) - trace sand and gravel, gray, moist, hard	15	27 (9,13,14)	13			
				874.2	END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)

○ Unconfined Compressive Strength (tsf)

Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)



DRAFT

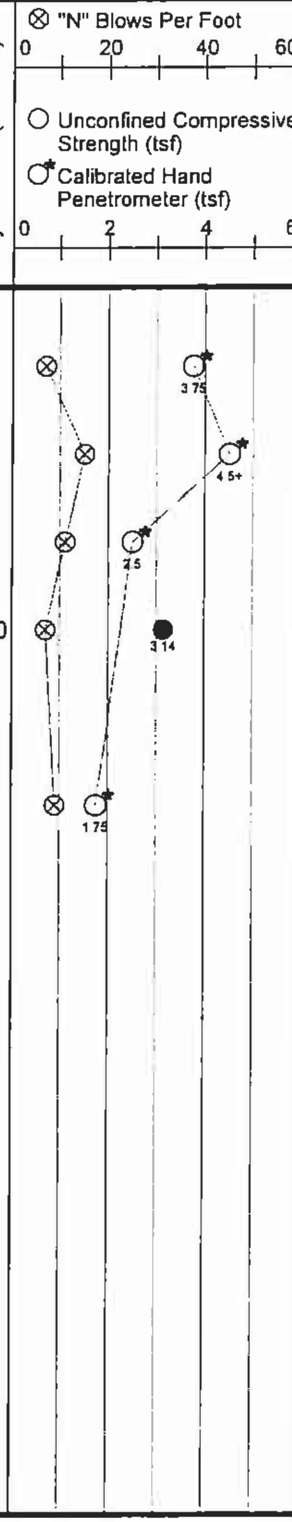
Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

∇ Water Level While Drilling 5.0'	Boring Started: **1/2/2007**	Completed: **1/2/2007**	Engineer: **JDH**
▼ Water Level At Completion 9.0'	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
Collapsed @ 10' After Completion	Driller: **P. Cody** / Drill Rig: **CME-75**	Hole Depth (ft): **15.5**	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: RW-2	psi Professional Service Industries, Inc.
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 107+28; 19' RT		

Surface Elevation: 886.62

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	886.0	8" ASPHALT PAVEMENT						
	885.3	8" CONCRETE PAVEMENT						
1SS	883.1	SILTY CLAY (OL/CL) - with sand, trace gravel and organics, mottled olive brown and grayish brown, moist, stiff		7 (2,2,5)	14			
2SS	880.1	SILTY CLAY (CL) - with sand, trace gravel, brown to brownish gray, moist, hard	5	15 (3,6,9)	14			
3SS		SILTY CLAY (CL) - trace sand and gravel, gray, moist, stiff to firm		11 (3,4,7)	15			
4SS			10	7 (2,2,5)	15	14	27	120
5SS	871.1		15	9 (3,4,5)	18			
		END OF BORING						



DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling None	Boring Started: 12/18/2006	Completed: 12/18/2006	Engineer: JDH
Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
________ After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 15.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: RW-3
	Sheet: 1 of 1	
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 109+30; 20' RT	**psi** Professional Service Industries, Inc.

DRAFT

Surface Elevation: 883.20

Legend: ⊗ "N" Blows Per Foot (scale 0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); ○* Calibrated Hand Penetrometer (tsf) (scale 0, 2, 4, 6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Strength (tsf)
	882.2	12.5" ASPHALT PAVEMENT							
	881.9	3" SAND AND GRAVEL BASE, dark gray, wet							
1SS	879.7	SILTY CLAY (OL/CL) - with sand, trace gravel and organics, mottled olive brown and grayish brown, very moist to moist, firm		4 (1,1,3)	18				1.5
2SS		SILTY CLAY (CL) - with sand, trace gravel, brown to brown and brownish gray, moist, hard	5	16 (3,6,10)	16				4.0
3SS				15 (3,6,9)	16			114	4.65
4SS			10	19 (3,7,12)	14				4.5+
	869.2								
5SS	867.7	SILTY CLAY (CL) - trace sand and gravel, gray, moist, stiff	15	10 (3,4,6)	15				2.0
		END OF BORING							

DRAFT

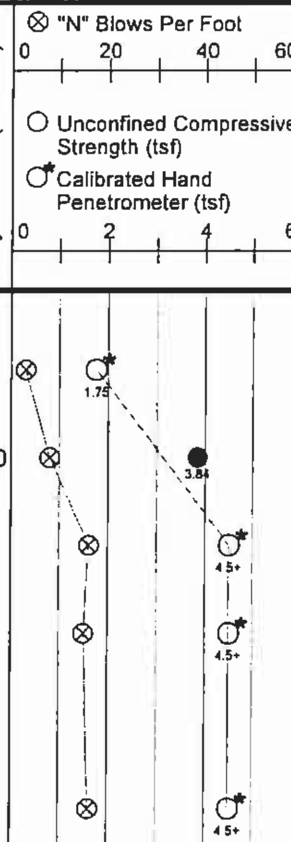
Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling 1.0'	Boring Started: 12/18/2006	Completed: 12/18/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 5.25' After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 15.5	Approved: JHC
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **RW-4**	**psi** *Professional Service Industries, Inc.*
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 111+00; 21' RT**		

Surface Elevation: **879.18**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	878.7	5.5" ASPHALT PAVEMENT						
	878.1	7" CONCRETE PAVEMENT						
1SS	877.7	5.5" SAND AND GRAVEL BASE, dark brown to dark gray		3 (1,1,2)	17			
2SS	875.7	SILTY CLAY (OL/CL) - with sand, trace gravel and organics, mottled olive brown and gray, moist, firm L.O.I. = 3.3%	5	8 (1,3,5)	15			120
3SS	872.7	SILTY CLAY (CL) - with sand, trace gravel, mottled yellowish brown and gray, moist, stiff		16 (4,6,10)	14			
4SS		SILTY CLAY (CL) - with sand, trace gravel, brown, moist, hard	10	15 (3,6,9)	14			
5SS			15	16 (4,6,10)	18			
	863.7	END OF BORING						



Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling None	Boring Started: **12/18/2006**	Completed: **12/18/2006**	Engineer: **JDH**
Water Level At Completion None	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
________ After Completion	Driller: **P. Cody** / Drill Rig: **CME-75**	Hole Depth (ft): **15.5**	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: RW-5	Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 114+10; 20' RT		

Surface Elevation: **869.01**

⊗ "N" Blows Per Foot (0, 20, 40, 60)
○ Unconfined Compressive Strength (tsf)
Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	868.5	6" ASPHALT PAVEMENT						
	867.8	8" CONCRETE PAVEMENT						
1SS		SILTY SAND (SM) - fine to medium, trace organics, dark brown to brown and reddish brown, moist, moderately compact		11 (2,6,5)	7			
2SS			5	12 (3,6,6)	6			
3SS	862.5	SAND (SP) - fine, light brown to whitish gray, moist, moderately compact		11 (3,5,6)	5			
4SS	860.0	SAND (SP-SM) - fine, with silt, yellowish brown, moist, moderately compact	10	16 (3,7,9)	5			
5SS	855.0	SILTY SAND (SM) - fine to medium, trace gravel and silt seams, brown, moist, moderately compact	15	17 (6,7,10)	7			
	853.5	END OF BORING						

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

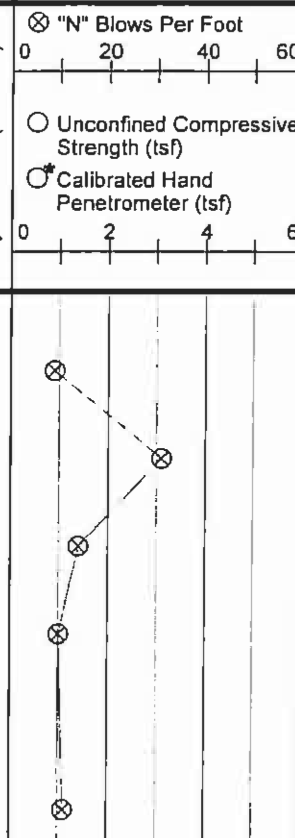
∇ Water Level While Drilling None	Boring Started: 12/19/2006	Completed: 12/19/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 15.5	Approved: MEE
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: RW-6	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan		

DRAFT

Surface Elevation:

Sample No./Type	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	4" Dark Brown SANDY TOPSOIL						
1SS	FILL - SILTY SAND, with organics, black and dark gray, trace gravel and seams of brown silty sand, moist L.O.I. = 5.0%		9 (2,4,5)	14			
2SS	SILTY SAND (SM) - fine to medium, trace gravel and seams of clayey sand, reddish brown, moist, compact	5	31 (4,21,10)	8			
3SS	SAND (SP-SM) - fine to coarse, with silt and gravel, brown and light brown, moist, moderately compact		14 (4,6,8)	4			
4SS	SAND (SP-SM) - fine to medium, with silt, trace gravel, light brown, moderately compact	10	10 (2,4,6)	6			
5SS		15	11 (5,5,6)	8			
	END OF BORING						



DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling: None	Boring Started: 12/14/2006	Completed: 12/14/2006	Engineer: JDH
Water Level At Completion: None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody	Drill Rig: CME-75 / Hole Depth (ft): 15.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: RW-7A	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 121+16; 61' LT		

DRAFT

Surface Elevation: 852.20

Sample No./Type	Sample Location	Sample Recovery	Graphical Log	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	⊗ "N" Blows Per Foot (0–60); ○ Unconfined Compressive Strength (tsf); Calibrated Hand Penetrometer (tsf) (0–6)
				851.7	6" Dark Brown SANDY TOPSOIL							
1SS					FILL - SILTY SAND, with organics, trace large gravel, dark gray to black, moist		50+ (15,25/2" Obstr)	6				⊗
2SS				848.2	FILL - SANDY CLAY, trace gravel, roots and pieces of wood, brick, dark brown and dark gray, moist	5	50+ (25/4" Obstr)	10				⊗
				846.7	END OF BORING							
					Boring terminated on obstruction at 4.5'; offset 5' west and re-drilled. See Boring B-7B							

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling None	Boring Started: 12/14/2006	Completed: 12/14/2006	Engineer: JDH
Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
_______ After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 5.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: RW-7B	psi *Professional Service Industries, Inc.*
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 121+09; 59' LT		

DRAFT

Surface Elevation: 852.59

⊗ "N" Blows Per Foot (0–60)
○ Unconfined Compressive Strength (tsf)
○* Calibrated Hand Penetrometer (tsf) (0–6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	Calibrated Hand Penetrometer (tsf)
	852.1	6" Dark Brown SANDY TOPSOIL							
1SS		FILL - SILTY SAND, fine, dark gray to black, trace roots and seams of brown silty sand, moist		6 (2,2,4)	12				
2SS	848.6	L.O.I. = 3.8%	5	6 (2,3,3)	17				
		FILL - CLAYEY SAND, trace gravel and root hairs, brown, dark grayish brown and dark reddish brown, moist to very moist							
3SS	846.1	FILL - SILTY CLAY, brown and yellowish brown, occasional seams of dark brown sandy organics, moist		6 (1,2,4)	17				2.5
4SS	843.6	L.O.I. = 4.5%	10	11 (2,4,7)	3				
		SAND (SP-SM) - fine to medium, with silt, trace gravel, brown and light brown, moist to wet, moderately compact							
5SS	837.1		15	21 (8,10,11)	12				
		END OF BORING							

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

∇ Water Level While Drilling 14.0'	Boring Started: 12/14/2006	Completed: 12/14/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
______ After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 15.5	Approved: MEE
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050
	Sheet: 1 of 1
	Boring Log Number: RW-8
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 122+81; 67' LT

Professional Service Industries, Inc.

DRAFT

Surface Elevation: **849.39**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	849.1	4" Dark Brown SANDY TOPSOIL						
1SS		FILL - SILTY CLAY, trace gravel, yellowish brown and gray, trace seams of brown silty sand, moist		5 (2,3,2)	15			
	845.4							
2SS		FILL - SILTY SAND, trace organics, seams of clay, gravel and pieces of concrete, brown, dark brown and black, moist	5	8 (6,5,3)	11			
	842.9							
3SS		SAND (SP-SM) - fine to coarse, with silt and gravel, brown and light brown, moist to wet, compact to moderately compact		33 (6,15,18)	4			
4SS			10	20 (6,9,11)	4			
5SS			15	18 (4,8,10)	19			
	833.9	END OF BORING						

"N" Blows Per Foot (0–60); Unconfined Compressive Strength (tsf); Calibrated Hand Penetrometer (tsf) (0–6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling 14.0'	Boring Started: 12/14/2006	Completed: 12/14/2006	Engineer: JDH
Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 12.25' After Completion	Driller: P. Cody	Drill Rig: CME-75	Hole Depth (ft): 15.5
			Approved: [signature]

Note: Boring backfilled with soil unless otherwise noted.

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **RW-9**	**psi** *Professional Service Industries, Inc.*
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 122+78; 51' RT**		

DRAFT

Surface Elevation: **851.38**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	851.1	3" Dark Brown SANDY TOPSOIL						
1SS	848.9	SILTY SAND (SM) - fine to medium, with clayey fines, brown to dark reddish brown, moist, loose		8 (3,3,5)	12			
2SS		SAND (SP-SM) - fine to coarse, with silt and gravel, brown and light brown, moist to wet, moderately compact	5	12 (2,5,7)	5			
3SS				19 (5,9,10)	5			
4SS			10	15 (4,6,9)	6			
5SS	835.9		15	18 (5,8,10)	13			

END OF BORING

Plot legend: ⊗ "N" Blows Per Foot (0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); ○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling 14.0'	Boring Started: **12/14/2006**	Completed: **12/14/2006**	Engineer: **JDH**
▼ Water Level At Completion None	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
Collapsed @ 12.5' After Completion	Driller: **P. Cody** Drill Rig: **CME-75**	Hole Depth (ft): **15.5**	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 / Sheet: 1 of 1	Boring Log Number: RW-10	Professional Service Industries, Inc.
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 125+36; 32' LT		

DRAFT

Surface Elevation: 862.11

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	861.3	10" ASPHALT PAVEMENT						
1SS		FILL - SAND, fine to medium, trace gravel, brown to reddish brown, trace dark brown silty organics, moist		19 (5,9,10)	7			
	858.1							
2SS		FILL - SAND, fine to medium, trace gravel, brown and light brown, occasional seams of dark brown silty organics, moist	5	5 (1,2,3)	11			
3SS				6 (3,3,3)	14			
4SS			10	4 (3,2,2)	10			
	848.1							
5SS		FILL - SILTY SAND, with organics and seams of clayey sand, brown and dark brown, trace fine to coarse sand, moist	15	5 (2,2,3)	12			
6SS			20	8 (2,3,5)	13			
	838.1							
7SS		SAND (SM) - fine to coarse, with silt and gravel, brown and light brown, moist to wet, moderately compact	25	30 (6,14,16)	6			
8SS			30	22 (4,10,12)	14			
9SS			35	26 (5,11,15)	17			
	826.6	END OF BORING						

Plot legend: ⊗ "N" Blows Per Foot (0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); ○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling 29.0'	Boring Started: 11/29/2006	Completed: 11/29/2006	Engineer: JDH
Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 27.25' After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 35.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: RW-11	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 125+69; 16' RT		

DRAFT

Surface Elevation: 863.70

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	863.3	5" ASPHALT PAVEMENT						
	862.6	8" CONCRETE PAVEMENT						
1SS		FILL - SILTY SAND, trace gravel and organics, brown, dark brown and dark reddish brown, moist		12 (2,6,6)	9			
	859.7							
2SS		FILL - SAND, fine to medium, trace gravel, brown, occasional seams of reddish brown silty sand and clayey sand, moist	5	15 (2,7,8)	6			
3SS				13 (2,5,8)	6			
4SS			10	3 (1,2,1)	9			
5SS			15	6 (5,3,3)	6			
	844.2							
6SS		CLAYEY SILT (OL) - with organics, dark gray to black, moist, loose L.O.I. = 5.7%	20	8 (3,3,5)	20			
	843.2							
7SS		SAND (SM) - fine to coarse, with silt and gravel, brown and light brown, moist to wet, loose to moderately compact	25	18 (4,9,9)	7			
8SS			30	19 (5,8,11)	13			
9SS			35	15 (2,6,9)	14			
	828.2	END OF BORING						

Graph legend: ⊗ "N" Blows Per Foot (0, 20, 40, 60); O Unconfined Compressive Strength (tsf); O* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling 29.0'	Boring Started: 12/18/2006	Completed: 12/18/2006	Engineer: JDH
Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 20.5' After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 35.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: RW-12	psi *Professional Service Industries, Inc.*
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 126+84; 17' LT		

DRAFT

Surface Elevation: **866.77**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	866.5	3.5" ASPHALT PAVEMENT						
	865.9	7" CONCRETE PAVEMENT						
1SS		FILL - SAND, fine to medium, trace gravel, brown and light brown, occasional seams of reddish brown silty sand and dark brown silty organics, moist		16 (5,7,9)	5			
2SS			5	4 (2,2,2)	6			
3SS				6 (2,3,3)	6			
4SS			10	3 (1,1,2)	7			
5SS			15	6 (2,3,3)	7			
	847.8	FILL - SILTY SAND, with clayey fines and organics, trace cinders, slag, reddish brown to dark reddish brown, trace light brown sand seams, moist						
6SS			20	6 (2,3,3)	13			
7SS			25	7 (2,3,4)	12			
	837.8	SAND (SM) - fine to coarse, with sill and gravel, brown and light brown, moist to wet, moderately compact **Sample Tested for Gradation						
8SS			30	14 (4,6,8)	7			
9SS			35	23 (7,10,13)	16			
10SS			40	23 (8,10,13)	16			
	826.3	END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)

○ Unconfined Compressive Strength (tsf)

○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

∇ Water Level While Drilling 34.0'	Boring Started: 11/29/2006	Completed: 11/29/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 24' After Completion	Driller: P. Cody — Drill Rig: CME-75	Hole Depth (ft): 40.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

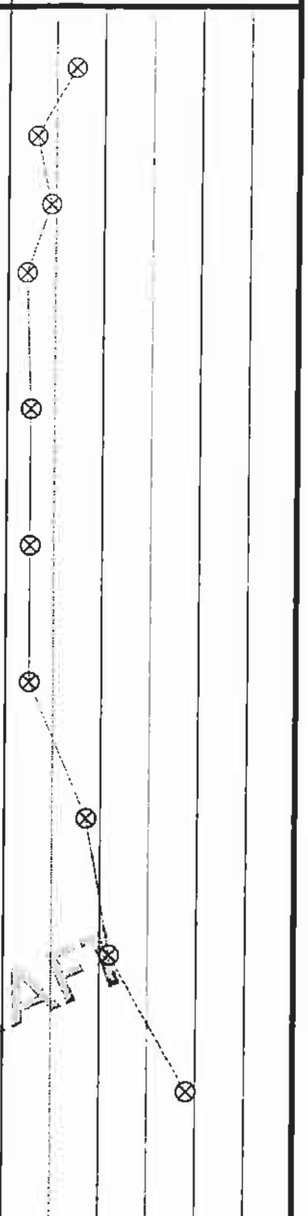
Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: RW-13	psi Professional Service Industries, Inc.
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 126+81; 17' RT		

DRAFT

Surface Elevation: 866.75

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	866.4	4" ASPHALT PAVEMENT						
	865.8	8" CONCRETE PAVEMENT						
1SS		FILL - SAND, fine to coarse, trace gravel, brown, occasional seams of silty sand and dark gray to dark brown silty organics, moist		14 (3,8,6)	7			
2SS			5	6 (4,3,3)	6			
3SS				9 (2,5,4)	8			
4SS			10	4 (2,2,2)	7			
5SS			15	5 (2,2,3)	8			
6SS	847.8	FILL - SILTY SAND, with organics, cinders, slag, brick fragments and seams of fine to coarse sand, brown, dark brown and dark reddish brown, moist L.O.I. = 5.5%	20	5 (2,2,3)	16			
7SS	842.8	CLAYEY SAND (SC) - fine to coarse, with gravel, mottled brown, moist, loose	25	5 (2,3,2)	6			
8SS	837.8	SAND (SM) - fine to coarse, with silt and gravel, brown and light brown, moist, moderately compact to compact	30	17 (3,7,10)	9			
9SS			35	22 (6,10,12)	15			
10SS			40	38 (9,15,23)	12			
	826.3	END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)
○ Unconfined Compressive Strength (tsf)
○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)



DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling 34.0'	Boring Started: 12/20/2006	Completed: 12/20/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 30.5' After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 40.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: RW-14	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 129+02; 17' LT		

DRAFT

Surface Elevation: **866.22**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	865.9	3.5" ASPHALT PAVEMENT						
	865.3	8" CONCRETE PAVEMENT						
1SS		FILL - SAND, fine to coarse, trace gravel, brown and light brown, occasional seams of reddish brown silty sand and clayey sand, moist		11 (5,5,6)	4			
2SS			5	8 (5,4,4)	7			
3SS				15 (3,8,7)	8			
4SS	857.2	FILL - CLAYEY SAND, trace gravel and organics, gray and dark gray, moist L.O.I. = 2.5%	10	9 (3,4,5)	11			
5SS	852.2	FILL - SAND, fine to medium, trace gravel, brown and light brown, occassional seams of reddish brown clayey sand and dark brown silty organics, moist	15	9 (5,4,5)	11			
6SS			20	13 (4,5,8)	6			
7SS	842.2	SAND (SM) - fine to coarse, with silt and gravel, light brown to brown, moist to wet, moderately compact **Sample Tested for Gradation	25	19 (4,8,11)	6			
8SS			30	23 (4,10,13)	6			
9SS			35	24 (4,10,14)	12			
10SS			40	25 (6,10,15)	15			
11SS			45	14 (3,5,9)	14			
	820.7	END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)
○ Unconfined Compressive Strength (tsf)
○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

∇ Water Level While Drilling 34.0'	Boring Started: 11/28/2006	Completed: 11/28/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 30.25' After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 45.5	Approved: MEE
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **RW-15**	*Professional Service Industries, Inc.*
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan** **STATION 129+61; 16' RT**		

DRAFT

Surface Elevation: **866.03**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	865.7	4" ASPHALT PAVEMENT						
	865.0	8" CONCRETE PAVEMENT						
1SS		FILL - SAND, fine to medium, with gravel, brown, occasional seams of reddish brown silty sand and clayey sand, moist		10 (4,4,6)	7			
2SS			5	8 (4,4,4)	7			
3SS				11 (3,6,5)	8			
4SS	857.0	FILL - SILTY SAND, with clayey fines, trace gravel and organics, gray and dark gray, moist L.O.I. = 2.3%	10	11 (6,5,6)	12			
5SS	852.0	FILL - SILTY SAND, fine to medium, with gravel and clayey fines, brown and reddish brown, moist	15	4 (2,2,2)	11			
6SS			20	5 (1,1,4)	8			
7SS	841.0	SAND (SP-SM) - fine to coarse, with silt and gravel, light brown to brown, moist, moderately compact to compact	25	16 (2,4,12)	5			
8SS		**Sample Tested for Gradation	30	23 (3,12,11)	8			
9SS			35	13 (3,7,6)	16			
10SS			40	16 (3,7,9)	12			
11SS	820.5		45	35 (5,9,26)	11			
		END OF BORING						

Water level while drilling is marked at about 34 ft.

⊗ "N" Blows Per Foot (0, 20, 40, 60)
○ Unconfined Compressive Strength (tsf)
○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

∇ Water Level While Drilling 34.0'	Boring Started: **11/28/2006**	Completed: **11/28/2006**	Engineer: **JDH**
▼ Water Level At Completion None	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
Collapsed @ 30.5' After Completion	Driller: **P. Cody** / Drill Rig: **CME-75**	Hole Depth (ft): **45.5**	Approved: MSE
	Note: Boring backfilled with soil unless otherwise noted.		

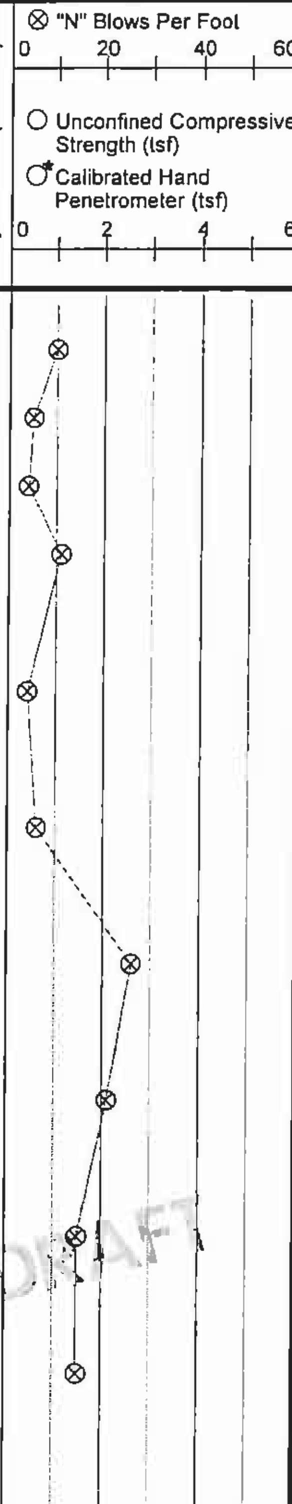
Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: RW-16	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 131+32; 17' LT		

DRAFT

Surface Elevation: **859.94**

Elevation (ft)	Description of Material
859.7	3" ASPHALT PAVEMENT
859.1	7" CONCRETE PAVEMENT
855.9	FILL - SAND, fine to coarse, with silt and gravel, light brown, occasional seams of reddish brown silty sand, moist
835.9	FILL - SILTY SAND, fine to medium, trace gravel, brown and reddish brown, occasional seams of clayey sand and dark brown silty organics, moist
825.9	SAND (SP-SM) - fine to coarse, with silt and gravel, brown and light brown, moist to wet, moderately compact
819.4	SAND (SM) - fine to coarse, with silt and gravel, gray, wet, moderately compact
	END OF BORING

Sample No./Type	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
1SS		10 (4,5,5)	5			
2SS	5	5 (4,3,2)	8			
3SS		4 (1,2,2)	9			
4SS	10	11 (4,6,5)	9			
5SS	15	4 (2,2,2)	10			
6SS	20	6 (2,2,4)	10			
7SS	25	26 (9,12,14)	7			
8SS	30	21 (5,10,11)	15			
9SS	35	15 (3,6,9)	17			
10SS	40	15 (5,6,9)	17			



Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

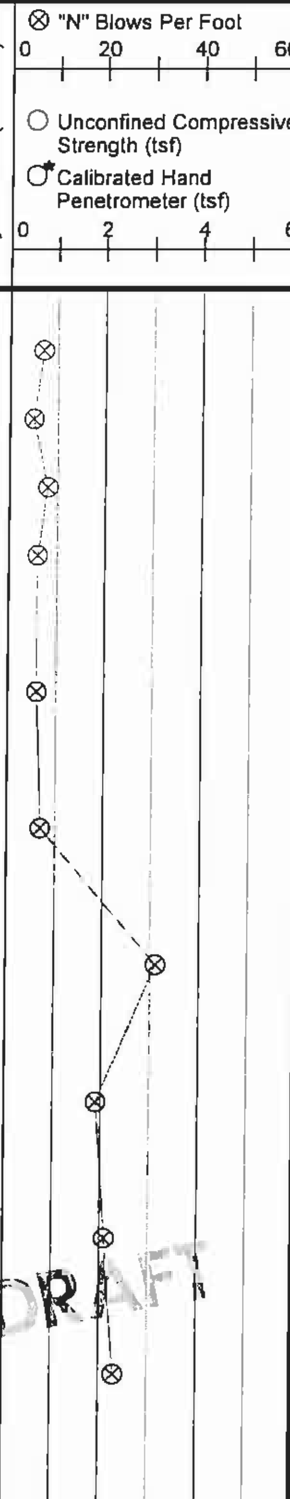
▽ Water Level While Drilling 29.0'	Boring Started: 11/27/2006	Completed: 11/27/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 23' After Completion	Driller: P. Cody · Drill Rig: CME-75	Hole Depth (ft): 40.5	Approved: JHK
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **RW-17**	**psi** Professional Service Industries, Inc.
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 131+48; 15' RT**		

Surface Elevation: **859.33**

DRAFT

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	859.0	4" ASPHALT PAVEMENT						
	858.4	7" CONCRETE PAVEMENT						
1SS		FILL - SAND, fine to medium, trace gravel, brown, occasional seams of reddish brown silty sand, clayey sand and dark gray silty organics, moist		7 (5,4,3)	13			
2SS			5	5 (2,2,3)	15			
3SS				8 (1,2,6)	9			
4SS			10	6 (3,3,3)	9			
5SS			15	6 (2,2,4)	11			
6SS	840.3	FILL - SAND, fine to medium, with silt and gravel, light brown, moist	20	7 (2,3,4)	8			
7SS	835.3	SAND (SP-SM) - fine to coarse, with silt and gravel, light brown to brown, moist to wet, compact to moderately compact	25	31 (4,14,17)	10			
8SS		▽	30	19 (3,5,14)	14			
9SS	825.3	SAND (SM) - fine to medium, with silt and gravel, gray, wet, moderately compact	35	21 (5,10,11)	15			
10SS	818.8		40	23 (4,8,15)	15			
		END OF BORING						



Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling 29.0'	Boring Started: 11/28/2006	Completed: 11/28/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 24.5' After Completion	Driller: P. Cody · Drill Rig: CME-75	Hole Depth (ft): 40.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: RW-18
	Sheet: 1 of 1	
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 133+19; 58' LT	

psi
Professional Service Industries, Inc.

DRAFT

Surface Elevation: 839.98

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)	"N" Blows Per Foot
	839.6	5" ASPHALT PAVEMENT							
1SS	838.5	CLAYEY SAND (SC) - trace gravel, brown to reddish brown, moist, moderately compact		25 (3,10,15)	4				⊗ 25
2SS		SAND (SP-SM) - fine to medium, with silt, gravel and coarse sand, brown and light brown, moist to wet, moderately compact	5	18 (3,9,9)	6				⊗ 18
		**Sample Tested for Gradation							
3SS				16 (2,7,9)	15				⊗ 16
4SS			10	15 (3,6,9)	15				⊗ 15
5SS	826.0	SAND (SM) - fine to medium, with silt and gravel, gray, wet, moderately compact	15	16 (6,6,10)	13				⊗ 16
	824.5	END OF BORING							

Legend: ⊗ "N" Blows Per Foot (0, 20, 40, 60); ○ Unconfined Compressive Strength (tsf); ○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

DRAFT

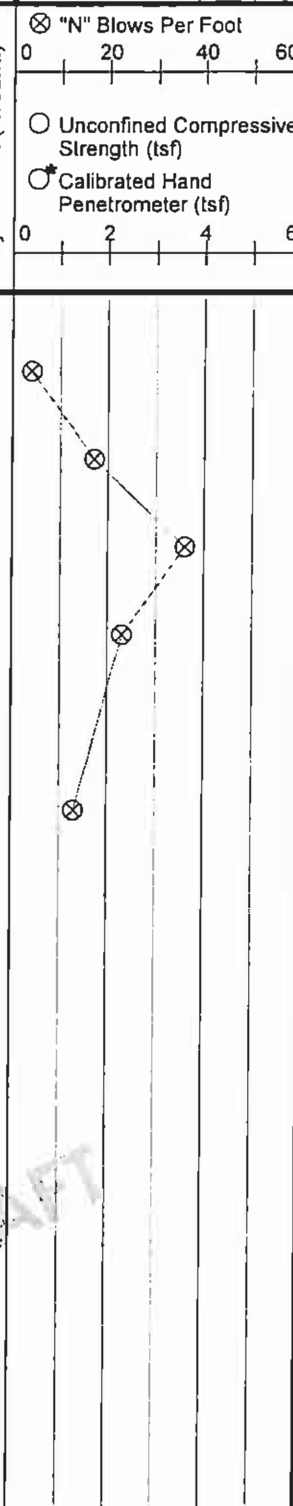
Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

∇ Water Level While Drilling 6.5'	Boring Started: 12/15/2006	Completed: 12/15/2006	Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 5.5' After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 15.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: RW-19	psi Professional Service Industries, Inc.
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 133+13; 44' RT		

Surface Elevation: **843.91**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	842.4	FILL - SILTY SAND, few gravel, some organics and clayey fines, dark brown, moist						
1SS	839.9	CLAYEY SAND (SC) - trace gravel, reddish brown, moist, loose		4 (2,2,2)	15			
2SS		SAND (SP-SM) - fine to medium, with silt, gravel and coarse sand, brown and light brown, moist to wet, moderately compact to compact	5	17 (3,7,10)	4			
3SS				36 (6,17,19)	5			
4SS			10	23 (6,12,11)	13			
5SS	828.4		15	13 (3,5,8)	20			
		END OF BORING						



Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling 9.0'	Boring Started: 1/3/2007	Completed: 1/3/2007	Engineer: JDH
Water Level At Completion None	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 9.5' After Completion	Driller: P. Cody / Drill Rig: CME-75	Hole Depth (ft): 15.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: Northwest Consultants, Inc.	PSI Project #: 381-65050 Sheet: 1 of 1	Boring Log Number: RW-20	Professional Service Industries, Inc.
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 135+56; 30' LT		

Surface Elevation: **841.41**

DRAFT

"N" Blows Per Foot (0, 20, 40, 60)
Unconfined Compressive Strength (tsf)
Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	840.9	6" Black SANDY TOPSOIL						
1SS	837.4	SANDY SILT (OL/ML) - trace roots and organics, black to dark gray and dark brown, moist, very loose L.O.I. = 3.2%		2 (1,1,1)	20			
2SS	834.9	CLAYEY SAND (SC) - fine to medium, trace gravel and seams of silty sand, brown, very moist, loose	5	5 (1,2,3)	14			
3SS		SAND (SP-SM) - fine to medium, with silt, gravel and coarse sand, brown and light brown, moist to wet, moderately compact		15 (3,5,10)	7			
4SS	827.4		10	13 (2,5,8)	11			
5SS	825.9	SAND (SM) - fine to medium, with silt and gravel, gray, wet, compact	15	33 (8,15,18)	16			
		END OF BORING						

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level	Boring Details			Personnel
∇ Water Level While Drilling 9.0'	Boring Started: 12/14/2006	Completed: 12/14/2006		Engineer: JDH
▼ Water Level At Completion None	Drilling Method: 3.25" HSA		Office: Plymouth	Drawn By: JDH
Collapsed @ 8' After Completion	Driller: P. Cody	Drill Rig: CME-75	Hole Depth (ft): 15.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.			

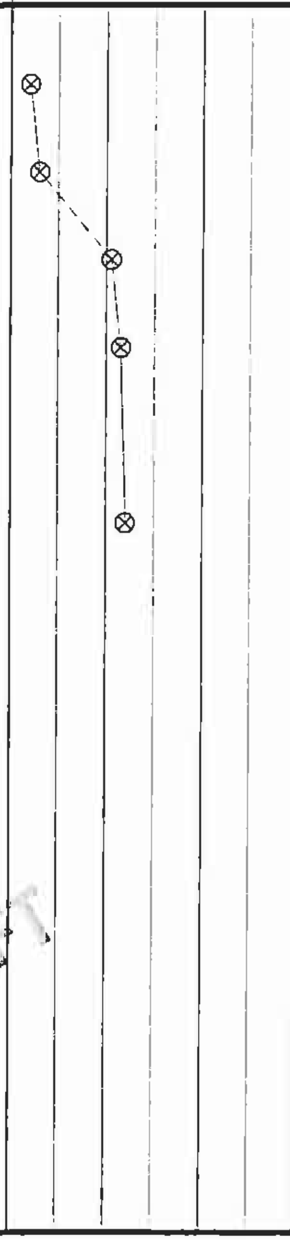
Client: Northwest Consultants, Inc.	PSI Project #: 381-65050	Boring Log Number: RW-21	psi Professional Service Industries, Inc.
	Sheet: 1 of 1		
Project: East Stadium Boulevard Structure Replacement Project	Location: City of Ann Arbor, Michigan STATION 135+73; 29' RT		

DRAFT

Surface Elevation: 841.55

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	840.8	9" Black SANDY TOPSOIL						
1SS	837.6	FILL - SILTY SAND, fine to medium, trace gravel, organics and clayey fines, brown, dark brown and dark reddish brown, moist		4 (1,2,2)	12			
2SS	835.1	SANDY SILT (OL/ML) - with organics, dark gray, moist, loose L.O.I. = 4.3%	5	6 (1,2,4)	21			
3SS		SAND (SP-SM) - fine to medium, with silt, gravel and coarse sand, brown and light brown, moist to wet, moderately compact		21 (4,9,12)	5			
4SS	827.6		10	23 (4,11,12)	11			
5SS	826.1	SAND (SM) - fine to coarse, with silt and gravel, grayish brown, wet, moderately compact	15	24 (7,11,13)	11			
		END OF BORING						

⊗ "N" Blows Per Foot (0, 20, 40, 60)
○ Unconfined Compressive Strength (tsf)
○* Calibrated Hand Penetrometer (tsf) (0, 2, 4, 6)



DRAFT

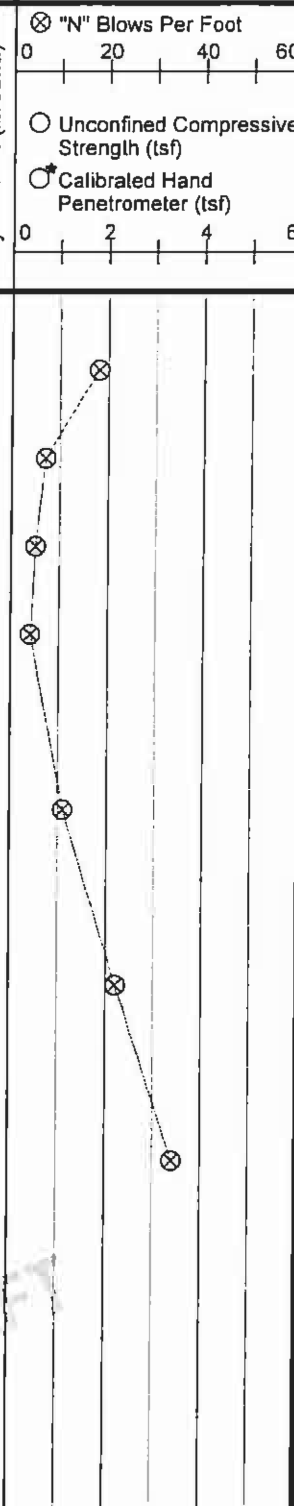
Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling 10.25'	Boring Started: 12/20/2006	Completed: 12/20/2006	Engineer: JDH
▼ Water Level At Completion 9.5'	Drilling Method: 3.25" HSA	Office: Plymouth	Drawn By: JDH
Collapsed @ 9.75' After Completion	Driller: P. Cody; Drill Rig: CME-75	Hole Depth (ft): 15.5	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **T-1**	**psi** *Professional Service Industries, Inc.*
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 124+29; 32' LT**		

Surface Elevation: **859.74**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	859.3	5.5" ASPHALT PAVEMENT						
	858.2	12.5" CRUSHED LIMESTONE BASE						
1SS		FILL - SAND, fine to coarse, with silt and gravel, brown and light brown, moist		18 (6,10,8)	6			
	855.7	FILL - SILTY SAND, fine to medium, trace gravel, brown and reddish brown, occasional seams of dark brown silty organics and clayey fines, moist						
2SS			5	7 (3,4,3)	10			
3SS				5 (2,3,2)	11			
4SS			10	4 (2,2,2)	10			
5SS	844.7	SAND (SM) - fine to coarse, with silt and gravel, brown and light brown to brown, moist to wet, moderately compact to compact **Sample Tested for Gradation	15	11 (2,4,7)	11			
6SS			20	22 (7,12,10)	6			
7SS	834.2		25	34 (11,15,19)	14			
		END OF BORING						



Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

▽ Water Level While Drilling 24.0'	Boring Started: **11/27/2006**	Completed: **11/27/2006**	Engineer: **JDH**
▼ Water Level At Completion None	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
Collapsed @ 21.25' After Completion	Driller: **P. Cody** / Drill Rig: **CME-75**	Hole Depth (ft): **25.5**	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

Client: **Northwest Consultants, Inc.**	PSI Project #: **381-65050** Sheet: **1** of **1**	Boring Log Number: **T-2**	psi *Professional Service Industries, Inc.*
Project: **East Stadium Boulevard Structure Replacement Project**	Location: **City of Ann Arbor, Michigan STATION 124+28; 18' RT**		

DRAFT

Surface Elevation: **860.23**

Sample No./Type	Elevation (ft)	Description of Material	Depth (ft)	Blows Per Foot	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Dry Unit Wt (lb/cu.ft.)
	859.7	6" ASPHALT PAVEMENT						
	859.1	8" CONCRETE PAVEMENT						
1SS		FILL - SILTY SAND, fine to medium, trace gravel, brown and reddish brown, occasional seams of clayey sand, moist		9 (5,4,5)	8			
2SS			5	12 (3,4,8)	10			
3SS				7 (3,3,4)	16			
4SS			10	6 (1,2,4)	13			
	846.2	SILTY SAND (OL/SM) - with clayey fines, trace organics, dark gray, moist, loose L.O.I. = 3.3%						
5SS			15	6 (4,3,3)	14			
	841.2	SAND (SM) - fine to coarse, with silt and gravel, brown and light brown to brown, moist to wet, compact **Sample Tested for Gradation						
6SS			20	43 (12,17,26)	7			
7SS			25	35 (11,16,19)	14			
	834.7	END OF BORING						

"N" Blows Per Foot (0–60); Unconfined Compressive Strength (tsf); Calibrated Hand Penetrometer (tsf) (0–6)

DRAFT

Note: The stratification lines indicated here are approximate. In-situ, the transition between soil types may be gradual.

Water Level While Drilling 24.0'	Boring Started: **11/22/2006**	Completed: **11/22/2006**	Engineer: **JDH**
Water Level At Completion None	Drilling Method: **3.25" HSA**	Office: **Plymouth**	Drawn By: **JDH**
Collapsed @ 19' After Completion	Driller: **P. Cody** / Drill Rig: **CME-75**	Hole Depth (ft): **25.5**	Approved: [signature]
	Note: Boring backfilled with soil unless otherwise noted.		

ATTACHMENT

APPENDIX A

Michigan Department of Transportation

Uniform Field Soil Classification System
(Modified Unified Description)

Introduction

The purpose of this system is to establish guidelines for the uniform classification of soils by inspection for MDOT Soils Engineers and Technicians. It is the intent of this system to describe only the soil constituents that have a significant influence on the visual appearance and engineering behavior of the soil. This system is intended to provide the best word description of the sample to those involved in the planning, design, construction, and maintenance processes. A method is presented for preparing a "word picture" of a sample for entering on a subsurface exploration log or other appropriate data sheet. The classification procedure involves visually and manually examining soil samples with respect to texture (grain-size), plasticity, color, structure, and moisture. In addition to classification, this system provides guidelines for assessment of soil strength (relative density for granular soils, consistency for cohesive soils), which may be included with the field classification as appropriate for engineering requirements. A glossary of terms is included at the end of this document for convenient reference.

It should be understood that the soil descriptions are based upon the judgement of the individual making the description. Laboratory classification tests are not intended to be used to verify the description, but to further determine the engineering behavior for geotechnical design and analysis, and for construction.

Primary Soil Constituents

The primary soil constituent is defined as the material fraction which has the greatest impact on the engineering behavior of the soil, and which usually represents the soil type found in the largest percentage. To determine the primary constituent, it must first be determined whether the soil is "Fine-Grained" or "Coarse-Grained" or "Organic" as defined below. The field soil classification "word picture" will be built around the primary constituent as defined by the soil types described below.

Coarse-Grained Soils: More than 50% of the soil is *RETAINED* on the 0.075 mm (#200) sieve. A good rule of thumb to determine if particles will be retained or pass the 0.075 mm sieve: If individual particles can be distinguished by the naked eye, then they will likely be retained. Also, the finest sand particles often can be identified by their sparkle or glassy quality.

Gravel Identified by particle size, gravel consists of rounded, partially angular, or angular (crushed faces) particles of rock. Gravel size particles usually occur in varying combinations with other particle sizes. Gravel is subdivided into particle size ranges as follows: (Note that particles > 75 mm are cobbles or boulders, as defined in the Glossary of Terms.)

Coarse - Particles passing the 75 mm (3 inch) sieve, and retained on the 19 mm (3/4 inch) sieve.

Fine - Gravel particles passing the 19 mm (3/4 inch) sieve, and retained on the 4.76 mm (#4 U.S. standard) sieve.

Note: The term "gravel" in this system denotes a particle size range and should not be confused with "gravel" used to describe a type of geologic deposit or a construction material.

Sand Identified by particle size, sand consists of rock particles, usually silicate (quartz) based, ranging between gravel and silt sizes. Sand has no cohesion or plasticity. Its particles are gritty grains that can easily be seen and felt, and may be rounded (natural) or angular (usually manufactured). Sand is subdivided into particle size ranges as follows:

Coarse - Particles that will pass the 4.76 mm (#4 U.S. Standard) sieve and be retained on the 2 mm (# 10 U.S. Standard) sieve.

Medium - Particles that will pass the 2 mm (#10 U.S. Standard) sieve and be retained on the 0.425 mm (# 40 U.S. Standard) sieve.

Fine - Particles that will pass the 0.425 mm (#40 U.S. Standard) sieve and be retained on the 0.075 mm (# 200 U.S. Standard) sieve.

Well-Graded - Indicates relatively equal percentages of Fine, Medium, and Coarse fractions are present.

Note: The particle size of coarse-grained primary soils is important to the Soil Engineer! Always indicate the particle size or size range immediately before the primary soil constituent. Exception: The use of 'Gravel' alone will indicate both coarse and fine gravel are present. Examples: **Fine & Medium** Sand; **Coarse** Gravel.

Include the particle shape (angular, partially angular, or rounded) when appropriate, such as for aggregates or manufactured sands. Example: **Rounded** Gravel.

Fine-Grained Soils: More than 50% of the soil *PASSES* the 0.075 mm (#200) sieve.

Silt Identified by behavior and particle size, silt consists of material passing the 0.075 mm (#200) sieve that is non-plastic (no cohesion) and exhibits little or no strength when dried. Silt can typically be rolled into a ball or strand, but it will easily crack and crumble. To distinguish silt from clay, place material in one hand and make 10 brisk blows with the other; if water appears on the surface, creating a glossy texture, then the primary constituent is silt.

Clay Identified by behavior and particle size, clay consists of material passing the 0.075 mm (#200) sieve AND exhibits plasticity or cohesion (ability of particles to adhere to each other, like putty) within a wide range of moisture contents. Moist clay can be rolled into a thin thread (3 mm) that will not crumble. Also, clay will exhibit strength increase with decreasing moisture content, retaining considerable strength when dry.

Clay is often encountered in combination with other soil constituents such as silt and sand. If a soil exhibits plasticity, it contains clay. The amount of clay can be related to the degree of plasticity; the higher the clay content, the greater the plasticity.

Note: When applied to laboratory gradation tests, silt size is defined as that portion of the soil finer than the 0.075 mm sieve and coarser than the 0.002 mm sieve. Clay size is that portion of soil finer than 0.002 mm. For field classification, the distinction will be strictly based upon cohesive characteristics.

Organic Soils:

Peat Highly organic soil, peat consists primarily of vegetable tissue in various stages of decomposition, accumulated under excessive moisture conditions, with texture ranging from fibrous to amorphous. Peat is usually black or dark brown in color, and has a distinct organic odor. Peat may have minor amounts of sand, silt, and clay in various proportions.

Fibrous Peat - Slightly or un-decomposed organic material having identifiable plant forms. Peat is relatively very light-weight and usually has spongy, compressible consistency.

Amorphous Peat (Muck) - Organic material which has undergone substantial decomposition such that recognition of plant forms is impossible. Its consistency ranges from runny paste to compact rubbery solid.

Marl Marl consists of fresh water sedimentary deposits of calcium carbonate, often with varying percentages of calcarious fine sand, silt, clay and shell fragments. These deposits are unconsolidated, so marl is usually lightweight. Marl is white or light-gray in color with consistency ranging from soft paste to spongy. It may also contain granular spheres, organic material, or inorganic soils. Note that marl will react (fizz) with weak hydrochloric acid due to the carbonate content.

Secondary Soil Constituents

Secondary soil constituents represent one or more soil types other than the primary constituent which appear in the soil in significant percentages sufficient to readily affect the appearance or engineering behavior of the soil. To correlate the field classification with laboratory classification, this definition corresponds to amounts of secondary soil constituents > 12% for fine-grained and >30% for coarse-grained secondary soil constituents. The secondary soil constituents will be added to the field classification as an adjective <u>preceding the primary constituent</u>. Two or more secondary soil constituents should be listed in <u>ascending</u> order of importance. <u>Examples:</u> Silty Fine Sand; Peaty Marl; Gravelly, <u>Silty</u> Medium Sand; Silty, <u>Sandy</u> Clay.

Tertiary Soil Constituents

Tertiary soil constituents represent one or more soil types which are present in a soil in quantities sufficient to readily identify, but NOT in sufficient quantities to significantly affect the engineering behavior of the soil. The tertiary constituent will be added to the field classification with the phrase "*with* __" at the end, following the primary constituent and all other descriptors. This definition corresponds to approximately 5-12% for fine-grained and 15-29% for coarse-grained tertiary soil constituents. <u>Example:</u> Silty Fine to Coarse Sand with Gravel and Peat.

Soil types which appear in the sample in percentages below tertiary levels <u>need not be included</u> in the field classification. However, the slight appearance of a soil type may be characteristic of a transition in soil constituents (more significant deposits nearby), or may be useful in identifying the soil during construction. These slight amounts can be included for descriptive purposes at the end of the field classification as "Trace of ___."

Additional Soil Descriptors

Additional descriptors should be added as needed to adequately describe the soil for the purpose required. These descriptors should *typically* be added to the field classification before the primary and secondary constituents, in ascending order of significance (Exceptions noted below). Definitions for several descriptive terms can be found in the Glossary of Terms below. Other terms may be used as appropriate for descriptive purposes, but not for soil constituents.

Color	Brown, Gray, Yellow, Red, Black, Light-, Dark-, Pale-, etc.
Moisture Content	Dry, Moist, Saturated. Judge by appearance of sample before manipulating.
Structure	Fissured, Friable, Blocky, Varved, Laminated, Lenses, Layers, etc.

Examples: **Gray-Brown Laminated** Silty Clay; **Light-Brown Saturated** Fine & Medium Sand.

Exceptions: Certain descriptive terms such as "Fill", may be more appropriate after the primary constituent or at the end of the field classification. Also, the description of distinct soils (inclusions) within a larger stratum should be added after the complete field classification of the predominant soil.

Examples of exceptions: Firm Brown Sandy Clay **Fill**, with Coarse Angular Gravel and Asphalt;
Gray Silty Clay with Saturated Marl, **Lenses of Saturated Fine Sand.**

Soil Strength Assessment

Soil strength refers to the degree of load-carrying capacity and resistance to deformation which a particular soil may develop. For cohesionless granular soils (sand, gravel, and silt) the relative in-place density is a measure of strength. The in-place consistency for cohesionless soils can be estimated by the Standard Penetration Test (SPT - Blow counts) and by resistance to drilling equipment or "pigtail" augers as described below. For cohesive soils, "consistency" is a measure of cohesion, or shear strength. The shear strength of clay soils can be estimated in the field using the manual methods described below, the

SPT, or resistance to drilling equipment. Note that for clay soils, loss of moisture will result in increased strength; therefore, consistency of clay soils should be estimated at the natural moisture content.

The soil consistency, when appropriate and available, should be added to the field classification at the very beginning, using the terminology described below. Examples: Loose Brown Rounded Fine Gravel; **Plastic** Gray Moist Sandy Clay.

Cohesionless Soil

Classification	Standard Penetration, N	Relative Density, %	Resistance to Advancement of a 1.2 m Long, 38 mm Diameter Spiral (Pigtail) Auger
Very Loose	< 4	0 - 15	The auger can be forced several inches into the soil, without turning, under the bodyweight of the technician.
Loose	4 - 10	15 - 35	The auger can be turned into the soil for its full length without difficulty. It can be chugged up and down after penetrating about 1/3 m, so that it can be pushed down 25 mm into the soil.
Moderately Compact	10 - 30	35 - 65	The auger cannot be advanced beyond ±3/4 m without great difficulty. Considerable effort by chugging required to advance further.
Compact	30 - 50	65 - 85	The auger turns until tight at ±1/3 m; cannot be advanced further.
Very Compact	> 50	85 - 100	The auger can be turned into the soil only to about the length of its spiral section.

Cohesive Soil

Classification	Manual Index for Consistency	Cohesion (psf)	Cohesion (kPa)	Standard Penetration, N
Very Soft	Extrudes between fingers when squeezed	0 - 250	0 - 12	< 2
Soft	Molded by light to moderate finger pressure	250 - 500	12 - 24	2 - 4
Plastic	Molded by moderate to firm finger pressure	500 - 1000	24 - 48	4 - 8
Firm	Readily indented by thumb, difficult to penetrate	1000 - 2000	48 - 96	8 - 15
Stiff	Readily indented by thumbnail	2000 - 4000	96 - 192	15 - 30
Hard	Indented with difficulty by thumbnail	4000 - 8000	192 - 384	> 30

Glossary of Terms

Blocky Cohesive soil which can be broken down into small angular lumps which resist further breakdown.

Boulder A rock fragment, usually rounded by weathering or abrasion, with average dimension of 300 mm (12") or more.

Calcareous Soil containing calcium carbonate, either from limestone deposits or shells. The carbonate will react (fizz) with weak hydrochloric acid.

Cemented The adherence or bonding of coarse soil grains due to presence of a cementicious material. May be *weak* (readily fragmented), *firm* (appreciable strength), or *indurated* (very hard, water will not soften, rock-like)

Cobble A rock fragment, usually rounded or partially angular, with an average dimension 75 to 300 mm (3" - 12").

Dry No appreciable moisture is apparent in the soil.

Fat Clay Fine-Grained soil with very high plasticity and dry strength. Usually has a sticky or greasy texture due to very high affinity for water. Remains plastic at very high water contents (Liquid Limit >50).

Fill Man-made deposits of natural soils and/or waste materials. Document the components carefully since presence and depth of fill are important engineering considerations.

Fissured The soil breaks along definite planes of weakness with little resistance to fracturing.

Frequent Occurring more than one per 300 mm (1') thickness.

Friable A soil which is easily crumbled or pulverized into smaller, non-uniform fragments or clumps.

Laminated Alternating horizontal strata of different material or color, usually in increments of 6 mm (1/4") or less.

psi

GENERAL NOTES

SAMPLE IDENTIFICATION

The Unified Soil Classification System is used to identify the soil unless otherwise noted.

SOIL PROPERTY SYMBOLS

N:	Standard Penetration Resistance "N": Blows per foot of a 140-pound hammer falling 30 inches on a 2 inch O.D. split-spoon
Qu:	Unconfined Compressive Strength, TSF
Qp:	Pocket penetrometer value, unconfined compressive strength, TSF
Mc:	Water Content, %
LL:	Liquid Limit, %
PI:	Plasticity Index, %
γd:	Dry Density, PCF
▼:	Observed groundwater level at time noted after completion of boring

DRILLING AND SAMPLING SYMBOLS

SS:	Split-Spoon – 1 3/8" I.D., 2" O.D., except where noted
ST:	Shelby Tube – 3" O.D., except where noted
AU:	Auger Sample
DB:	Diamond Bit
CB:	Carbide Bit
WS:	Washed Sample

RELATIVE DENSITY AND CONSISTENCY CLASSIFICATIONS

NON-COHESIVE SOILS	RELATIVE DENSITY, %	SPT, N BLOWS PER FOOT
Very Loose	0 – 15	0 – 4
Loose	15 – 35	4 – 10
Medium	35 – 65	10 – 30
Dense	65 – 85	30 – 50
Very Dense	85 – 100	Over 50

COHESIVE SOILS	Qu – (TSF)	SPT, N BLOWS PER FOOT
Very Soft	0 – 0.25	0 – 2
Soft	0.25 – 0.50	2 – 4
Medium Stiff	0.50 – 1.00	4 – 8
Stiff	1.00 – 2.00	8 – 15
Very Stiff	2.00 – 4.00	15 – 30
Hard	Over 4.00	Over 30

PARTICLE SIZES

Boulders		Over 12 in. (305 mm)
Cobbles		3 in. (76 mm) – 12 in. (305 mm)
Gravel –	Coarse	3/4 in. (19 mm) – 3 in. (76 mm)
	Fine	0.19 in. (4.75 mm) – 3/4 in. (19 mm)
Fines –	Silt	0.0002 in. (0.005 mm) – 0.0029 in. (0.075 mm)
	Clay	Less than 0.0002 in. (0.005 mm)
Sand –	Coarse	0.079 in. (2 mm) – 0.19 in. (4.75 mm)
	Medium	0.017 in. (0.425 mm) – 0.079 in. (2mm)
	Fine	0.0029 in. (0.075 mm) – 0.017 in. (0.425 mm)

SOIL CONSTITUENTS

Trace	Less than 5%
Few (Gravel & Cobbles)	Less than 5%
Some	5 – 12%
With	12 – 30%

APPENDIX
SECTION NO. 3

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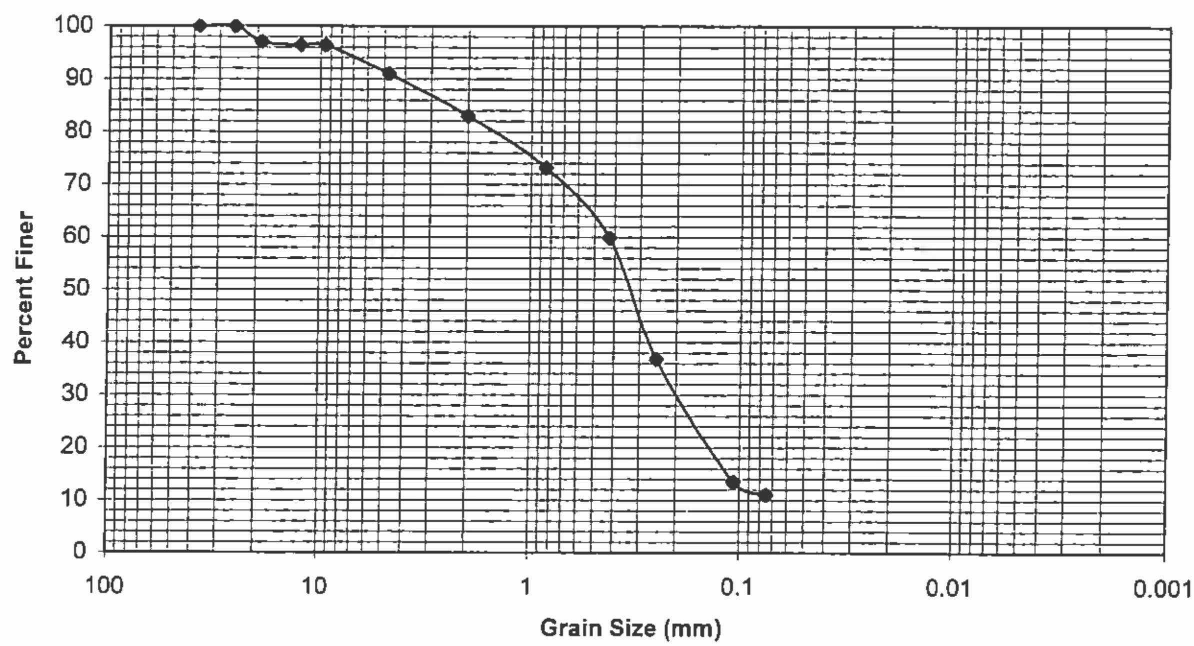
Project: East Stadium Boulevard	Project #: 381-65050
Date Sampled: 11/22/2006	Date Tested: 1/4/2007
Sampled by: Pat Cody	Source: B-20; 1SS, 2SS, 3SS
Location City of Ann Arbor, Michigan	Specification: NA

Soil Information:				
% >1.5 in.=	0.0	PI=	n/a	D_{10}=
% Gravel=	9.0	LL=	n/a	D_{30}=
% Sand=	79.9	PI=	n/a	D_{60}=
Coarse	8.0%	USCS:	SP-SM	Cu=
Medium	23.2%	AASHTO:		Cc=
Fine	48.8%	Description:		
% Fines=	11.1	SAND, fine to medium, some silt, gravel and coarse sand		
Silt	n/a			
Clay	n/a			

Grain Size Distribution



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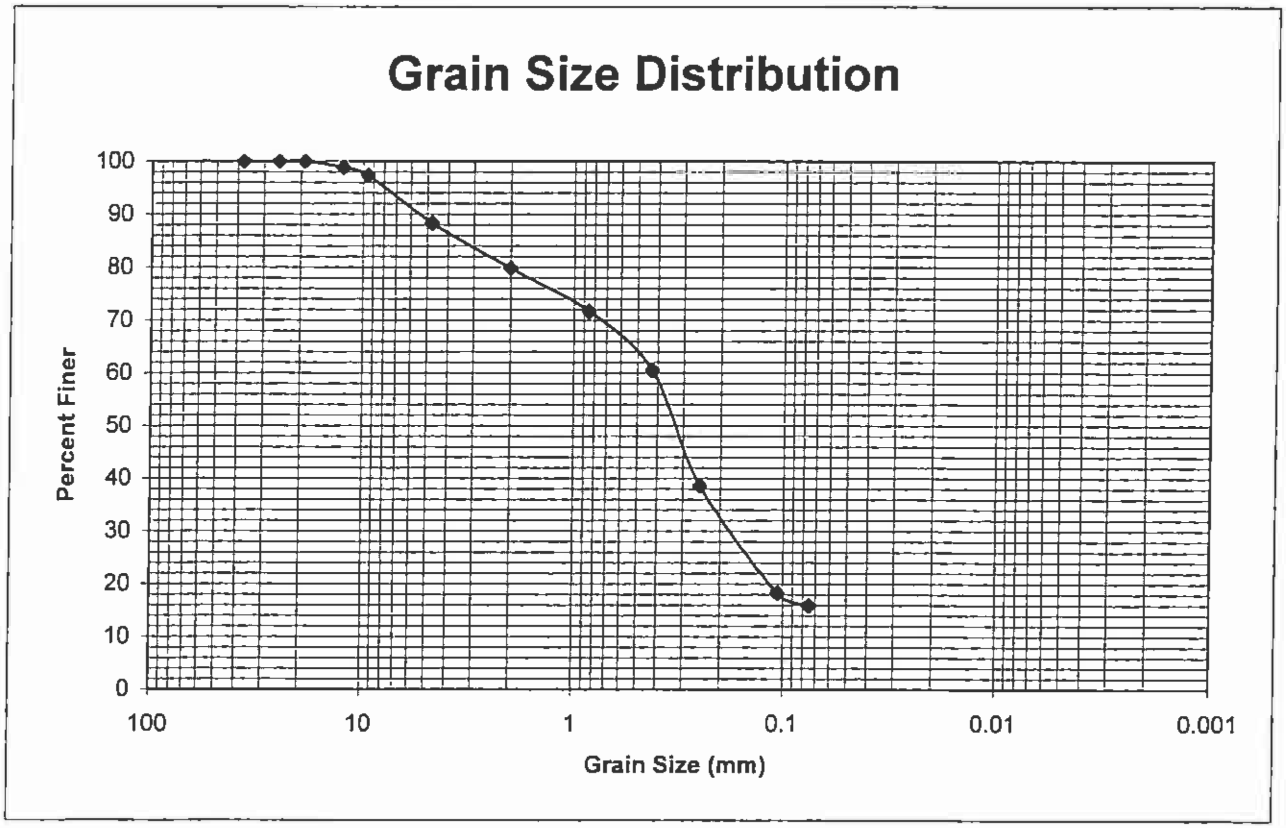
Project: East Stadium Boulevard	**Project #:** 381-65050
Date Sampled: 11/28/2006	**Date Tested:** 1/4/2007
Sampled by: Pat Cody	**Source:** B-26; 1SS, 2SS, 3SS
Location City of Ann Arbor, Michigan	**Specification:** NA

Soil Information:					
% >1.5 in.=	**0.0**		PI=	**n/a**	D_{10}=
% Gravel=	**11.6**		LL=	**n/a**	D_{30}=
% Sand=	**72.4**		PI=	**n/a**	D_{60}=
	Coarse	**8.5%**	USCS:	**SM**	Cu=
	Medium	**19.4%**	AASHTO:		Cc=
	Fine	**44.5%**	Description:		
% Fines=	**15.9**		**SILTY SAND, fine to medium, some gravel and coarse sand**		
	Silt	**n/a**			
	Clay	**n/a**			



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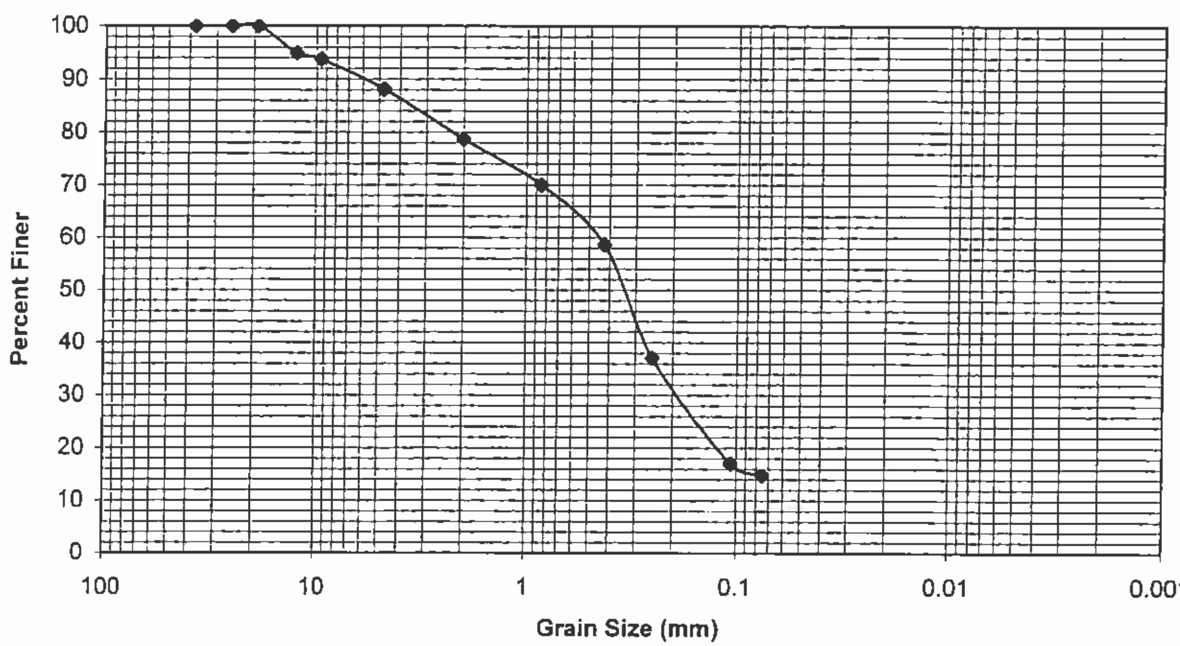
Project: East Stadium Boulevard	**Project #:** 381-65050
Date Sampled: 11/27/2006	**Date Tested:** 1/4/2007
Sampled by: Pat Cody	**Source:** B-27; 1SS, 2SS
Location City of Ann Arbor, Michigan	**Specification:** NA

Soil Information:

% >1.5 in.=	**0.0**	PI=	**n/a**	D_{10}=	
% Gravel=	**11.9**	LL=	**n/a**	D_{30}=	
% Sand=	**73.3**	PI=	**n/a**	D_{60}=	
Coarse	**9.4%**	USCS:	**SM**	Cu=	
Medium	**20.1%**	AASHTO:		Cc=	
Fine	**43.8%**	Description:			
% Fines=	**14.8**	**SILTY SAND, fine to medium, some gravel and coarse sand**			
Silt	**n/a**				
Clay	**n/a**				

Grain Size Distribution



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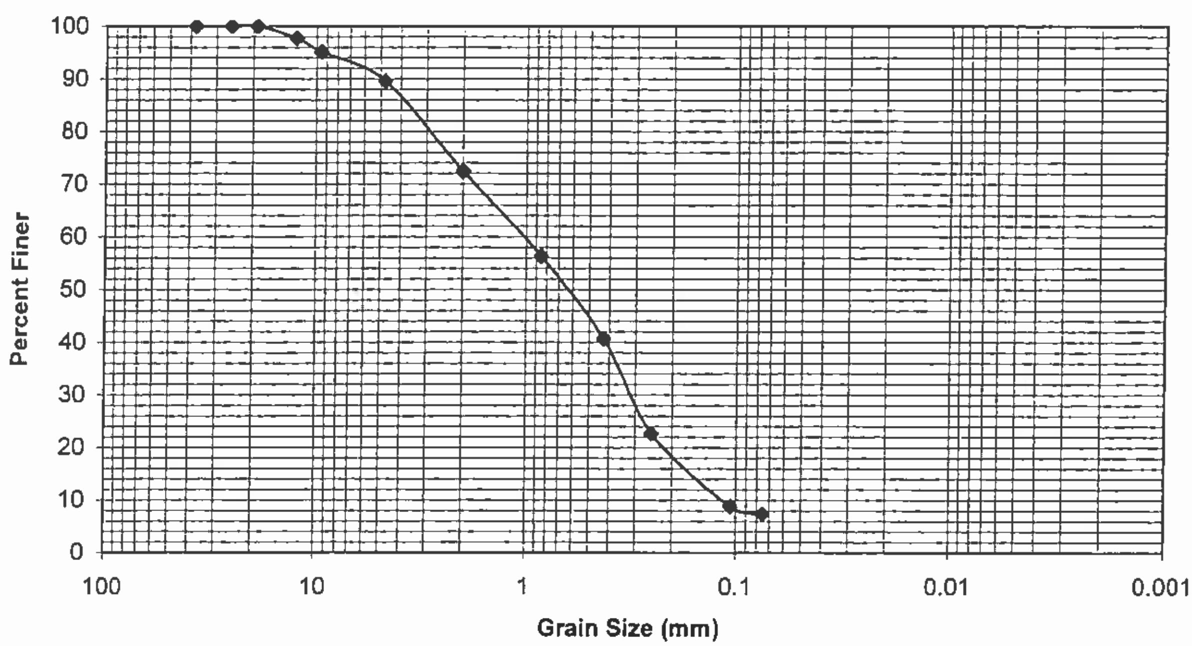
Project: East Stadium Boulevard	**Project #:** 381-65050
Date Sampled: 12/15/2006	**Date Tested:** 1/4/2007
Sampled by: Pat Cody	**Source:** B-33; 1SS, 2SS
Location City of Ann Arbor, Michigan	**Specification:** NA

Soil Information:

% >1.5 in.=	**0.0**	PI=	**n/a**	D_{10}=	
% Gravel=	**10.5**	LL=	**n/a**	D_{30}=	
% Sand=	**82.2**	PI=	**n/a**	D_{60}=	
Coarse	**17.1%**	USCS:	**SP-SM**	Cu=	
Medium	**31.7%**	AASHTO:		Cc=	
Fine	**33.3%**	Description:			
% Fines=	**7.4**	**SAND, fine to coarse, some silt and gravel**			
Silt	**n/a**				
Clay	**n/a**				

Grain Size Distribution



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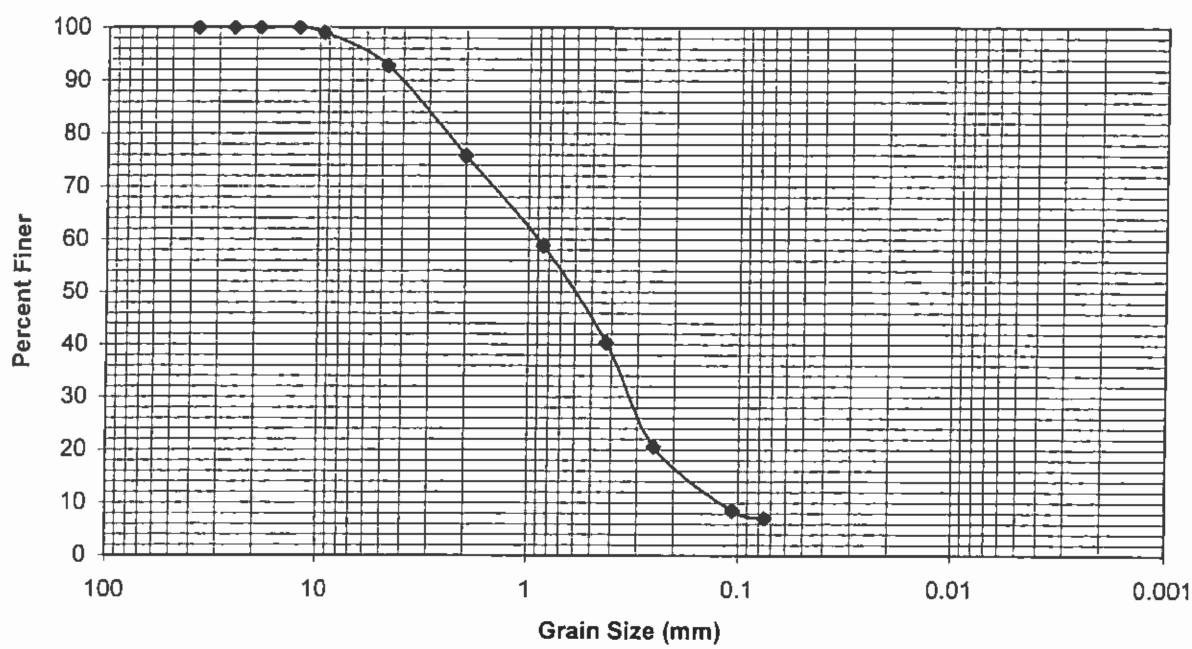
Project: East Stadium Boulevard	**Project #:** 381-65050
Date Sampled: 12/15/2006	**Date Tested:** 1/4/2007
Sampled by: Pat Cody	**Source:** B-38, B-39; 1SS
Location City of Ann Arbor, Michigan	**Specification:** NA

Soil Information:

% >1.5 in.=	**0.0**	PI=	**n/a**	D_{10}=
% Gravel=	**7.2**	LL=	**n/a**	D_{30}=
% Sand=	**85.7**	PI=	**n/a**	D_{60}=
Coarse	**17.0%**	USCS:	**SP-SM**	Cu=
Medium	**35.5%**	AASHTO:		Cc=
Fine	**33.3%**	Description:		
% Fines=	7.1	**SAND, fine to coarse, some silt and gravel**		
Silt	**n/a**			
Clay	**n/a**			

Grain Size Distribution



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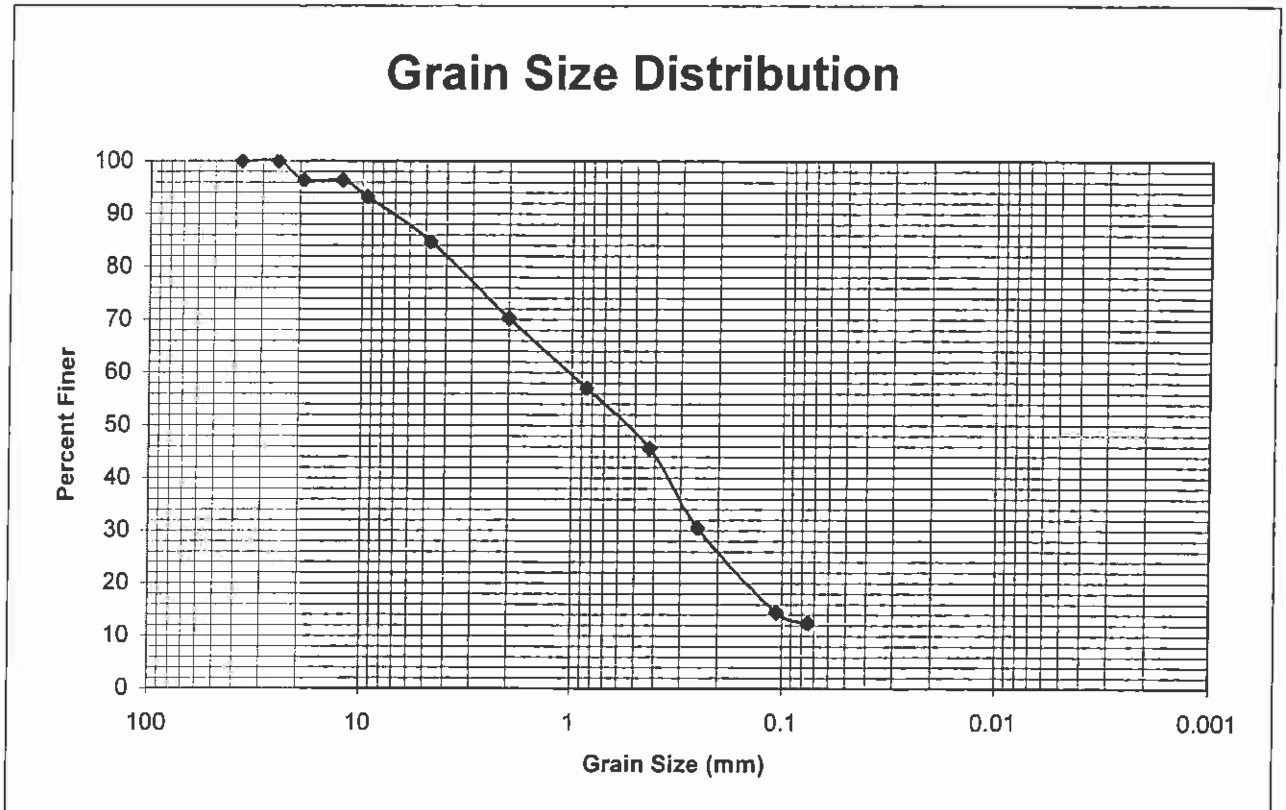
Project: East Stadium Boulevard	**Project #:** 381-65050
Date Sampled: 11/29/2006	**Date Tested:** 1/4/2007
Sampled by: Pat Cody	**Source:** RW-12; 8SS, 9SS
Location City of Ann Arbor, Michigan	**Specification:** NA

DRAFT

Soil Information:				
% >1.5 in.=	**0.0**	PI=	**n/a**	D_{10}=
% Gravel=	**15.3**	LL=	**n/a**	D_{30}=
% Sand=	**72.3**	PI=	**n/a**	D_{60}=
Coarse	**14.5%**	USCS:	**SM**	Cu=
Medium	**24.6%**	AASHTO:		Cc=
Fine	**33.2%**	Description:		
% Fines=	**12.4**	**SILTY SAND, fine to coarse, with gravel**		
Silt	**n/a**			
Clay	**n/a**			



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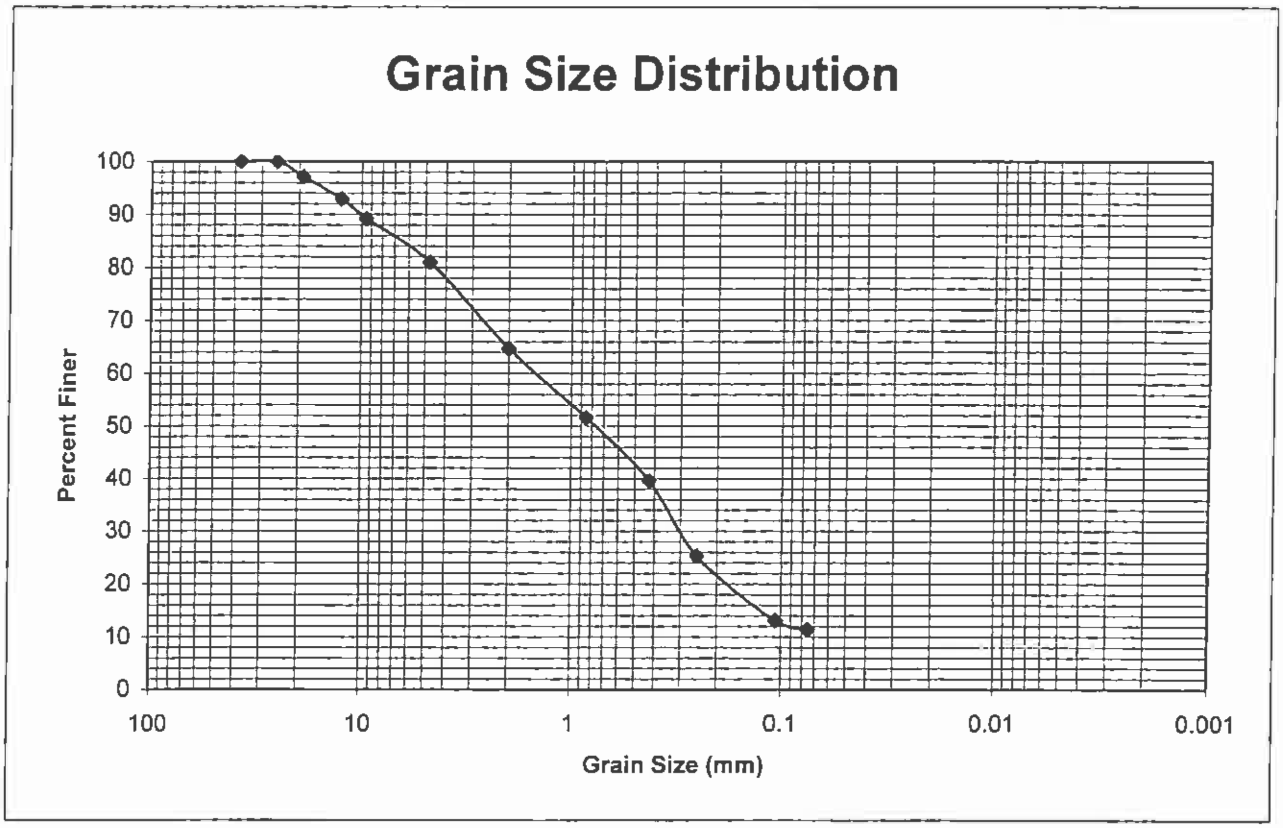
Project: East Stadium Boulevard	**Project #:** 381-65050
Date Sampled: 11/28/2006	**Date Tested:** 1/4/2007
Sampled by: Pat Cody	**Source:** RW-14, RW-15; 8SS,9SS
Location City of Ann Arbor, Michigan	**Specification:** NA

DRAFT

Soil Information:

% >1.5 in.=	**0.0**	PI=	**n/a**	D_{10}=
% Gravel=	**19.0**	LL=	**n/a**	D_{30}=
% Sand=	**69.6**	PI=	**n/a**	D_{60}=
Coarse	**16.3%**	USCS:	**SP-SM**	Cu=
Medium	**25.1%**	AASHTO:		Cc=
Fine	**28.1%**	Description:		
% Fines=	**11.4**	**SAND, fine to coarse, with gravel**		
Silt	**n/a**			
Clay	**n/a**			



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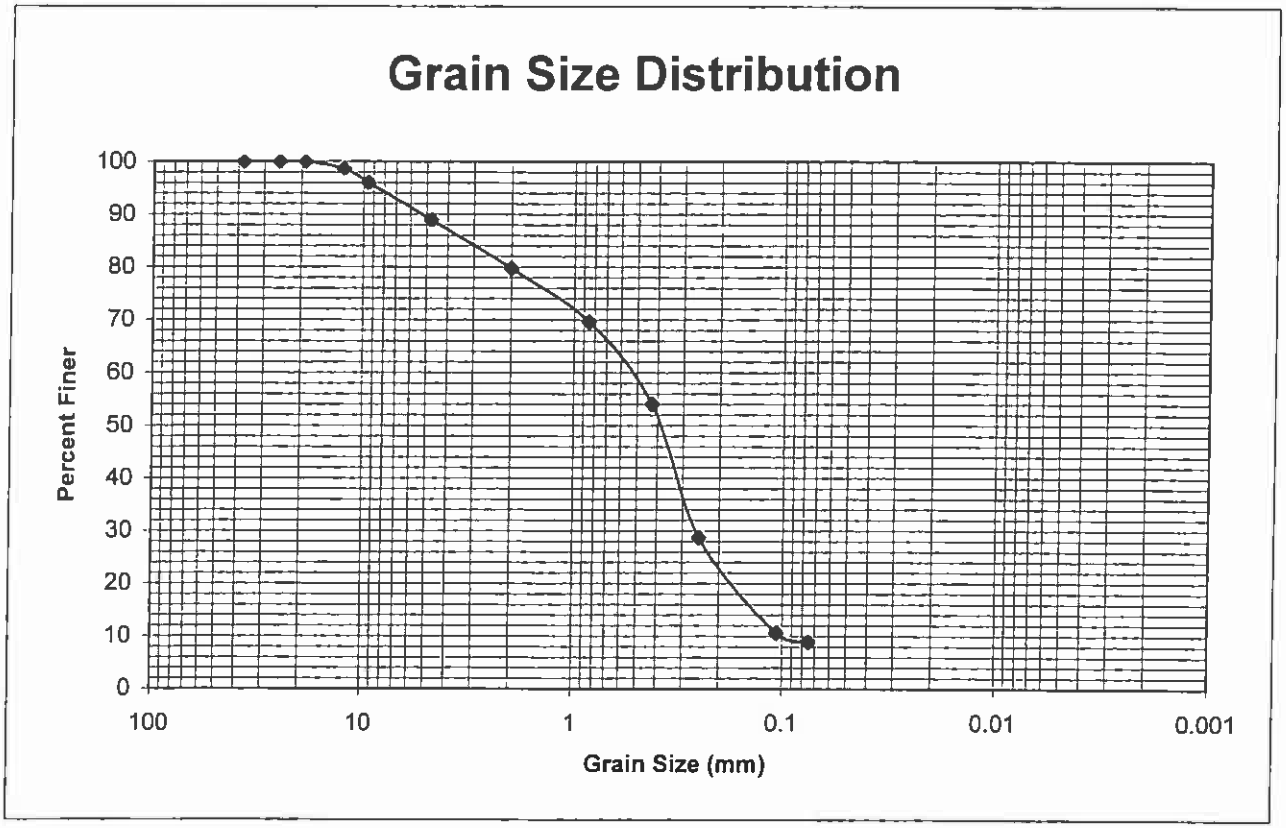
Project: East Stadium Boulevard	**Project #:** 381-65050
Date Sampled: 12/15/2006	**Date Tested:** 1/4/2007
Sampled by: Pat Cody	**Source:** RW-18; 1SS, 2SS, 3SS
Location City of Ann Arbor, Michigan	**Specification:** NA

DRAFT

Soil Information:					
% >1.5 in.=	**0.0**		PI=	**n/a**	D_{10}=
% Gravel=	**11.1**		LL=	**n/a**	D_{30}=
% Sand=	**80.0**		PI=	**n/a**	D_{60}=
	Coarse	**9.2%**	USCS:	**SP-SM**	Cu=
	Medium	**25.6%**	AASHTO:		Cc=
	Fine	**45.1%**	Description:		
% Fines=	**8.9**		**SAND, fine to medium, some silt, gravel and coarse sand**		
	Silt	**n/a**			
	Clay	**n/a**			



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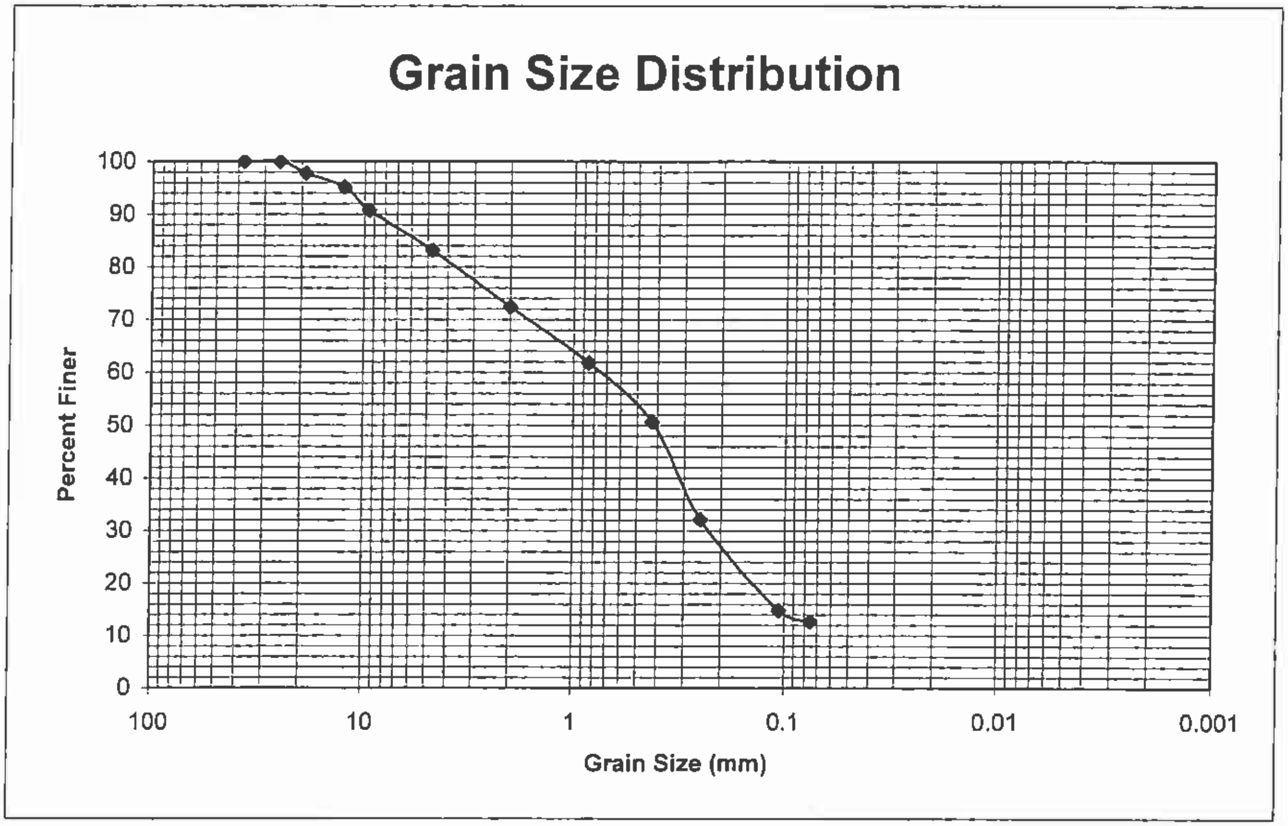
Engineering • Consulting • Testing

Project: East Stadium Boulevard	**Project #:** 381-65050
Date Sampled: 11/27/2006	**Date Tested:** 1/4/2007
Sampled by: Pat Cody	**Source:** T-1, T-2; 6SS, 7SS
Location City of Ann Arbor, Michigan	**Specification:** NA

Soil Information:					
% >1.5 in.=	**0.0**		PI=	**n/a**	D_{10}=
% Gravel=	**16.8**		LL=	**n/a**	D_{30}=
% Sand=	**70.5**		PI=	**n/a**	D_{60}=
	Coarse	**10.8%**	USCS:	**SM**	Cu=
	Medium	**21.7%**	AASHTO:		Cc=
	Fine	**38.0%**	Description:		
% Fines=	**12.7**		**SILTY SAND, fine to coarse, with gravel**		
	Silt	**n/a**			
	Clay	**n/a**			



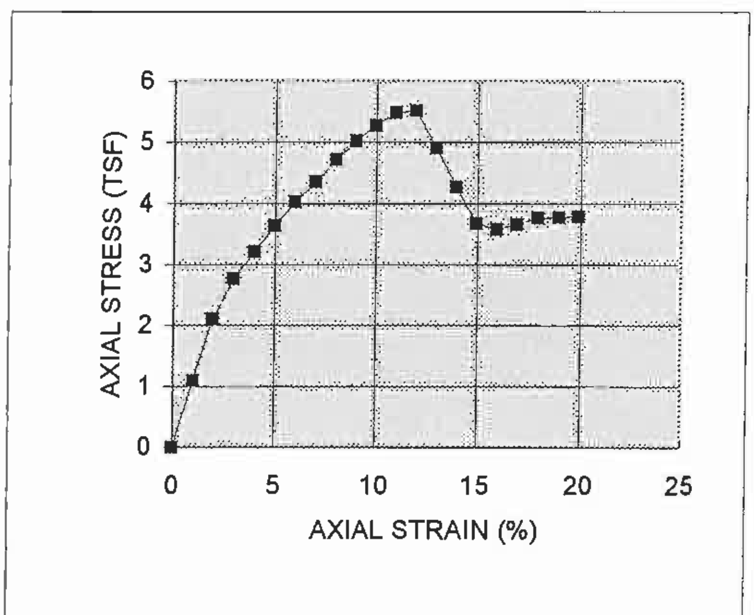
Professional Service Industrial Inc. 45749 Helm St. Plymouth, MI 48170-6025
Phone: (734) 453-7900 Fax: (734) 453-0724

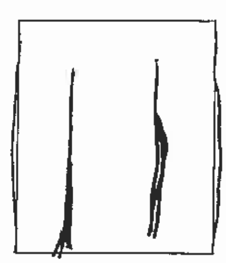
UNCONFINED COMPRESSIVE STRENGTH

Project Name: East Stadium Boulevard
Location: City of Ann Arbor, Michigan
Project No.: 381-65050
Source: B-4 3 SS **Sample Depth:** 6.5 - 8.0 feet
Description: SILTY CLAY (CL) - some sand, few gravel, brown
Qp (tsf): 4.5+
Wet Weight (gm): 163.67
Date Tested: 1/2/2007
Tested By: ZS

Height:	3.130 inches		79.49 mm	
Diameter:	1.356 inches		34.44 mm	
Moisture Content:	14%	**Saturation (%):**		
Ht.-Diameter Ratio:	2.31	**Specific Gravity:**		
Dry Density:	121 pcf			

READING NUMBER	DEFORM. (in.)	LOAD (lbs)	STRAIN (%)	CORRECTED AREA (in^2)	AXIAL STRESS (tsf)
0	0.000	0.0	0.00	1.444	0.00
1	0.031	22.0	0.99	1.458	1.09
2	0.062	43.1	1.99	1.473	2.11
3	0.093	57.2	2.97	1.488	2.77
4	0.124	67.1	3.97	1.503	3.21
5	0.156	76.8	4.97	1.519	3.64
6	0.187	85.8	5.97	1.535	4.02
7	0.218	93.9	6.97	1.552	4.36
8	0.249	102.8	7.97	1.569	4.72
9	0.281	110.7	8.97	1.586	5.02
10	0.311	117.6	9.95	1.603	5.28
11	0.343	123.6	10.95	1.621	5.49
12	0.374	125.7	11.95	1.640	5.52
13	0.405	113.1	12.95	1.658	4.91
14	0.436	99.4	13.95	1.678	4.27
15	0.468	86.7	14.94	1.697	3.68
16	0.499	85.2	15.94	1.718	3.57
17	0.530	88.3	16.94	1.738	3.66
18	0.561	91.9	17.94	1.759	3.76
19	0.593	93.4	18.93	1.781	3.78
20	0.624	94.9	19.93	1.803	3.79
Qu =	5.52	tsf	528.38 kPa,	Strain	11.95%





Failure Sketch

psi

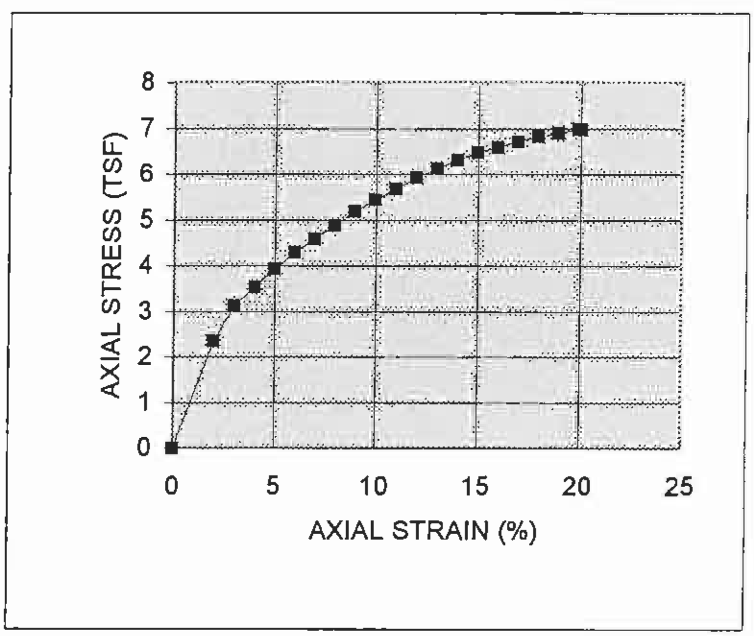
UNCONFINED COMPRESSIVE STRENGTH

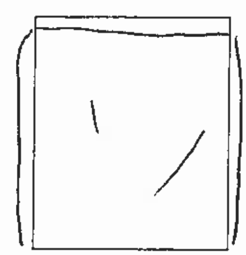
Project Name: East Stadium Boulevard
Location: City of Ann Arbor, Michigan
Project No.: 381-65050
Source: B-6 2 SS **Sample Depth:** 4.0 - 5.5 feet
Description: SILTY CLAY (CL) - some sand, gray
Qp (tsf): 4.5+
Wet Weight (gm): 163.96
Date Tested: 1/2/2007
Tested By: ZS

Height:	3.036 inches	77.12 mm	
Diameter:	1.368 inches	34.75 mm	
Moisture Content:	13%	**Saturation (%):**	
Ht.-Diameter Ratio:	2.22	**Specific Gravity:**	
Dry Density:	124 pcf		

READING NUMBER	DEFORM. (in.)	LOAD (lbs)	STRAIN (%)	CORRECTED AREA (in^2)	AXIAL STRESS (tsf)
0	0.000	0.0	0.00	1.470	0.00
1	0.060	48.9	1.99	1.500	2.35
2	0.091	65.7	2.99	1.515	3.12
3	0.121	75.2	3.97	1.531	3.54
4	0.151	84.5	4.97	1.547	3.93
5	0.181	93.3	5.97	1.563	4.30
6	0.212	100.6	6.97	1.580	4.59
7	0.242	108.4	7.97	1.597	4.89
8	0.272	116.4	8.95	1.614	5.19
9	0.302	123.2	9.95	1.632	5.43
10	0.333	130.3	10.95	1.651	5.68
11	0.363	137.5	11.95	1.669	5.93
12	0.393	143.8	12.95	1.688	6.13
13	0.424	149.6	13.95	1.708	6.31
14	0.454	155.5	14.95	1.728	6.48
15	0.484	160.1	15.93	1.748	6.59
16	0.514	165.0	16.93	1.769	6.71
17	0.544	169.8	17.93	1.791	6.83
18	0.575	173.5	18.93	1.813	6.89
19	0.605	178.3	19.93	1.836	7.00
20	0.608	178.3	20.03	1.838	6.99

Qu = 6.48 tsf 620.20 kPa, Strain 14.95%





Failure Sketch

psi

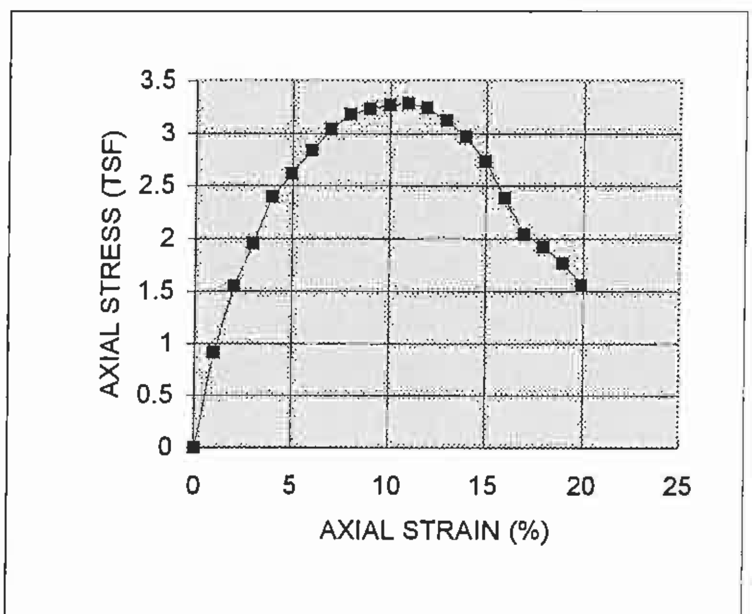
UNCONFINED COMPRESSIVE STRENGTH

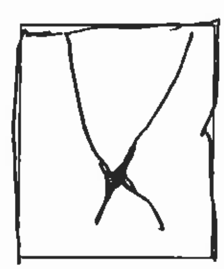
Project Name:	East Stadium Boulevard				
Location:	City of Ann Arbor, Michigan				
Project No.:	381-65050				
Source:	B-8	1 SS	**Sample Depth:**	1.5 - 3.0	feet
Description:	SILTY CLAY (CL) - some sand, mottled yellowish brown and gray				
Qp (tsf):	4.5+				
Wet Weight (gm):	164.94				
Date Tested:	1/2/2007				
Tested By:	ZS				

Height:	3.098 inches	78.70 mm	
Diameter:	1.357 inches	34.48 mm	
Moisture Content:	15%	**Saturation (%):**	
Ht.-Diameter Ratio:	2.28	**Specific Gravity:**	
Dry Density:	122 pcf		

DRAFT

READING NUMBER	DEFORM. (in.)	LOAD (lbs)	STRAIN (%)	CORRECTED AREA (in^2)	AXIAL STRESS (tsf)
0	0.000	0.0	0.00	1.447	0.00
1	0.031	18.5	0.99	1.461	0.91
2	0.062	31.7	1.99	1.476	1.55
3	0.092	40.6	2.98	1.491	1.96
4	0.123	50.2	3.98	1.507	2.40
5	0.154	55.3	4.97	1.523	2.62
6	0.185	60.7	5.97	1.539	2.84
7	0.216	65.6	6.97	1.555	3.04
8	0.247	69.5	7.96	1.572	3.18
9	0.278	71.5	8.96	1.589	3.24
10	0.309	72.9	9.96	1.607	3.26
11	0.340	74.1	10.96	1.625	3.28
12	0.370	74.0	11.95	1.643	3.24
13	0.401	72.1	12.95	1.662	3.12
14	0.432	69.2	13.95	1.681	2.97
15	0.463	64.6	14.95	1.701	2.73
16	0.494	57.0	15.94	1.721	2.39
17	0.524	49.5	16.93	1.742	2.05
18	0.555	47.0	17.93	1.763	1.92
19	0.586	43.8	18.93	1.785	1.77
20	0.617	39.2	19.93	1.807	1.56
Qu =	3.28	tsf	314.46 kPa,	Strain	10.96%





Failure Sketch

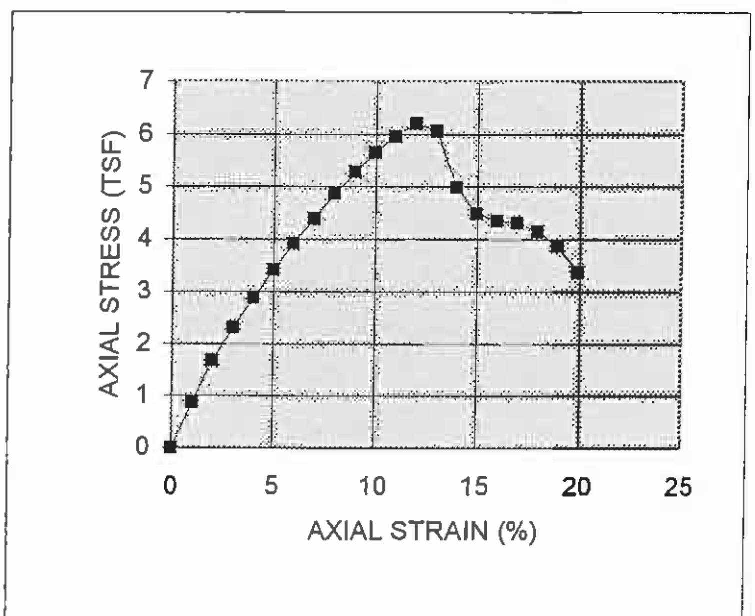
psi

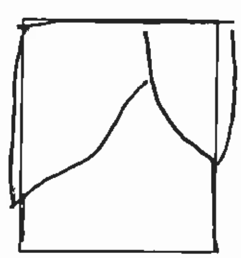
UNCONFINED COMPRESSIVE STRENGTH

Project Name:	East Stadium Boulevard		
Location:	City of Ann Arbor, Michigan		
Project No.:	381-65050		
Source:	B-10 1 SS	Sample Depth:	1.5 - 3.0 feet
Description:	SILTY CLAY (CL) - some sand, mottled yellowish brown and gray		
Qp (tsf):	4.5+		
Wet Weight (gm):	164.83		
Date Tested:	1/2/2007		
Tested By:	ZS		

Height:	3.228 inches	81.99 mm	
Diameter:	1.350 inches	34.28 mm	
Moisture Content:	14%	Saturation (%):	
Ht.-Diameter Ratio:	2.39	Specific Gravity:	
Dry Density:	120 pcf		

READING NUMBER	DEFORM. (in.)	LOAD (lbs)	STRAIN (%)	CORRECTED AREA (in^2)	AXIAL STRESS (tsf)
0	0.000	0.0	0.00	1.431	0.00
1	0.032	17.5	0.99	1.445	0.87
2	0.064	34.0	1.99	1.460	1.68
3	0.096	47.4	2.97	1.474	2.31
4	0.128	59.7	3.97	1.490	2.89
5	0.161	71.4	4.97	1.505	3.42
6	0.193	82.9	5.97	1.521	3.92
7	0.225	93.7	6.97	1.538	4.39
8	0.257	105.1	7.97	1.554	4.87
9	0.289	115.4	8.97	1.571	5.29
10	0.321	124.6	9.95	1.589	5.65
11	0.353	133.0	10.95	1.606	5.96
12	0.386	140.0	11.95	1.625	6.20
13	0.418	138.3	12.95	1.643	6.06
14	0.450	115.3	13.95	1.662	4.99
15	0.482	104.9	14.95	1.682	4.49
16	0.515	103.1	15.95	1.702	4.36
17	0.546	103.2	16.93	1.722	4.32
18	0.579	100.5	17.93	1.743	4.15
19	0.611	95.2	18.93	1.765	3.88
20	0.643	83.9	19.93	1.787	3.38
Qu =	6.20	tsf	594.16 kPa,	Strain	11.95%





Failure Sketch

psi

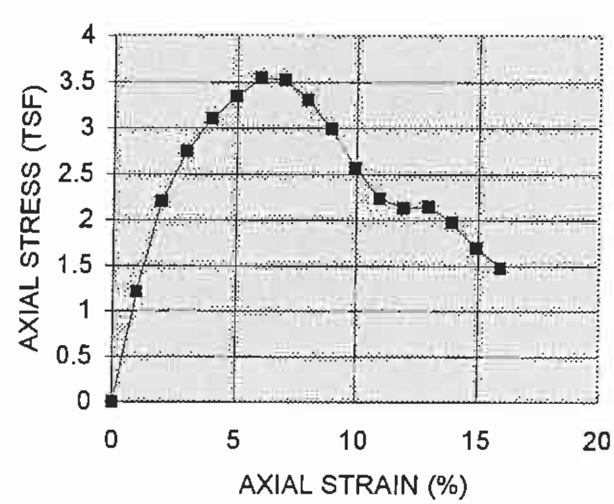
UNCONFINED COMPRESSIVE STRENGTH

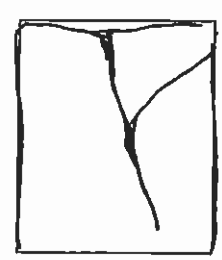
Project Name: East Stadium Boulevard
Location: City of Ann Arbor, Michigan
Project No.: 381-65050
Source: B-14 2 SS **Sample Depth:** 4.0 - 5.5 feet
Description: SILTY CLAY (CL) - some sand, mottled yellowish brown and gray
Qp (tsf): 4.5+
Wet Weight (gm): 157.41
Date Tested: 1/2/2007
Tested By: ZS

Height: 3.088 inches	78.43 mm		
Diameter: 1.381 inches	35.07 mm		
Moisture Content: 16%		**Saturation (%):**	
Ht.-Diameter Ratio: 2.24		**Specific Gravity:**	
Dry Density: 112 pcf			

DRAFT

READING NUMBER	DEFORM. (in.)	LOAD (lbs)	STRAIN (%)	CORRECTED AREA (in^2)	AXIAL STRESS (tsf)
0	0.000	0.0	0.00	1.497	0.00
1	0.030	25.4	0.98	1.512	1.21
2	0.061	46.8	1.98	1.528	2.20
3	0.092	58.9	2.98	1.543	2.75
4	0.123	67.2	3.98	1.559	3.10
5	0.154	73.2	4.98	1.576	3.35
6	0.185	78.3	5.98	1.593	3.54
7	0.215	78.8	6.98	1.610	3.52
8	0.246	74.8	7.96	1.627	3.31
9	0.277	68.3	8.96	1.645	2.99
10	0.307	59.2	9.96	1.663	2.56
11	0.338	52.2	10.96	1.682	2.24
12	0.369	50.4	11.95	1.701	2.13
13	0.400	51.2	12.95	1.720	2.14
14	0.430	47.7	13.94	1.740	1.97
15	0.461	41.4	14.94	1.760	1.69
16	0.492	36.6	15.92	1.781	1.48
17	0.000	0.0	0.00		0.00
18	0.000	0.0	0.00		0.00
19	0.000	0.0	0.00		0.00
20	0.000	0.0	0.00		0.00
Qu =	3.54	tsf	339.19 kPa,	Strain	5.98%





Failure Sketch

psi

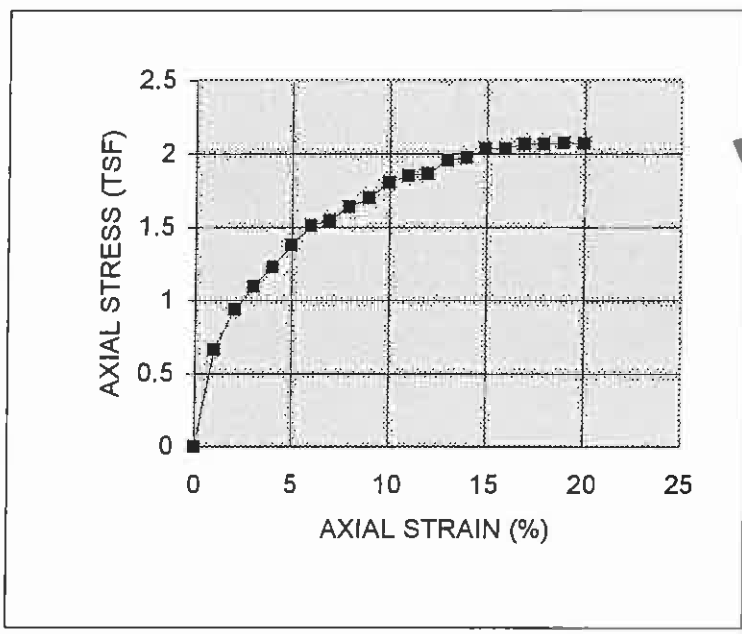
UNCONFINED COMPRESSIVE STRENGTH

Project Name: East Stadium Boulevard
Location: City of Ann Arbor, Michigan
Project No.: 381-65050
Source: F-1 2 SS **Sample Depth:** 4.0 - 5.5 feet
Description: SILTY CLAY (CL) - some sand, mottled olive brown and grayish brown
Qp (tsf): 2.25
Wet Weight (gm): 155.01
Date Tested: 12/22/2006
Tested By: ZS

Height:	3.077 inches	78.16 mm		
Diameter:	1.383 inches	35.12 mm		
Moisture Content:	19%	**Saturation (%):**		
Ht.-Diameter Ratio:	2.23	**Specific Gravity:**		
Dry Density:	107 pcf			

READING NUMBER	DEFORM. (in.)	LOAD (lbs)	STRAIN (%)	CORRECTED AREA (in^2)	AXIAL STRESS (tsf)
0	0.000	0.0	0.00	1.501	0.00
1	0.030	14.0	0.99	1.516	0.66
2	0.061	20.0	1.99	1.532	0.94
3	0.092	23.6	2.99	1.547	1.10
4	0.123	26.6	3.99	1.563	1.23
5	0.153	30.3	4.97	1.580	1.38
6	0.184	33.5	5.97	1.596	1.51
7	0.214	34.7	6.97	1.614	1.55
8	0.245	37.1	7.97	1.631	1.64
9	0.276	39.0	8.97	1.649	1.70
10	0.307	41.8	9.96	1.667	1.80
11	0.337	43.4	10.96	1.686	1.85
12	0.368	44.2	11.94	1.705	1.87
13	0.398	46.9	12.94	1.724	1.96
14	0.429	47.9	13.94	1.744	1.98
15	0.460	49.9	14.94	1.765	2.04
16	0.491	50.6	15.94	1.786	2.04
17	0.521	51.9	16.94	1.807	2.07
18	0.552	52.6	17.94	1.829	2.07
19	0.583	53.4	18.93	1.852	2.07
20	0.613	54.0	19.93	1.875	2.07

Qu = 2.04 tsf 195.10 kPa, Strain 14.94%



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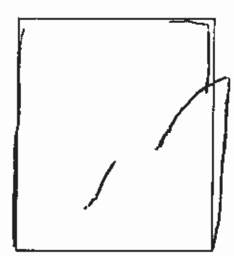


Failure Sketch

psi

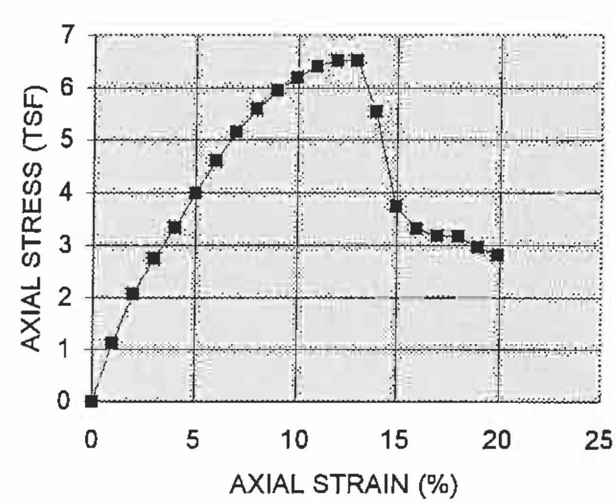
UNCONFINED COMPRESSIVE STRENGTH

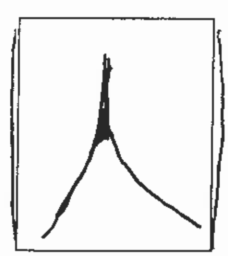
Project Name: East Stadium Boulevard
Location: City of Ann Arbor, Michigan
Project No.: 381-65050
Source: F-2 2 SS **Sample Depth:** 4.0 - 5.5 feet
Description: SILTY CLAY (CL) - some sand, few gravel, brown
Qp (tsf): 4.5+
Wet Weight (gm): 147.58
Date Tested: 1/2/2007
Tested By: ZS

Height:	2.875 inches	73.03 mm	
Diameter:	1.348 inches	34.23 mm	
Moisture Content:	15%	**Saturation (%):**	
Ht.-Diameter Ratio:	2.13	**Specific Gravity:**	
Dry Density:	119 pcf		

READING NUMBER	DEFORM. (in.)	LOAD (lbs)	STRAIN (%)	CORRECTED AREA (in^2)	AXIAL STRESS (tsf)
0	0.000	0.0	0.00	1.427	0.00
1	0.028	22.6	0.98	1.441	1.13
2	0.057	41.7	1.98	1.456	2.06
3	0.086	56.2	2.98	1.471	2.75
4	0.114	69.0	3.98	1.486	3.35
5	0.143	83.2	4.98	1.501	3.99
6	0.172	97.1	5.98	1.517	4.61
7	0.201	109.7	6.98	1.534	5.15
8	0.229	120.5	7.96	1.550	5.60
9	0.258	129.5	8.96	1.567	5.95
10	0.286	136.4	9.96	1.584	6.20
11	0.315	142.7	10.96	1.602	6.41
12	0.344	146.9	11.95	1.620	6.53
13	0.372	148.4	12.95	1.639	6.52
14	0.401	127.6	13.94	1.658	5.54
15	0.430	87.3	14.94	1.677	3.75
16	0.458	78.3	15.94	1.697	3.32
17	0.487	75.8	16.94	1.718	3.18
18	0.516	76.5	17.94	1.739	3.17
19	0.544	72.4	18.93	1.760	2.96
20	0.573	69.7	19.92	1.782	2.82

Qu = 6.53 tsf 625.08 kPa, Strain 11.95%





Failure Sketch

psi

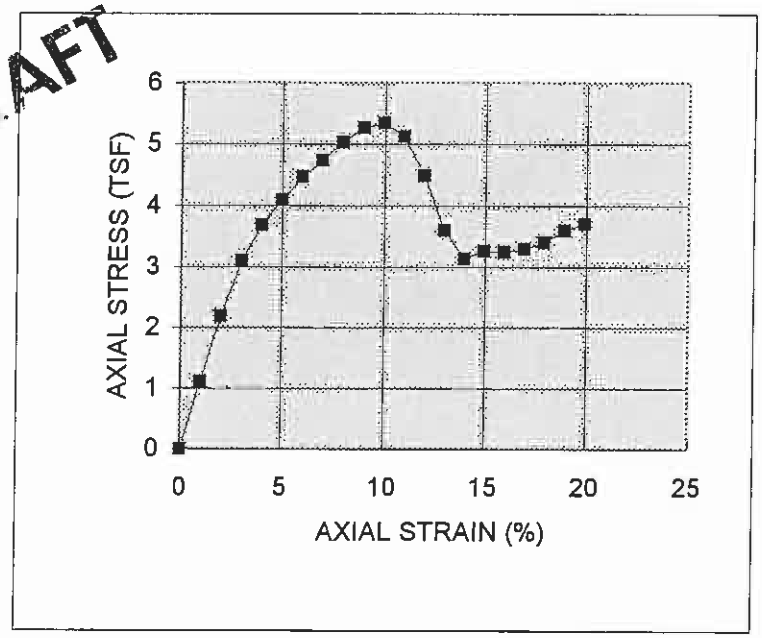
UNCONFINED COMPRESSIVE STRENGTH

Project Name: East Stadium Boulevard
Location: City of Ann Arbor, Michigan
Project No.: 381-65050
Source: F-3 3 SS **Sample Depth:** 6.5 - 8.0 feet
Description: SILTY CLAY (CL) - some sand, mottled yellowish brown and gray
Qp (tsf): 4.5+
Wet Weight (gm): 142.67
Date Tested: 1/2/2007
Tested By: ZS

Height: 2.982 inches		75.74 mm	
Diameter: 1.316 inches		33.43 mm	
Moisture Content: 14%		**Saturation (%):**	
Ht.-Diameter Ratio: 2.27		**Specific Gravity:**	
Dry Density: 117 pcf			

READING NUMBER	DEFORM. (in.)	LOAD (lbs)	STRAIN (%)	CORRECTED AREA (in^2)	AXIAL STRESS (tsf)
0	0.000	0.0	0.00	1.361	0.00
1	0.029	21.2	0.99	1.374	1.11
2	0.059	42.3	1.99	1.388	2.19
3	0.089	60.4	2.98	1.403	3.10
4	0.119	72.5	3.98	1.417	3.68
5	0.149	81.4	4.98	1.432	4.09
6	0.178	89.8	5.96	1.447	4.47
7	0.208	96.3	6.96	1.463	4.74
8	0.237	103.4	7.96	1.479	5.03
9	0.267	109.6	8.96	1.495	5.28
10	0.297	112.3	9.96	1.511	5.35
11	0.327	108.9	10.96	1.528	5.13
12	0.356	96.3	11.94	1.545	4.49
13	0.386	78.0	12.95	1.563	3.59
14	0.416	68.8	13.94	1.581	3.13
15	0.446	72.4	14.94	1.600	3.26
16	0.475	73.0	15.94	1.619	3.25
17	0.505	74.9	16.94	1.638	3.29
18	0.535	78.3	17.93	1.658	3.40
19	0.564	84.0	18.93	1.678	3.60
20	0.594	87.3	19.92	1.699	3.70

Qu = 5.35 tsf 512.49 kPa, Strain 9.96%



Failure Sketch

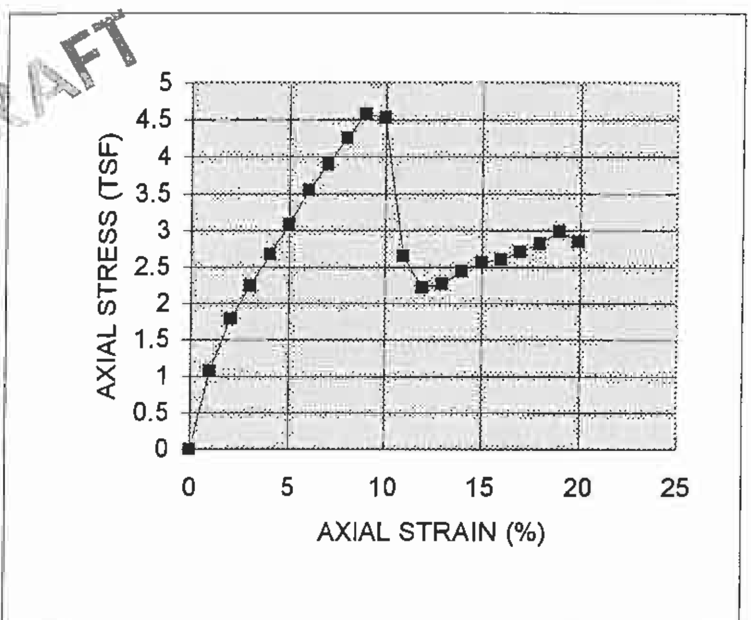
psi

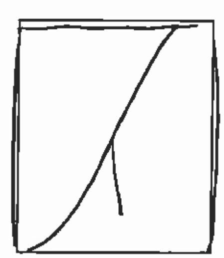
UNCONFINED COMPRESSIVE STRENGTH

Project Name: East Stadium Boulevard
Location: City of Ann Arbor, Michigan
Project No.: 381-65050
Source: F-4 2 SS **Sample Depth:** 4.0 - 5.5 feet
Description: SILTY CLAY (CL) - some sand, mottled yellowish brown and gray
Qp (tsf): 4.5+
Wet Weight (gm): 152.93
Date Tested: 1/2/2007
Tested By: ZS

Height:	2.992 inches	76.00 mm		
Diameter:	1.344 inches	34.15 mm		
Moisture Content:	15%		**Saturation (%):**	
Ht.-Diameter Ratio:	2.23		**Specific Gravity:**	
Dry Density:	119 pcf			

READING NUMBER	DEFORM. (in.)	LOAD (lbs)	STRAIN (%)	CORRECTED AREA (in^2)	AXIAL STRESS (tsf)
0	0.000	0.0	0.00	1.419	0.00
1	0.029	21.4	0.99	1.433	1.07
2	0.059	36.1	1.99	1.448	1.80
3	0.089	45.6	2.98	1.463	2.24
4	0.119	54.8	3.98	1.478	2.67
5	0.149	64.1	4.97	1.493	3.09
6	0.179	74.4	5.97	1.509	3.55
7	0.208	82.6	6.97	1.526	3.90
8	0.238	91.2	7.97	1.542	4.26
9	0.268	99.2	8.96	1.559	4.58
10	0.298	99.3	9.96	1.576	4.54
11	0.328	58.8	10.96	1.594	2.66
12	0.357	49.7	11.94	1.612	2.22
13	0.387	51.4	12.94	1.630	2.27
14	0.417	56.1	13.95	1.649	2.45
15	0.447	59.6	14.95	1.669	2.57
16	0.477	61.2	15.93	1.688	2.61
17	0.507	64.3	16.93	1.709	2.71
18	0.536	67.8	17.93	1.729	2.82
19	0.566	72.7	18.93	1.751	2.99
20	0.596	70.2	19.93	1.773	2.85
Qu =	4.58	tsf	438.56	kPa, Strain	8.96%





Failure Sketch

psi

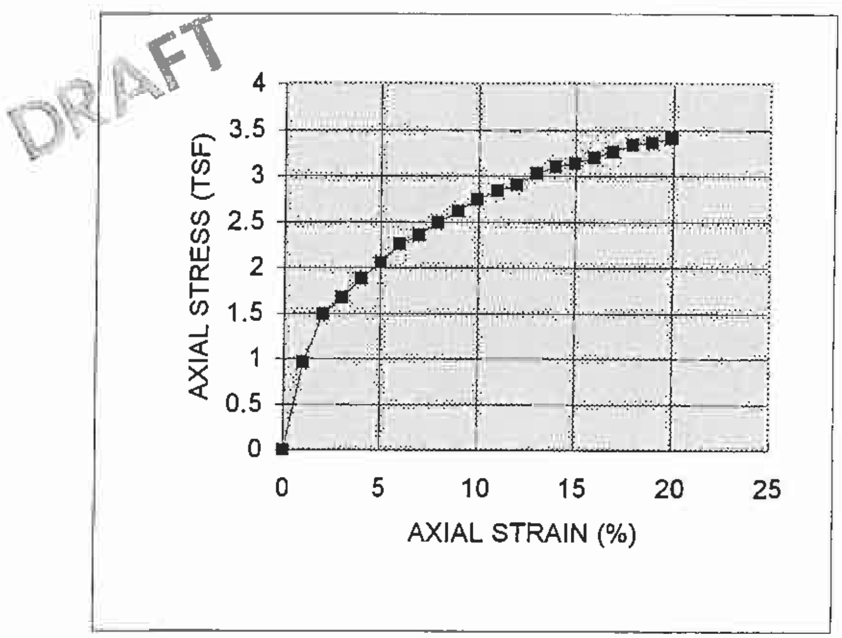
UNCONFINED COMPRESSIVE STRENGTH

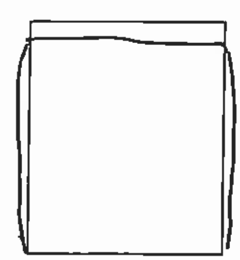
Project Name: East Stadium Boulevard
Location: City of Ann Arbor, Michigan
Project No.: 381-65050
Source: RW - 2 4 SS **Sample Depth:** 9.0 - 10.5 feet
Description: SILTY CLAY (CL) - some sand, gray
Qp (tsf): 2.75
Wet Weight (gm): 164.94
Date Tested: 1/2/2007
Tested By: ZS

Height:	3.065 inches	77.85 mm	
Diameter:	1.373 inches	34.87 mm	
Moisture Content:	15%	**Saturation (%):**	
Ht.-Diameter Ratio:	2.23	**Specific Gravity:**	
Dry Density:	120 pcf		

READING NUMBER	DEFORM. (in.)	LOAD (lbs)	STRAIN (%)	CORRECTED AREA (in^2)	AXIAL STRESS (tsf)
0	0.000	0.0	0.00	1.481	0.00
1	0.030	19.9	0.99	1.495	0.96
2	0.061	31.3	1.99	1.511	1.49
3	0.091	35.5	2.97	1.526	1.67
4	0.122	40.2	3.97	1.542	1.88
5	0.152	44.5	4.97	1.558	2.06
6	0.183	49.3	5.97	1.575	2.26
7	0.214	52.1	6.97	1.592	2.36
8	0.244	55.8	7.97	1.609	2.50
9	0.274	59.0	8.95	1.626	2.61
10	0.305	62.7	9.95	1.644	2.75
11	0.336	65.5	10.95	1.663	2.84
12	0.366	67.9	11.95	1.682	2.91
13	0.397	71.6	12.95	1.701	3.03
14	0.428	74.2	13.95	1.721	3.10
15	0.458	75.9	14.95	1.741	3.14
16	0.488	78.3	15.93	1.761	3.20
17	0.519	80.8	16.93	1.782	3.26
18	0.550	83.8	17.93	1.804	3.34
19	0.580	85.4	18.93	1.826	3.37
20	0.611	87.7	19.93	1.849	3.41

Qu = 3.14 tsf 300.50 kPa, Strain 14.95%





Failure Sketch

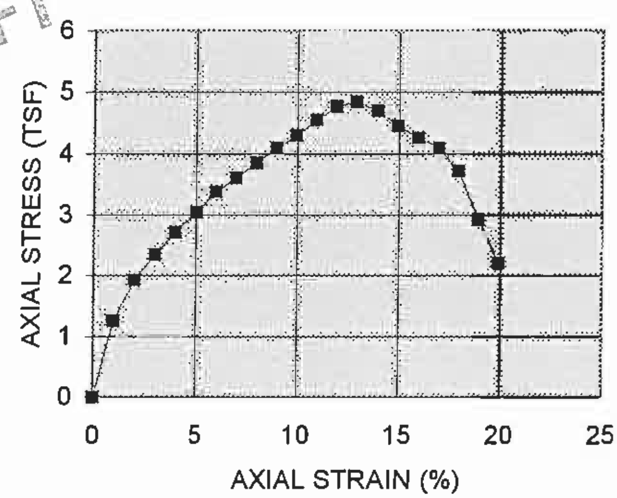
psi

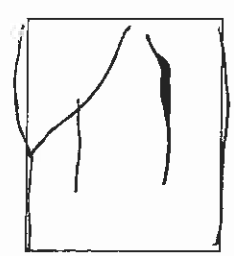
UNCONFINED COMPRESSIVE STRENGTH

Project Name: East Stadium Boulevard
Location: City of Ann Arbor, Michigan
Project No.: 381-65050
Source: RW-3 3 SS **Sample Depth:** 6.5 - 8.0 feet
Description: SILTY CLAY (CL) - some sand, few gravel, brown
Qp (tsf): 4.5+
Wet Weight (gm): 159.40
Date Tested: 1/2/2007
Tested By: ZS

Height:	3.083 inches	78.32 mm	
Diameter:	1.377 inches	34.98 mm	
Moisture Content:	16%	**Saturation (%):**	
Ht.-Diameter Ratio:	2.24	**Specific Gravity:**	
Dry Density:	114 pcf		

READING NUMBER	DEFORM. (in.)	LOAD (lbs)	STRAIN (%)	CORRECTED AREA (in^2)	AXIAL STRESS (tsf)
0	0.000	0.0	0.00	1.490	0.00
1	0.030	26.2	0.99	1.505	1.25
2	0.061	40.7	1.99	1.520	1.93
3	0.092	50.2	2.98	1.536	2.35
4	0.123	58.5	3.98	1.552	2.71
5	0.154	66.2	4.98	1.568	3.04
6	0.184	74.4	5.96	1.584	3.38
7	0.215	80.3	6.96	1.601	3.61
8	0.246	86.5	7.96	1.619	3.85
9	0.276	92.9	8.96	1.637	4.09
10	0.307	98.9	9.97	1.655	4.30
11	0.338	105.8	10.95	1.673	4.55
12	0.368	112.2	11.95	1.692	4.77
13	0.399	115.2	12.95	1.711	4.85
14	0.430	113.0	13.94	1.731	4.70
15	0.461	108.5	14.94	1.752	4.46
16	0.492	104.9	15.94	1.772	4.26
17	0.522	101.8	16.94	1.794	4.09
18	0.553	93.7	17.92	1.815	3.72
19	0.584	74.6	18.93	1.838	2.92
20	0.614	57.0	19.93	1.861	2.21
Qu =	4.85	tsf	464.08 kPa,	Strain	12.95%





Failure Sketch

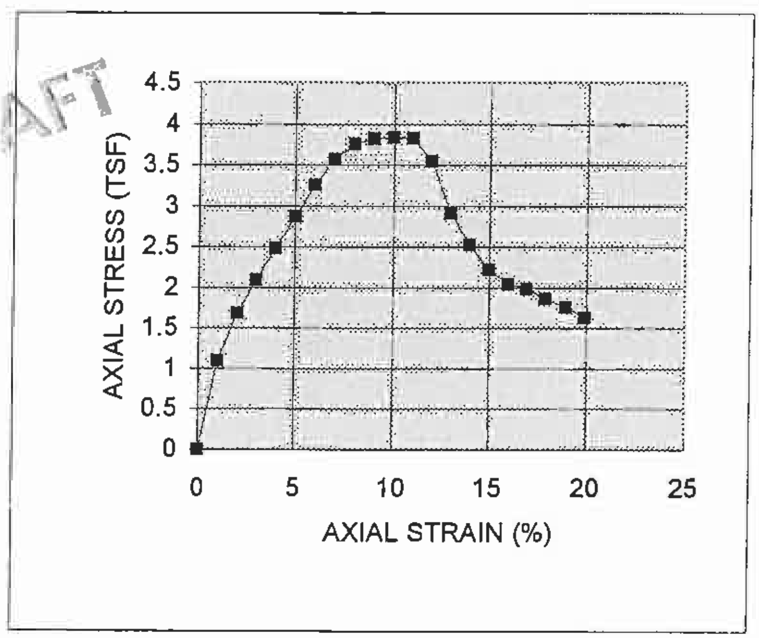
psi

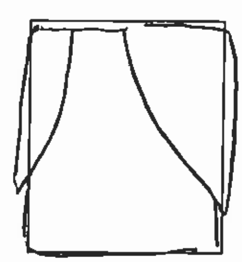
UNCONFINED COMPRESSIVE STRENGTH

Project Name: East Stadium Boulevard
Location: City of Ann Arbor, Michigan
Project No.: 381-65050
Source: RW-4 2 SS **Sample Depth:** 4.0 - 5.5 feet
Description: SILTY CLAY (CL) - some sand, mottled yellowish brown and gray
Qp (tsf): 3.75
Wet Weight (gm): 153.60
Date Tested: 1/2/2007
Tested By: ZS

Height:	3.062 inches		77.78 mm	
Diameter:	1.331 inches		33.79 mm	
Moisture Content:	15%	**Saturation (%):**		
Ht.-Diameter Ratio:	2.30	**Specific Gravity:**		
Dry Density:	120 pcf			

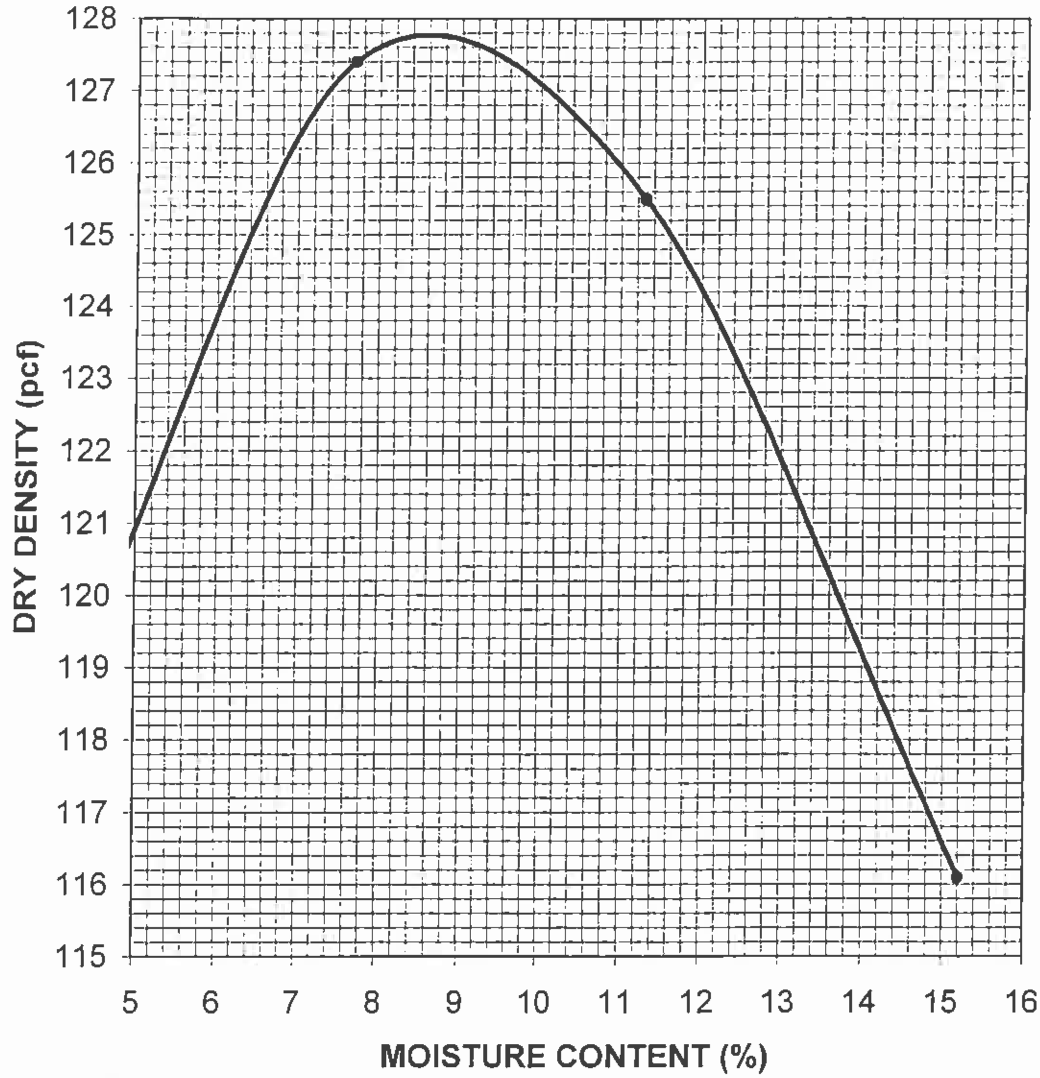
READING NUMBER	DEFORM. (in.)	LOAD (lbs)	STRAIN (%)	CORRECTED AREA (in^2)	AXIAL STRESS (tsf)
0	0.000	0.0	0.00	1.390	0.00
1	0.030	21.4	0.99	1.404	1.10
2	0.061	33.2	1.99	1.419	1.68
3	0.092	41.7	2.99	1.433	2.10
4	0.122	50.0	3.97	1.448	2.49
5	0.152	58.3	4.97	1.463	2.87
6	0.183	66.9	5.97	1.479	3.26
7	0.213	74.1	6.97	1.494	3.57
8	0.244	78.8	7.97	1.511	3.76
9	0.275	81.1	8.97	1.527	3.82
10	0.305	82.4	9.97	1.544	3.84
11	0.335	83.2	10.95	1.561	3.84
12	0.366	77.9	11.95	1.579	3.55
13	0.397	64.6	12.95	1.597	2.91
14	0.427	56.7	13.95	1.616	2.53
15	0.458	50.3	14.95	1.635	2.22
16	0.488	47.0	15.95	1.654	2.05
17	0.518	46.2	16.93	1.674	1.99
18	0.549	43.9	17.93	1.694	1.86
19	0.580	41.9	18.93	1.715	1.76
20	0.610	39.4	19.93	1.736	1.64
Qu =	3.84	tsf	367.69	kPa, Strain	9.97%





Failure Sketch

psi



Sample Identification: Bulk sample from Borings B-3, 5, 7, 16, 18; 1 - 6 feet
Sample Description: SILTY CLAY, some sand, brown, dark brown, dark gray
Maximum Dry Density: 127.8 pcf (ASTM D-1557, Procedure "A")
Optimum Moisture Content: 8.6% (ASTM D-1557, Procedure "A")

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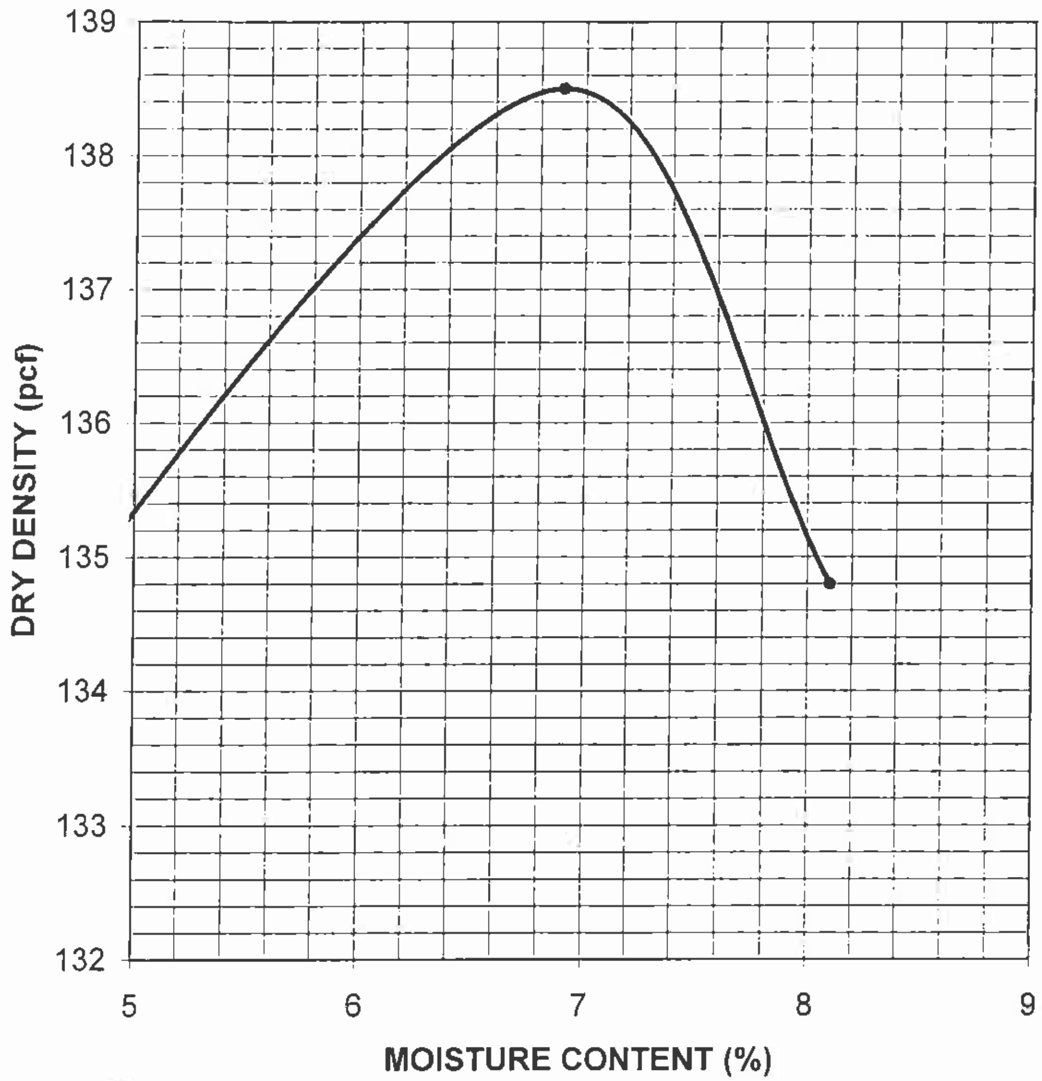
PROCTOR CURVE

Client: Northwest Consultants, Inc.
Project: East Stadium Boulevard Structure Replacement Project
Location: City of Ann Arbor, Washtenaw County, Michigan
PSI Project Number: 381-65050



Sample Identification: Bulk sample from Borings B-30, 32, 34, 36; 1 - 6 feet
Sample Description: SILTY SAND, few gravel, brown
Maximum Dry Density: 138.5 (ASTM D-1557, Procedure "A")
Optimum Moisture Content: 6.9% (ASTM D-1557, Procedure "A")

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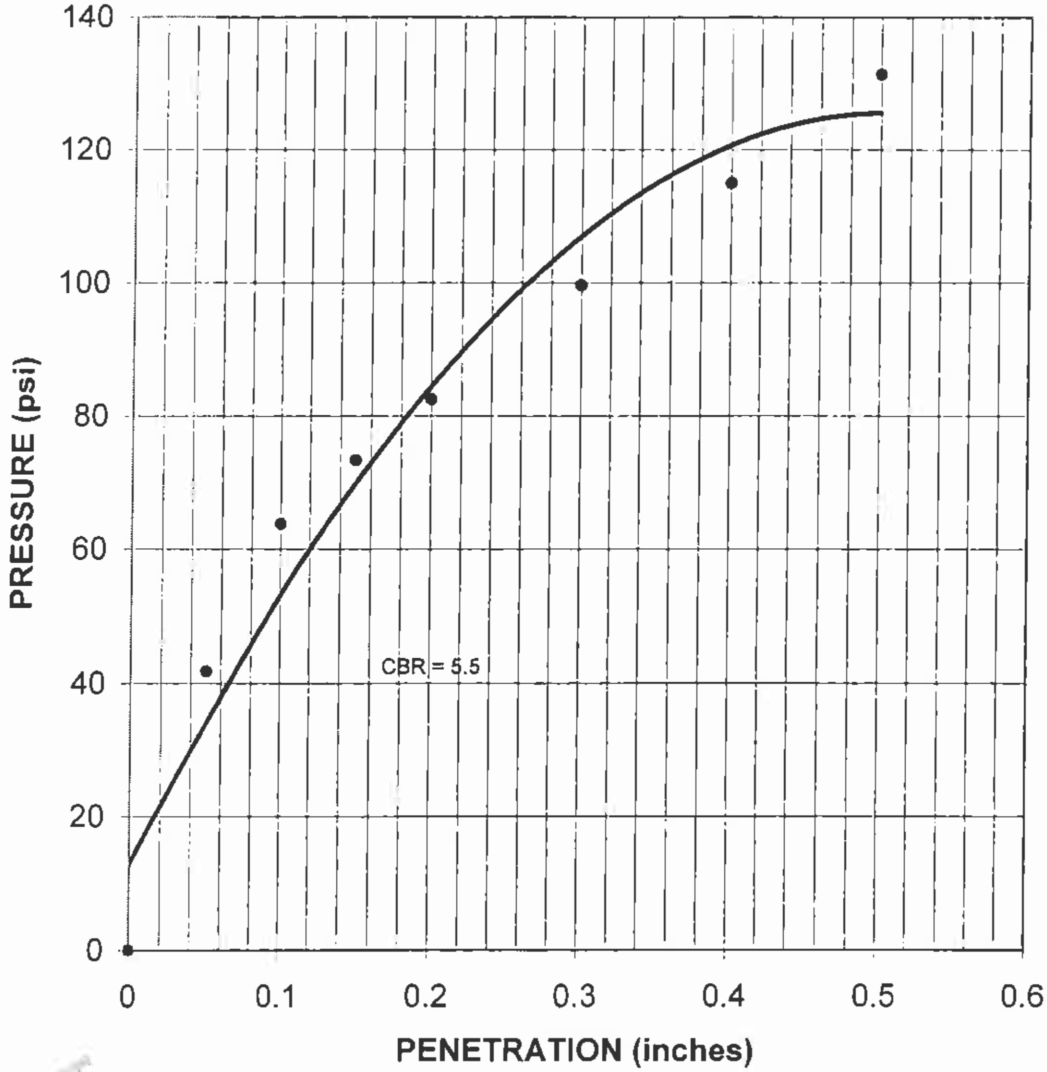
PROCTOR CURVE

Client: Northwest Consultants, Inc.
Project: East Stadium Boulevard Structure Replacement Project
Location: City of Ann Arbor, Washtenaw County, Michigan
PSI Project Number: 381-65050



Sample Identification:	Bulk sample from Borings B-3, 5, 7, 16, 18; 1 - 6 feet
Sample Description:	SILTY CLAY, some sand, brown, dark brown and dark gray
Moisture Content Before Soaking:	12.2% (3.6% above optimum per ASTM D-1557)
Dry Density Before Soaking 96 Hours:	119.3 pcf (93.3% compaction per ASTM D-1557)
Swell:	+2.1% under surcharge of 10.0 pounds
Moisture Content of top 25 mm After Soaking:	17.7% (9.1% above optimum per ASTM D-1557)

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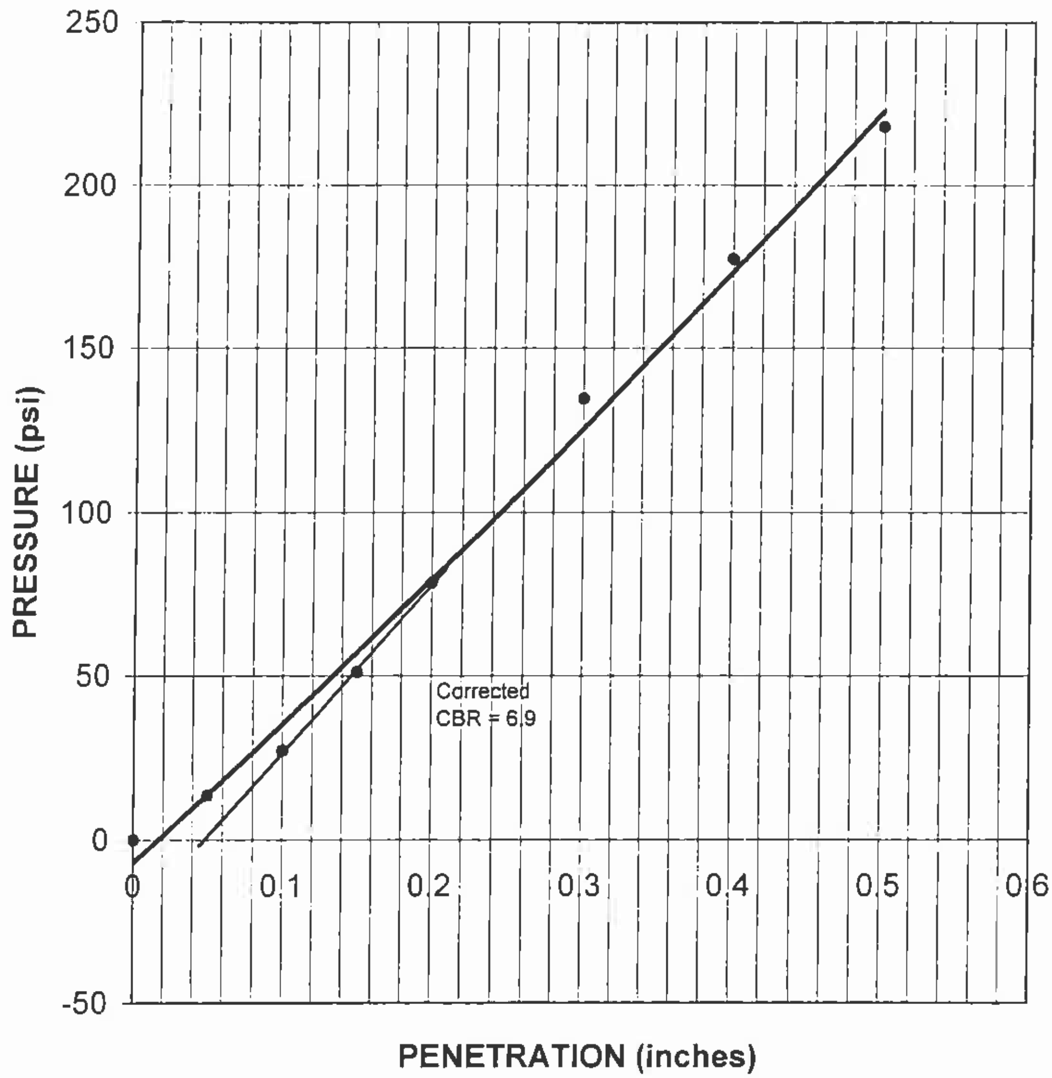
CALIFORNIA BEARING RATIO TEST

Client: Northwest Consultants, Inc.

Project: East Stadium Boulevard Structure Replacement Project

Location: City of Ann Arbor, Washtenaw County, Michigan

PSI Project Number: 381-65050



Sample Identification: Bulk sample from Borings B-30, 32, 34, 36; 1 - 6 feet
Sample Description: SILTY SAND, few gravel, brown
Moisture Content Before Soaking: 9.2% (2.3% above optimum per ASTM D-1557)
Dry Density Before Soaking 96 Hours: 130.8 pcf (94.4% compaction per ASTM D-1557)
Swell: -1.0% under surcharge of 10.0 pounds
Moisture Content of top 25 mm After Soaking: 9.7% (2.7% above optimum per ASTM D-1557)

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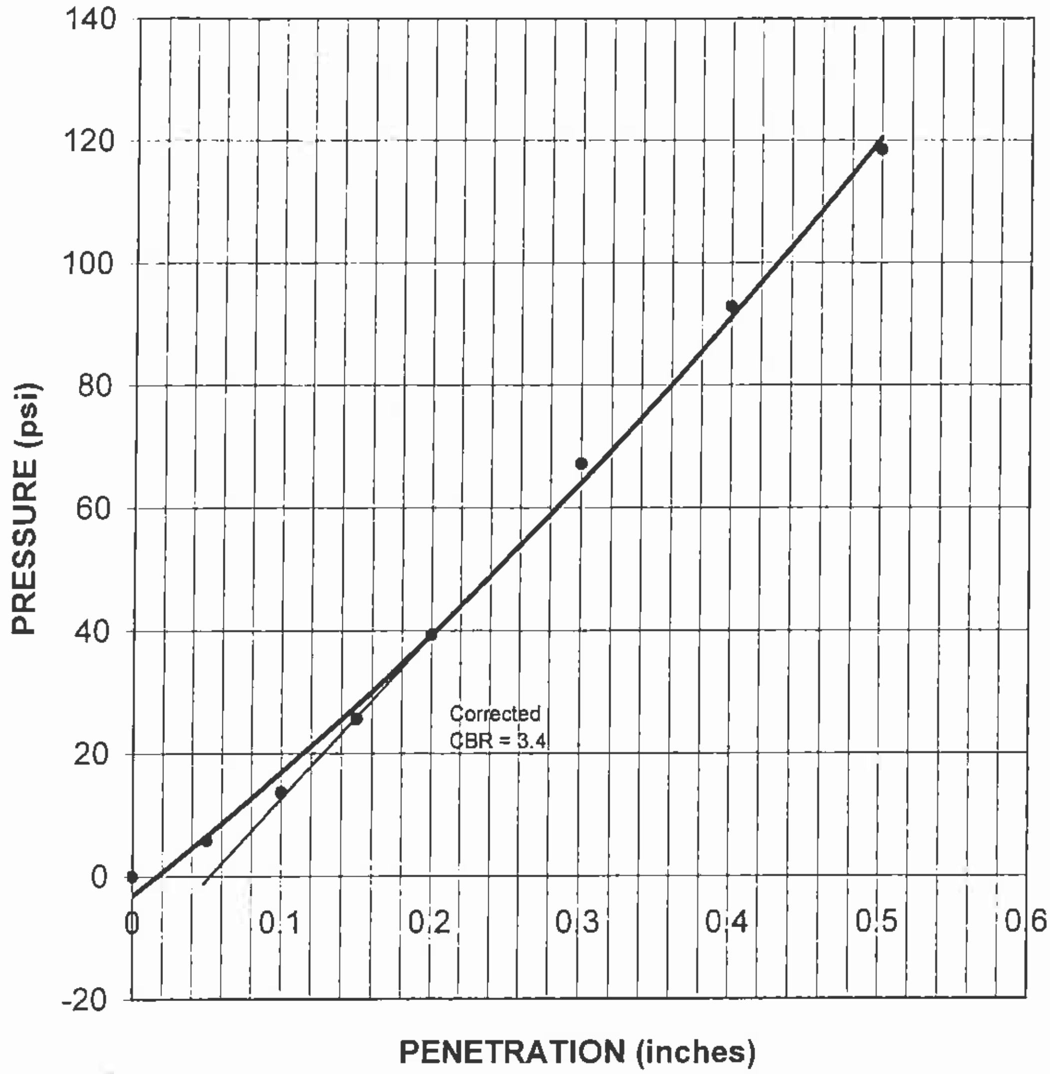
CALIFORNIA BEARING RATIO TEST

Client: Northwest Consultants, Inc.
Project: East Stadium Boulevard Structure Replacement Project
Location: City of Ann Arbor, Washtenaw County, Michigan
PSI Project Number: 381-65050



DRAFT

Sample Identification:	Bulk sample from Borings B-30, 32, 34, 36; 1 - 6 feet
Sample Description:	SILTY SAND, few gravel, brown
Moisture Content Before Soaking:	9.4% (2.5% above optimum per ASTM D-1557)
Dry Density Before Soaking 96 Hours:	130.0 pcf (93.9% compaction per ASTM D-1557)
Swell:	-1.0% under surcharge of 10.0 pounds
Moisture Content of top 25 mm After Soaking:	9.7% (2.7% above optimum per ASTM D-1557)

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CALIFORNIA BEARING RATIO TEST

Client: Northwest Consultants, Inc.

Project: East Stadium Boulevard Structure Replacement Project

Location: City of Ann Arbor, Washtenaw County, Michigan

PSI Project Number: 381-65050

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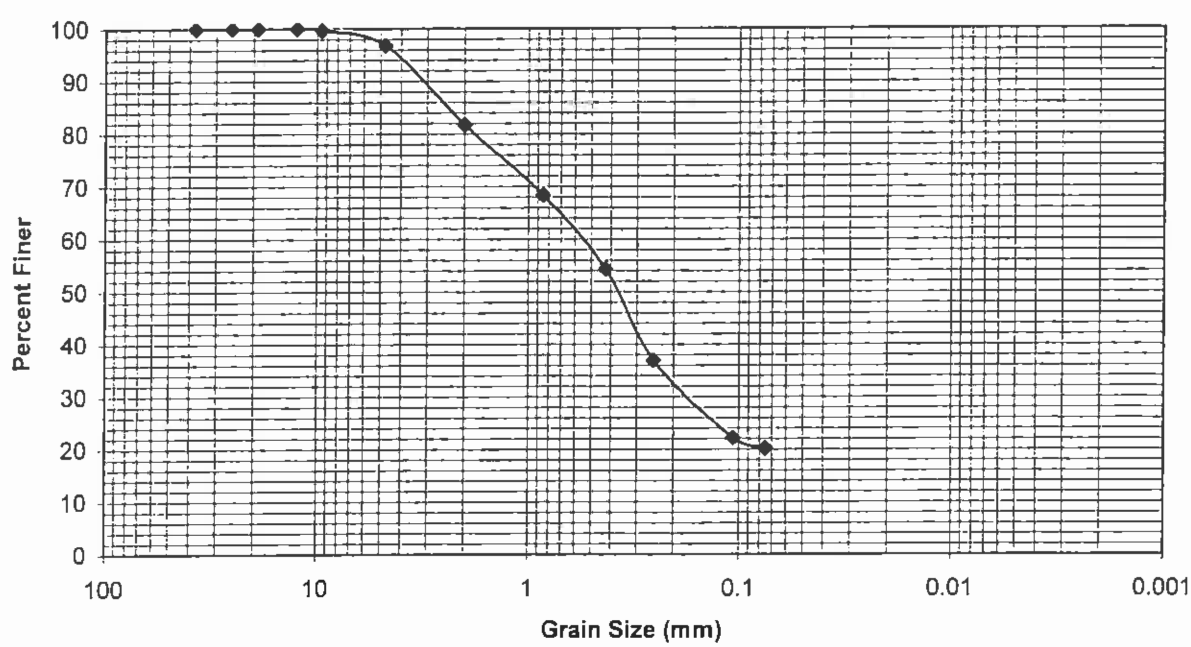
Project: East Stadium Boulevard	Project #: 381-65050
Date Sampled: 1/2/2007	Date Tested: 1/25/2007
Sampled by: Pat Cody	Source: CBR Bulk Sample
Location City of Ann Arbor, Michigan	Specification: NA

Soil Information:

% >1.5 in.=	0.0	PI=	n/a	D_{10}=
% Gravel=	3.2	LL=	n/a	D_{30}=
% Sand=	76.6	PI=	n/a	D_{60}=
Coarse	15.1%	USCS:	SM	Cu=
Medium	27.4%	AASHTO:		Cc=
Fine	34.1%	Description: SAND, fine to coarse, some silt and gravel		
% Fines=	20.2			
Silt	n/a			
Clay	n/a			

Grain Size Distribution

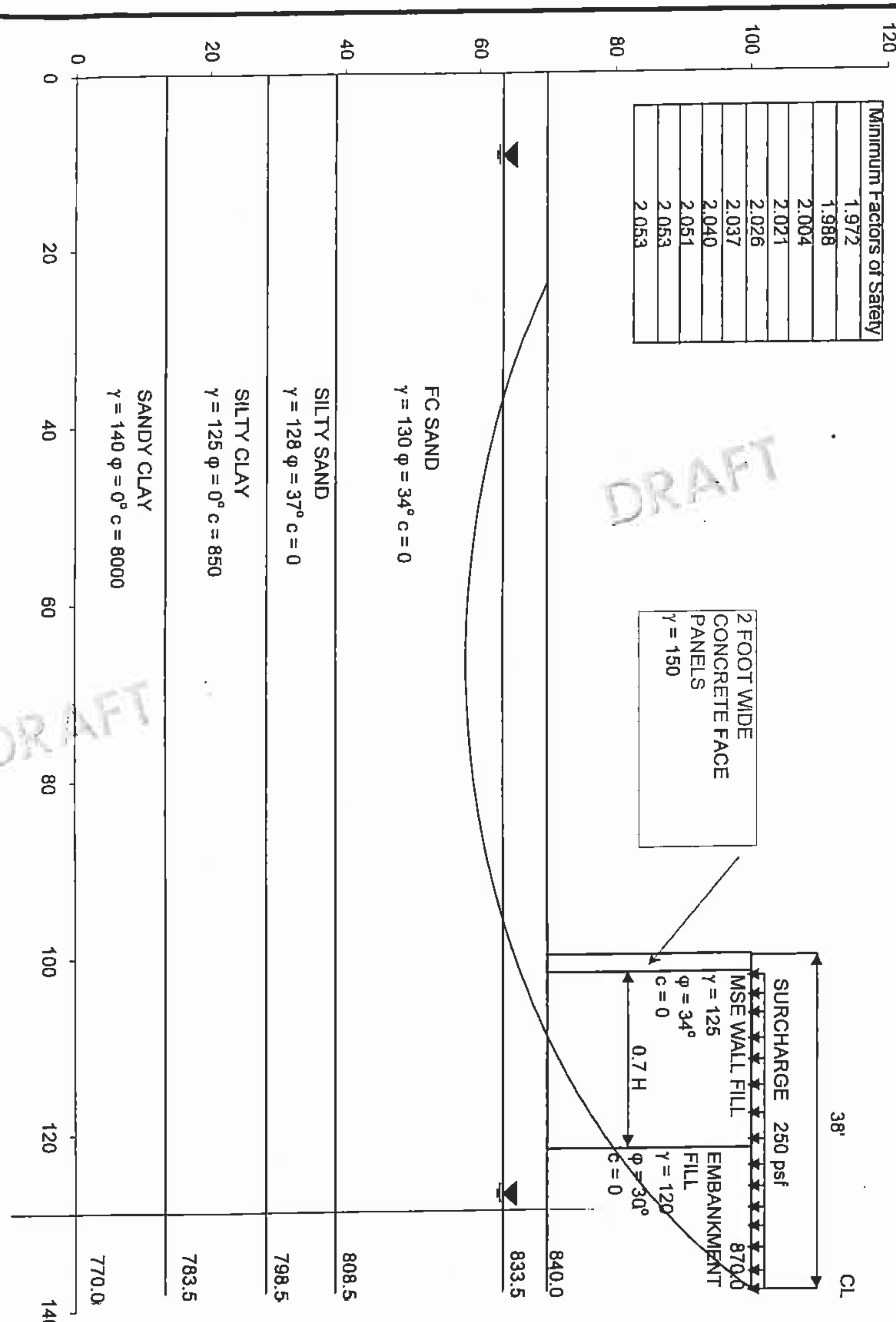


Professional Service Industrial Inc. 45749 Helm St. Plymouth, MI 48170-6025
Phone: (734) 453-7900 Fax: (734) 453-0724

DRAFT

APPENDIX
SECTION NO. 4

DRAFT



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East Stadium Boulevard
Structure Replacement Project
City of Ann Arbor, Washtenaw County, Michigan

Slope Stability Diagram
Figure No. 5

Scale: NA	Date: 01/17/2007	Drawn By: JDH	PSI Project No.: 381-65050

DRAFT

Table No. 1 Summary of Existing Pavement Section						
Boring Number	Station Number	Lane Identification	Asphalt Thickness	Concrete Thickness	Aggregate Base Thickness	Total Pavement Section Thickness
East Stadium Boulevard						
B-1	103+43	6	5.5	8	--	13.5
B-2	103+42	3	5.5	8	--	13.5
B-3	104+18	6	6	8	--	14
B-4	104+21	1	12	-	-	12
B-5	106+41	6	6	8	--	14
B-6	106+66	3	6	6	--	12
RW-2	107+28	1	8	8	--	16
B-7	108+19	6	5	7	--	12
B-8	108+24	5	5	6.5	--	11.5
RW-3	109+30	1	12.5	--	3	15.5
B-9	109+92	4	11	--	10	21
B-10	109+99	3	4	8	--	12
RW-4	111+00	1	5.5	7	--	12.5
F-1	111+72	3	4	7	--	11
B-11	112+28	6	3.5	6	--	9.5
B-12	112+51	3	10	--	7	17
F-2	112+94	1	5	6	--	11
RW-5	114+10	1	6	8	--	14
B-13	114+29	4	12	--	6	18
B-14	114+29	3	4.5	7	--	11.5
F-3	114+58	2	11.5	-	3	14.5
F-4	115+79	3	4	6	--	10
B-15	116+33	2	10.5	--	--	10.5
B-16	116+30	5	4.5	7	--	11.5
B-17	118+37	4	12	--	6	18
B-18	118+30	3	4	7	--	11
F-5	118+77	6	4.5	6	--	10.5
F-6	119+71	3	3.5	8	--	11.5
B-19	120+36	6	5	8	--	13
B-20	120+37	1	5	--	13	18
B-21	122+32	4	10	--	--	10
B-22	121+77	3	5	8	--	13
B-23	124+34	4	11	--	--	11
B-24	124+06	3	4.5	8	--	12.5
T-1	124+29	4	5.5	--	12.5	18
T-2	124+28	1	6	8	--	14
RW-10	125+36	4	10	--	--	10
RW-11	125+69	1	5	8	--	13
F-7	125+90	4	10	--	--	10
B-25	126+15	3	3	8	--	11

Table No. 1
Summary of Existing Pavement Section, Cont.

Boring Number	Station Number	Lane Identification	Asphalt Thickness	Concrete Thickness	Aggregate Base Thickness	Total Pavement Section Thickness
East Stadium Boulevard, cont.						
B-26	126+56	1	4	9	--	13
RW-12	126+84	4	3.5	7	--	10.5
RW-13	126+81	1	4	8	--	12
RW-14	129+02	4	3.5	8	--	11.5
RW-15	129+61	1	4	8	--	12
B-27	130+30	4	3	8	--	11
B-28	130+37	3	4	8	--	12
RW-16	131+32	4	3	7	--	10
RW-17	131+48	1	4	7	--	11
F-8	133+37	3	3	7	--	10
B-29	134+17	6	2	9	--	11
B-30	133+93	1	3	8	--	11
B-31	135+20	4	3	9	--	12
B-32	135+06	3	4	8	--	12
B-33	137+17	5	6	--	11	17
B-34	137+17	1	6	--	12	18
B-35	139+19	4	5	--	13	18
B-36	139+20	3	6	--	12	18
B-37	140+17	5	6.5	--	12	18.5
B-38	143+29	5	5.5	--	15	20.5
B-39	145+05	4	6	--	10	16
B-40	145+22	1	6	--	12	18
State Street						
B-41			9	6	--	15
B-42			12	--	--	12
B-43	310+54		7	6	--	13
B-44	312+38		6	8	11	14
White Street						
B-45			5	--	3	8
B-46	407+72		3.5	--	--	3.5
B-47	409+33		4	--	--	4
Rose Street						
B-48	NA		7	--	--	7
B-49	NA		4	--	--	4

above ground storage tank
air quality
asbestos/lead based paint
baseline environmental assessment
brownfield redevelopment
building/infrastructure restoration
caisson/piles
coatings
concrete
construction materials services
corrosion
dewatering
drilling
due care analysis
earth retention system
environmental site assessment
facility asset management
failure analyses
forensic engineering
foundation engineering
geodynamic/vibration
geophysical survey
geosynthetic
greyfield redevelopment
ground modification
hydrogeologic evaluation
industrial hygiene
indoor air quality/mold
instrumentation
ISO14001 EMS
masonry/stone
metals
nondestructive testing
pavement evaluation/design
property condition assessment
regulatory compliance
remediation
risk assessment
roof system management
sealants/waterproofing
settlement analysis
slope stability
storm water management
structural steel/welding
underground storage tank

DRAFT

FALLING WEIGHT DEFLECTOMETER TESTING

STADIUM BOULEVARD
ANN ARBOR, MICHIGAN

SME Project Number PP54180
January 16, 2007

Soil and Materials Engineers, Inc.

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January 16, 2007

DRAFT

Dr. Mahmoud El-Gamal
Professional Service Industries
45749 Helm Street
Plymouth, MI 48170

RE: Falling Weight Deflectometer Testing
Stadium Boulevard
Ann Arbor, Michigan
SME Project No. PP54180

Dear Dr. El-Gamal:

We have completed our analysis for the referenced project. Three copies of the final report are enclosed.

We appreciate the opportunity to work with you on this project. If you have any questions about the enclosed report, or if we can be of further assistance, please do not hesitate to contact us.

Very truly yours,

SOIL AND MATERIALS ENGINEERS, INC.

Rohan W. Perera, PhD, PE
Project Engineer

Starr D. Kohn, PhD, PE
Senior Vice President

Enclosure: Three copies of the final report.

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1. INTRODUCTION

This report presents the results obtained from analyzing the data obtained from Falling Weight Deflectometer testing, that was performed on Stadium Boulevard (between Main and Golden), which is located in Ann Arbor, Michigan. Soil and Materials Engineers, Inc. (SME) was retained by Professional Service Industries (PSI) to provide this service. The pavement testing and analysis was performed in general conformance with the scope of services outlined in our Proposal No. P03-0840 dated October 10, 2006. Dr. Mahmoud El-Gamal of PSI authorized this project. The FWD testing was carried out to determine the condition of the existing pavement and to evaluate subgrade conditions.

Stadium Boulevard is a roadway that runs in the northwest - southeast direction within the evaluated limits. FWD testing on Stadium Boulevard was conducted between stations 112+43 and 155+20. Station 112+43 is approximately 200 ft west of the west edge of Main Street, while station 155+20 is approximately at the centerline of Golden Avenue. This roadway is a five-lane road with two lanes in each direction, and a center turning lane; an additional lane is present in the westbound direction starting approximately from station 135+47.

2. SCOPE

The scope of services for this project consisted of the following tasks:

1. Perform nondestructive testing (NDT) of the pavement using our Dynatest Model 8081 Falling Weight Deflectometer (FWD).

2. Use the data obtained from the FWD to estimate the structural number (SN) of the pavement. If a concrete pavement is present below the asphalt surface a SN cannot be determined. For such cases, use the deflection data to estimate the modulus of the concrete layer.

3. Use the data obtained from the FWD to estimate the subgrade modulus.

4. Prepare a report documenting the field procedures and results from the data analysis.

3. FIELD OPERATIONS

Nondestructive tests are used to evaluate the structural and subsurface conditions of in-place pavements. Nondestructive testing of the roadway was performed using our Dynatest Model 8081 FWD. This device is capable of applying loads in the range of 6,500 to 54,000 lbf, and recording the resulting pavement surface deflections. The impulse load of the FWD is obtained by dropping a weight on a buffer system, which transmits the load to the pavement through a 12-inch diameter plate. A rubber pad attached to the bottom of the plate evenly distributes the applied load to the pavement. A load cell measures the applied load, while high-speed velocity transducers measure the deflections at the pavement surface. The transducers are attached to a bar and placed on the pavement surface. The transducers are spaced at 0, 8, 12, 18, 24, 36, and 60 inches from the center of the load plate. All operations of the equipment are computer controlled from the tow vehicle. The applied loads as well as the measured deflections are recorded in the computer. Figure 3.1 presents a schematic sketch that shows the operating principle of the FWD.

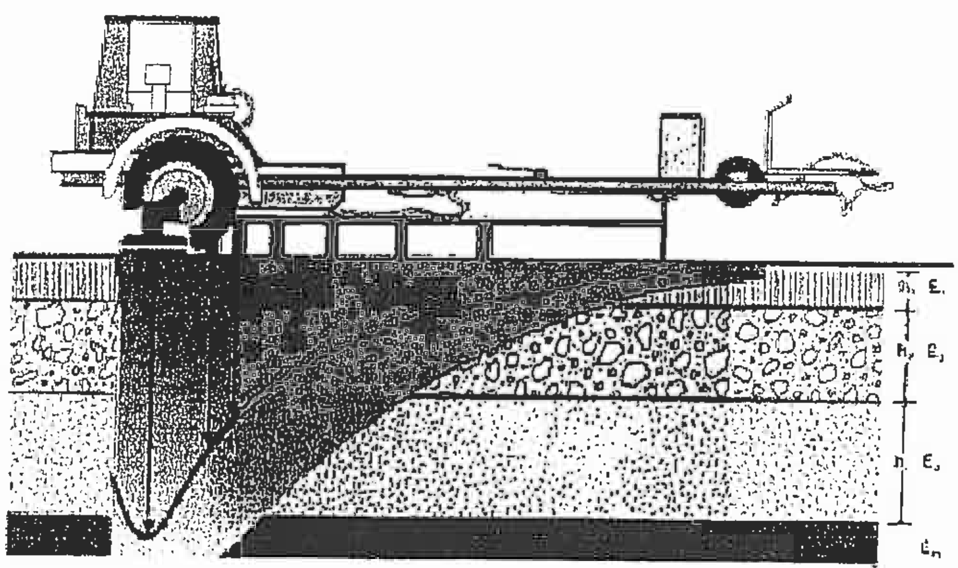

Figure 3.1. Schematic Sketch of the Operating Principle of the FWD.

Pavement testing of the roadway was conducted on October 31, 2006. Pavement testing was performed at four load levels—7,500, 10,000, 13,000 and 18,000 lbf. The lane notations that were used for testing are shown in Figure 3.2. Deflection tests on each lane was performed at a spacing of approximately 200 feet, with tests on two adjacent lanes being offset by 100 feet to provide an effective test spacing of 100 feet.

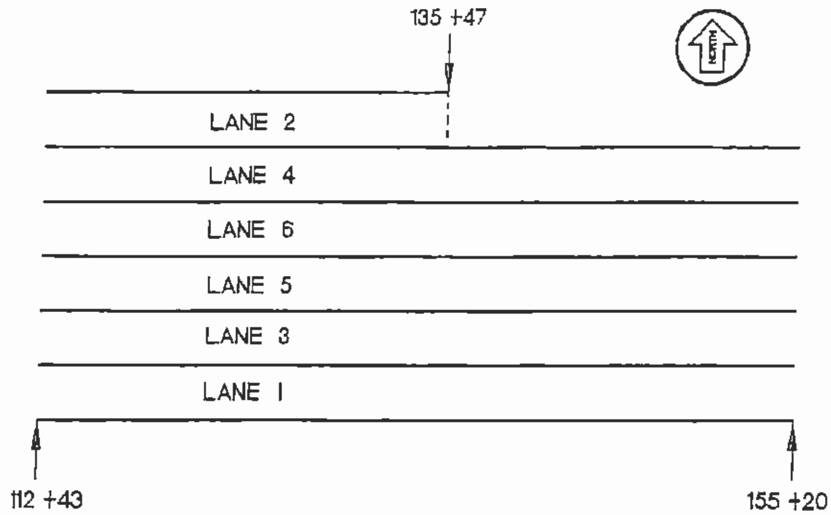

Figure 3.2. Lane Notations Used for FWD Testing.

4. PAVEMENT THICKNESS

Soil borings were performed by PSI at several locations along the roadway, and the thickness of the pavement layers was recorded during drilling. PSI provided SME the pavement thickness recorded at the boring locations, and the draft soil borings. Table 4.1 shows the pavement thickness at each boring location, with the results grouped according to test lanes. A summary of the pavement thickness observed for each test lane is presented separately.

Lane 1: A portland cement concrete (PCC) pavement was encountered below the asphalt concrete (AC) surface at all boring locations except at B-4, RW-3, B-12, B-20, and B-40. The average AC and PCC thickness in the area where a PCC pavement was encountered was 5.1 and 8 inches, respectively. An aggregate base was not reported below the PCC layer at all locations. In the areas where a PCC pavement was not encountered, the thickness of the AC layer ranged from 5 to 12.5 inches. An aggregate base was reported below the AC layer at borings RW-3, B-12, B-20, and B-40, with the thickness ranging from 3 to 13 inches.

Table 4.1. Pavement Thickness.

Boring Number	Station Number	Lane Designation	Layer Thickness (in)		
			Asphalt	Concrete	Aggregate Base
B-4	114+00	1	12	–	–
RW-2	117+00	1	8	8	–
RW-3	119+00	1	12.5	–	3
B-12	122+00	1	10	–	7
RW-5	123+82	1	6	8	--
B-20	130+00	1	5	--	13
T-2	134+42	1	6	8	–
RW-11	135+00	1	5	8	–
B-26	136+00	1	4	9	–
RW-13	136+50	1	4	8	–
RW-15	139+25	1	4	8	–
RW-17	141+15	1	4	7	–
B-40	154+75	1	5	–	3
F-3	124+19	2	11.5	–	3
B-15	126+00	2	10.5	–	–
B-23	134+00	2	11	–	–
T-1	134+25	2	5.5	–	12.5
RW-10	135+00	2	10	–	–
F-7	135+47	2	10	--	–
B-2	113+00	3	5.5	8	–
B-6	116+00	3	6	6	–
B-10	120+00	3	4	8	–
F-1	121+44	3	4	7	–
F-2	122+42	3	5	6	–
B-14	124+00	3	4.5	7	–
F-4	125+43	3	4	6	--
B-18	128+00	3	4	7	–
F-6	129+44	3	3.5	8	–
B-22	132+00	3	5	8	–
B-28	140+00	3	4	8	–
B-32	145+00	3	6	--	11
B-9	120+00	4	11	–	10
B-13	124+00	4	12	–	6
B-17	128+00	4	12	–	6
B-21	132+00	4	10	–	–
B-25	136+00	4	3	8	--
RW-12	136+50	4	3.5	7	--
RW-14	139+00	4	3.5	8	–
B-27	140+00	4	3	8	–
RW-16	141+00	4	3	7	–
B-31	145+00	4	3	9	–
B-35	149+00	4	5	--	13
B-39	154+75	4	6	–	10
B-8	118+00	5	5	6.5	–
B-16	126+00	5	4.5	7	–
B-24	134+00	5	4.5	8	–
B-38	153+00	5	5.5	–	15.5
B-11	122+00	6	3.5	6	–
F-5	128+39	6	4.5	6	–
B-19	130+00	6	5	8	–
B-29	144+00	6	2	9	–

Lane 2: A PCC pavement was not encountered below the AC surface at all boring locations. The thickness of the AC layer ranged from 10 to 11.5 inches, except at one location where the thickness was 5.5 inches. An aggregate base was encountered at borings F-3 and T-1, with the thickness of the layer being 3 and 12.5 inches, respectively.

Lane 3: A PCC layer was encountered below the AC surface at all locations except for B-32. At the locations where a PCC pavement was encountered, the average thickness of the AC and the PCC layers was 4.5 and 7.2 inches, respectively. An aggregate base was not reported below the PCC layer at all locations. At B-32, the pavement consisted of a 6 inch AC layer over an 11 inch thick aggregate base.

Lane 4: A PCC layer was encountered below the AC surface at borings B-25, RW-12, RW-14, B-27, RW-16, and B-31, with the average AC and PCC thickness being 3.2 and 7.8 inches, respectively. An aggregate base was not reported at all these locations. The AC thickness encountered at B-9, B-13, B-17, and B-21 ranged from 10 to 12 inches, with an average of 11.25 inches. The AC thickness encountered at borings B-35 and B-39 was 5 and 6 inches, respectively. At locations where only an AC pavement was encountered, an aggregate base was reported below the AC layer at all locations except for B-21. The thickness of the aggregate base ranged from 6 to 13 inches.

Lane 5: A concrete pavement was encountered below the AC surface at all borings except for B-38. In the area where a PCC pavement was encountered, the average thickness of the AC and the PCC layer was 4.7 and 7.2 inches, respectively. At B-38, the thickness of the AC layer and the aggregate base was 5.5 and 15.5 inches, respectively.

Lane 6: A PCC layer was encountered below the AC surface at all boring locations. The average thickness of the AC and the PCC layer was 3.75 and 7.25 inches, respectively.

5. ANALYSIS OF NONDESTRUCTIVE DEFLECTION TEST DATA

5.1 General

The analysis of the measured surface deflections was performed in general accordance with the methods outlined in the 1993 AASHTO Guide for Design of Pavement Structures and other literature. The analysis involved estimating the structural number of the pavement in areas where a PCC pavement was not present below the AC layer, estimating the subgrade modulus, and determining the condition of the PCC pavement in areas where a PCC pavement was encountered below the AC surface.

5.2 Evaluation of Deflection Data

Appendix A includes plots that show the maximum deflection below the load and the deflection at a distance of 60 inches from the load (for a normalized load of 9,000 lb) for each test lane. The deflections obtained at each test location are tabulated in the tables included in Appendix B. The average deflection obtained along each lane below the center of the load plate and at a distance of 60 inches from the load for a normalized load of 9000 lb is shown in Table 5.1. The deflection below the center of the load plate represents the response of the pavement structure and the subgrade, and is dependent on the thickness and the modulus of the pavement layers as well as the subgrade modulus. The deflection obtained at 60 inches from the load plate is mostly dependant on the subgrade modulus.

Table 5.1. Average Deflections.

Lane	Average Deflection (mils)	
	Below Load	At 60" From Load
1	6.8	1.8
2	8.7	1.7
3	6.2	1.7
4	6.5	1.6
5	8.4	1.9
6	7.2	1.8

One location in lane 5 had a high deflection (39 mils) below the load, and this value was omitted when computing the average deflection. Lane 5 (center lane) and lane 2 (the outermost westbound lane that begins from approximate station 135+47) had higher average deflections below the load when compared to the other lanes.

5.3 Structural Number

A structural number (SN) can be computed for a full depth AC pavement or an AC pavement underlain by an aggregate base. However, a SN has no meaning for an AC pavement that is underlain by a PCC pavement.

Based on the deflection data, it appears that the pavement after station 146+00 to the end of testing does not have a PCC pavement below the AC surface. The transition from an AC/PCC pavement to an AC only pavement appears to be occurring between stations 145+00 and 146+00. This observation is verified by the pavement thickness obtained during the soil borings. The deflection data also indicated that a PCC layer was not present below the AC surface in lane 2. This observation was also verified by the pavement thickness determined during the soil borings. Deflection data in lane 4 indicated that a PCC layer was probably not present below the AC surface between stations 119+21 and 127+21 (Note: The transition into a AC pavement from a AC/PCC pavement appears to be occurring between stations 117+20 and 119+21, and 127+21 and 129+20). Soil borings taken within these limits in lane 4 indicated that a PCC pavement was not present below the existing AC surface. The information described previously is summarized in Table 5.2 to show pavement areas where the existing AC surface did not have a PCC pavement below it. The FWD data obtained in the pavement areas shown in Table 5.2 were used to estimate the SN value at each test location.

Table 5.2. Areas where only an AC Pavement is Present.

Lane	Limits
1, 3, 4, 5, 6	After Station 146+00 to end of testing (Note 1)
2	Entire Lane
4	From Approximate Station 119+21 to 127+21 Note 2)
Note 1: The transition from a AC/PCC pavement to a AC pavement appears to be occurring between station 145+00 and 146+00 **Note 2:** The transition from a AC/PCC pavement to a AC pavement appears to be occurring between the following stations: stations 117+20 and 119+21, and stations 127+21 and 129+20	

The SN values computed at all test locations after station 146+00 to end of testing are shown in Table 5.3, separated according to lanes. The average SN for each lane is also shown in this table. The soil borings taken within this area indicated the average AC and aggregate base thickness to be 5.5 and 10.5 inches, respectively. The theoretical SN for this pavement structure assuming structural coefficients of 0.42 and 0.14 for the AC layer and the aggregate base is 3.78. (Note: The structural coefficient of 0.42 for the AC layer assumes that the layer is in a good condition.) However, the SN values estimated from FWD test data are much higher than the theoretical SN. Soil borings conducted within this area were extended to a depth of 10 ft below the pavement surface, and the subgrade generally consisted of a fine to coarse sand layer underlain by a silty sand layer. The fine to coarse sand layer extended to depths ranging from 4 to

7 ft below the pavement surface, except at one location where it extended to the end of boring. The fine to coarse sand layer had blowcounts ranging from 14 to 39 blows/ft, with an average blowcount of 19 blows/ft. This sand layer is acting as a subbase and contributing to the SN estimated from FWD testing, which is the cause for the SN estimated from FWD testing to be higher than the theoretical SN computed by considering only the AC layer and the aggregate base.

Table 5.3. SN Estimated from FWD Testing: Station 146+00 to End of Testing.

Lane	Station	SN	Average
1	146+43	5.18	
1	148+44	5.24	
1	150+44	4.57	
1	152+44	6.11	
1	154+43	5.13	5.25
3	147+43	6.18	
3	149+43	5.70	
3	151+43	5.82	
3	153+43	4.70	
3	155+43	5.76	5.63
4	147+20	5.32	
4	149+20	4.52	
4	151+19	4.90	
4	153+20	3.06	
4	155+20	5.07	4.57
5	148+69	2.08	
5	150+70	5.04	
5	152+75	4.49	
5	154+70	4.42	
5	155+20	4.69	4.14
6	146+19	5.71	
6	148+19	5.37	
6	150+20	5.15	
6	152+20	4.21	
6	154+20	4.97	
6	155+20	4.68	5.02

The SN values estimated using FWD data for test locations in lane 2 are shown in Table 5.3. High SN values were noted at stations 114+61 and 128+18. The cause for these high SN values could not be determined from the deflection data. The soil borings indicated the pavement structure in lane 2 consisted of a full depth AC pavement having a thickness ranging from 10 to 11.5 inches, except for one location that had 5.5 inches of AC over 12.5 inches of aggregate base. The theoretical SN of a full depth AC pavement with no distress having a thickness ranging from 10 to 11.5 inches is estimated to range from 3.71 to 4.24. The soil borings indicated a sand layer below the AC surface at some locations. For such cases, the deflection data indicated the sand layer is acting as a subbase and contributing to the SN estimated by FWD testing. The SN estimated by the FWD data is generally consistent with the existing pavement structure observed during the soil borings.

Table 5.4. Estimated SN Values – Lane 2.

Station	SN
114+61	7.13*
116+22	3.14
118+20	3.44
120+20	3.54
122+20	3.87
124+19	3.73
126+21	3.69
128+18	8.57*
130+19	4.30
132+20	4.65
134+20	5.45
135+47	4.44
Average	4.03
Note: * - Not used for computing the average	

The SN values estimated from FWD data in lane 4 from station 119+21 to 127+21 are shown in Table 5.4. Borings conducted within these limits indicated the thickness of the AC layer ranged from 11 to 12 inches, while the thickness of the aggregate base ranged from 6 to 10 inches. The theoretical SN of such a pavement structure with no distress is expected to range from 4.66 to 5.41. The SN estimated by the FWD data is generally consistent with the existing pavement structure observed during the soil borings.

Table 5.5. Estimated SN Values - Lane 4 (Station 119+21 to 127+21).

Station	SN
119+21	4.39
121+19	3.50
123+19	4.14
125+19	5.55
127+21	6.49*
Average	4.40
Note: * - Probable PCC pavement below AC, values not used for computing the average	

In Lane 1, six borings were obtained between Stations 114+00 and 130+00. Borings obtained at 117+00 and 123+82 indicated a PCC layer was present below the AC layer. However, a PCC layer was not encountered at borings performed at Stations 114+00, 119+00, 122+00, and 130+00. Hence, the pavement structure within these limits was variable. As the AC thickness at many borings ranged from 10 to 12.5 inches, the computed SN values cannot be used to determine if there was a PCC pavement below the AC surface at a test location. Therefore, SN values were not computed for the pavement area within these limits, as a SN computed for a PCC pavement that is overlaid with AC has no meaning. During backcalculation (see next section) an evaluation will be performed to identify locations that probably do not have a PCC layer below the existing AC surface.

5.4 Backcalculation of Moduli

An AC surface underlain by a PCC pavement was identified based on the deflection data and information from the soil borings in the areas shown in Table 5.6. The average pavement layer thickness in these areas is also shown in this table.

Deflection data obtained within these limits were used to estimate the modulus of the PCC layer using a procedure called backcalculation. In backcalculation, the elastic moduli for pavement layers are assumed, and the theoretical deflections are computed using a multi-layer model. The moduli of pavement layers are adjusted until the theoretical deflections match the measured deflections within a specified tolerance. The computer program Modulus, developed by the Texas Transportation Institute, was used to backcalculate the elastic layer moduli of pavement layers at all test locations. A subgrade layer that extends from below the pavement surface to a depth of 240 inches from the pavement surface was used to model the subgrade layer for backcalculation. The backcalculated PCC modulus at each test location is shown in the table included in Appendix B. The elastic modulus of PCC generally varies from 3 to 7 million psi. A

PCC modulus of less than 2 million psi generally indicates fractured portland cement concrete. ***Locations that have a PCC modulus of less than 2 million psi indicates either the PCC pavement at that location is deteriorated or there is no PCC pavement below the existing AC surface, and such locations are flagged in the table included in Appendix B.***

Table 5.6. Areas where a PCC Pavement is Present below the AC Pavement.

Lane	Limits	Pavement Thickness (in)	
		AC	PCC
1	From start of testing to station 146+00 (Note 1,3, 4)	5.1	8.0
3	From start of testing to station 146+00 (Note 3,4)	4.5	7.2
4	From station 119+21 to 127+21 (Note 2)	3.2	7.8
5	From start of testing to station 146+00 (Note 3, 4)	4.7	7.2
6	From start of testing to station 146+00 (Note 3, 4)	3.8	7.3

Note 1: A PCC layer was not encountered at some borings between station 114+00 and 130+00
Note 2: Transition from AC/PCC to AC only pavement appears to be occurring between stations 117+20 and 119+21, and 127+21 and 129+21
Note 3: Transition from a AC/PCC pavement to AC only pavement appears to be occurring between stations 145+00 and 146+00
Note 4: Localized areas that contain an AC pavement may be present within these limits

5.5 Subgrade Modulus

Backcalculation was also used to estimate the subgrade modulus at each FWD test location. The obtained results are shown in the tables included in Appendix B. The 1993 supplement to the AASHTO Guide presents a procedure for computing the k-value of the subsurface layer below an existing composite pavement (i.e., AC pavement over a PCC pavement). This procedure was used to estimate the k-value of the subsurface layers at locations where a PCC pavement was present below the AC surface. The computed k-values are also shown in the tables included in Appendix B. A subgrade modulus of less than 3000 psi or a k-value less than 100 psi/in may indicate locations where weak subgrade conditions are present. Such locations are flagged in the tables included in Appendix B.

It should be noted that during backcalculation an average modulus for the subgrade layer that is present below the test location is estimated. ***Hence, there is a possibility for a weak subgrade stratum to be located at the test location, but that location may not be flagged in the table included in Appendix B because of the averaging effect. During pavement reconstruction, the subgrade within the first 3 ft has a significant impact on construction. Because of the averaging nature of backcalculation, a test location may not be flagged in the tables included in Appendix B, but it may yet have weak subgrade conditions at the top. The***

soil boring logs should be consulted to determine potential construction problems due to weak subgrade conditions. The subgrade modulus values indicated in the table included in Appendix B must be evaluated together with the boring logs to determine a suitable resilient modulus value for the subgrade for use in pavement design.

6. GENERAL COMMENTS

This report has been prepared in accordance with generally accepted geotechnical engineering and pavement engineering practices to aid in the evaluation of roadway and to assist the Engineer in the design of this project. The analysis submitted in this report are based upon data obtained from the nondestructive tests generally conducted along each lane at a spacing of 200 feet and the pavement thickness at the boring locations and the draft boring logs provided to us by PSI. This report does not reflect variations that may occur between the nondestructive test locations. The nature and extent of variations may not become evident until the time of construction. If significant variations become evident, it may be necessary for us to re-evaluate the data presented in this report.

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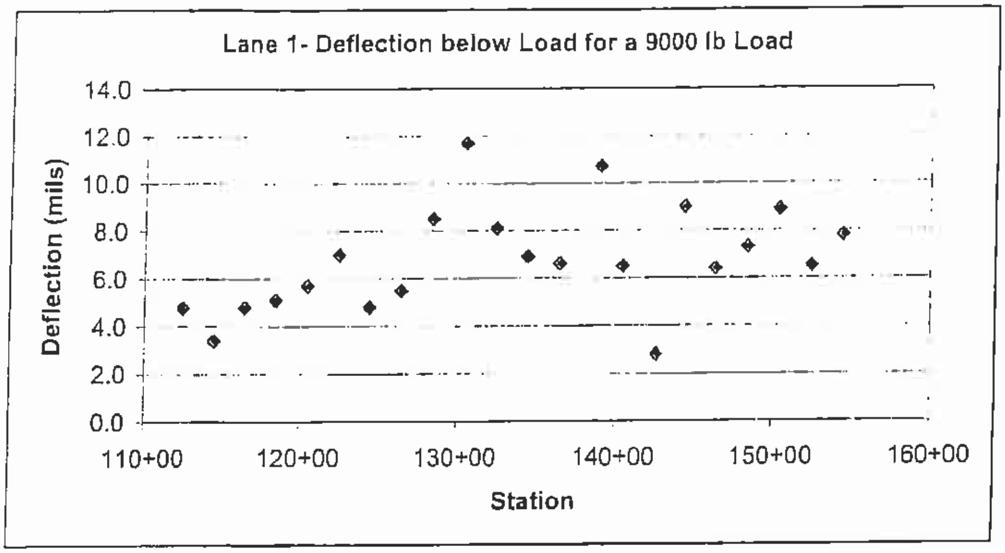
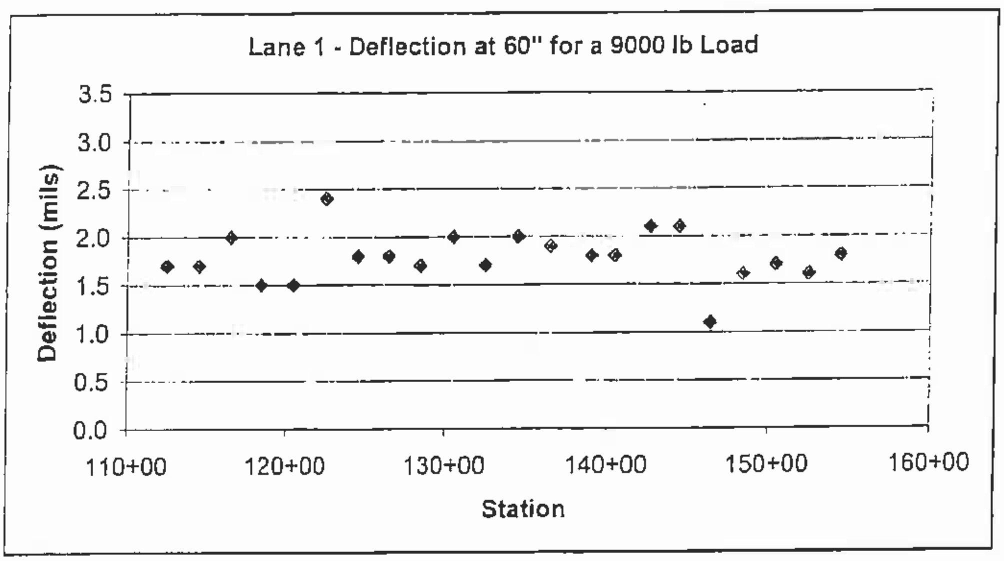
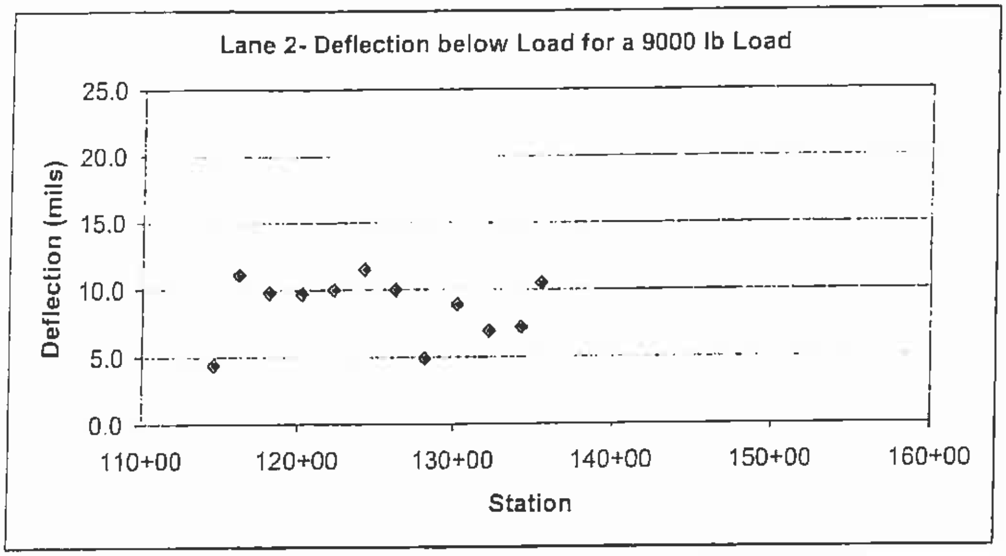
APPENDIX A
DEFLECTION PLOTS

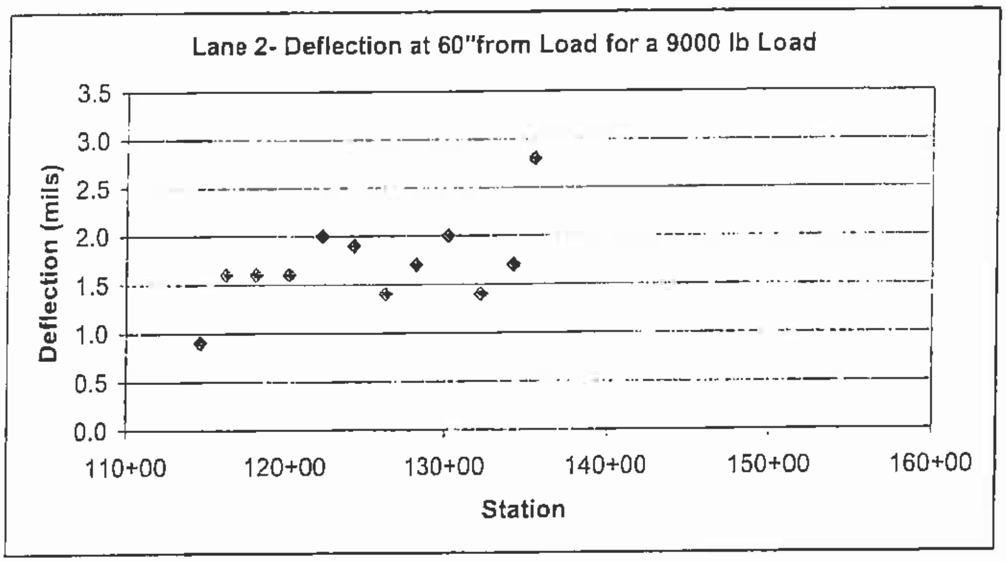


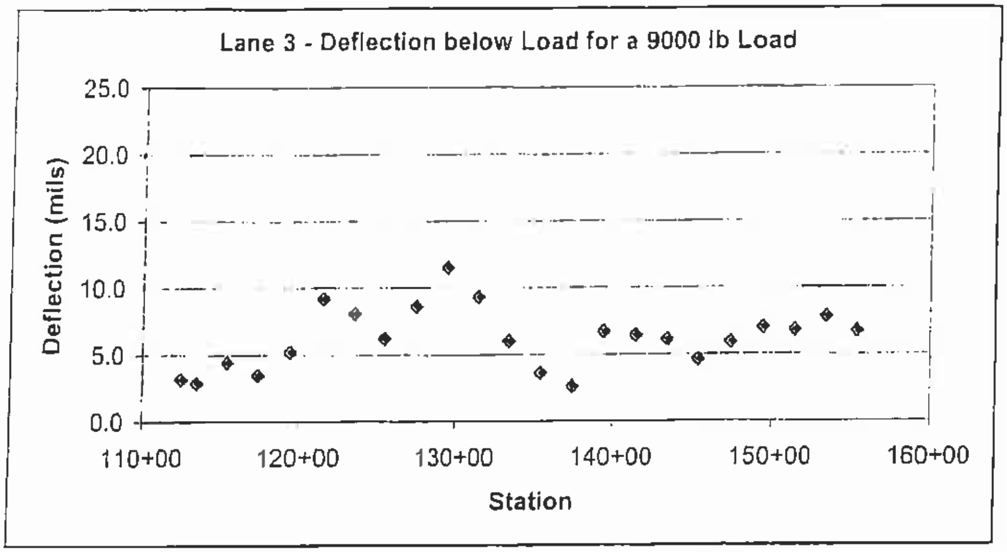
Lane 1- Deflection below Load for a 9000 lb Load
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Deflection (mils)
110+00
120+00
130+00
140+00
150+00
160+00
Station

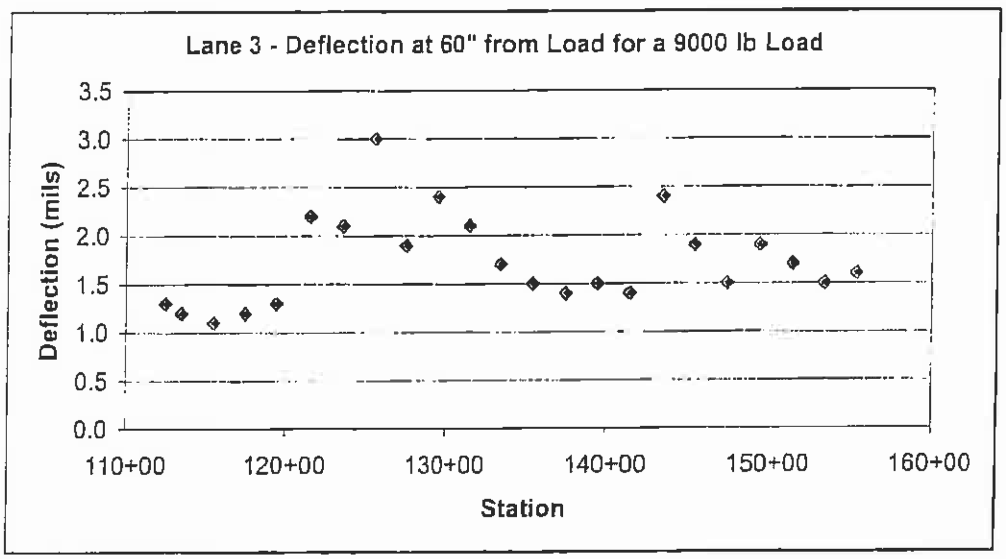


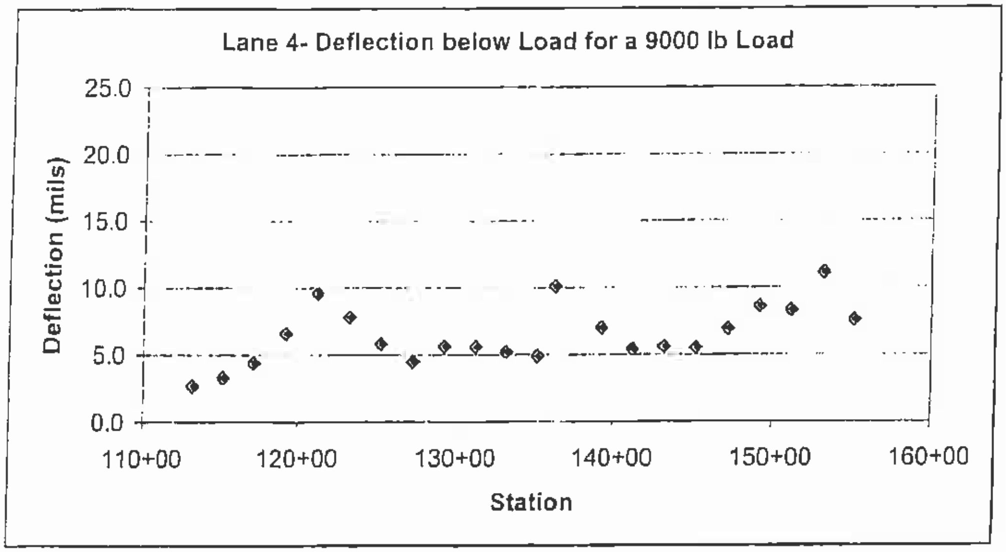
Lane 1 - Deflection at 60" for a 9000 lb Load
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Deflection (mils)
110+00
120+00
130+00
140+00
150+00
160+00
Station


Lane 2- Deflection below Load for a 9000 lb Load
25.0
20.0
15.0
10.0
5.0
0.0
Deflection (mils)
110+00
120+00
130+00
140+00
150+00
160+00
Station

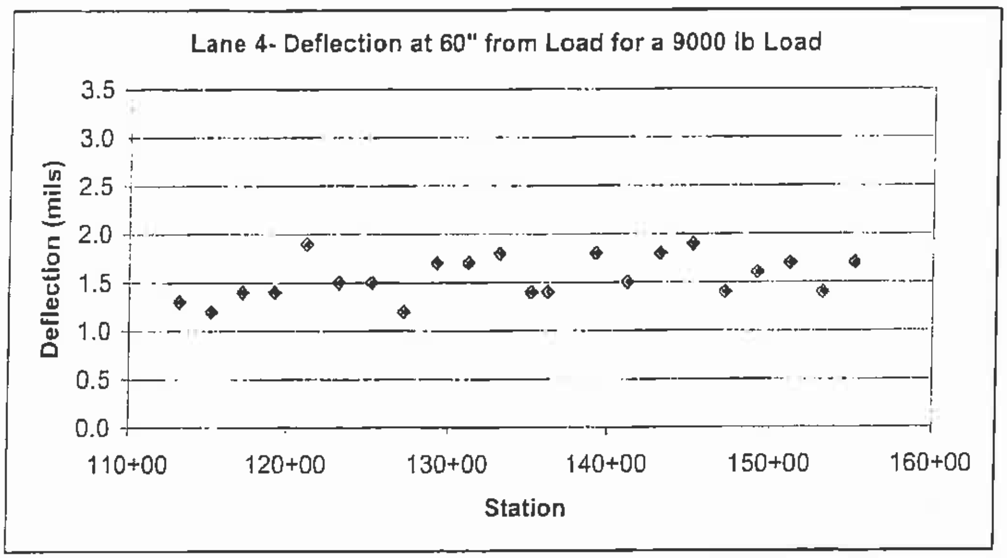

Lane 2- Deflection at 60"from Load for a 9000 lb Load
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Deflection (mils)
110+00
120+00
130+00
140+00
150+00
160+00
Station


Lane 3 - Deflection below Load for a 9000 lb Load
Deflection (mils)
25.0
20.0
15.0
10.0
5.0
0.0
110+00
120+00
130+00
140+00
150+00
160+00
Station

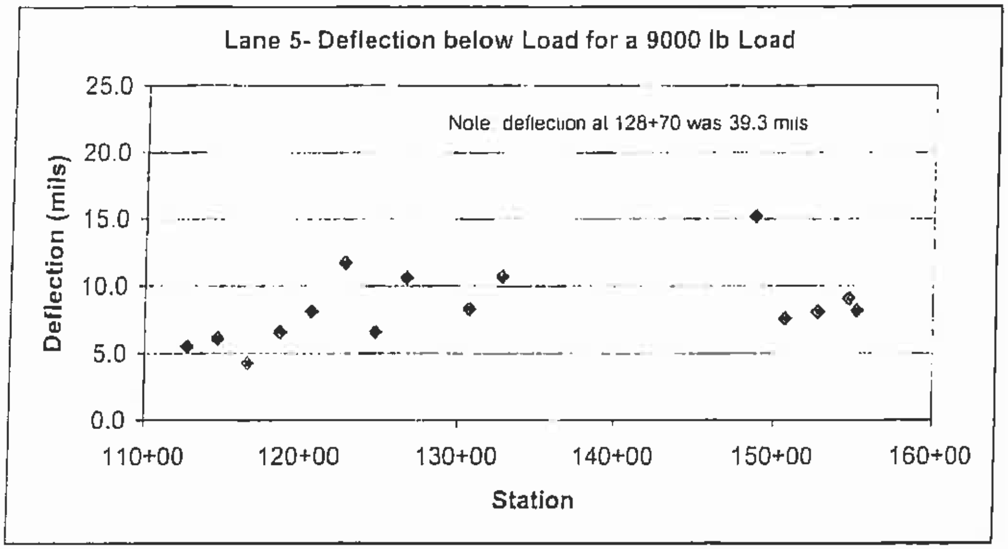

Lane 3 - Deflection at 60" from Load for a 9000 lb Load
Deflection (mils)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
110+00
120+00
130+00
140+00
150+00
160+00
Station

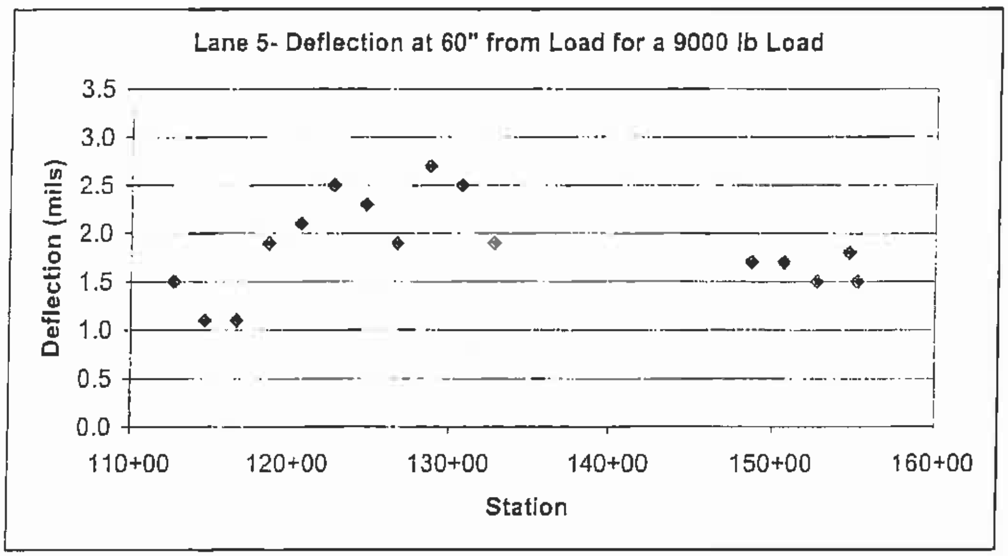


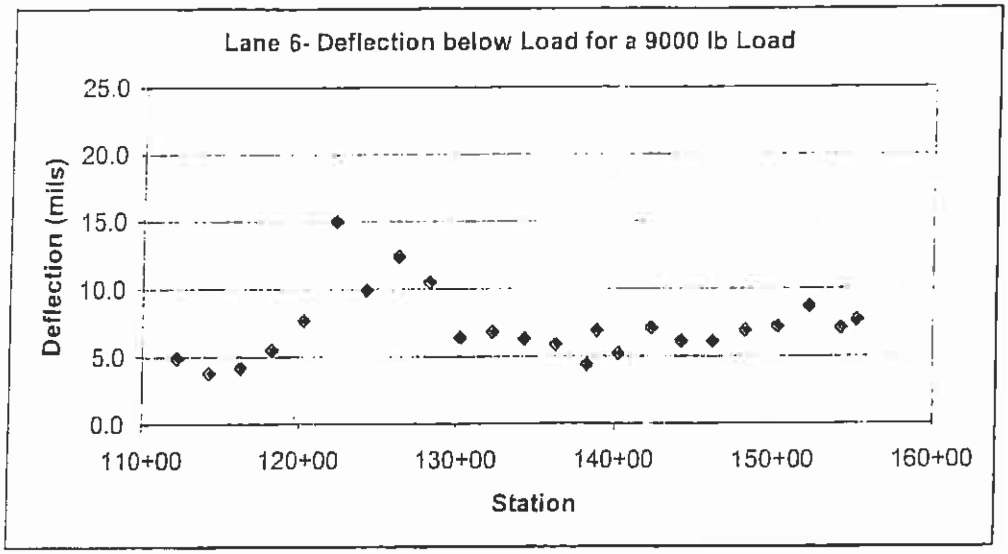
Lane 4- Deflection below Load for a 9000 lb Load
Deflection (mils)
25.0
20.0
15.0
10.0
5.0
0.0
110+00
120+00
130+00
140+00
150+00
160+00
Station



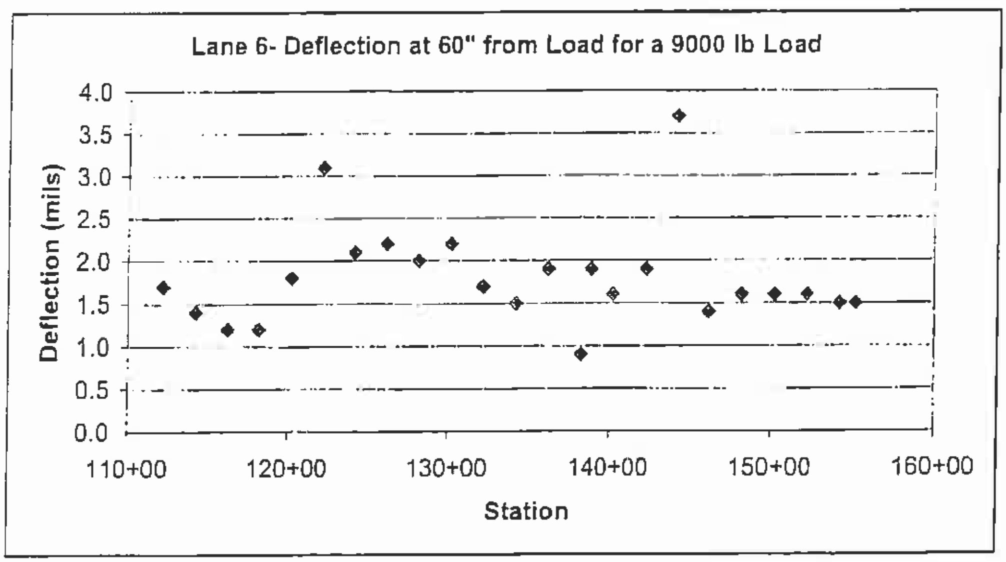
Lane 4- Deflection at 60" from Load for a 9000 lb Load
Deflection (mils)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
110+00
120+00
130+00
140+00
150+00
160+00
Station


Lane 5- Deflection below Load for a 9000 lb Load
Note deflection at 128+70 was 39.3 mils
25.0
20.0
15.0
10.0
5.0
0.0
Deflection (mils)
110+00
120+00
130+00
140+00
150+00
160+00
Station


Lane 5- Deflection at 60" from Load for a 9000 lb Load
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Deflection (mils)
110+00
120+00
130+00
140+00
150+00
160+00
Station



Lane 6- Deflection below Load for a 9000 lb Load
Deflection (mils)
25.0
20.0
15.0
10.0
5.0
0.0
110+00
120+00
130+00
140+00
150+00
160+00
Station



Lane 6- Deflection at 60" from Load for a 9000 lb Load
Deflection (mils)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
110+00
120+00
130+00
140+00
150+00
160+00
Station

APPENDIX B
DEFLECTION TEST RESULTS

Lane	Station	Deflection for 9000 lb Load at:							K-Value (psi/in)	PCC Modulus (psi)	Subgrade Modulus (psi)	Comment	Subgrade Comment
		0"	8"	12"	18"	24"	36"	60"					
1	112+43	4.8	4.2	4.0	3.8	3.6	2.8	1.7	88	2,256,000	4225		Weak Subgrade
1	114+43	3.4	3.1	3.0	2.8	2.7	2.4	1.7	74	4,999,989	4645		Weak Subgrade
1	116+44	4.8	4.3	4.0	3.8	3.6	2.9	2.0	74	4,315,417	3734		Weak Subgrade
1	118+44	5.1	4.4	4.1	3.7	3.5	2.6	1.5	116	1,600,185	4875	Det.PCC or AC Pavement	
1	120+43	5.7	5.0	4.5	4.1	3.8	2.7	1.5	119	777,713	4837	Det.PCC or AC Pavement	
1	122+42	7.0	6.4	5.9	5.4	4.9	3.9	2.4	74	721,447	3075	Det.PCC or AC Pavement	Weak Subgrade
1	124+43	4.8	4.3	4.0	3.7	3.5	2.8	1.8	89	1,824,601	4145	Det.PCC or AC Pavement	Weak Subgrade
1	126+44	5.5	5.0	4.6	4.2	3.9	3.0	1.8	97	920,292	4124	Det.PCC or AC Pavement	Weak Subgrade
1	128+43	8.5	7.3	6.5	5.3	4.7	3.0	1.7	133	--	4334	AC Pavement	
1	130+43	11.7	9.7	8.6	6.9	5.9	3.7	2.0	113	--	3577	AC Pavement	Weak Subgrade
1	132+43	8.1	7.2	6.5	5.6	4.7	3.1	1.7	127	--	4326	AC Pavement	
1	134+43	6.9	5.6	4.9	4.3	4.0	3.1	2.0	97	2,882,410	3951		Weak Subgrade
1	136+43	6.6	5.5	4.8	4.1	3.7	2.9	1.9	113	2,776,176	4224		
1	138+98	10.7	7.4	6.0	4.8	4.2	3.0	1.8	133	994,356	4586	Det.PCC or AC Pavement	
1	140+43	6.5	5.4	4.8	4.3	4.0	3.0	1.8	103	2,084,445	4268		
1	142+62	2.8	2.6	2.6	2.6	2.6	2.5	2.1	19	4,999,989	5399		Weak Subgrade
1	144+45	9.0	7.3	6.1	5.2	4.8	3.6	2.1	96	1,417,050	3697	Det.PCC or AC Pavement	Weak Subgrade
1	146+43	6.4	5.5	4.9	4.0	3.4	2.1	1.1	198	--	6388	AC Pavement	
1	148+44	7.3	6.5	5.9	5.0	4.4	3.0	1.6	130	--	4573	AC Pavement	
1	150+44	8.9	8.0	7.2	6.0	5.2	3.4	1.7	120	--	4008	AC Pavement	
1	152+44	6.5	6.0	5.6	4.8	4.3	3.0	1.6	125	--	4454	AC Pavement	
1	154+43	7.8	7.0	6.4	5.4	4.8	3.2	1.8	120	--	4091	AC Pavement	
2	114+61	4.4	3.9	3.5	3.0	2.7	1.7	0.9	224	--	8064	PCC maybe present below AC	
2	116+22	11.1	9.0	7.7	6.0	4.9	2.9	1.6	147	--	4613	AC Pavement	
2	118+20	9.8	8.1	6.9	5.4	4.6	2.8	1.6	150	--	4755	AC Pavement	
2	120+20	9.7	7.9	6.8	5.4	4.6	3.0	1.6	142	--	4618	AC Pavement	
2	122+20	10.0	8.6	7.6	6.3	5.5	3.6	2.0	111	--	3786	AC Pavement	Weak Subgrade
2	124+19	11.5	10.0	9.0	7.5	6.5	4.2	1.9	100	--	3473	AC Pavement	Weak Subgrade
2	126+21	10.0	7.9	6.9	5.8	5.1	3.3	1.4	127	--	4618	AC Pavement	

Lane	Station	Deflection for 9000 lb Load at:							K-Value (psi/in)	PCC Modulus (psi)	Subgrade Modulus (psi)	Comment	Subgrade Comment
		0"	8"	12"	18"	24"	36"	60"					
2	128+18	4.9	4.5	4.1	3.6	3.3	2.5	1.7	122	--	5668	PCC maybe present below AC	
2	130+19	8.9	7.5	6.7	5.6	5.0	3.4	2.0	112	--	3915	AC Pavement	Weak Subgrade
2	132+20	6.9	5.7	5.1	4.2	3.7	2.4	1.4	164	--	5475	AC Pavement	
2	134+20	7.2	6.4	5.8	5.0	4.5	3.2	1.7	115	--	4308	AC Pavement	
2	135+47	10.5	9.1	8.2	7.0	6.3	4.5	2.8	79	--	2877	AC Pavement	Weak Subgrade
3	112+43	3.2	2.8	2.7	2.5	2.4	2.0	1.3	113	4,999,989	6377		
3	113+43	2.9	2.5	2.4	2.3	2.2	1.9	1.2	102	4,999,989	7477		
3	115+42	4.4	3.9	3.6	3.3	3.0	2.2	1.1	151	1,471,968	6651	Det.PCC or AC Pavement	
3	117+45	3.5	2.9	2.7	2.5	2.3	1.8	1.2	147	4,999,989	6678		
3	119+43	5.2	4.4	4.1	3.7	3.4	2.5	1.3	133	1,607,717	5674	Det.PCC or AC Pavement	
3	121+44	9.2	8.0	7.2	6.4	5.9	3.8	2.2	91	500,001	3375	Det.PCC or AC Pavement	Weak Subgrade
3	123+43	8.1	7.2	6.7	6.0	5.5	3.9	2.1	87	654,607	3434	Det.PCC or AC Pavement	Weak Subgrade
3	125+43	6.2	6.0	5.4	4.6	4.1	3.7	3.0	70	3,441,223	2868		Weak Subgrade
3	127+42	8.6	6.4	5.7	4.9	4.5	3.3	1.9	106	2,529,445	4130		
3	129+44	11.5	9.0	7.8	6.7	6.0	4.2	2.4	87	1,349,825	3218	Det.PCC or AC Pavement	Weak Subgrade
3	131+44	9.3	6.7	5.8	5.0	4.6	3.4	2.1	98	3,328,629	3803		Weak Subgrade
3	133+43	6.0	4.0	3.8	3.6	3.4	2.6	1.7	94	4,999,989	4921		
3	135+42	3.6	3.3	3.1	2.9	2.8	2.2	1.5	103	4,999,989	5353		
3	137+44	2.6	2.2	2.1	2.0	1.9	1.7	1.4	83	4,999,989	8696		Weak Subgrade
3	139+43	6.7	5.6	4.6	3.8	3.5	2.5	1.5	147	3,046,305	5171		
3	141+44	6.4	5.2	4.1	3.3	2.9	2.1	1.4	181	3,555,168	6159		
3	143+43	6.1	5.3	5.1	4.7	4.4	3.5	2.4	71	3,844,195	3204		Weak Subgrade
3	145+42	4.6	4.2	4.1	3.8	3.6	2.9	1.9	83	4,579,804	3817		Weak Subgrade
3	147+43	5.9	5.3	4.8	4.1	3.6	2.5	1.5	148	--	5178	AC Pavement	
3	149+43	7.0	6.3	5.8	5.0	4.4	3.0	1.9	120	--	4178	AC Pavement	
3	151+43	6.8	6.2	5.7	4.9	4.4	3.0	1.7	123	--	4333	AC Pavement	
3	153+43	7.8	6.6	5.8	4.8	4.3	2.9	1.5	138	--	4932	AC Pavement	
3	155+43	6.7	6.0	5.5	4.7	4.1	2.9	1.6	131	--	4693	AC Pavement	

Lane	Station	Deflection for 9000 lb Load at:							K-Value (psi/in)	PCC Modulus (psi)	Subgrade Modulus (psi)	Comment	Subgrade Comment
		0"	8"	12"	18"	24"	36"	60"					
4	113+20	2.7	2.6	2.5	2.3	2.2	1.8	1.3	122	4,999,989	7608		
4	115+20	3.3	2.9	2.7	2.5	2.4	1.9	1.2	130	4,999,989	6742		
4	117+20	4.4	3.9	3.6	3.3	3.0	2.3	1.4	129	4,061,685	5631		
4	119+21	6.6	5.7	5.1	4.4	3.9	2.6	1.4	145	--	5290	AC Pavement	
4	121+19	9.6	8.2	7.4	6.2	5.4	3.6	1.9	111	--	3855	AC Pavement	Weak Subgrade
4	123+19	7.8	6.9	6.3	5.4	4.8	3.1	1.5	127	--	4504	AC Pavement	
4	125+19	5.8	5.3	4.9	4.4	4.0	2.9	1.5	118	1,293,268	4945	Del.PCC or AC Pavement	
4	127+21	4.5	4.0	3.8	3.3	3.1	2.2	1.2	157	1,758,638	6175	Del.PCC or AC Pavement	
4	129+20	5.6	4.7	4.3	3.8	3.5	2.7	1.7	114	4,602,857	4520		
4	131+18	5.6	4.9	4.6	4.1	3.8	2.8	1.7	112	3,011,753	4580		
4	133+19	5.2	4.9	4.6	4.0	3.6	2.7	1.8	120	2,118,875	4458		
4	135+20	4.9	4.3	3.8	3.3	2.9	2.2	1.4	155	3,899,461	5727		
4	136+25	10.1	8.4	5.0	3.4	3.0	2.3	1.4	201	500,001	6782	Del.PCC or AC Pavement	
4	139+20	7.0	5.6	4.8	4.2	3.8	2.9	1.8	112	3,450,763	4464		
4	141+20	5.4	4.0	3.6	3.2	3.0	2.3	1.5	126	4,999,989	5628		
4	143+21	5.6	5.1	4.9	4.5	4.3	3.3	1.8	87	2,501,126	3991		Weak Subgrade
4	145+19	5.5	4.9	4.6	4.3	4.1	3.2	1.9	81	3,882,102	3878		Weak Subgrade
4	147+20	6.9	6.1	5.5	4.6	4.0	2.7	1.4	149	--	5146	AC Pavement	
4	149+20	8.6	7.5	6.7	5.5	4.8	3.0	1.6	135	--	4515	AC Pavement	
4	151+19	8.3	7.4	6.7	5.7	5.0	3.3	1.7	119	--	4100	AC Pavement	
4	153+20	11.1	8.1	6.9	5.3	4.4	2.6	1.4	166	--	5061	AC Pavement	
4	155+20	7.6	6.7	6.1	5.1	4.4	3.0	1.7	131	--	4452	AC Pavement	
5	112+70	5.5	4.3	3.9	3.5	3.3	2.4	1.5	125	4,713,716	5230		
5	114+68	6.1	4.5	4.0	3.4	3.0	2.1	1.1	184	2,201,931	6730		
5	116+69	4.3	3.6	3.3	3.0	2.7	1.9	1.1	174	1,965,237	7060	Del.PCC or AC Pavement	
5	118+71	6.6	5.6	5.2	4.6	4.3	3.1	1.9	103	2,049,467	4152		
5	120+69	8.1	6.8	6.0	5.2	4.7	3.4	2.1	101	2,036,969	3778		Weak Subgrade
5	122+70	11.7	10.5	9.3	7.7	6.6	4.1	2.5	96	500,001	3118	Del.PCC or AC Pavement	Weak Subgrade

Lane	Station	Deflection for 9000 lb Load at:							K-Value (psi/in)	PCC Modulus (psi)	Subgrade Modulus (psi)	Comment	Subgrade Comment
		0"	8"	12"	18"	24"	36"	60"					
5	124+70	6.6	5.9	5.4	4.8	4.6	3.4	2.3	83	3,720,411	3383		Weak Subgrade
5	126+70	10.6	9.2	8.4	7.4	6.7	4.7	1.9	82	500,001	3401	Det.PCC or AC Pavement	Weak Subgrade
5	128+70	39.3	27.3	21.7	15.2	11.5	5.7	2.7	75	500,001	2027	Det.PCC or AC Pavement	Weak Subgrade
5	130+69	8.3	6.9	6.2	5.3	4.9	3.7	2.5	86	3,707,666	3207		Weak Subgrade
5	132+70	10.7	7.3	6.0	4.9	4.4	3.2	1.9	119	1,989,737	4227	Det.PCC or AC Pavement	
5	148+69	15.2	8.7	7.3	5.6	4.7	2.8	1.7	150	--	4604	AC Pavement	
5	150+70	7.6	6.8	6.1	5.1	4.5	3.0	1.7	129	--	4438	AC Pavement	
5	152+75	8.1	7.0	6.2	5.1	4.3	2.7	1.5	151	--	4899	AC Pavement	
5	154+70	9.1	8.1	7.3	6.0	5.2	3.3	1.8	123	--	4011	AC Pavement	
5	155+20	8.2	7.2	6.5	5.3	4.7	3.0	1.5	137	--	4614	AC Pavement	
6	112+20	4.9	4.2	3.8	3.5	3.2	2.5	1.7	107	4,999,989	4871		
6	114+20	3.8	3.2	2.8	2.6	2.5	2.0	1.4	112	4,999,989	6133		
6	116+21	4.2	3.5	3.2	2.9	2.6	2.0	1.2	156	4,999,989	6689		
6	118+20	5.5	5.2	5.1	4.3	3.6	2.2	1.2	183	554,921	5905	Det.PCC or AC Pavement	
6	120+20	7.7	6.1	5.6	4.9	4.4	3.1	1.8	113	2,341,106	4338		
6	122+20	15.0	12.4	10.8	8.8	7.7	5.3	3.1	75	803,277	2558	Det.PCC or AC Pavement	Weak Subgrade
6	124+20	9.9	7.2	6.2	5.4	4.8	3.5	2.1	100	2,524,525	3791		Weak Subgrade
6	126+20	12.4	9.9	8.6	6.8	6.0	4.1	2.2	102	635,455	3426	Det.PCC or AC Pavement	Weak Subgrade
6	128+20	10.5	9.4	8.5	7.1	6.0	3.7	2.0	109	500,001	3598	Det.PCC or AC Pavement	Weak Subgrade
6	130+19	6.4	5.6	4.9	4.5	4.2	3.5	2.2	72	4,314,226	3596		Weak Subgrade
6	132+20	6.8	4.4	4.2	3.9	3.6	2.8	1.7	99	4,999,989	4834		Weak Subgrade
6	134+21	6.3	4.8	4.2	3.6	3.2	2.4	1.5	145	4,502,065	5453		
6	136+17	5.9	5.2	4.7	4.2	3.9	3.0	1.9	99	4,785,668	4111		Weak Subgrade
6	138+19	4.4	4.0	3.7	3.2	1.7	1.2	0.9	349	500,001	10093	Det.PCC or AC Pavement	
6	138+81	6.9	6.1	5.6	4.9	4.6	3.3	1.9	101	1,902,663	4034	Det.PCC or AC Pavement	
6	140+20	5.2	4.8	4.6	4.1	3.8	2.9	1.6	111	2,147,936	4511		
6	142+34	7.1	5.7	5.1	4.5	4.2	3.2	1.9	98	3,863,060	4093		Weak Subgrade
6	144+20	6.1	5.9	5.7	5.6	5.5	5.0	3.7	22	3,127,947	2607		Weak Subgrade

Lane	Station	Deflection for 9000 lb Load at:							K-Value (psi/in)	PCC Modulus (psi)	Subgrade Modulus (psi)	Comment	Subgrade Comment
		0"	8"	12"	18"	24"	36"	60"					
6	146+19	6.1	5.4	4.9	4.1	3.6	2.4	1.4	161	--	5447	AC Pavement	
6	148+19	6.9	6.1	5.5	4.6	4.1	2.7	1.6	141	--	4823	AC Pavement	
6	150+20	7.2	6.4	5.7	4.8	4.2	2.8	1.6	138	--	4729	AC Pavement	
6	152+20	8.7	7.5	6.6	5.3	4.5	2.8	1.6	147	--	4768	AC Pavement	
6	154+20	7.1	6.2	5.5	4.6	3.9	2.6	1.5	153	--	4971	AC Pavement	
6	155+20	7.7	6.6	5.9	4.8	4.2	2.7	1.5	150	--	4947	AC Pavement	

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

PSI
45749 Helm St.
Plymouth, Michigan
USA

DRAFT

Flexible Structural Design Module

East Stadium Boulevard
Flexible Pavement Design - 2007 ADT
City of Ann Arbor, Michigan

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	2,710,155
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	90 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	5,000 psi
Stage Construction	1
Calculated Design Structural Number	4.58 in

Simple ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	26,500
Number of Lanes in Design Direction	2
Percent of All Trucks in Design Lane	80 %
Percent Trucks in Design Direction	50 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	2 %
Average Initial Truck Factor (ESALs/truck)	1.75
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	0 %
Growth	Simple
Total Calculated Cumulative ESALs	2,710,155

Rigorous ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	26,500
Number of Lanes in Design Direction	2
Percent of All Trucks in Design Lane	80 %
Percent Trucks in Design Direction	50 %

Vehicle Class	Percent of ADT	Annual % Growth	Average Initial Truck Factor (ESALs/ Truck)	Annual % Growth in Truck Factor	Accumulated 18-kip ESALs over Performance Period
Total	-	-	-	-	-

Growth Simple

Total Calculated Cumulative ESALs - *

*Note: This value is not represented by the inputs or an error occurred in calculation.

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Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
1	HMA - MDOT 4C	0.44	1	2	2	350,000	-	2.00	0.88
2	HMA - MDOT 3C	0.44	1	2.5	-	350,000	-	2.50	1.10
3	HMA Base - MDOT 2C	0.36	1	3	-	250,000	-	3.00	1.08
4	MDOT 21AA Aggreg...	0.14	0.7	-	-	30,000	-	15.51	1.52
Total	-	-	-	-	-	-	-	23.01	4.58

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

PSI
45749 Helm St.
Plymouth, Michigan
USA

DRAFT

Flexible Structural Design Module

East Stadium Boulevard
Flexible Pavement Design - 2027 ADT
City of Ann Arbor, Michigan

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	2,999,579
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	90 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	5,000 psi
Stage Construction	1
Calculated Design Structural Number	4.65 in

Simple ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	29,330
Number of Lanes in Design Direction	2
Percent of All Trucks in Design Lane	80 %
Percent Trucks in Design Direction	50 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	2 %
Average Initial Truck Factor (ESALs/truck)	1.75
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	0 %
Growth	Simple
Total Calculated Cumulative ESALs	2,999,579

Rigorous ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	29,330
Number of Lanes in Design Direction	2
Percent of All Trucks in Design Lane	80 %
Percent Trucks in Design Direction	50 %

Vehicle Class	Percent of ADT	Annual % Growth	Average Initial Truck Factor (ESALs/ Truck)	Annual % Growth in Truck Factor	Accumulated 18-kip ESALs over Performance Period
Total	-	-	-	-	-

Growth Simple

Total Calculated Cumulative ESALs - *

*Note: This value is not represented by the inputs or an error occurred in calculation.

DRAFT

Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
1	HMA - MDOT 4C	0.44	1	2	-	350,000	-	2.00	0.88
2	HMA - MDOT 3C	0.44	1	2.5	-	350,000	-	2.50	1.10
3	HMA Base - MDOT 2C	0.36	1	3.5	-	250,000	-	3.50	1.26
4	MDOT 21AA Aggreg...	0.14	0.7	-	-	30,000	-	14.39	1.41
Total	-	-	-	-	-	-	-	22.39	4.65

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

PSI
45749 Helm St.
Plymouth, Michigan
USA

Flexible Structural Design Module

State Street
Flexible Pavement Design - 2007 ADT
City of Ann Arbor, Michigan

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	2,561,864
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	90 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	5,000 psi
Stage Construction	1
Calculated Design Structural Number	4.54 in

Simple ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	20,040
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	50 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	2 %
Average Initial Truck Factor (ESALs/truck)	1.75
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	0 %
Growth	Simple
Total Calculated Cumulative ESALs	2,561,864

Rigorous ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	20,040
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	50 %

Vehicle Class	Percent of ADT	Annual % Growth	Average Initial Truck Factor (ESALs/ Truck)	Annual % Growth in Truck Factor	Accumulated 18-kip ESALs over Performance Period
Total	-	-	-	-	-

Growth Simple

Total Calculated Cumulative ESALs - *

*Note: This value is not represented by the inputs or an error occurred in calculation.

Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
1	HMA - MDOT 4C	0.44	1	2	2	390,000	-	2.00	0.88
2	HMA - MDOT 3C	0.44	1	2.5	-	390,000	-	2.50	1.10
3	HMA Base - MDOT 2C	0.36	1	3	-	275,000	-	3.00	1.08
4	MDOT 21AA Aggreg...	0.14	0.7	-	-	30,000	-	15.10	1.48
Total	-	-	-	-	-	-	-	22.60	4.54

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Flexible Structural Design Module

State Street
Flexible Pavement design - 2027 ADT
City of Ann Arbor, Michigan

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	2,905,746
Initial Serviceability	4.5
Terminal Serviceability	2.5
Reliability Level	90 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	5,000 psi
Stage Construction	1
Calculated Design Structural Number	4.63 in

Simple ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	22,730
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	50 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	2 %
Average Initial Truck Factor (ESALs/truck)	1.75
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	0 %
Growth	Simple
Total Calculated Cumulative ESALs	2,905,746

Rigorous ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	22,730
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	50 %

Vehicle Class	Percent of ADT	Annual % Growth	Average Initial Truck Factor (ESALs/ Truck)	Annual % Growth in Truck Factor	Accumulated 18-kip ESALs over Performance Period
Total	-	-	-	-	-

Growth Simple

Total Calculated Cumulative ESALs - *

*Note: This value is not represented by the inputs or an error occurred in calculation.

Layered Thickness Design

Thickness precision Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
1	HMA - MDOT 4C	0.44	1	2	2	390,000	-	2.00	0.88
2	HMA - MDOT 3C	0.44	1	2.5	-	390,000	-	2.50	1.10
3	HMA base - MDOT 2C	0.36	1	3.5	-	275,000	-	3.50	1.26
4	MDOT 21AA Aggreg...	0.14	0.7	-	-	30,000	-	14.18	1.39
Total	-	-	-	-	-	-	-	22.18	4.63

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

PSI
45749 Helm St.
Plymouth, Michigan
USA

Rigid Structural Design Module

East Stadium Boulevard
Rigid Pavement Design - 2027 ADT
City of Ann Arbor, Michigan

Rigid Structural Design

Pavement Type	JPCP
18-kip ESALs Over Initial Performance Period	2,999,579
Initial Serviceability	4.5
Terminal Serviceability	2.5
28-day Mean PCC Modulus of Rupture	670 psi
28-day Mean Elastic Modulus of Slab	4,200,000 psi
Mean Effective k-value	138 psi/in
Reliability Level	90 %
Overall Standard Deviation	0.34
Load Transfer Coefficient, J	3.2
Overall Drainage Coefficient, Cd	1
Calculated Design Thickness	8.14 in

Effective Modulus of Subgrade Reaction

Period	Description	Roadbed Soil Resilient Modulus (psi)	Base Elastic Modulus (psi)
1	-	5,000	30,000

Base Type	MDOT 20A
Base Thickness	18 in
Depth to Bedrock	200 ft
Projected Slab Thickness	10 in
Loss of Support Category	1
Effective Modulus of Subgrade Reaction	138 psi/in

Simple ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	29,330
Number of Lanes in Design Direction	2
Percent of All Trucks in Design Lane	80 %
Percent Trucks in Design Direction	50 %

Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	2 %
Average Initial Truck Factor (ESALs/truck)	1.75
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	0 %
Growth	Simple
Total Calculated Cumulative ESALs	2,999,579

Rigorous ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	29,330
Number of Lanes in Design Direction	2
Percent of All Trucks in Design Lane	80 %
Percent Trucks in Design Direction	50 %

Vehicle Class	Percent of ADT	Annual % Growth	Average Initial Truck Factor (ESALs/ Truck)	Annual % Growth in Truck Factor	Accumulated 18-kip ESALs over Performance Period
Total	-	-	-	-	-

Growth	Simple
Total Calculated Cumulative ESALs	- *

*Note: This value is not represented by the inputs or an error occurred in calculation.

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

PSI
45749 Helm St.
Plymouth, Michigan
USA

Rigid Structural Design Module

East Stadium Boulevard
Rigid Pavement design - 2007 ADT
City of Ann Arbor, Michigan

Rigid Structural Design

Pavement Type	JPCP
18-kip ESALs Over Initial Performance Period	2,710,155
Initial Serviceability	4.5
Terminal Serviceability	2.5
28-day Mean PCC Modulus of Rupture	670 psi
28-day Mean Elastic Modulus of Slab	4,200,000 psi
Mean Effective k-value	138 psi/in
Reliability Level	90 %
Overall Standard Deviation	0.34
Load Transfer Coefficient, J	3.2
Overall Drainage Coefficient, Cd	1
Calculated Design Thickness	8.01 in

Effective Modulus of Subgrade Reaction

Period	Description	Roadbed Soil Resilient Modulus (psi)	Base Elastic Modulus (psi)
1	-	5,000	30,000

Base Type	MDOT 20A
Base Thickness	18 in
Depth to Bedrock	200 ft
Projected Slab Thickness	10 in
Loss of Support Category	1
Effective Modulus of Subgrade Reaction	138 psi/in

Simple ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	26,500
Number of Lanes in Design Direction	2
Percent of All Trucks in Design Lane	80 %
Percent Trucks in Design Direction	50 %

Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	2 %
Average Initial Truck Factor (ESALs/truck)	1.75
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	0 %
Growth	Simple
Total Calculated Cumulative ESALs	2,710,155

Rigorous ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	26,500
Number of Lanes in Design Direction	2
Percent of All Trucks in Design Lane	80 %
Percent Trucks in Design Direction	50 %

Vehicle Class	Percent of ADT	Annual % Growth	Average Initial Truck Factor (ESALs/ Truck)	Annual % Growth in Truck Factor	Accumulated 18-kip ESALs over Performance Period
Total	-	-	-	-	-

Growth	Simple
Total Calculated Cumulative ESALs	- *

*Note: This value is not represented by the inputs or an error occurred in calculation.

psi

City of Ann Arbor
Stormwater Model Calibration and Analysis Project

Final Report

June 1, 2015

CDM Smith

Contents

Appendices

Figures

Tables

1. Executive Summary

The stormwater model calibration and analysis project (SWM project) began in July 2012 with an expected 2.5 - 3 year timeline. Preliminary model calibration was performed in 2012 using available data sources, additional calibration data was collected in 2013, and final model calibration and analysis using the collected information was completed in 2014. Project documentation, including this report, was finalized in early 2015.

A. Purpose:

The overall goal of the SWM project was to develop the computer model as a stormwater analysis tool for the entire City of Ann Arbor drainage system and to provide answers to the City's current stormwater system management questions. Specifically, the project developed to address the following objectives:

- Provide an accurate stormwater model of the entire City of Ann Arbor conveyance system, calibrated and validated using collected flow and rainfall data
- Involve stakeholders and interested citizens in the project to build awareness of the stormwater collection system and assist with the collection of stormwater system information for large rainfall events.
- Analyze existing stormwater system performance to determine the current level of service provided to the residents of the City of Ann Arbor and to recommend improvements to the stormwater system.
- Evaluate the effectiveness of potential stormwater management strategies to determine the return on these investments.
- Utilize the results of the updated model to provide a comparison point for the existing FEMA Flood Insurance Rate Map (FIRM) 100-year floodplain delineation.
- Implement a modeling strategy that will allow for flexibility to address climate change and other future changes with the stormwater system or with stormwater management policies.

B. Model Configuration:

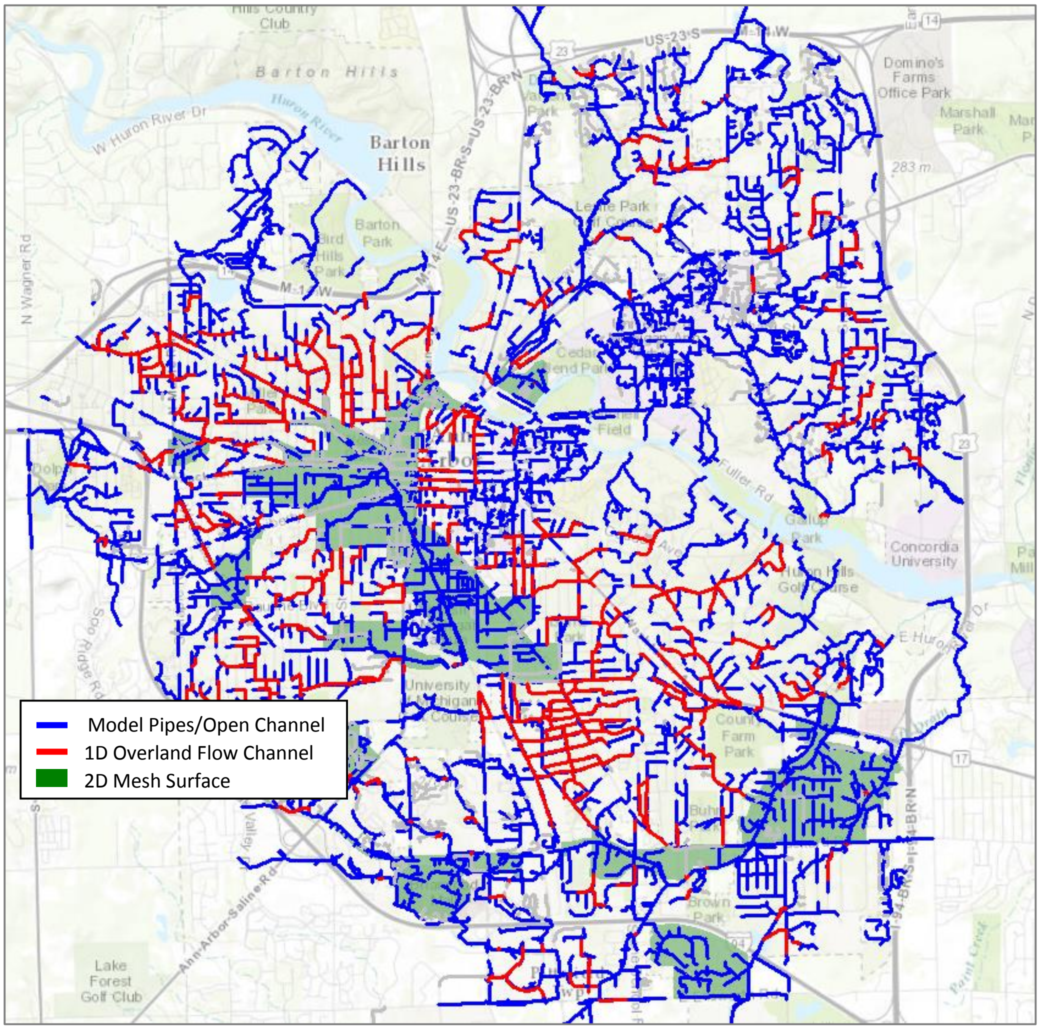
To accomplish these objectives, the stormwater model needed to include stormwater conveyance items beyond just stormwater pipes and open channels. The elements included in the analysis are presented in **Figure 1-1** on the next page, and described below:

- Catchment Areas – A detailed analysis of the areas tributary to the stormwater system inlets was performed in a previous phase of stormwater model development. These catchment areas and inlet locations were updated based on the stormwater data collection and analysis activities.
- Conveyance System – The stormwater computer model was developed using the available information collected in a previous phase of stormwater model development for stormwater inlets, pipes, manholes, open channels, 300 existing stormwater basins, and outfalls. The engineering characteristics of these elements including sizes, slopes, and material of construction were incorporated into the model setup to allow the stormwater conveyance through this network.
- Street Conveyance – Since the stormwater model was intended for simulation work for large events, it explicitly incorporated the street system as conveyance elements where this takes

place in the system. This provided an accurate representation of the movement of water throughout the City of Ann Arbor.

- Surface Storage/Conveyance – For more detailed simulations of the movement and extent of stored water, the surface storage and conveyance system in areas where stormwater was known to accumulate was explicitly incorporated into the stormwater model.

Figure 1-1 – Stormwater System Components



C. Major Project Outcomes:

The primary outcome of the SWM project is the delivery of the calibrated stormwater model itself. The City's investment in this project has allowed for the development of a tool for municipal stormwater management that is highly complex and refined. The model is capable of providing valuable information for various applications, from green infrastructure planning and stormwater system design, to floodplain analysis and emergency management. Output from the model for each of these applications can be relied upon confidently as the best information available. Most critically, the model can continue to be utilized easily and efficiently by the City to help optimize the allocation of stormwater utility funding.

Following are the major findings that developed from the stormwater analysis work:

- Majority of City Meets the Design Standard Level of Service – The analysis work has determined that the stormwater conveyance system is, in general, performing at a consistent design level of service for most areas of the City. The current stormwater system design standard for the City of Ann Arbor is the 10% annual exceedance probability (AEP), 12-hour storm. This storm is 2.9" of rainfall using NOAA Atlas 14 rainfall volumes. However, in the Allen Creek watershed and in the Malletts Creek watershed, there are areas where surface flooding is predicted during the 10% AEP storm and in some cases during the 20% AEP storm. It is important to note that design storm standards have increased periodically so that much of the City's stormwater system was designed and built to handle a smaller storm as compared to the current 10% AEP storm.
- Recommended Improvements Developed to Address Level of Service Concerns – To address these limitations in the level of service in these locations, a total of 16 study areas were evaluated for potential stormwater system improvements and these improvements were presented in a series of public meetings in November, 2014. The recommended improvements will be considered as part of the City's CIP Programming process. The total estimated capital cost of the recommended stormwater improvements was determined to be approximately $34 million in year 2017 dollars. These recommended improvements do not include the cost of long-term stormwater management strategies that were recommended specifically for the Allen Creek watershed, which are estimated to be another $80 million to $120 million.
- Green Streets and Rain Garden Policies Yield Expected Stormwater Benefits – The evaluation of stormwater management strategies under future implementation timelines indicated that the City should continue with incorporating the Green Streets Policy with street redesign projects and promoting the residential rain garden programs. There should also be significant efforts put into encouraging compliance with new development standards during redevelopment of commercial, multi-family, and school or University properties.
- FEMA Floodplain Comparison Developed – A floodplain delineation was performed using flow and water level data generated by the new InfoSWMM model for the 1% annual exceedance probability (AEP) storm. Using NOAA Atlas 14 rainfall volumes, this storm is a 5.11" rain event over 24 hours. The 1% AEP floodplain delineation generated using the newer data was compared with the existing FEMA Flood Insurance Rate Map (FIRM) floodplain contours.
- Project Documentation will Allow Continued Stormwater Analysis – Project documentation is being provided to the City, including archives of project files and model files. Training sessions and written procedures for model updates and storm scenario updates have been prepared that will allow City staff to continue to utilize the stormwater model as a system management tool.

2. Project Structure

This project is the second element of the stormwater system management program which the City of Ann Arbor (City) has implemented as follows:

- Stormwater GIS and Model Project (SGM); 2006-2009: This project included review of as-built drawings for stormwater system facilities, creation of a provisional geographic information system (GIS), collection of flow and rainfall data for large tributary areas, and conversion of the GIS to an InfoSWMM base hydraulic model. InfoSWMM is the hydraulic modeling software that was selected by the City of Ann Arbor to integrate modeling activities with the ArcGIS software which is used to manage the utility information. InfoSWMM software is constructed around the Environmental Protection Agency Stormwater Management Model (EPA SWMM) dynamic rainfall-runoff model.

- Stormwater Model Calibration and Analysis Project (SWM); 2012-2015: This project included two phases, with the first focused on calibration, and the second focused on analysis.
    - Phase I – Preliminary calibration, data collection, final calibration of the stormwater model
    - Phase II – Use of the calibrated model to perform an analysis of the level of services, review of the stormwater improvements needed to meet the level of service desired, and modeling to allow a comparison of the floodplain defined by the separate FEMA model analysis

This purpose of this report is to serve as a single source of project information, with a primary focus on the Phase II analysis, results, and recommendations.

Individual task summaries developed for the SWM project are provided as a reference, and directions to obtain more detailed versions of project documentation and output are included.

A. Task 1 – Phase I Public Engagement

The objective of this task was to understand the community issues and concerns with the management of stormwater that should be addressed throughout the project. It was also intended to gain an understanding of the specific stormwater-related questions and concerns in different sections of the city to help focus the modeling in these areas.

Work on Task 1 included development of a public engagement strategy, management of the City's project website, and the development of a stormwater advisory group (SWAG), which helped to plan and implement the public engagement strategy. The primary public engagement work item in Phase I was a series of seven public meetings held throughout the City during 2013 to gather information about experiences of the residents in these different areas with stormwater and their expectations for the City's stormwater management programs. This information was also obtained via a community-wide online stormwater survey that ran in parallel with the public outreach work. The Phase I public engagement effort was summarized in a Phase I Technical Memorandum, which can be found as part of the project file archive.

Another aspect of the Task 1 work was initial engagement with the City's Technical Oversight and Advisory Group (TOAG) for wet-weather projects. At interim steps during the project, City staff and/or CDM Smith staff presented project updates. Formal project presentations were made to the TOAG on March 20, 2014 at the end of final model calibration and on December 11, 2014, following the public meeting presentations. The TOAG group will also be assisting with review of the final project report in spring 2015.

B. Task 2 – Preliminary Model Calibration and Validation

The objective of this task was to utilize the stormwater model assembled under the prior project and utilize previously collected rainfall, flow, and level data to perform a preliminary calibration of the stormwater model. This version of the model was also validated using independent storm events to evaluate the stormwater model performance and to generate recommendations for model improvements.

During this task, model updates were made to incorporate recent changes in infrastructure or hydrology. A field verification task was utilized to perform additional field investigation to verify key topographic or hydraulic elevations. The model was also updated to account for physical inlet restrictions and for sump pump flows generated by the Footing Drain Disconnect (FDD) Program.

A preliminary model calibration effort was performed using stormwater flow and level data collected during the 2007 Stormwater GIS and Model (SGM) project. The 2007 data set was supplemented with records from long term USGS gauges located at the outlets of Allen Creek and Malletts Creek. Model simulation output was compared to the flow data, and the model parameters were iteratively adjusted to align model performance to be reflective of the measured data. Validation storms were used to evaluate model performance after calibration, which helped to understand locations where additional flow and rainfall data would be helpful to prepare a better model.

The preliminary calibration task was summarized in a preliminary calibration technical memorandum, which was provided to the City of Ann Arbor in 2013. The preliminary calibration report concluded that additional data collection and calibration should be performed for the following reasons:

- The dormant season model calibration was limited due by the lack of dormant season calibration events. Additional soil parameter calibration was needed to improve dormant season calibration.
- Provide additional support for upstream boundary conditions for locations where stormwater flows enter the City. The City's stormwater system does not extend into these areas but the stormwater behavior in these areas directly affects the City system and must be included in the model. These selected locations included Traver Creek at M-14 and Malletts Creek at I-94.
- Collect data for better model refinement in selected study locations. Since the 2007 data collection effort, large storms had highlighted collection system performance and level of service concerns in Malletts Creek and along lower Allen Creek. Additional monitoring of major branches of these creeksheds was recommended.
- Improve calibration and validation to meet percent difference goals of 15% on volume and 20% on peak flow, when comparing model-predicted values to monitored values.

C. Task 3 – Data Collection

The objectives of Task 3 were to develop a monitoring plan to collect additional flow and rainfall data and implement the monitoring plan at the selected locations.

Along with the three USGS stream gauges at the Allen Creek mouth, Doyle Park and the Malletts Creek mouth, a total of 15 temporary flow monitors were installed throughout the City and used to monitor system performance between March and November 2013 to support final model calibration efforts. **Figure 2-1** and **Table 2-1** show the location of these monitors and their tributary areas.

Figure 2-1 – 2013 Flow Monitor Locations and Tributary Areas

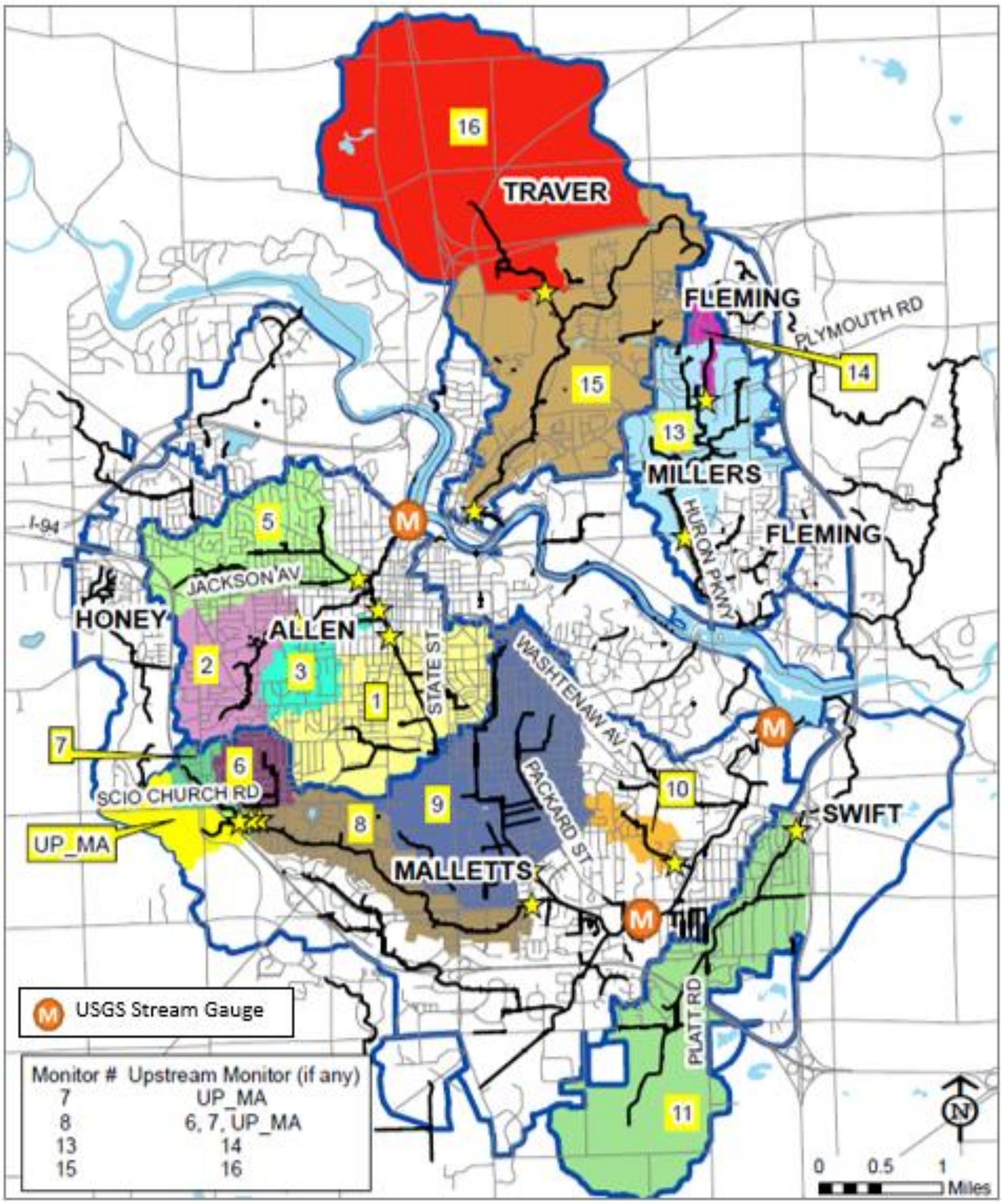


Table 2-1 – Flow Monitor Tributary Area Characteristics

Watershed	Site #	Area (acre)	Impervious %	Structure ID	Notes	Dates Installed (all 2013)
Allen	1*	1,003	55	92-61836	Upstream 30% of Allen Creek tributary area (south) In FEMA floodplain	3/29 – 11/26
Allen	2*	557	48	92-60256	Murray-Washington Drain	3/29 – 11/26
Allen	3	244	41	92-60016	Eberwhite Drain 2007 Monitor Site #3	3/29 – 11/26
Allen	4	Number not used				
Allen	5*	812	42	92-063256	Immediate downstream of 2007 Monitor Site #2. Monitor both branches west of West Park	3/29 – 6/22, 7/10 – 11/26
Malletts	6*	222	45	92-52016	2007 Monitor Site #6 Upstream of Lansdowne area	4/10 – 11/26
Malletts	7*	392	33	92-52033	Upstream of Lansdowne area (west of I-94)	4/10 – 11/26
Malletts	8*	1,283	42	92-51565	Lansdowne + Eisenhower	3/29 – 11/26
Malletts	9*	1,459	45	92-50565	Portion of Malletts Creek tributary area with no in-line detention ponds	4/12 – 11/26
Malletts	10*	152	31	92-50865	2007 Monitor Site #10	4/10 – 11/26
Malletts	UP_MA*	228	30	92-52034	For Upper Malletts Creek project Township area bounded by I-94, Oak Valley Blvd, AA District Library and Scio Church Rd	5/10 – 11/26
Swift Run	11*	1,631	18	91-51339	Swift Run before exiting Ann Arbor (level-only gauge)	4/30 – 6/23, 7/25 – 11/26
Swift Run	12	Number not used				
Millers	13	969	38	91-51591	Downstream monitoring	4/12 – 11/26

Watershed	Site #	Area (acre)	Impervious %	Structure ID	Notes	Dates Installed (all 2013)
Traver	14	90	40	92-54857	Georgetown area	3/29 – 11/26
	15*	4,466	13	91-50318	Flow meter at the box culvert immediate downstream of HRWC level gauge	4/10 – 11/26
	16*	2,648	5	91-50193	Monitor runoff response from rural areas outside Ann Arbor	

***** Located in County Drain

For each location the area, imperviousness, structure identification number, and various comments are provided in the table. Except for the Swift Run site where only a level probe was installed, Teledyne ISCO 2150 area-velocity flow modules were deployed to measure level, velocity and flows at each site. Data were downloaded on-site and reviewed on a monthly basis. The collected information was corrected when data quality was deemed poor. Typically this was due to velocity sensor errors, but level data were generally available and consistent. Calculations based on the Manning's equation (see below) and stage-discharge relationships were developed for most of the sites to allow for correction of flow data using level only.

Figure 2-2 – Conceptual Description of Manning's Equation

$$Q = \frac{Cn}{n} AR^{2/3} S_f^{1/2}$$

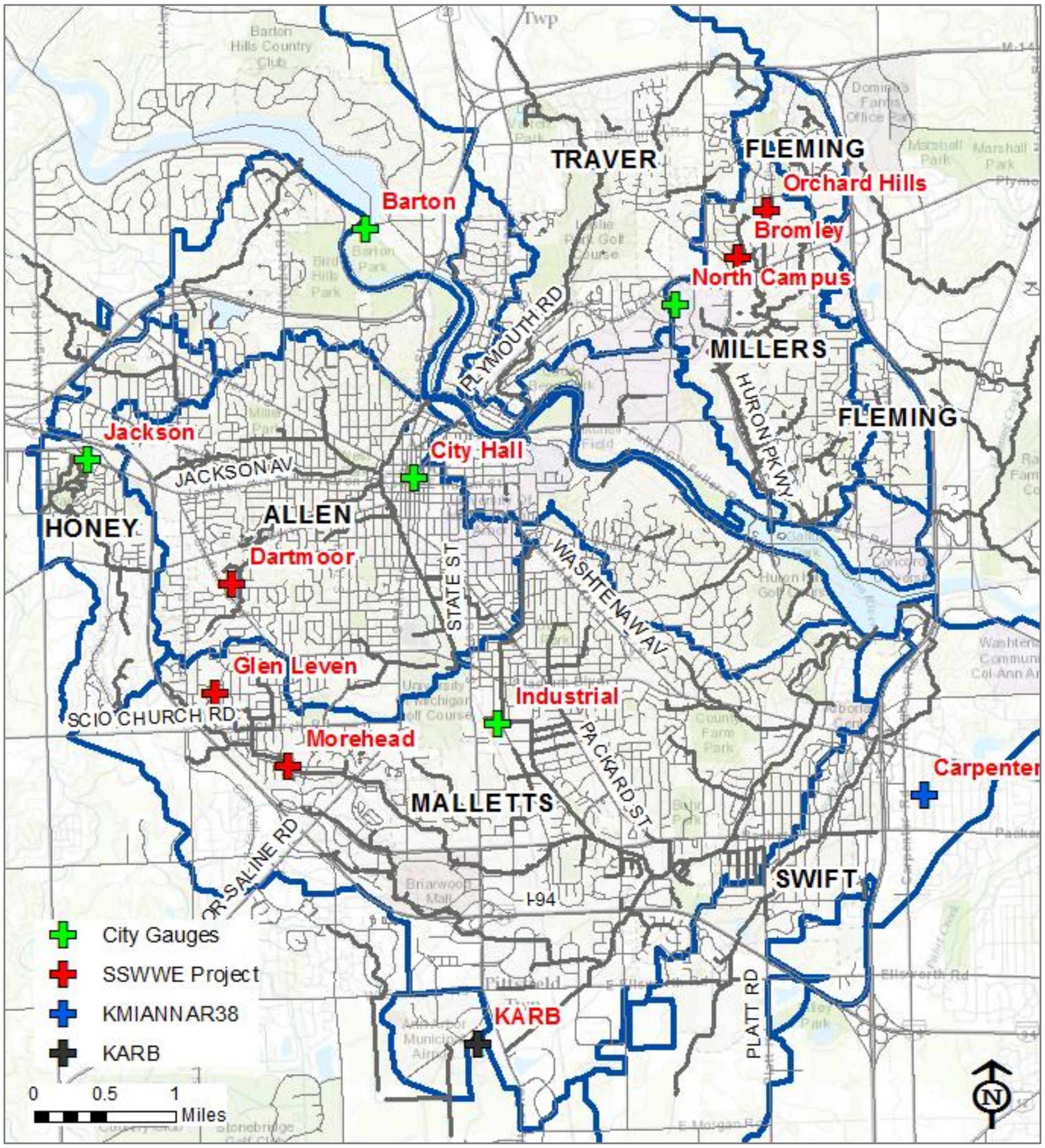
Q = Flowrate
$AR^{2/3}$ = Conveyance (depth, channel shape)
S_f = Energy Slope

Data from 12 ground-based rain gauges from different sources were collected to support the model calibration efforts. New rain gauges were installed at North Campus and at City Hall as part of this project. The gauges used during calibration included the following locations:

- Permanent City-maintained rain gauges: Barton Dam, Jackson Road, South Industrial, North Campus, City Hall
- Temporary rain gauges installed for the Sanitary Sewer Wet Weather Evaluation Project: Glen Leven, Morehead, Bromley, Dartmoor, Orchard Hills
- Rain gauges from National Oceanic and Atmospheric Administration (NOAA) / National Weather Service (NWS): KARB (located at Ann Arbor Airport)
- Carpenter Elementary School gauge (KMIANNAR38) available on Weather Underground

Figure 2-2 shows the location of rain gauges. These gauges were used to calibrate radar rainfall data and compute rainfall volume for each model subcatchment. Issues with the power supply and with gauge operation were frequently noted for the South Industrial gauge during the data collection period. As a result, this site was not used for analysis for some of the calibration and validation events. The South Industrial gauge was later relocated as part of this project and the power supply issues have also been resolved.

Figure 2-3 – Rain Gauges for Final Model Calibration



To supplement the flow and rainfall data, a program was established to gather observational data of surface flooding and other stormwater behavior at targeted sites throughout the City. With input from City staff and neighborhood groups, a total of 42 locations were identified for Large Event Data

Gathering (LEDG). The data collection plan for these sites (shown in **Figure 2-3**) consisted of two components:

- Storm corps observations – Citizen volunteers worked with established observation sites to document the extent of flooding during large rain events. Photographs and visual observations were also collected.
- Crest-stage gauges - Crest-stage gauges were installed at locations around the City of Ann Arbor watersheds to understand the runoff response and extent of flooding during intense storm events. These gauges recorded maximum water levels for large events.

Figure 2-4 – Large Event Data Gathering Sites

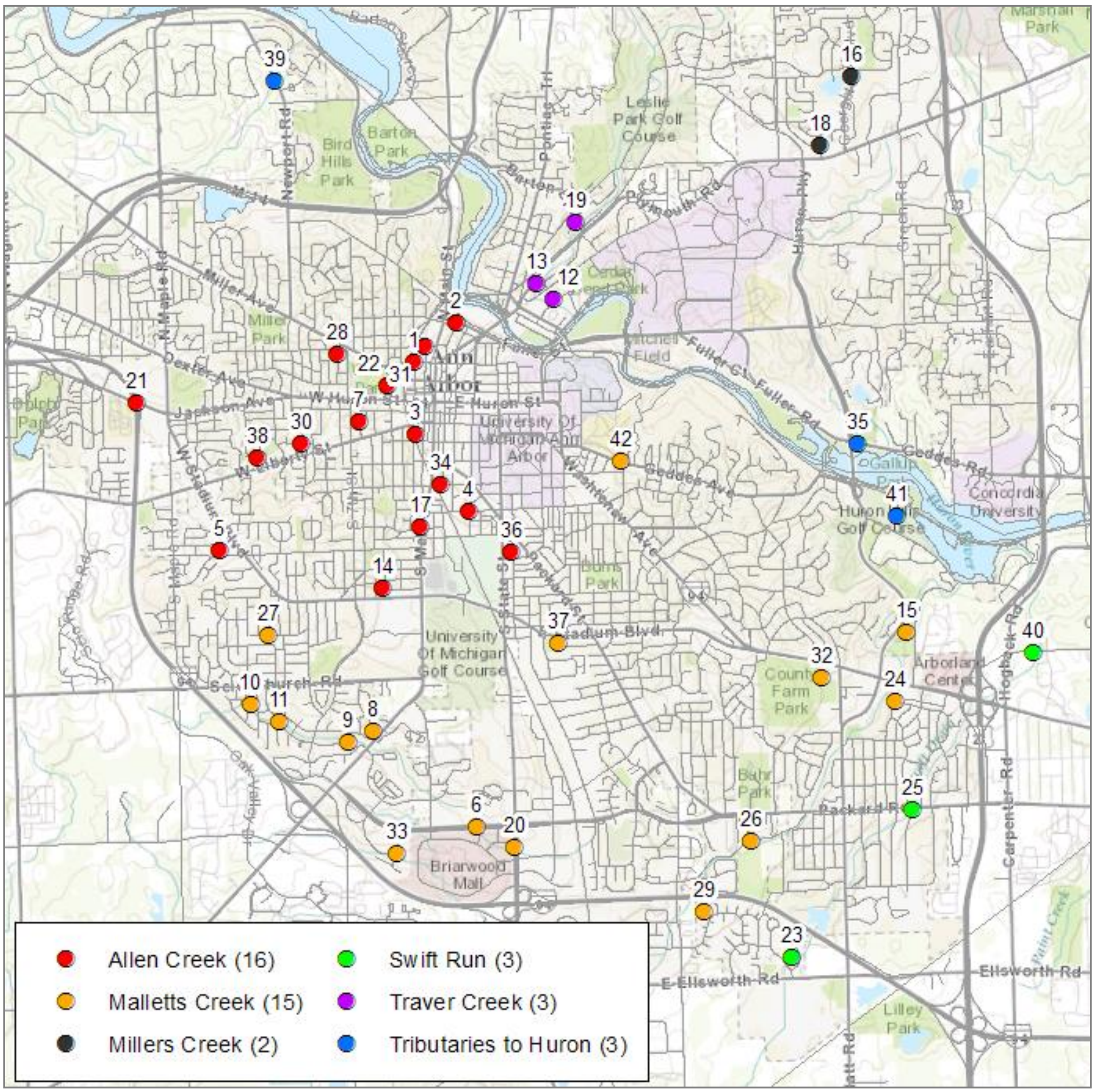


Table 2-2 shows a list of site IDs and locations for the LEDG sites. The majority of the sites were located in the Allen and Malletts Creek watersheds (16 and 15 respectively). Frequent street flooding was

reported at these sites during intense storm events in the past and the locations were refined using citizen reports gathered at neighborhood stormwater meetings in January through March of 2013.

Table 2-2 – List of Large Event Data Gathering Sites

Allen Creek		**Malletts Creek**	
ID	Location	ID	Location
1	1st and Kingsley	6	Eisenhower and Plaza Dr
2	Depot/4th/Summit	8	2295 Chaucer Ct
3	First and William	9	1115 Morehead Ct
4	Hill and Division	10	Churchill/Wiltshire Intersection
5	Park Place Apartments	11	2279 Mershon
7	306 Mulholland	15	Brentwood Sq.
14	Edgewood and Snyder	20	State and Mall Dr
17	Davis and S Main	24	Parkwood and Fernwood
21	I-94 and Jackson	26	Doyle Park dam
22	West Park	27	Avondale and Catalina
28	504 Maple Ridge (south of Arborview)	29	Englewood and Manitou
30	Bemidji and Montgomery	32	Meri Lou Murray Recreation Center
31	Felch/N. Ashley intersection	33	Signature and Waymarket
34	Madison and 4th (Fingerle)	37	Iroquois south of Stadium
36	1128 White St	42	Geddes and Linden
38	Behind Glendale Circle (west of Virginia Park)		
Millers Creek		**Swift Run**	
ID	Location	ID	Location
16	2369 Georgetown (south of Bluett)	23	University Townhouses
18	Prairie and Briarcliff	25	Packard and Pittsfield
		40	Swift Run at Clark Rd
Traver Creek		**Tributary to Huron River**	
ID	Location	ID	Location
12	Traver Creek at Nielsen Ct	35	Geddes/Fuller/Huron Pkwy
13	Plymouth Park adjacent to Manna Market	39	Newport Creek at Newport Rd
19	Traver Creek at Barton Dr	41	Huron Hills Golf Course

LEDG data was used during calibration to validate flooding predictions. It was also used during the existing conditions modeling to assist in the delineation of localized flooding areas.

Data collected from rainfall and flow monitoring, as well as from the LEDG program, has been provided to the City as part of the final data files for the project.

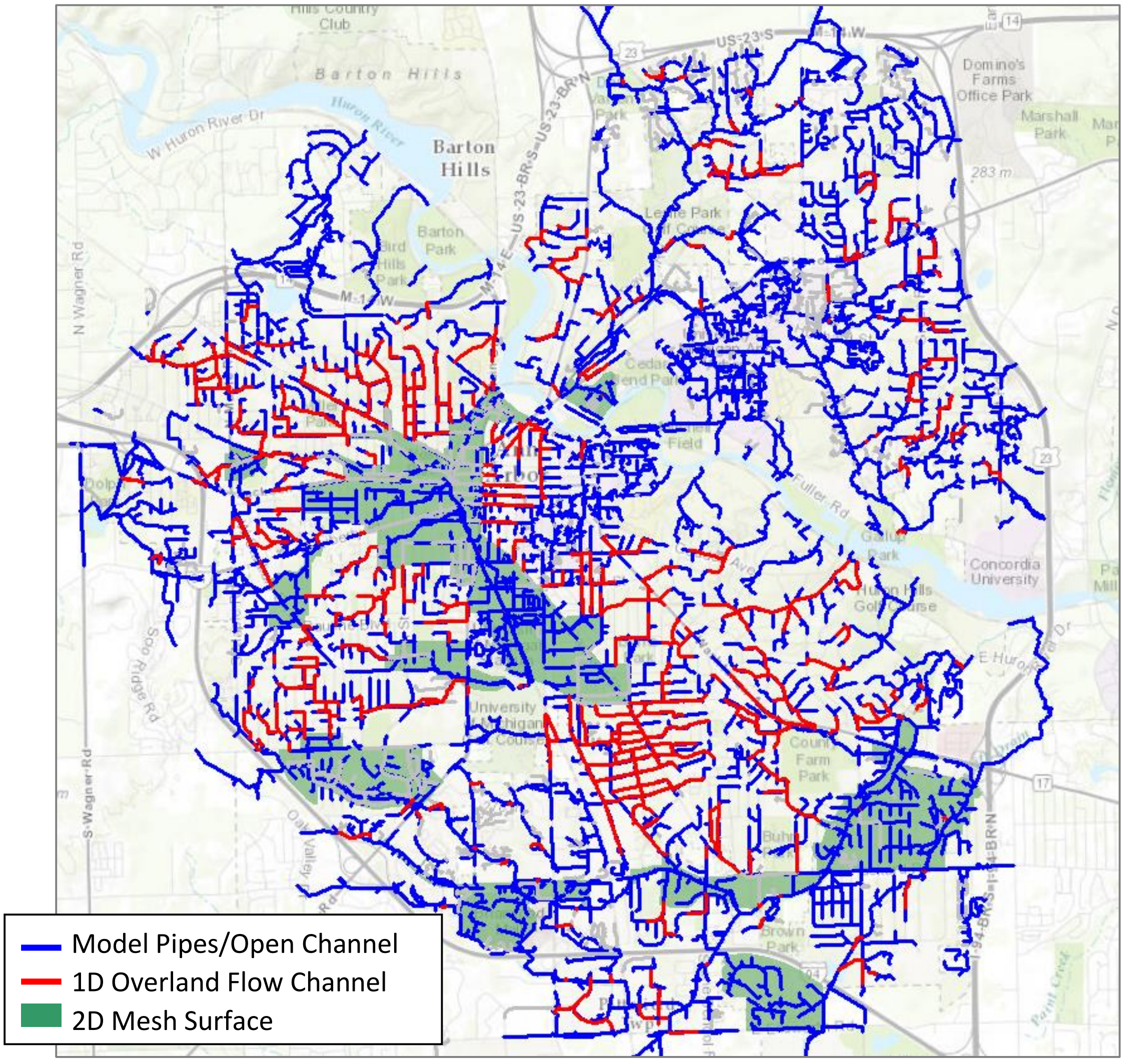
D. Task 4 – Final Model Calibration and Validation

The objective of Task 4 was to utilize the preliminary calibrated model and newly collected flow and rainfall data to provide final model calibration and validation.

Prior to final calibration, the model hydrology and hydraulics were updated to 2013 conditions. Significant changes are described as follows:

- New or modified stormwater facilities were included for West Park, County Farm Park, and for the Traver Creek improvements in Leslie Park Golf Course.
- FDD flows were added to the model and represented as Rainfall Dependent Inflow/Infiltration (RDII) hydrographs. This allowed for analysis of different FDD Program scenarios without having to manually adjust hydrologic parameters. The FDD scenario evaluations were presented in an FDD Flows Technical Memorandum, dated November 20, 2013. This tech memo can be found in the final project documentation.
- 1D and 2D overland flow channels were also incorporated into the model for calibration. 1D refers to one-dimensional modeling, where overland flow is represented by a secondary model link between the two manholes. In 2D, or two-dimensional modeling, overland flows is represented by surface polygons that are based on elevation contour data. **Figure 2-4** shows the areas with 1D and 2D overland flow surfaces. The 2D surface occupies more than 10% of the model area, mostly located within Federal Emergency Management Agency (FEMA) 100-year floodplain and flood-prone areas.

Figure 2-5 – Model Overland Flow Channels and 2D Surface Locations



In general, the model updates were made to align the model framework with the actual system conditions present during the 2013 monitoring period.

Final calibration was performed to refine and improve the model parameters established in preliminary calibration. The detailed process and results of calibration are presented in Section 3 of this report, and in the Final Calibration Report.

E. Task 5 – Phase I Documentation

The objective of Task 5 was to provide comprehensive documentation of the model update and calibration processes for future reference. This was accomplished primarily in the delivery of the project model, which includes all calibration scenarios as part of the InfoSWMM scenario manager.

This task also included delivery of an archive of project data files and documentation, including the flow and rainfall data, GIS data files generated throughout the project, and other administrative documentation.

Phase I work was summarized in the final calibration report, which can be found in the project data file archive.

F. Task 6 – Procedures

The objective of Task 6 was to provide written support to City of Ann Arbor staff that will routinely use or update the model with new stormwater management features, infrastructure changes, or with new design storm information.

The model procedures were developed in conjunction with the model training sessions described in Task 7. These written procedure documents cover the steps needed to incorporate new BMPs or other stormwater improvements into the model. A separate procedure document was created to explain storm update procedures, which could be used to modify design storm information or to create a new storm scenario altogether.

G. Task 7 – Training

The objective of Task 7 was to develop training materials and provide both general and detailed training for the newly developed modeling tools. Detailed training sessions were held on March 2-3, 2015 with City staff who will be the primary model users. General training to explain the model development and model applications was held on March 24, 2015. The training presentations were included as handouts in each session and copies are also included in the project file archives.

H. Task 8 – Phase II Public Engagement

The objective of Task 8 was to continue the information sharing and public education processes that were established in Phase I, while adding new activities to disseminate project results and recommendations.

Three public meetings were held in November 2014, with dates and times selected to enable maximum community participation:

- Wednesday, November 5 – 6:30 p.m. — Ann Arbor District Library – Downtown
- Thursday, November 6 – 10:00 a.m. — Ann Arbor District Library – Downtown
- Sunday, November 9 – 2:30 p.m. — Ann Arbor District Library – Malletts Creek

The purpose of these meetings was to share the project's findings, including proposed recommendations and the rationale behind each. Meeting attendees were invited to indicate their level of interest among all the geographic areas in which recommended system improvements were proposed, in order to properly prioritize the contents of the presentation.

The other new public engagement activity in Phase II was the development of a stormwater video that would help to draw attention to the project and to stormwater management issues facing the City of Ann Arbor. The stormwater video entered production in March 2015 and will be released near the end of the project schedule.

I. Task 9 – Model Analysis and Recommendations

The objective of Task 9 was to utilize the final calibrated model to evaluate the performance of the stormwater drainage system throughout the City of Ann Arbor and to identify and analyze proposed improvements.

The basis for evaluating the existing conditions performance of the stormwater system performance was a series of design storm scenarios, that include different volumes and rainfall distributions based on the annual exceedance probability (AEP) standards established in NOAA Atlas 14. A range of storms was analyzed from 100% AEP to 0.2% AEP. In general, the 10% AEP, 12-hour duration storm and the 20% AEP, 1-hour duration storm were used to evaluate the level of service being provided by the stormwater system. The 10% AEP storm is the current stormwater design standard, but most areas of the City were constructed to a smaller storm recurrence standard and at a time when the storm volumes associated with the standards were smaller. Analysis of the 20% storm allowed for identification of areas that would first begin to have capacity problems as the storm size increases.

Locations were identified where the current pipe capacity cannot convey the flows generated by these storms, and where surface flooding occurs as a result of the capacity shortfall. A list of study locations was developed and potential stormwater improvement alternatives were considered for each location. These included alternatives for stormwater Best Management Practices (BMPs), local and regional stormwater storage, and conveyance improvements.

The calibrated model was also used to analyze stormwater management impacts. For future condition scenarios, the model was used to predict the impacts of broad stormwater management initiatives, such as residential rain gardens, commercial property redevelopment, and the City's Green Streets program for stormwater management in right-of-way (ROW) areas.

Details on the model analysis work and stormwater improvement recommendations are included in Sections 4 and 5 of this report.

J. Task 10 – Verify FEMA Mapping

The objective of Task 10 was to compare the calibrated model results to existing FEMA Flood Insurance Rate Map (FIRM) flood mapping to provide the City with an additional source of flood level data that could be used for future floodplain analysis and management.

The InfoSWMM model was used with a 1% AEP, 24-hour storm, and peak flows and peak water surface elevation (WSEL) data were generated. The water surface elevations from the model were then used to delineate floodplain contours using the latest Light Detection and Ranging (LiDAR)-based topographic data and differences between the model-based contours and the FEMA FIRM floodplain contours were compiled. The comparison data was provided to the City of Ann Arbor to support future floodplain management decisions.

K. Task 11 – Documentation

Final documentation for the project includes this final report, along with project model files and data files generated during Phase II activities.

3. Stormwater Modeling

A. Model background and calibration

Preliminary calibration of the stormwater model was performed using available flow monitoring data collected by CDM Smith as part of the Stormwater GIS and Model development (SGM) project. The SGM flow data from 2007 was supplemented with United States Geologic Service (USGS) flow data from long term flow gauges. In total, nine (9) storm events from May 2007 to March 2012 were selected for the preliminary calibration effort. It was found that during the growth-season events, model results were generally within 15% of volumes and 20% of peak flows observed at the monitors and USGS gauges.

A percent difference of 15% for volume and of 20% for peak flows were the initial targets used by CDM Smith to evaluate the effectiveness of calibration, based on experience with other stormwater models of similar size and level detail. The model was validated using three (3) storm events from 2007 and was generally within 20% of volumes for monitored flows. The peak flow comparison was also within 20% for most meter areas, but there were some areas with wider variability (in the range of 50% difference) between model-predicted and monitor-observed flows.

The preliminary calibration report concluded that additional data collection and calibration should be performed for the following reasons:

- The dormant season model calibration was limited due by the lack of dormant season calibration events. Additional soil parameter calibration will be needed to improve dormant season calibration.
- Provide additional support for upstream boundary conditions for locations where stormwater flows enter the City. These include Traver Creek at M-14 and Malletts Creek at I-94
- Collect data for better model refinement in expected study locations. Since the 2007 data collection effort, large storms have highlighted collection system performance and level of service concerns in Malletts Creek and along lower Allen Creek. Additional monitoring of major branches of these creeksheds was recommended.
- Improve calibration and validation to meet percent difference goals of 15% on volume and 20% on peak flow, when comparing model-predicted values to monitored values.

The preliminary calibration report, submitted in 2013, included the conclusions above and recommended additional flow and rainfall monitoring in 2013 to be used for a final model calibration. Final calibration and validation were performed in early 2014, using the flow and rainfall data collected during 2013.

i. Storm Events for Calibration

Unlike 2007, the monitoring period between March and November 2013 yielded a few large events that significantly tested the performance of the storm drainage system. That includes the June 27th 2013 event that caused surface flooding in parts of the Allen Creek and Malletts Creek watersheds. A total of seven 2013 storm events of various volumes were selected for calibration (**Table 3-1**).

Table 3-1 – Summary of Calibration and Validation Events

#	Date	Precip Total (in)	Sources	Season
1	6/27/2013	1.1 – 3.0	calibrated radar rain data	growth
2	8/12/2013	1.7 – 2.9	calibrated radar rain data	growth
3	10/31/2013	1.5 – 1.9	calibrated radar rain data	growth*
4	6/13/2013	1.3 – 1.8	calibrated radar rain data	growth
5	4/17/2013	1.3 – 1.6	ground gauges	dormant/growth transition
6	7/9/2013	0.1 – 1.2	ground gauges	growth
7	8/27/2013	0.3 – 0.6	ground gauges	growth

* This low-intensity long-duration event was observed to behave like growth season event after calibration

The total precipitation (measured at individual gauges) of these events ranged from 0.1 inches to 3.0 inches. 5-minute calibrated radar rainfall data in 1km x 1km resolution were purchased from Vieux Inc. for the four largest events. For the other events, precipitation at each subcatchment was computed with ground gauge records with inverse-distance-weighted interpolation, which assigns precipitation to each subcatchment using a weighted calculation based on the nearest ground gauges.

ii. Calibration Methods

The model calibration was performed using an iterative approach by refining the following model parameters to match model-simulated hydrographs with flow monitoring data:

- Green-Ampt infiltration parameters
- Percent of runoff routed from impervious to pervious surface (related to % of directly-connected impervious surface)
- Subcatchment width (overland flow length)
- Manning's n (roughness coefficient) for impervious and pervious surface
- Depression storage for impervious and pervious surface (negligible on larger storms)

Due to the model's large scale, the calibration first started by matching flow hydrographs at downstream gauges (USGS stream gauges at Allen Creek, Doyle Park and Malletts Creek mouth, Swift Run (#11), Millers Creek (#13) and Traver Creek (#15)). This first calibration step was then followed by matching the flow hydrographs for the upstream temporary monitors. In addition, there was an emphasis placed on matching flow hydrographs for the larger storms rather than the smaller storms.

iii. Calibrated Model Parameters

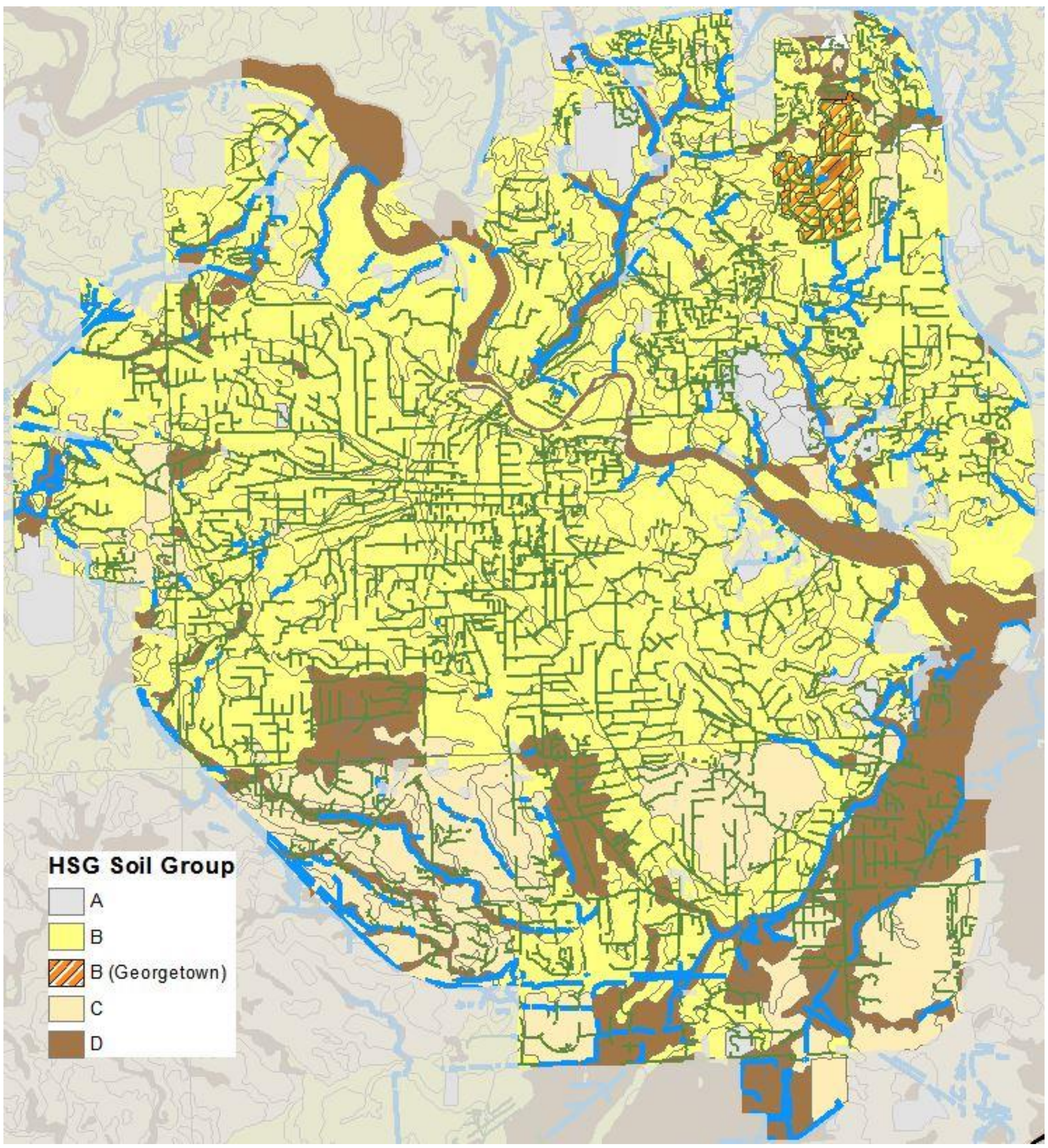
During the final round of model calibration, model parameters were fine-tuned to reflect the new hydrologic conditions as discussed below:

<u>*Soil Parameters*</u>

The soil parameters in the model affect the amount of rainfall that is predicted to infiltrate into the ground. Originally, four different soil types were set up in model setting based on the Hydrologic Soil Group (HSG) Soil Group (A, B, C and D). After going through the iterative calibration process and upon further review of the United States Department of Agriculture (USDA) Soil Map and potential soil infiltration rates, an additional soil parameter group (B1) was added. The monitor #14 (Georgetown) area has primarily type B soil according to the USDA Soils Map, but the model continued to over-estimate runoff peak and volume. A better match was obtained when the B1 soil parameter was used, which included increasing the soil infiltration rate from 1 in/hr to 1.8 in/hr.

The Malletts Creek area upstream of the Mary Beth Doyle Park pond is primarily of type C soil, but the USDA Soil Map showed that the soil infiltration rates of the first foot of soil more closely resemble type B soil. To better match the storm sewer hydrographs for these storm events, these areas were assigned to have type B soil. Soil classification data is shown in **Figure 3-1**.

Figure 3-1 – Hydrologic Soil Groups (HSG) for stormwater model areas



The dormant season soil parameters were not adjusted from the 2007 parameters because there were no large storm events during the dormant season in 2013.

Table 3-2 summarizes the Green-Ampt soil parameters assigned for each model soil type:

Table 3-2 – Green-Ampt Infiltration Parameters

Model Soil Type	Suction (in), Conductivity (in/hr), Initial Deficit (fraction)		
	Growth Season	Dormant/Growth Transition	Dormant Season (May 2010, Nov 2011)
A	2.41, 2.35, 0.312	3.94, 0.7, 0.221	3.75, 0.5, 0.191
B	4.15, 1.0, 0.252	4.97, 0.4, 0.182	8.19, 0.15, 0.149
B1	4.15, 1.8, 0.252		
C	6.2, 0.3, 0.174	9.86, 0.06, 0.096	12.45, 0.02, 0.079
D	7.52, 0.2, 0.158	12.45, 0.02, 0.079	12.93, 0.01, 0.073

Percent Runoff Routing from Impervious to Pervious Surface

This parameter is related to the directly-connected impervious surface, and has important impacts on runoff volume. It was assigned to a range of values primarily based on land use and land cover. Compared to preliminary calibration, the percentages were increased slightly as shown in **Table 3-3**.

Subcatchment Width (Overland Flow Length)

Overland flow length was simplified to either 100 or 150 feet in urban areas and 500 feet for rural areas. During preliminary calibration, the subcatchment width parameter was assigned as one of 12 different flow lengths ranging from 50 to 200 feet, based on subcatchment slope and imperviousness. These were within the range of typical values as suggested from the EPA SWMM Help Manual.

Table 3-3 – Summary of % Runoff Routed to Pervious Surface Based on Land Use/Land Cover

Land Use/ Land Cover	% Routed	
	Preliminary	Final
Commercial	25 – 40 (mostly 25)	25 – 40 (mostly 40)
Downtown (Imp >85%)	5	
Residential	56 – 68	60 – 72
Road/parking lot	10	10 – 20
Water body	0	
Wooded/non-developed area	90 – 100	

Manning's n for Impervious and Pervious Surface (Overland Flow)

The overland flow Manning's n is a model parameter that relates to overland flow velocities, affecting both runoff and infiltration. Typical values were used for this parameter. It is set at 0.05 for impervious surfaces, and 0.2 for pervious surfaces. This parameter was found to have slight impact in shaping peak flows and volume in calibration.

Depression Storage for Impervious and Pervious Surface

Depression storage parameters represent the initial surface storage volume that is filled during a precipitation event prior to the start of any runoff. Assignment of these parameters was simplified compared to preliminary calibration. Typical values were used: 0.08 inch for impervious surfaces, 0.16 inch for grass areas, and 0.2 inch for wooded areas.

iv. Calibration Results

In general, the model was able to replicate the hydrographs at the USGS stream gauges and temporary flow monitors. The results were generally within 15% for volumes and 20% for peak flows, which match with calibration goals for a stormwater model of this size and complexity.

Tables 3-4 and **3-5** show the event-specific percent difference in volume and peak flow for each monitor location. The percent difference in each case is calculated using the following formula:

$$\% \boldsymbol{Difference} = \frac{(\boldsymbol{Model\ predicted\ value} - \boldsymbol{Monitor\ observed\ value})}{(\boldsymbol{Monitor\ observed\ value})}\ \boldsymbol{x\ 100}\%$$

Figures 3-3 to **3-4** show hydrographs for some of the major monitors while the full version of the final calibration report includes all the hydrographs at these monitors and gauges for reference.

Discussions of some of the outliers are as follows:

- Monitor Sites #1 and #2 were surcharged/flooded during 6/27/13 storm. Flows were likely under-reported by the monitors at these sites during peak flow.
- The model under-predicted flows for Traver Creek sites for 4/17 (#15 and #16), and 6/13 (#15) storms by at least 30%. There seemed to be an unaccounted flow source from outside the city limits after those storm events. Review of nearby rain gauge data did not reveal additional precipitation in the vicinity. Additional field investigation work in Ann Arbor Township would be required to determine why the response for these storms varied from other storms for which the calibration was better matched.
- Monitor #10 in the Malletts Creek watershed had good agreement on hydrologic response pattern but poor volume agreement for the 10/31/2013 event. Because other events for this monitor had more consistent agreement, this was likely due to monitor error, possibly from fall leaf debris. This was also the smallest monitored tributary area, with the lowest flows, making it more subject to this type of problem.
- For the Swift Run monitoring site, the culvert configuration did not allow for installation of an ultrasonic flow meter. Instead, a continuous level monitor was installed, and a rating curve that had been developed in 2007 was used to calculate flow. The rating curve provides a correlation between the level monitor reading and a predicted flow rate. However, the measured flow rate values were much lower than model predictions, suggesting that the rating curve may not have been representative in 2013 (potentially due to changes in sediment levels in the culverts or changes in streambank characteristics). As a result, the model parameters were refined to match model-predicted levels with recorded levels for this site (#11)

Table 3-4 – % Difference for Model-Predicted Volume to Monitor-Observed Volume

Flow Monitor		Calibration						
		6/27/13	8/12/13	10/31/13	6/13/13	4/17/13	7/9/13	8/27/13
Allen	1	**66%**	**43%**	18%		15%	1%	9%
Allen	2	**269%**	9%					4%
Allen	3	23%	16%	-12%	12%	**-41%**	22%	21%
Allen	5		9%	-3%	5%	-1%		6%
Allen	USGS	3%	-1%	10%	4%	-8%	-7%	-4%
Malletts Creek	6	-7%	6%	12%	3%	-13%	11%	13%
Malletts Creek	7	-15%	-5%	-6%	-13%	-21%	-13%	-2%
Malletts Creek	8	8%	9%	-7%	-3%	-11%	4%	-27%
Malletts Creek	9	19%	4%	12%	-5%	-15%	17%	**33%**
Malletts Creek	10	4%	10%	**107%**	1%	-15%	5%	11%
Malletts Creek	UP_MA	-10%	7%	14%	-6%		7%	7%
Malletts Creek	USGS Doyle	1%	2%	-7%	-3%	-4%	2%	3%
Malletts Creek	USGS Malletts	1%	-9%	-8%	4%	-12%	-7%	6%
SR	11 (level)		2%	0%				-3%
Millers	13		8%		-13%	-25%	14%	17%
Millers	14	-16%	9%	30%	-2%	-6%	19%	**113%**
Traver	15	-4%	-5%	-3%	**-30%**	**-32%**	-6%	1%
Traver	16	-4%	-5%	4%	-4%	**-71%**	-2%	4%

- For areas with open channels, there seemed to be a prolonged runoff response not effectively represented by the Green-Ampt infiltration model. This was apparent when monitored flows dropped off more slowly than the model prediction, lasting for many hours after the 4/17 event. This prolonged runoff response was represented by adding response hydrographs based on the Rainfall Dependent Inflow/Infiltration RTK method (RDII RTK) along the open channel reaches in Malletts Creek, Swift Run and Traver Creek.
- The distance-weighted average of ground rain gauge data did not seem to be representative enough for the 8/27 event. Although the runoff volumes were matched within 15% for most of the sites, the model missed the first runoff peak as recorded by the flow monitors.

Table 3-5 – % Difference for Model-Predicted Flow Rate to Monitor-Observed Flow Rate

Flow Monitor		Calibration						
		6/27/13	8/12/13	10/31/13	6/13/13	4/17/13	7/9/13	8/27/13
Allen	1	**33%**	**41%**	15%		**46%**	-8%	-10%
	2	**184%**	0%					-8%
	3	**36%**	-6%	2%	-5%	-26%	-23%	-23%
	5		-3%	19%	-4%	25%		-4%
	USGS	-4%	2%	-11%	-11%	-9%	-4%	**-45%**
Malletts Creek	6	31%	14%	-16%	5%	-4%	-8%	-26%
	7	29%	-2%	-6%	-11%	**-38%**	-11%	-18%
	8	20%	9%	-19%	-7%	-16%	8%	-25%
	9	-7%	-1%	23%	10%	-3%	2%	-24%
	10	**46%**	-4%	**32%**	-7%	4%	16%	-4%
	UP_MA	4%	-10%	12%	-6%		-10%	**-36%**
	USGS Doyle	-11%	17%	15%	-9%	0%	10%	-1%
	USGS Malletts	-17%	-24%	-9%	-11%	-26%	13%	**-49%**
SR	11 (level)		-6%	-3%				**-31%**
Millers	13		15%		6%	-9%	-12%	-29%
	14	4%	11%	18%	16%	-7%	-10%	**83%**
Traver	15	-11%	-3%	-13%	-19%	-19%	8%	**-45%**
	16	-29%	9%	-1%	2%	**-82%**	4%	19%

Figure 3-2a-d – Flow Hydrographs for Major Monitors for 6/27/13 Event

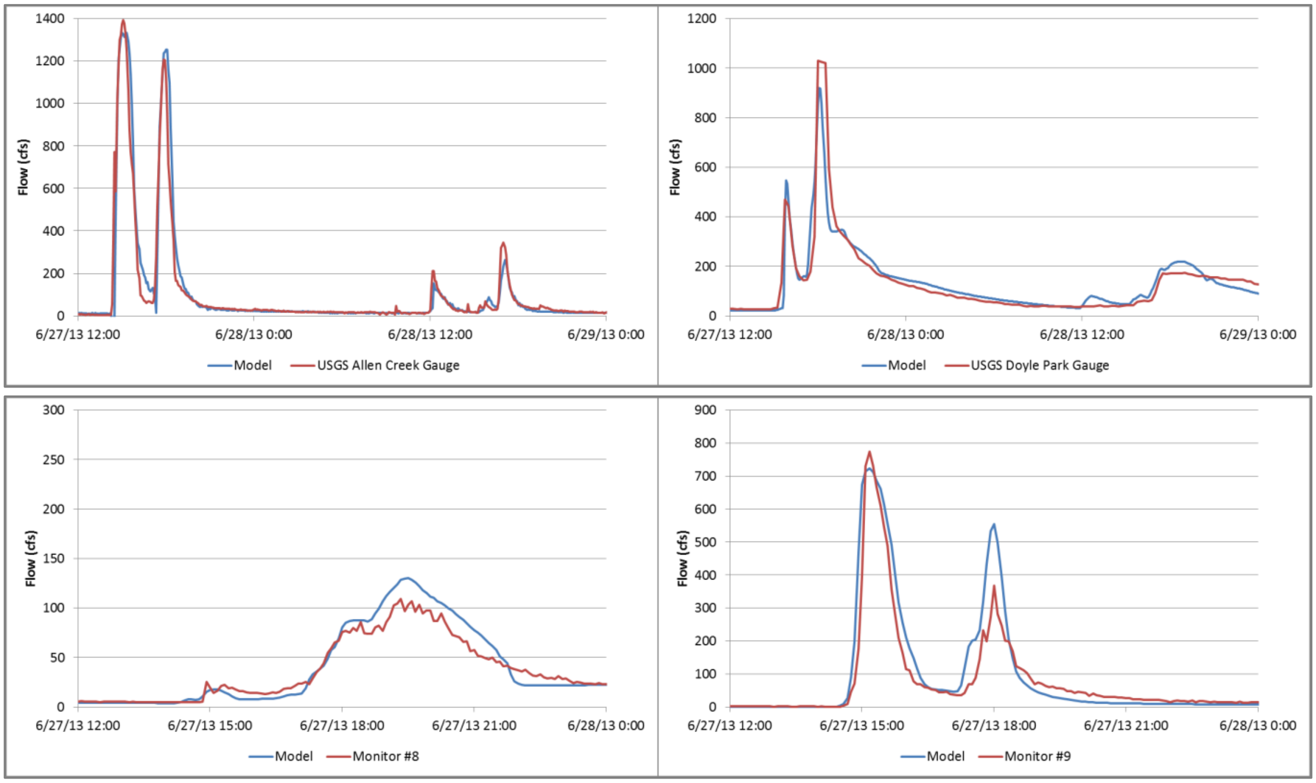


Figure 3-3a-d – Flow Hydrographs for Major Monitors for 8/12/13 Event

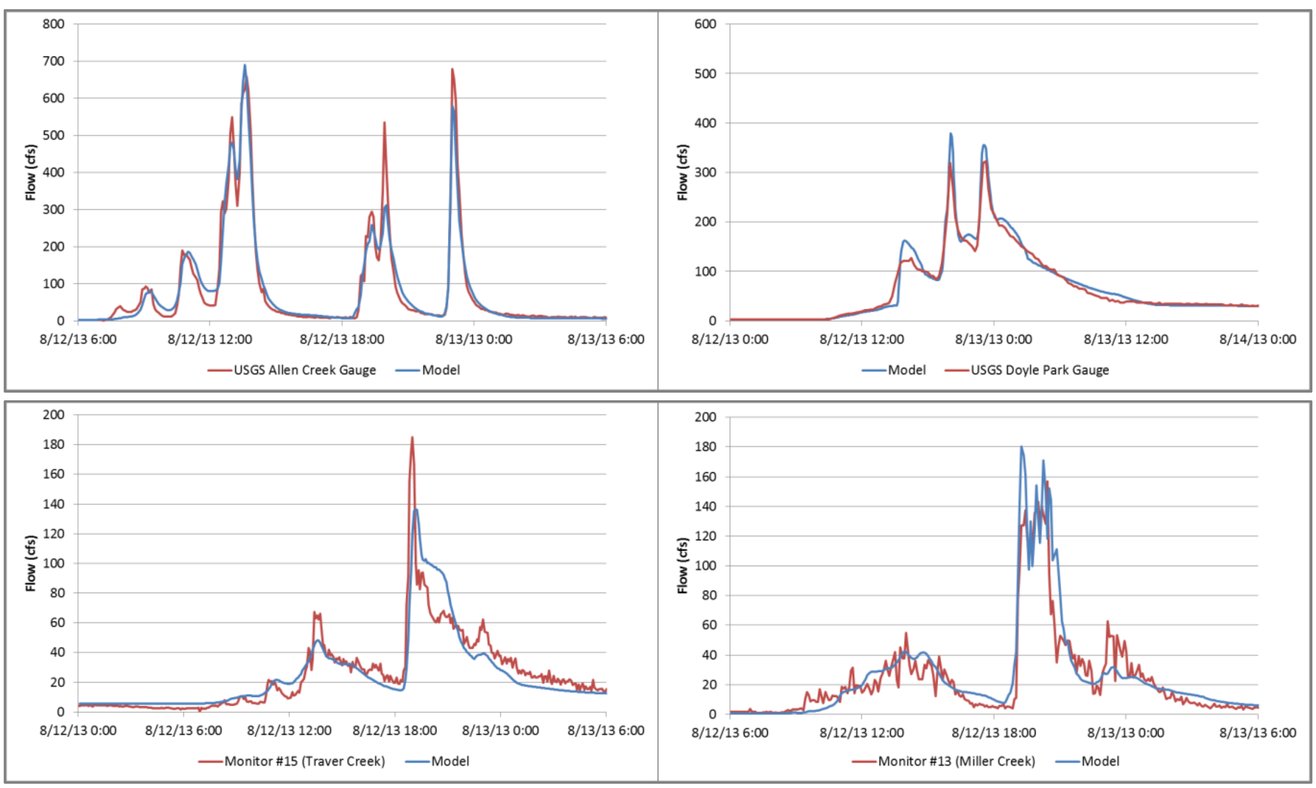
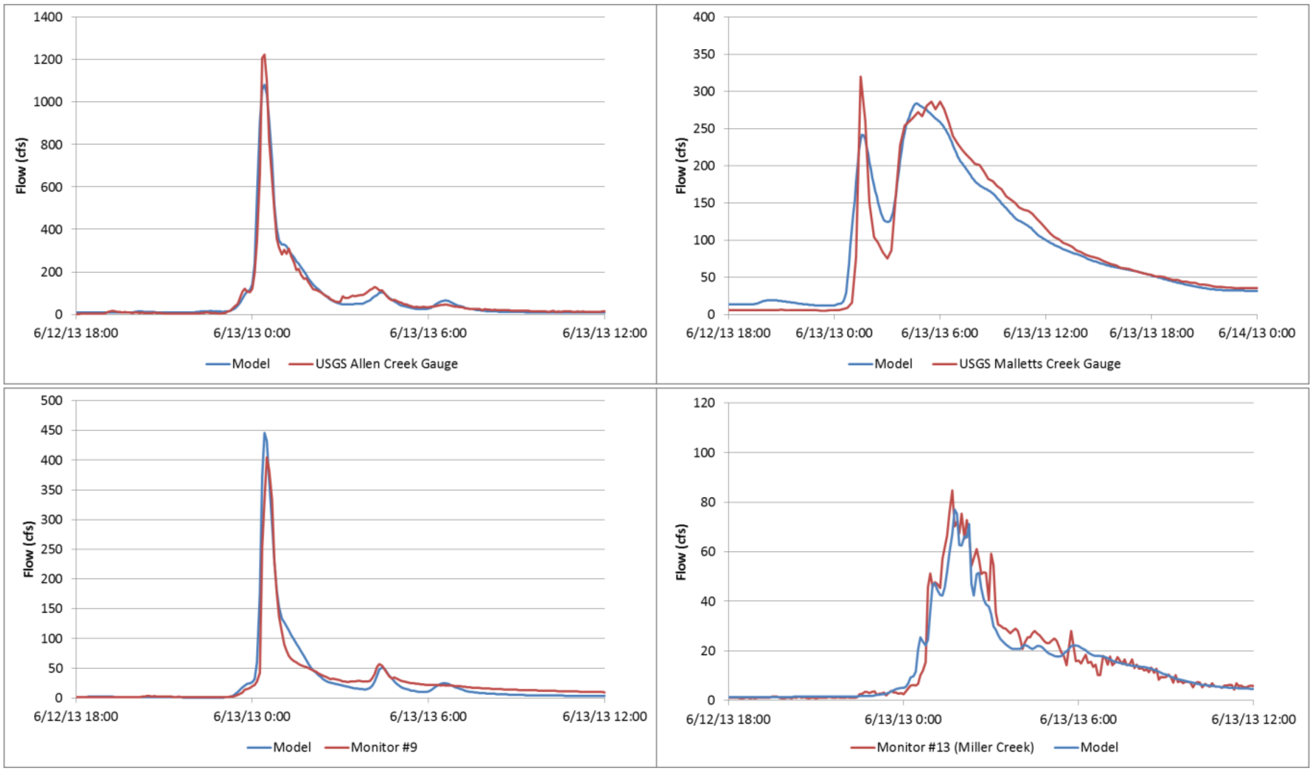


Figure 3-4a-d – Flow Hydrographs for Major Monitors for 6/13/13 Event



B. Model Validation

i. Validation Events

Three (3) storm events in 2013 were selected for model validation. The total precipitation for these events ranged from 0.1 inches for the 7/27 event to 1.6 inches for the 10/5/2013 event. **Table 3-6** summarizes the range of precipitation computed for the monitoring districts for each of the validation events.

Table 3-6 – Summary of Validation Events

#	Date	Precip Total (in)	Sources	Season
1	10/5/2013	1.3 – 1.6	ground gauges	growth
2	11/17/2013	0.6 – 0.8	ground gauges	dormant
3	7/27/2013	0.1 – 0.5	ground gauges	growth

ii. Validation Results

Table 3-7 summarizes the comparison of runoff volume and peak flow values between the model-predicted and monitor-observed data. As with the calibration comparison, the validation results are presented in terms of a % difference. The comparison was made at all gauges with available data, including the USGS gauges.

Table 3-7 – % Difference for Model-Predicted vs. Monitor-Observed Volume/Peak Flow

Flow Monitor		Volume			Peak		
		7/27/13	10/5/13	11/17/13	7/27/13	10/5/13	11/17/13
Allen	1	21%	13%	11%	-8%	0%	7%
	2	-4%			0%	-11%	
	3	13%	18%	-14%	-25%	-6%	-27%
	5		4%	6%		17%	26%
	USGS	6%	9%	13%	-8%	-11%	-13%
Malletts Creek	6	12%	11%	-10%	-16%	-4%	9%
	7	3%	1%	-16%	18%	-6%	-13%
	8	-14%	-3%	4%	7%	7%	-7%
	9	23%	72%	5%	-16%	-6%	10%
	10	-3%	-1%	7%	0%	7%	13%
	UP_MA	39%	10%	2%	-23%	16%	34%
	USGS Doyle	0%	10%	-13%	-3%	-3%	-26%
	USGS Malletts	-4%	13%	-14%	-48%	-27%	-27%
SR	11 (level)	8%	0%	-7%	7%	-2%	10%
Millers	13	16%	14%		-10%	-12%	
	14	6%	19%	18%	-33%	-2%	-11%
Traver	15	0%	-3%	-5%	20%	-30%	-12%
	16	3%	2%	-3%	21%	4%	-12%

More calibration information is available in the final calibration report, which shows all of the calibration hydrographs at each monitor for each event. In general, the model-predicted flows and volumes were within 15% of recorded data. As noted earlier, this falls within the expected range of agreement for stormwater models of this size and level of detail.

The calibration and validation work performed with 2013 data had good agreement between model-predicted values and monitor-observed values for volume and flow rate. Adjustments were made to the preliminary model parameters to improve the model performance, including:

- Establishment of a B1 soil classification
- Runoff parameter refinement for more sensitive parameters, specifically with % routing
- Simplification of parameter assignments for subcatchment width and depression storage, which have less impact on model results

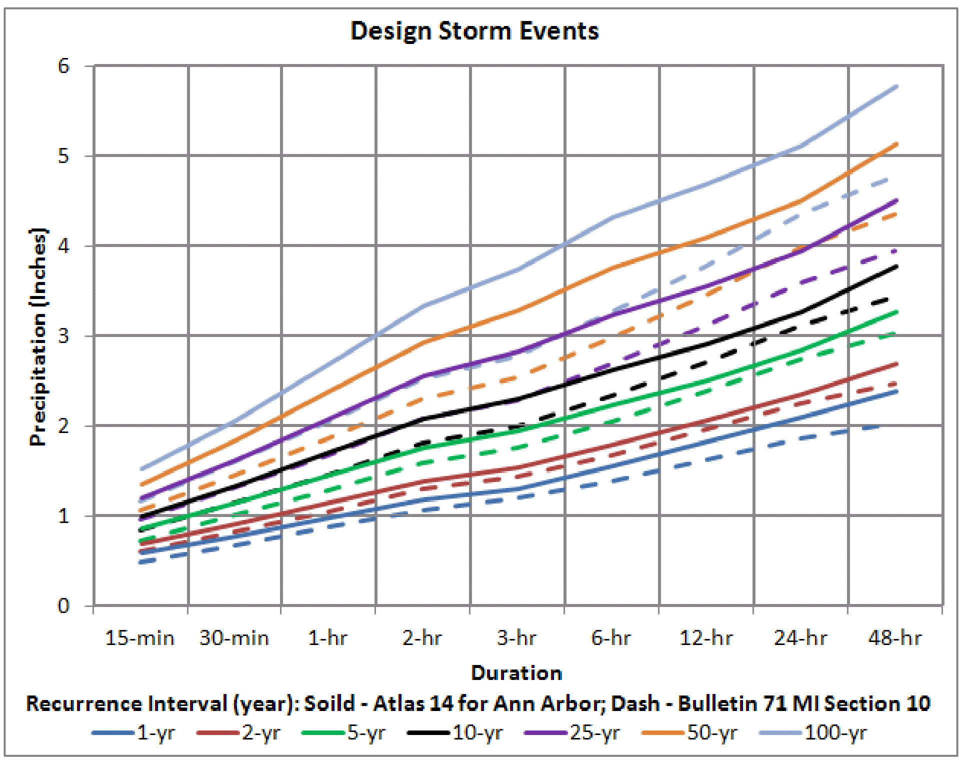
C. Existing conditions modeling

The final calibrated model was used to determine the level of service provided by the existing storm drainage system and to help identify priority areas for improvements. Eight (8) design storm simulations, as shown in **Figure 3-5**, were prepared to identify capacity constraints and flooding locations in the system. The range of design storms include:

- 100% annual exceedance probability (AEP) 1-Hour: 0.97" (could serve as baseline for BMP evaluation)
- 50% AEP 24-Hour: 2.35" (could serve as baseline for BMP evaluation)
- 20% AEP 1-Hour: 1.44" (Older part of the system were designed for old 20% storm volume)
- 10% AEP 12-Hour: 2.90" (Represents current design standard)
- 4% AEP 24-Hour: 3.93"
- 2% AEP 24-Hour: 4.5"
- 1% AEP 24-Hour: 5.11" (Design standard for detention storage, used for FEMA map comparison)
- 0.2% AEP 24-Hour: 6.74" (new probability from Atlas 14, also used in FEMA flood analysis)

Rainfall volumes were obtained from NOAA Rainfall Atlas 14 Volume 8 (version 2). They were 8% to 28% higher compared to Bulletin 71 (Please refer to Design Storm Tech Memo for detailed discussion).

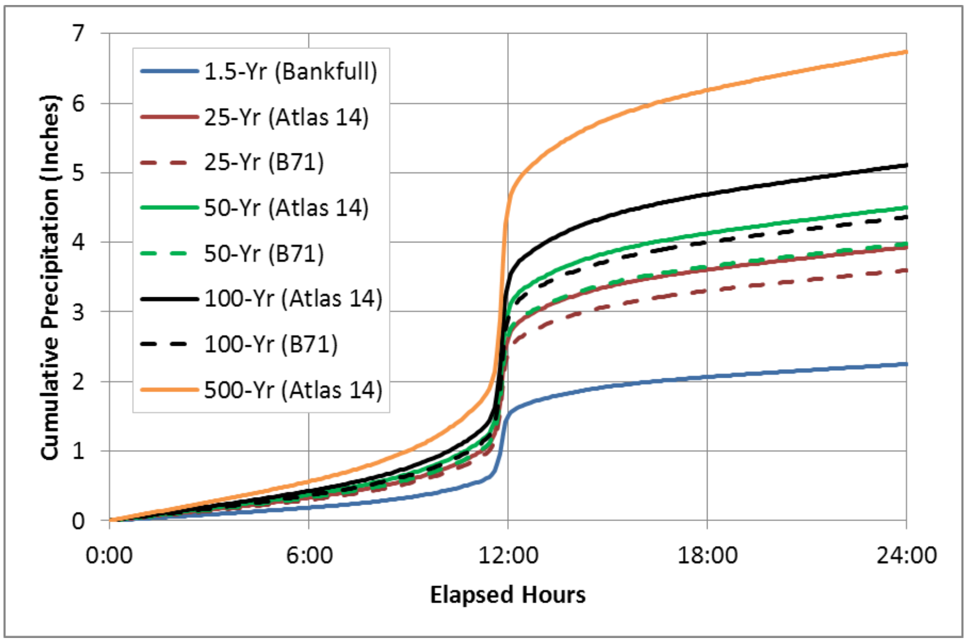
Figure 3-5 – Design Storm Events



The Huff 1st quartile, alternating block, and SCS Type II distributions were used for 1-hour, 12-hour and 24-hour duration storms, respectively. An alternating block distribution is similar to SCS Type II except it is not limited to 24-hour duration storms. Both of these distributions represent an intense rainfall pattern that is commonly associated with thunderstorm activity likely to occur during summer. These rainfall distributions are shown in **Figure 3-6**.

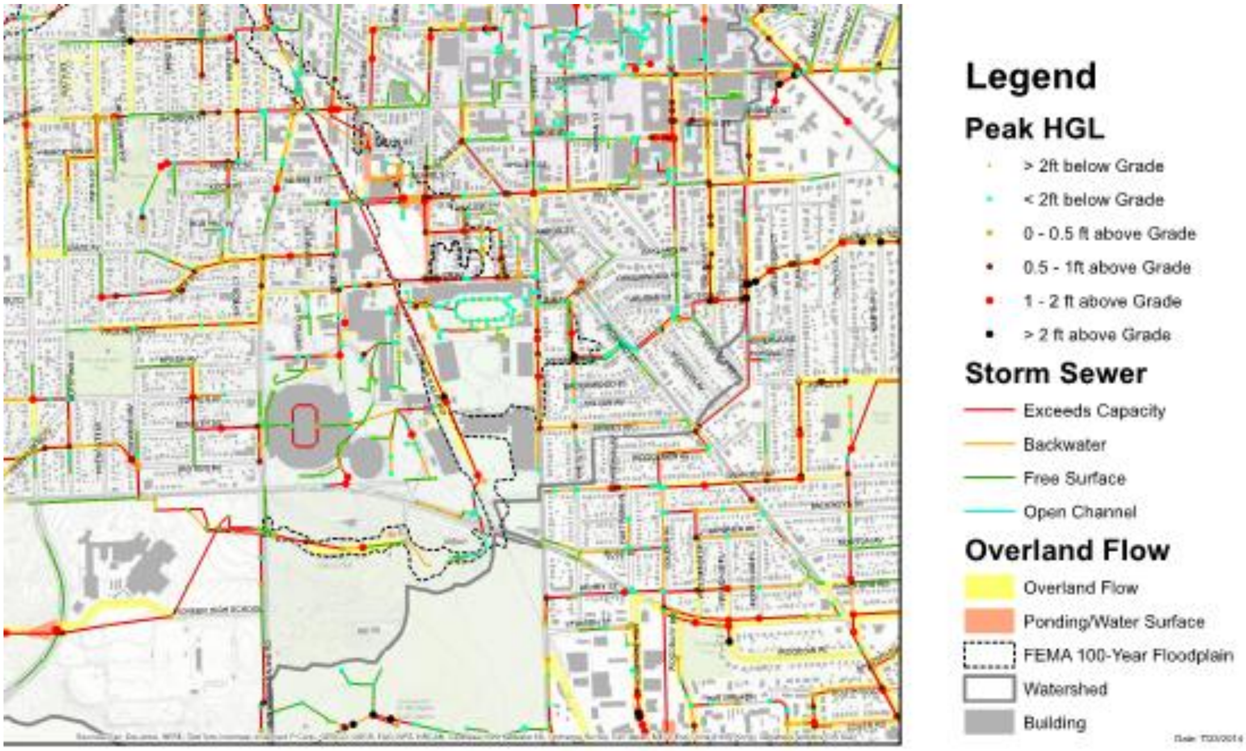
Climate change was a frequent point of discussion during the project. The use of newer rainfall volume standards from NOAA Rainfall Atlas 14 for design storms was one consideration. As noted in the previous paragraph, use of the SCS Type II distribution was another decision made so that the project was considering not only the most intense type of storm event, but potentially accounting for more frequent storms of this type in the future.

Figure 3-6 – Cumulative Rainfall Distributions



Appendix A contains two series of sewer system maps showing the level of service provided by the existing storm drainage system in different parts of the City: Capacity Exceedance maps and Peak flow condition maps. For the capacity exceedance map, pipes were color-coded based on the smallest design storms that pipe capacity was exceeded. For the peak flow condition maps (one map per design storm), pipes were shown in green if capacity is not exceeded, yellow if backwater condition occurred, and red if capacity is exceeded during storms. **Figure 3-7** below shows an example peak flow condition map.

Figure 3-7 – Example HGL Condition Map



In addition to the pipe capacity, the maps also show locations where flooding would occur during different design storm events. Surface flooding locations were categorized into either street overland flow (usually with less than 6 inch of water) or ponding (more than 6 inches of water), and their boundaries were delineated using LiDAR data provided by Washtenaw County.

With higher precipitation estimates from Atlas 14, most of the current drainage system had pipe capacities that were more in line with the 20% AEP storm instead of the 10% AEP storm, which is the current standard. While it was not unexpected that newer parts of the system and open channels can usually handle larger storm events better than older parts of the system, most areas of the stormwater system are still able to convey the 10% AEP, 12-hour storm without significant flooding. This includes almost the entire creekshed areas for Traver Creek, Millers Creek, Swift Run, Newport Creek, and areas that drain directly to the Huron River, where only a few isolated surface flooding areas were identified for additional study during review of existing conditions model data.

The Allen Creek and the Malletts Creek watersheds include more impervious surface area and in general have older stormwater infrastructure. Therefore, most of the capacity issues and surface flooding areas are located in these two creeksheds. Further information on the process used to identify priority areas for improvement and the associated recommendations are discussed in Section 4.

4. Stormwater System Improvements

A. Study Area Selection

Existing conditions modeling results were reviewed in a series of progress meetings and workshops with City Staff in the spring and summer of 2014. Sewer system maps were generated showing the pipe segments that were within design capacity for flow and those that had model-predicted flows that would exceed the design capacity. The maps also showed model nodes where surcharging to ground was predicted (where the water surface elevation would exceed the manhole rim elevation).

Existing conditions results are included in the maps in Appendix A. For the initial review, the current stormwater system design standard storm was used. This design storm has a 10% Annual Exceedance Probability (AEP), and a duration of 12 hours, with a rainfall volume of 2.9 inches. The initial review of the system performance under this storm event showed that the many areas of the system were unable to convey this storm. This has primarily been due to recent changes in the design storm standard, so that the current 10% AEP storm is larger than it was when these pipes were designed and constructed. As a result, a smaller design storm was also evaluated to identify potential locations for stormwater improvements. When the 20% AEP, 1-hour duration storm, with a volume of 1.44", was reviewed with the model, more distinct areas with performance issues were revealed.

For both the 10% AEP, 12-hour storm and the 20% AEP, 1-hour storm, preliminary screening locations were identified by comparing model-predicted flow to design capacity and by identifying locations with predicted surface flooding. The preliminary screening list was also compared with LEDG sites and with public input about flooding locations that was gathered in Phase I public meetings and surveys.

Once preliminary screening was complete, the sites were prioritized using two risk metrics:

- The **probability metric** considered the frequency of flooding occurrence, with the following ratings of 1, 2, or 3:
    1. Model predicts flooding in 10% AEP storm, but no reports
    2. Model predicts flooding in 20% AEP storm and/or frequent public reports
    3. Model predicts flooding in 50% AEP storm and/or frequent public reports

- The **impact metric** considered the extent or severity of flooding with the following ratings:
    1. Flooding limited to streets and parking areas with a depth of 6" or less
    2. Flooding affects private properties, typically with predicted depths of 6" - 12"
    3. Flooding affects structures, typically with predicted depths greater than 12"

These two metrics were multiplied together to generate an overall flooding risk rating, with a higher value indicating a higher risk of flood damage. The assigned values and prioritization are shown in **Table 4-1**:

Table 4-1 – Preliminary Study Area Prioritization

Site	Watershed	P	I	R (P x I)
1. Lower Allen Creek – Main Branch	Allen	3	3	9
2. Edgewood / Snyder	Allen	3	2	6
3. Park Place Apartments	Allen	2	3	6
4. Churchill Downs / Lansdowne	Malletts	2	3	6
5. South University / East University	Allen	3	2	6
6. Mulholland Drive	Allen	2	2	4
7. Scio Church / S. Seventh Street	Malletts	2	2	4
8. Glendale / Charlton	Allen	2	1	2
9. Glen Leven	Allen	2	1	2
10. Church St / Cambridge	Malletts	2	1	2
11. Village Oaks / Chaucer Ct	Malletts	1	2	2
12. Parkwood / Pittsfield Village	Malletts	2	1	2
13. Signature Drive	Malletts	2	1	2
14. S Industrial / Packard Rd area	Malletts	2	1	2
15. Traver / Barton	Traver	2	1	2

Additional sites were identified during the public meeting series that either had not been selected for study or had been eliminated during the preliminary screening process. To address the questions about these sites, they have been included in the comments below:

- Glendale Circle / Virginia Park – This location is predicted to have flooding affecting private properties during the 10% AEP, 12-hour storm, so it should have been included in the original screening, with a probability metric of 1 and an impact metric of 2. A full evaluation of stormwater improvements for this site is included in section 4C.
- Geddes Road at Huron Parkway – This reported flooding may have been related to a culvert problem that was repaired in the past couple years. The model does not predict flooding that would impact any roadways or private properties for the 10% AEP, 12-hour storm.
- Newport Road at Westport – The model predicts some surface flooding in the 10% AEP, 12-hour storm, but overland conveyance allows flow into the wooded area to the east along an existing drainage easement. This site would have probability and impact metrics of 1, so it was not included in screening for evaluation of stormwater improvements.
- Washtenaw Avenue at South University Avenue – Attendees at the public meetings mentioned some surface drainage issues affecting properties on Washtenaw Avenue. The model predicts

some overland flow in the areas of Wilmot Street and South University, but no extensive surface flooding to the south along Washtenaw Avenue. It is likely that the affected property, which sits lower than the roadway, receives roadway runoff during intense rainfall events due to catch basin limitations and/or curb, gutter, and roadway grading issues. Washtenaw Avenue is an MDOT business route so any improvements to the stormwater system would most likely be initiated as part of an MDOT roadway improvement project.

B. Improvements modeling

Three conceptual approaches were considered for stormwater improvement alternatives. These approaches were constructed in the model to represent how these stormwater improvements would function at each study location and how they would impact the stormwater system performance. While the screening process used surface flooding and property impacts as screening criteria, the improvements modeling used the current stormwater design standard (handling the 10% AEP, 12-hour storm with water surface elevations at least 2' below the ground surface) as a design performance goal.

1. *Green Streets / Localized BMPs:*

   The Green Streets improvement concept aims to minimize runoff volume through localized storage and infiltration within the City right-of-way (ROW).

   The City's Green Streets policy includes on-site infiltration standards for public roadway and right-of-way (ROW) construction and reconstruction projects. The policy calls for infiltration of 1 inch (1st flush), 2.35 inches (50% annual chance 24-hour storm) or 3.26 inches (10% annual chance 24-hour storm) of total precipitation volume that falls on the ROW, depending on site soil conditions, slope and proximity to floodplain. It was assumed that on-site infiltration is not practical in areas that have historically had groundwater levels within 5 feet of the ground surface.

   To represent the Green Streets BMPs, the "depression storage" parameter for the relevant sub-catchments was increased accordingly to represent additional storage of runoff and the subsequent infiltration within ROW. The additional depression storage volume was calculated as the area-weighted average between storage in the ROW area (1 to 3.26 in) and non-ROW area (0.08 in for impervious area and 0.16 inch for pervious area).

2. *Engineered Storage:*

   This concept aims to reduce peak flow rates by detaining runoff flows with designated underground or surface storage locations.

   Large underground or surface detention facilities were considered based on availability of large open space. It is assumed that the facilities would be drained by gravity so their depths would be limited by the invert elevations of the adjacent storm drainage system. Some realignment of existing storm sewers would usually be involved to re-route runoff to the desired engineered storage location. Siting involves initial assessment of utility conflicts based on GIS data, but further evaluation would be required upon moving to the preliminary design phase for any of these locations.

When evaluating the storage elements in the stormwater model, these facilities were either represented as a rectangular storage node or as a large conduit link. The storage volume for each location was determined by storing enough 10% AEP storm runoff to minimize flooding at the study location, while limiting outflow from the storage feature(s) to the pre-development release rate standard of 0.15 cfs/acre.

3. *Conveyance Improvement:*

   This conceptual improvement approach is intended to move runoff offsite from the study location by providing additional capacity in the pipe system.

   This concept looks at increasing the capacity of the existing drainage system to convey more runoff downstream from the study area and reduce the peak hydraulic grade line (HGL) to be at least 2 feet below ground during the 10% AEP, 12-hour storm. This is an iterative approach that could include increasing the size of existing storm pipes or installing new storm relief pipes.

Improvements were all evaluated using the 10% AEP, 12-hour design storm (2.9 inch). Improvement scenarios for each site were based on one of the concepts or a combination, if improvements could not be achieved by one concept alone. Not all of the conceptual approaches were considered for each site, since their application at some sites would not be feasible or practical.

It is noted that the scope of this project was focused on using the model to evaluate stormwater system changes but other approaches should also be considered for addressing the study areas. Alternative approaches could include the purchase and/or modification of affected properties so that predicted surface flooding does not affect private property. This approach would not improve the system to the current stormwater design standard, but it may be significantly less costly. Model output showing the number of parcels and structures affected by predicted surface flooding could be used for further consideration of this approach.

C. Site descriptions and recommendations

The stormwater improvements evaluations are presented in this section following a similar format to the public meeting presentations. For each study area, the following items are described:

- Problem Definition
- Alternatives analysis
- Evaluation summary and recommendation

The evaluation summary was developed to support the prioritization of each recommended project as part of the City's Capital Improvements Programming (CIP). The stormwater model and improvements evaluation were used to generate output that would align with City's established scoring criteria, as shown in **Table 4-2**:

Table 4-2 – SWM project alignment with CIP scoring criteria

CIP Criteria	Weighting	SWM Output for City Scoring
System Influence/Capacity	100	# of parcels benefitted; # of structures benefitted
Water Quality	100	% reduction in peak flow and volume
Safety/Compliance/Emergency Preparedness	75	Notes on potential safety issues during construction or O&M activities
Coordination with Other Projects	75	
Funding	70	Cost estimate
O&M (Operations & Maintenance)	70	O&M cost estimates
User Experience (Level of Service)	65	Net improvement in LOS
Partnerships	65	Notes on impacts/benefits for WCWRC, UM or Townships
Sustainability/Environmental Goals	50	Notes on alignment with Sustainability goals
Innovation	40	Notes on inclusion of BMPs
Master Plan Objectives	25	Notes on alignment with Master Plan goals

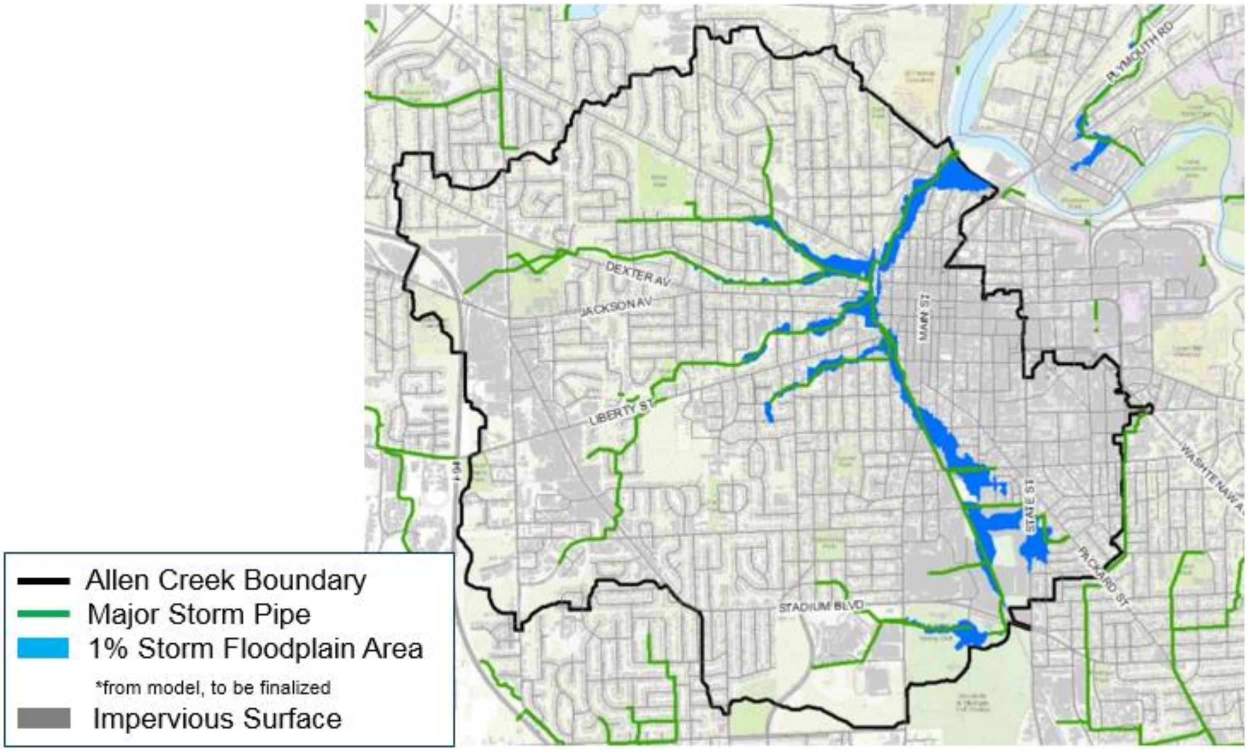
Where cost estimates are presented, these have been developed using unit costs from current City construction projects with cost escalation to year 2017. The Springwater Subdivision Improvements Project was used for direct unit costs for storm sewer pipe, and multipliers were added to account for design/engineering, other structures and utilities, and construction contingencies to develop the overall project costs presented. A similar approach was taken for project cost estimates for infiltration BMPs, underground storage, and surface storage. Upper end cost estimates from more complex projects were used to estimate costs for areas where construction would be more difficult.

i. Lower Allen Creek

The Allen Creek tributary area has a much higher proportion of impervious surfaces compared to other areas of Ann Arbor. The Allen Creek watershed includes downtown Ann Arbor, as well as the majority of the University of Michigan Central Campus and South Campus areas. Major branches of Allen Creek extend to the west, collecting drainage from the west side of Ann Arbor.

Almost the entire length of the creek has been enclosed in storm sewers that are owned by either the City of Ann Arbor or the Washtenaw County Water Resources Commissioner. The lower sections of the enclosed creek were built in the early 1900’s and only have capacity to convey the 50% AEP storm. Surface flooding occurs frequently in lower areas and extensive surface flooding is predicted in the 1% AEP storm, as shown in **Figure 4-1**.

Figure 4-1 – Allen Creek Stormwater System Overview



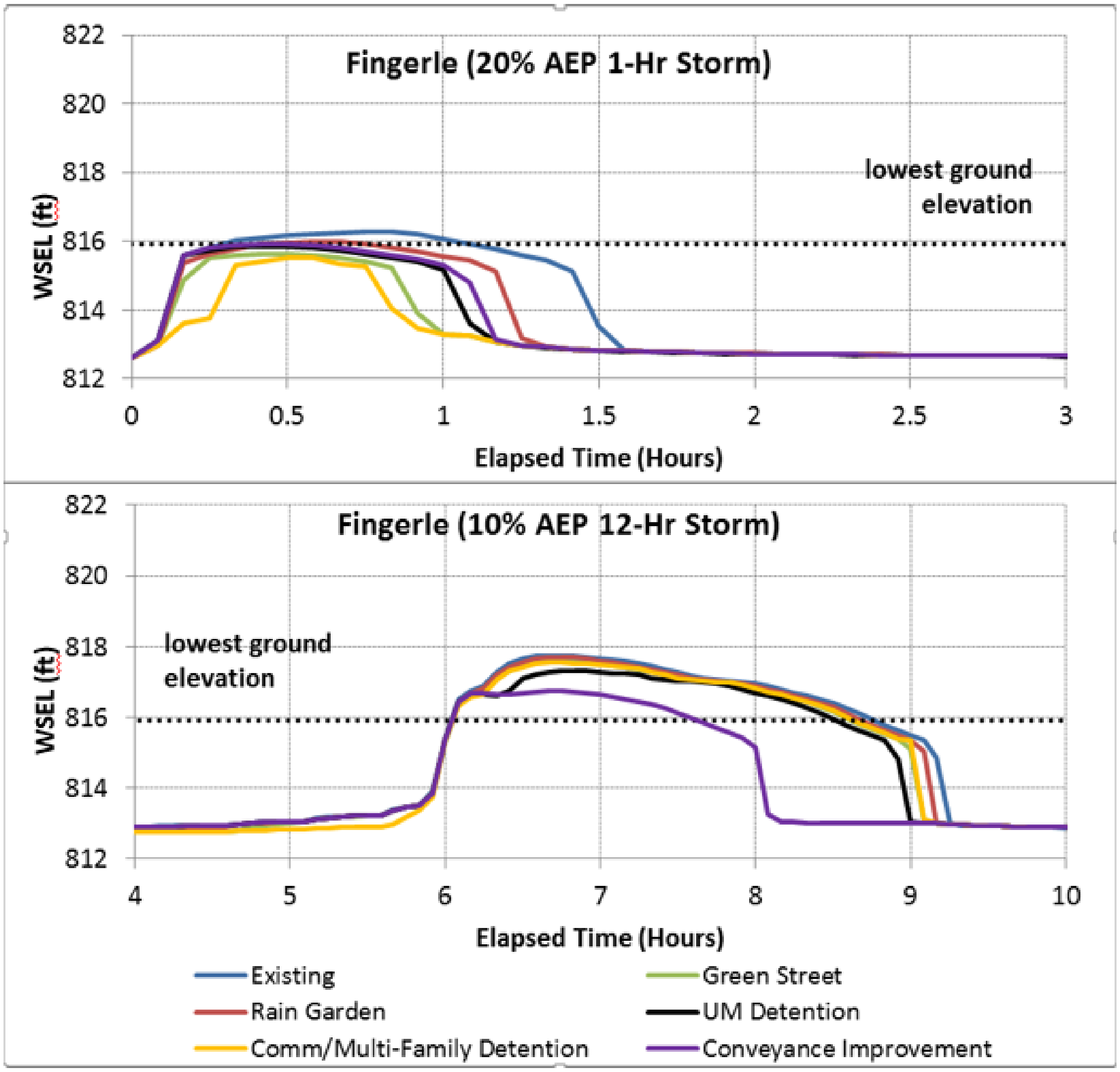
The 1997 stormwater master plan for the City of Ann Arbor evaluated conveyance improvements, and it was estimated that increasing the pipe size to accommodate the 10% AEP design storm at that time would cost around $40 million. A similar evaluation was prepared as part of this project and an overall estimate range of $150M - $200M was established for conveyance of the 10% AEP design storm. This cost estimate includes land acquisition of properties that would be substantially impacted by the expanded pipe footprint, but a complete engineering analysis to evaluate the feasibility of construction and land acquisition was beyond the scope of this project.

Because of the scale of the Allen Creek flooding problems, the project team recognized that a single improvement strategy, such as the conveyance improvements noted above, would be very difficult to implement and would have a high construction cost. Therefore, the model evaluation process for the Lower Allen Creek was designed to provide comparative information on different improvement strategies so that long term programs could be put in place to reduce or manage stormwater flows as effectively and efficiently as possible. The major sources of stormwater runoff are from impervious surfaces and management of these sources was considered in the following strategies:

- Right-of-Way areas - Green Streets Policy - Infiltration criteria based on Green Street Policy
- Residential properties - Rain gardens for single family homes- Capture the runoff from first 1" of precipitation
- University of Michigan properties - 1% AEP storm detention for all UM properties
- Commercial/Multi-family Residential properties - Storm detention for all commercial / multi-family properties per current development standards

As a reference, the results for these different strategies are shown in comparison to the 1997 master plan conveyance improvement strategy. **Figure 4-2** below shows the predicted water surface elevation for baseline conditions (blue) and for the other stormwater improvement strategies for Allen Creek at Madison near the Fingerle Lumber property.

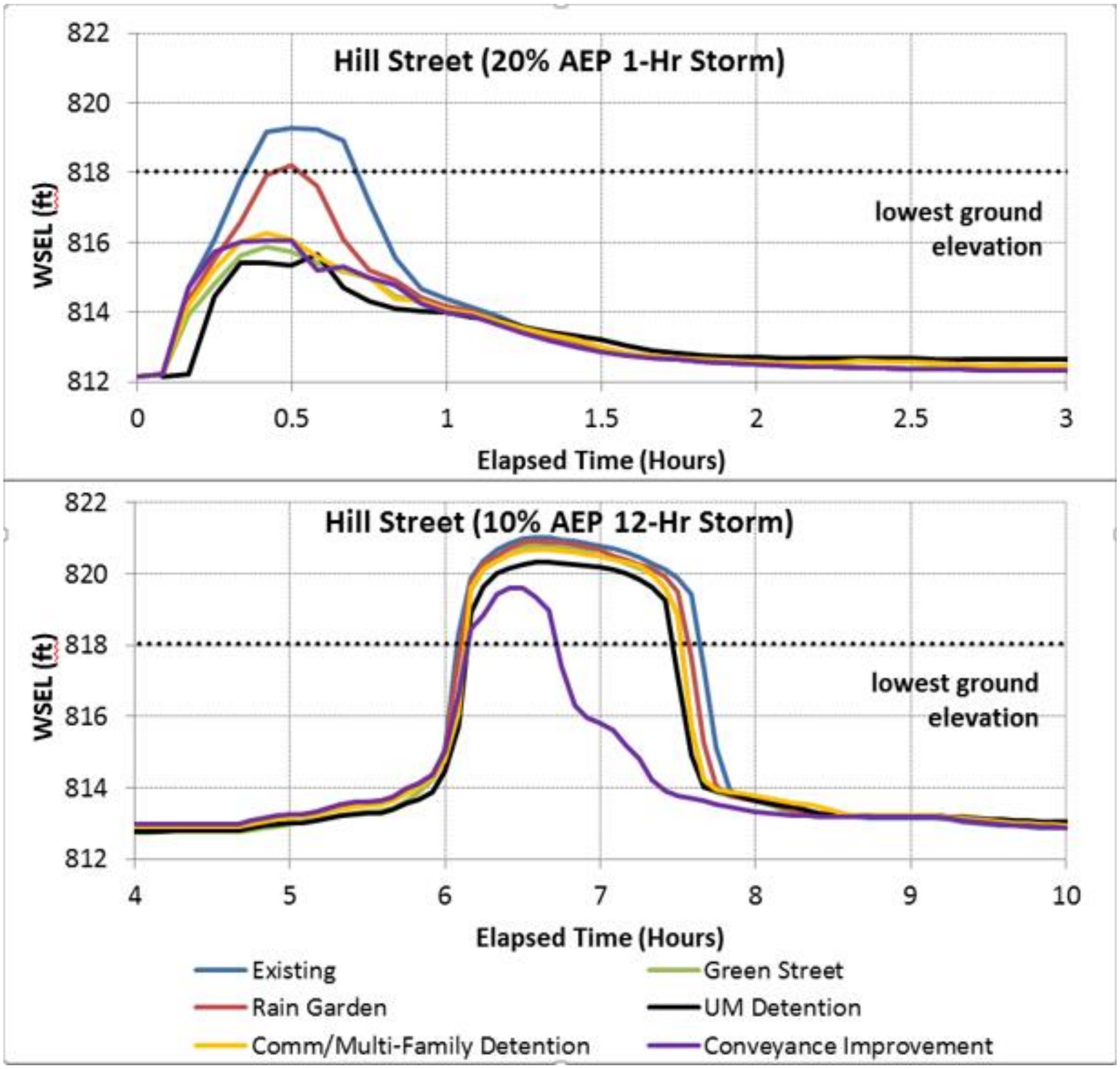
Figure 4-2 – Stormwater Improvement Comparison for Allen Creek at Madison Avenue



The top graphic shows the water surface elevation (WSEL) for the 20% AEP, 1-hour storm. While the model predicts surface flooding under baseline conditions, each of the individual improvement strategies would bring water levels below the ground surface at this location. For the 10% AEP, 12-hour storm, however, the individual stormwater management strategies have minimal impacts on peak water levels.

Similar results are seen at Hill Street in **Figure 4-3**, although it is notable that the impacts of University of Michigan properties are more significant since they make up a larger portion of the tributary area to this location.

Figure 4-3 – Stormwater Improvement Comparison for Allen Creek at Hill Street



Recommendation

The individual stormwater management strategies are not sufficient to eliminate flooding in the 10% AEP, 12-hour design storm as the pipe capacity along most of the lower sections of Allen Creek would still be exceeded. However, each strategy can be effective at reducing the frequency of flooding, and are especially effective during smaller storm events. University of Michigan properties are significant for the local stormwater system and for Allen Creek in the Hoover to Hill Street area. Our recommendation is to continue work on all of the studied stormwater management strategies to achieve incremental improvements in reducing peak stormwater flows over time.

Application of the Green Streets policy throughout the Allen Creek watershed, would require an investment of $80 million to $120 million (in 2017 dollars to match other project cost information). Other stormwater management alternatives would generally be funded by private property owners as part of redevelopment or as part of future stormwater management policies, so these costs have not been included. The cost of Green Streets implementation, which would be spread over many decades as roadways are reconstructed, compares favorably to a conveyance improvement for Allen Creek, which was estimated to cost up $150 million to $200 million, and which would require significant property acquisition in areas that would impacted by installation of a large pipeline.

For stormwater management on private property, the City should be proactive in creating and enacting policies that require property owners to manage stormwater on site. Requiring stormwater management during redevelopment would be a good next step, but incentivizing the implementation of stormwater management should also be considered. This approach could be similar to the current residential stormwater credit programs for becoming a RiverSafe Home partner, or building a rain garden or installing rain barrels.

Additional information about model analysis of stormwater management options for both Allen Creek and other creeksheds is included in section 5 of this report. Section 5 presents the options in different levels of combination in terms of the projected level of completion under future scenarios.

ii. Edgewood/Snyder

This location is characterized by street flooding in the low area at the intersection of Edgewood and Snyder. While the stormwater drainage system travels south across W. Stadium, the surface grade of W. Stadium is higher than the Edgewood/Snyder intersection, preventing a surface outflow pathway as shown in **Figure 4-4**. The upstream pipe system along Martha Avenue and Snyder does not have sufficient capacity to convey the 10% AEP design storm, so overland street flow is predicted.

Figure 4-4 – Existing conditions results for Edgewood/Snyder (10% AEP, 12-hour storm)

Alternative 1: Green Streets and Storage

Soil conditions in this area are expected to be suitable for infiltration so a significant infiltration capacity was assumed for the right of way (ROW) areas. The modeling assumed 3.26" of infiltration for the full extent of the upstream ROW, as shown in **Figure 4-5**. This would provide a total infiltration volume of 2.22 million gallons (MG). Even with this level of infiltration, pipe upsizing would be required along Edgewood and 0.22 MG of underground storage would still be required.

Figure 4-5 – Conceptual Layout of Green Streets Alternative for Edgewood/Snyder

Alternative 2: Conveyance Improvement and Storage

The model was used to evaluate a storage improvement alternative, as shown in **Figure 4-6**. Pipe upsizing would be provided along Martha Avenue, Snyder, and Edgewood to address the street flow, and 0.64 MG of storage volume would be required. Siting for a specific storage location was beyond the scope of this evaluation, but the open area between Stadium Blvd. and the existing Pioneer High School retention basin is shown as the general location assumed for the modeling analysis.

Figure 4-6 – Conceptual Layout of Storage Alternative for Edgewood/Snyder

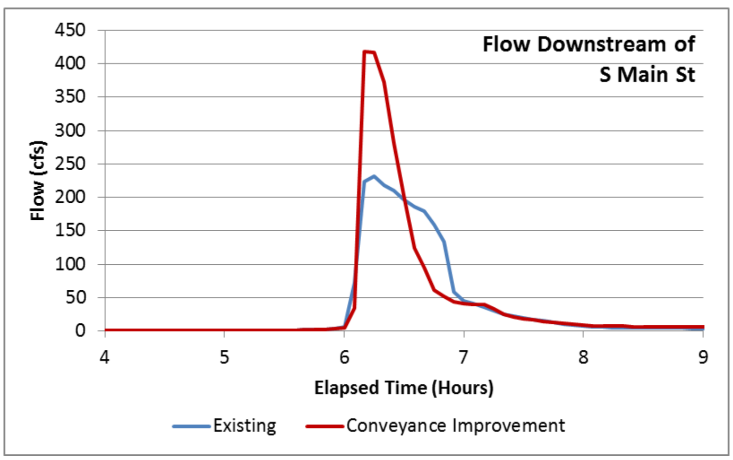
Alternative 3: Conveyance Improvement and Relief

In this alternative, the conveyance improvements are made in the neighborhood and the increased flows are bypassed around the Pioneer High retention basin, since this facility is already at its capacity. This option is shown in **Figure 4-7**.

Figure 4-7 – Conceptual Layout of Conveyance Alternative for Edgewood/Snyder

During the 10% AEP storm, the conveyance improvements would primarily move street overland flow into the expanded pipe system. Moving these flows downstream more quickly would nearly double the peak flows and would impact the performance of the stormwater ponds on the University of Michigan golf course, as shown in **Figure 4-8**. A 54" diameter relief pipe would be needed for this option and the total length of pipe upsizing would be 6,900 LF.

Figure 4-8 – Flow Hydrograph Comparison for Conveyance Alternative at Edgewood/Snyder



Recommendation

The recommended solution for Edgewood/Snyder is the local conveyance and storage alternative as shown in **Table 4-3**. This approach would reduce properties affected by flooding in the 10% AEP storm by 15 properties and would reduce the risk of structure impacts by 6.

Table 4-3 – Recommended Edgewood/Snyder Option

Alternative	Probable Cost
Green Streets + Engineered Storage	$7.0m - $7.9m
Conveyance Improvement + Engineered Storage	$3.5m - $4.1m
Conveyance Improvement + Relief Pipe	$2.5m - $2.9m

Evaluation Matrix Criteria	
System Influence/Capacity	15 parcels w/ improved drainage; 6 structures at reduced risk of flooding
Water Quality	2% reduction in peak flow; no change in volume
Funding	$4.1m capital cost; $10K annual O&M cost
Level of Service (LOS)	LOS improves from 50% AEP storm to 10% AEP storm
Other Criteria	Opportunities for upstream BMPs in future; improved vehicle access; partnership potential with AAPS, UM

Other considerations for this recommended alternative include coordination with the upcoming West Stadium improvements project and potential local storage at the Edgewood/Snyder intersection, especially if the church parking lot at the southeast corner could be utilized.

The City should also consider a long term phasing approach where the local flooding issue at Edgewood/Snyder is addressed first, with other neighborhood improvements addressed in the future. While it would not immediately address the 10% AEP storm, this approach may be the most feasible and cost-efficient. This approach would likely include the following steps:

1. Upsize pipe across W. Stadium at Edgewood to provide outlet capacity
2. Provide local storage at Edgewood/Snyder intersection or south of Stadium Blvd. to reduce peak flows through storage and infiltration.
3. Evaluate street flooding impacts versus Green Streets impacts as road reconstruction projects are completed in the future.

iii. Park Place Apartments

The stormwater system problem at this location is caused by both the pipe size and the surface grading, which prevents an overland flow pathway. Under existing conditions, the pipe capacity is reached during the 50% AEP storm, and surface flooding begins to appear at the 20% AEP storm or larger. Surface flooding affects the lower level units of the apartment building located at the eastern edge of the property, as shown in **Figure 4-9**.

Figure 4-9 – Existing conditions results for Park Place Apartments (10% AEP, 12-hour storm)

Alternative 1: Infiltration BMPs

Because this is a private property, a Green Streets approach was not considered. Instead, the infiltration volume needed to allow the existing system to convey the 10% AEP storm was calculated. 0.93 MG of infiltration would be required, which would be difficult to achieve in this area, due to limited space and unknown soil infiltration capacity. This alternative would require significant property owner cooperation, as most of the infiltration area is located outside of the City's drainage easement.

Alternative 2: Detention Storage

Surface flooding can be controlled in the 10% storm with some pipe upsizing at the bottom of the parking lot area, and underground detention in the open area at the eastern edge of the property. This alternative is feasible but would require work outside of the City's existing drainage easement. This option is shown in **Figure 4-10**.

Figure 4-10 – Conceptual Layout for Storage Alternative at Park Place Apartments

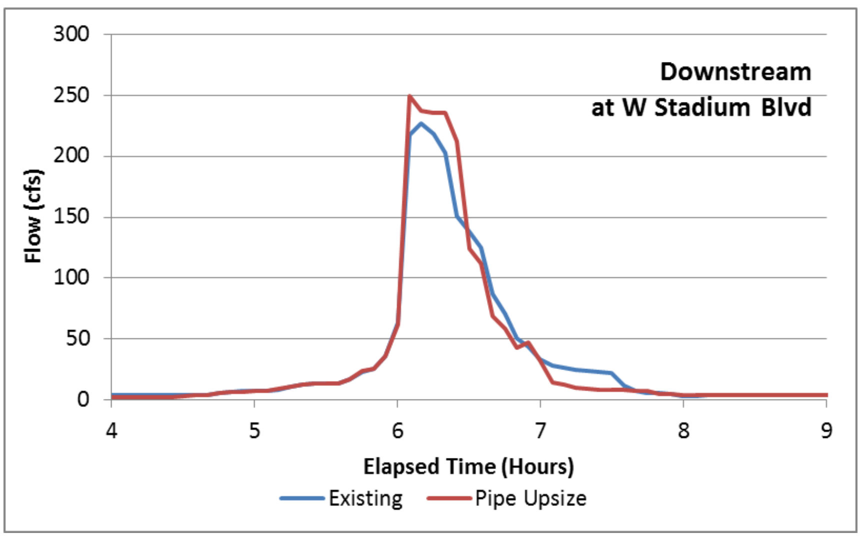
Alternative 3: Conveyance Improvement

Pipe upsizing can be provided to convey peak flows for the 10% AEP storm with only minimal impacts on downstream peak flows. This alternative would require upsizing of storm pipes from Pennsylvania Ave to W. Stadium Blvd, as shown in **Figure 4-11**. By conveying the larger storm, the basement apartment units would be protected up to the 4% AEP 24-hour storm.

Figure 4-11 - Conceptual Layout for Conveyance Alternative at Park Place Apartments

Downstream peak flows at W. Stadium would increase by approximately 10% as shown in **Figure 4-12**. This increase could be mitigated using local storage or BMPs at available locations on the property.

Figure 4-12 – Flow Hydrograph Comparison for Conveyance Alternative at Park Place Apartments



Recommendation

The recommended approach for improvements for the Park Place Apartments would be to provide conveyance improvements, which can be provided within the City's existing drainage easement at a reasonable cost and without any major property impacts. To mitigate peak flow increases downstream, the City should seek a cooperative solution with the property owners to provide infiltration within the property.

iv. Churchill Downs

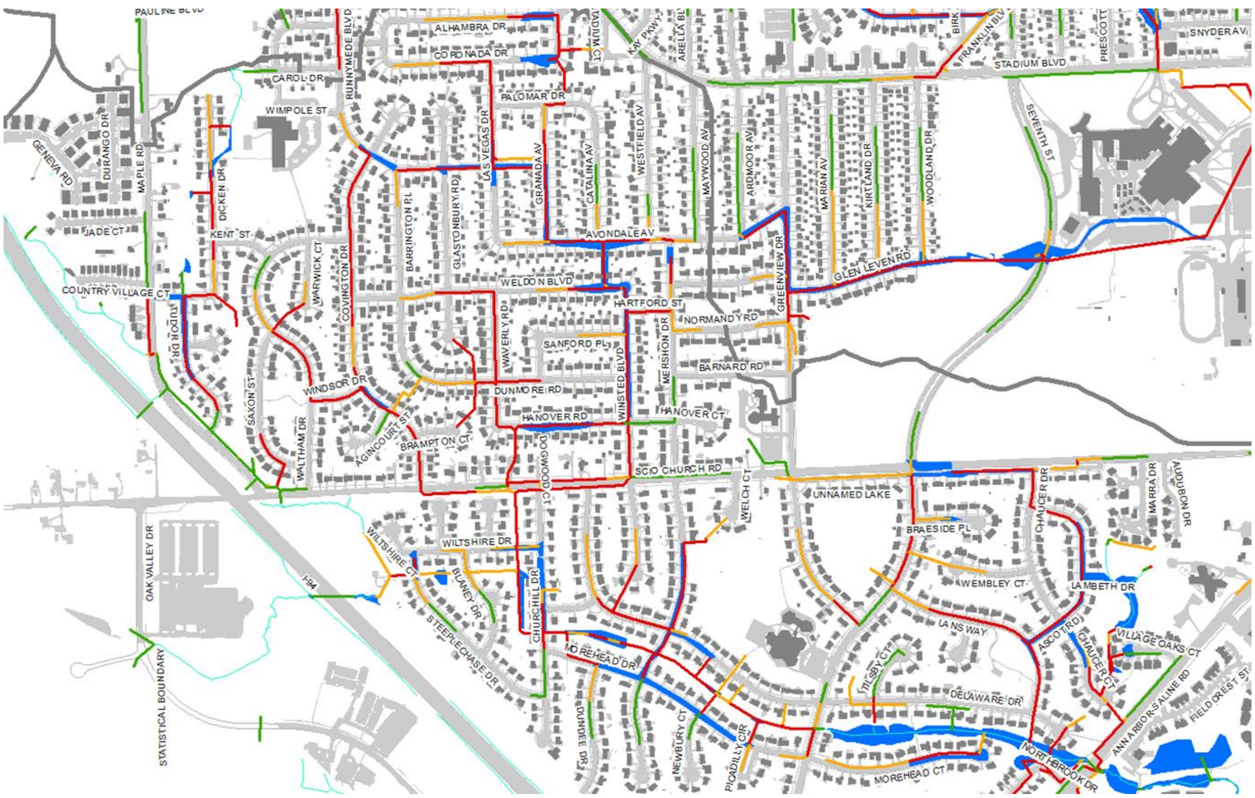
The Churchill Downs subdivision is located in the upper portion of the Malletts Creek watershed. The creek itself is a County Drain from Ann Arbor-Saline Road up to I-94. Local Ann Arbor stormwater pipes collect stormwater flows from the local streets, as well as the Glen Leven neighborhood, which is located north of Scio Church Road. Portions of Pittsfield Township, located west of I-94, also drain into this area.

The County Drain sections of the stormwater system, along with other local pipes, reach their capacity during the 50% AEP storm and surface flooding is predicted in the 10% AEP storm. Stormwater drainage issues in this area were highlighted during the March 15, 2012 event, when surface flooding affected numerous properties and streets.

The Upper Malletts Stormwater Conveyance Study, completed in early 2014, considered potential stormwater improvements to control flooding under a storm equivalent to the March 15, 2012 event. It should be noted that the 10%, 12-hour design standard has a much greater volume than the March 15, 2012 event, which was a shorter duration event, with a peak rainfall duration of only 75 minutes and a total storm duration of less than 3 hours.

Figure 4-13 below shows the existing conditions modeling results for the 10% AEP storm for the Churchill Downs and Lansdowne neighborhoods. Pipe capacity is exceeded for most of the stormwater system and surface flooding is predicted in many locations.

Figure 4-13 – Existing conditions results for Churchill Downs (10% AEP, 12-hour storm)

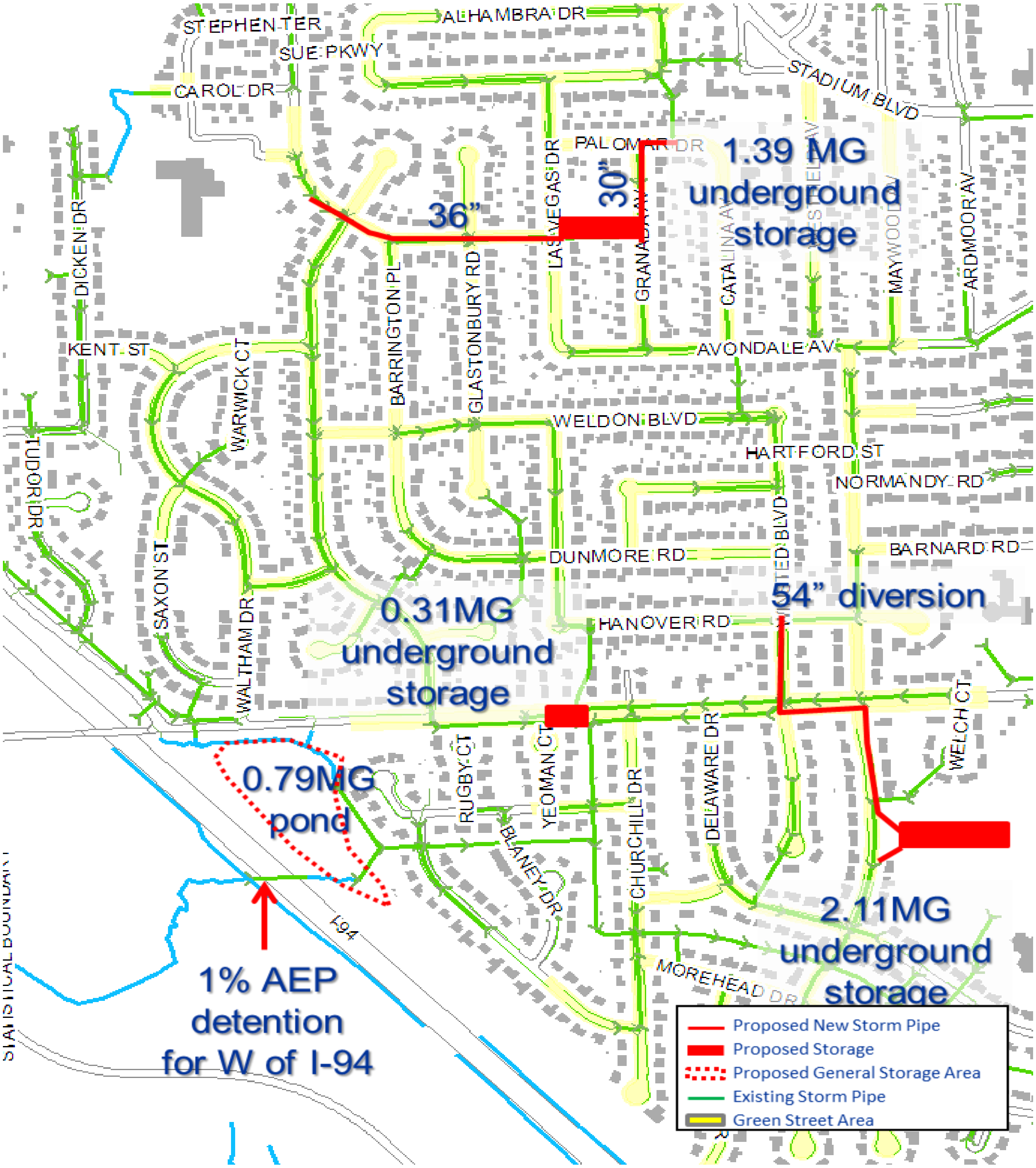


Alternative 1: Green Streets Improvements

Alternative 1 was built around the City's Green Streets policy for runoff control in right of way (ROW) areas. Because of poor soils for infiltration, BMPs were assumed to provide capture and storage of the first flush 1" of ROW runoff. These measures alone were not sufficient to achieve current stormwater design standards, so some conveyance and storage improvements are also included in this alternative.

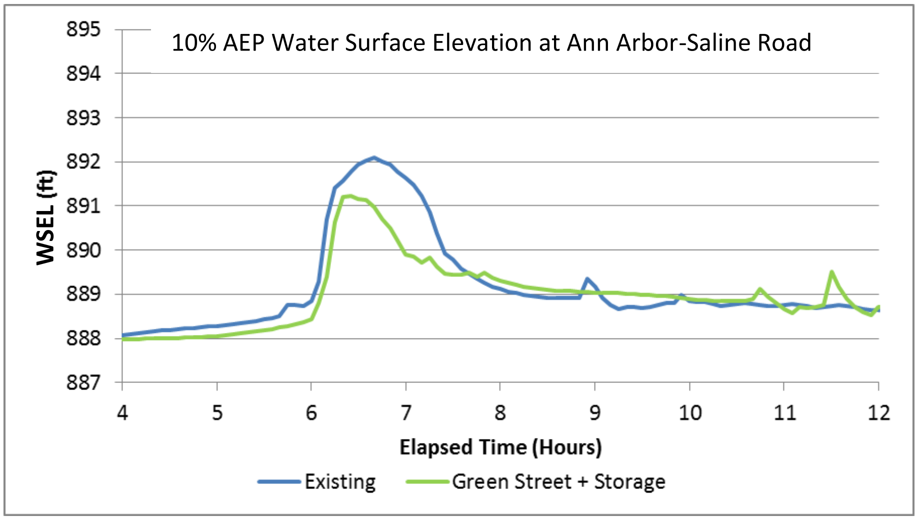
The alternative 1 conceptual layout is shown in **Figure 4-14**. More details on the individual stormwater improvement features are included in alternative 2, which was developed with a focus on stormwater storage.

Figure 4-14 – Conceptual Layout for Green Streets Alternative for Churchill Downs



Using this alternative, the model predicts that the stormwater system would be within capacity during the 10% AEP storm, and the neighborhood outlet pipe at Ann Arbor – Saline Road would have a lower peak water surface elevation, as shown in **Figure 4-15**.

Figure 4-15 – Water Surface Elevation comparison for Green Streets Alternative for Churchill Downs



Alternative 2: Local and Regional Storage

Because of the limited infiltration soils, some conveyance improvements and storage would be required to supplement a BMP-focused alternative, as described in Alternative 1. Taking away the BMPs for ROW runoff, more stormwater flows would need to be conveyed and stored but the overall nature of the pipes and storage facilities would not need to change. As shown in **Figure 4-16**, the same locations are utilized for conveyance and storage improvements, although the sizing does increase.

Notable features of this alternative are as follows:

- Underground storage at Las Vegas Park – Storm drain pipes along Runnymede and Granada would be upsized to convey 10% AEP design flows. These increased flows would be mitigated at Las Vegas Park, where underground storage could be provided without significant impacts on trees or park uses.
- Winsted Blvd. diversion and Lawton Park underground storage – The current drainage pathway for the tributary area north of Winsted Blvd. (including Weldon Blvd., Avondale Ave, and connecting streets to the north) is west along Scio Church Road to the County Drain behind properties on the west side of Churchill Drive. This alternative would divert flows from Winsted Blvd. into a new storm drain pipe that would convey flows to a new underground storage basin at Lawton Park.
- Surface storage pond at Eisenhower Park – Stormwater flows from Maple Road, Tudor Drive, and Dicken Drive are conveyed across Scio Church Road through an open channel pathway in Eisenhower Park and then into the County Drain at Churchill Downs Park. Storage of these flows is recommended in Eisenhower Park in a surface storage pond. Other options for storage could be explored to the north along Maple Road or the I-94 corridor, but Eisenhower Park was

assumed for the purposes of evaluating flow impacts in this study. The small storage area under Scio Church Road west of Churchill could also be eliminated if stormwater flows from Covington were diverted to Eisenhower Park. Under this scenario, the size of the Eisenhower basin would need to be expanded to accommodate additional volume.

- Upstream detention for areas west of I-94 – Currently, a 54" diameter pipe brings flow from I-94 and Oak Valley Drive under the freeway and into the Churchill Downs neighborhood at Churchill Downs Park. While some properties in Pittsfield Township have stormwater controls, a control basin at the freeway culvert would reduce peak flows into the county drain. This area is outside of the City of Ann Arbor so any infrastructure improvements would have to be designed and constructed in cooperation with the Washtenaw County Water Resources Commissioner, the Michigan Department of Transportation (MDOT), and Pittsfield Township.

Figure 4-16 – Conceptual Layout for Storage Alternative for Churchill Downs

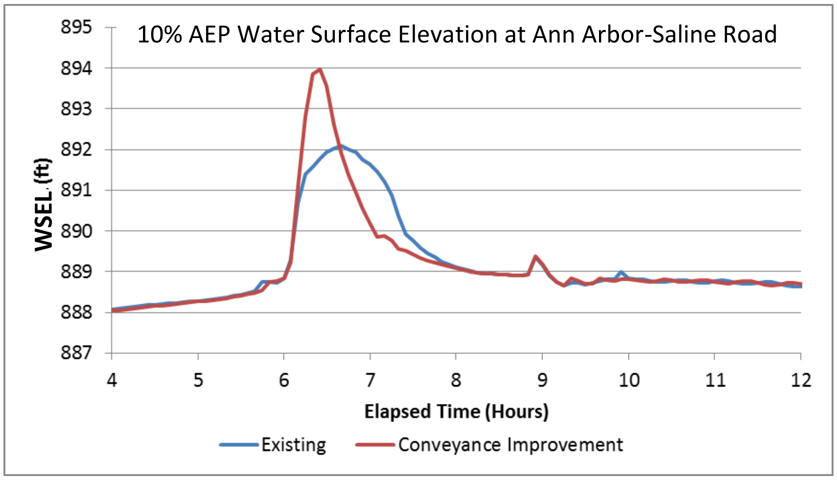
Alternative 3 – Conveyance Improvement

The stormwater model was used to evaluate an alternative focused around increased conveyance capacity. Starting with Runnymede Blvd., Palomar Drive, and Granada Avenue, larger pipes would be installed to convey the flows predicted for the 10% AEP storm, as shown in **Figure 4-1**7. Following the main flow pathway along Avondale, Weldon, Winsted, and Scio Church, the pipe size would be increased to 54" and then 72" diameter. Once the County Drain is reached, the predicted flows would require a parallel relief storm pipe of 72" to 84" in diameter. With limited space in the backyard areas, the relief pipe would likely need to be installed along Churchill Drive, Delaware Drive or Morehead Drive.

Figure 4-17 – Conceptual Layout for Conveyance Alternative for Churchill Downs

With the increased conveyance capacity along the primary drainage pathway, peak flows during the 10% AEP storm would be increased by nearly 100% and the peak water surface elevation at the neighborhood outlet at Ann Arbor – Saline road would increase by 2 feet, as shown in **Figure 4-18** below.

Figure 4-18 – Water Surface Elevation Comparison for Conveyance Alternative at Churchill Downs



Recommendation

Because of the soil characteristics in this area, a BMP-focused alternative cannot achieve 10% AEP stormwater management without some conveyance and storage facilities. The incremental cost of increasing the sizes of these facilities to handle the stormwater makes the storage-focused alternative the best solution for this study area, as shown in **Table 4-4**.

Table 4-4 – Recommended Churchill Downs Solution

Alternative	Probable Cost
Conveyance Improvement + Regional Storage + Green Street	\$27m - \$31m
Conveyance Improvement + Regional Storage	\$14m - \$16m
Conveyance Improvement	Not feasible; Increases flooding

Evaluation Matrix Criteria	
System Influence/Capacity	54 parcels with improved drainage; 7 structures at reduced risk of flooding
Water Quality	28% decrease in peak flow, no change in volume
Funding	\$16m capital cost; \$25k annual O&M cost increase
Level of Service	LOS improves from 20% AEP storm to 10% AEP storm
Other Criteria	Improved vehicle access; Low-to-medium soil infiltration; Possible partnership with Pittsfield Twp., MDOT;

While the total cost of the improvements is high, the different features can be implemented selectively to achieve improved stormwater system performance. The recommended improvements should be prioritized as follows to provide the greatest impacts on flows and on locations with predicted surface flooding:

1. Winsted Blvd. diversion and Lawton Park underground storage - This storage basin and the associated flow diversions and conveyance upgrades would have the greatest impact on flooding locations south of Scio Church Road. However, it would also be the most costly ($7M - $8M) due to the size of the underground storage required.

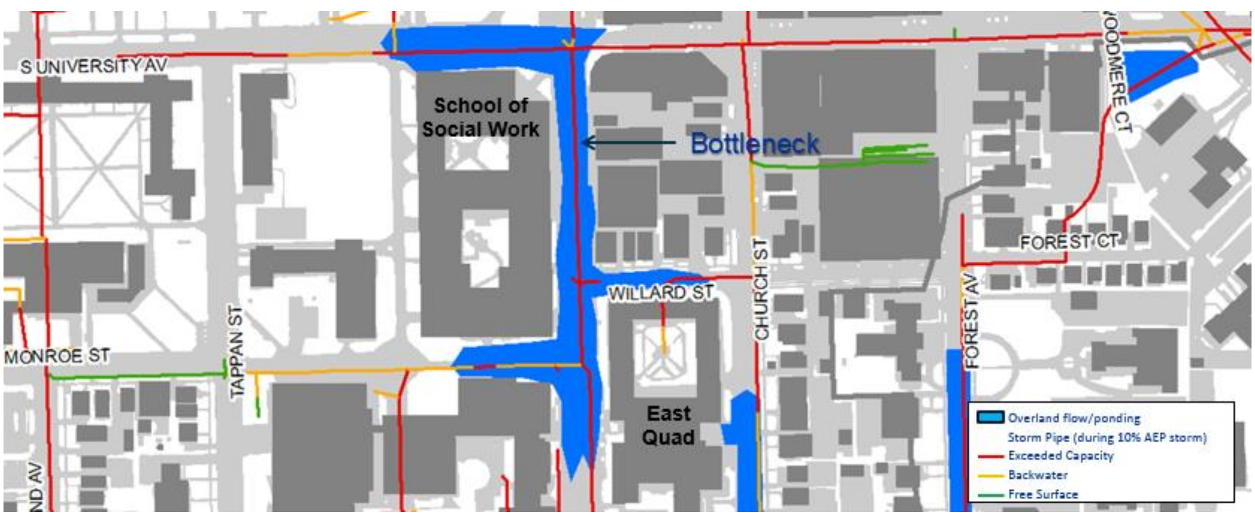
2. Surface storage pond at Eisenhower Park – Taken by itself, this storage feature has a less significant impact on stormwater system performance and flooding because of its smaller volume, but it would be much less costly, and would be necessary to eliminate flooding in Churchill Downs. Depending on how flows from Covington Drive and from west of I-94 are handled, this feature is estimated to cost $1.5M - $2M.

3. Underground storage at Las Vegas Park – This feature would primarily reduce street flooding and overland conveyance along Runnymede and Avondale and would not significantly reduce flooding in the Churchill Downs area. With an estimated cost of $5.5M - $6M, this element of the storage alternative is only recommended in order to bring the entire study area to a consistent design standard.

v. East University/South University

Street flooding is predicted along East University Avenue and South University Avenue during the 10% AEP storm as shown in **Figure 4-19** below. This surface flooding was verified during the June 2013 storm.

Figure 4-19 – Existing conditions results for East University (10% AEP, 12-hour storm)

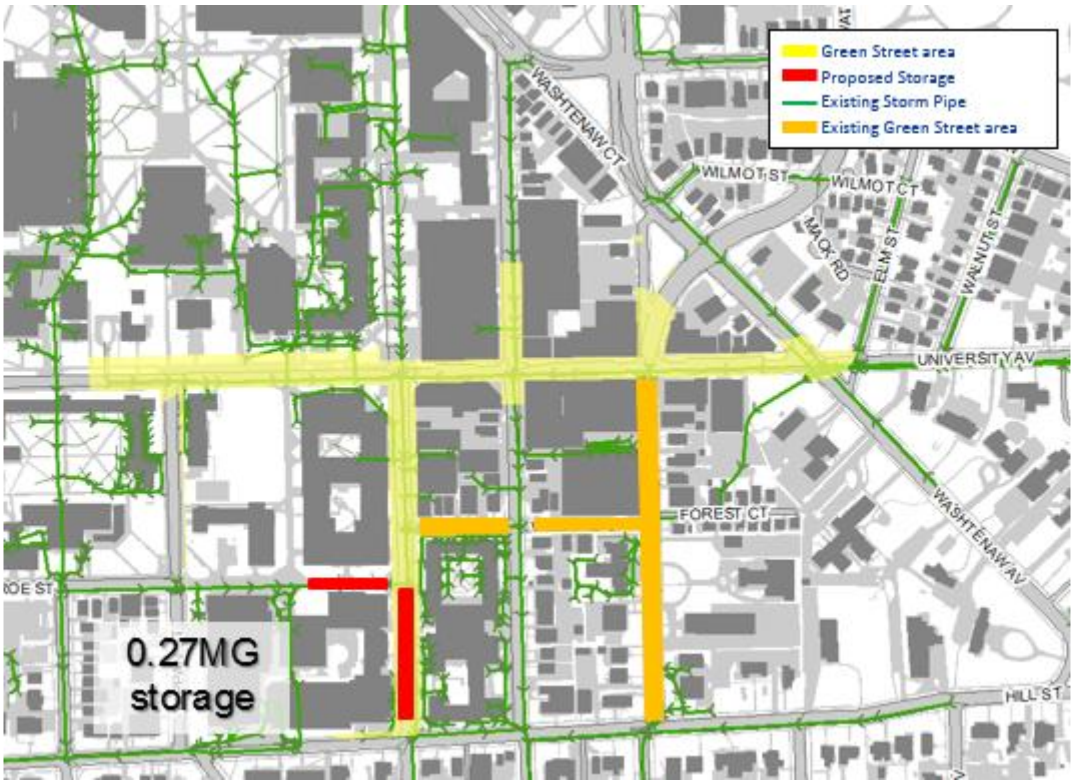


The stormwater pipe size along East University Avenue between South University and Willard is particularly undersized, causing a bottleneck that reaches its capacity during the 50% AEP storm. In addition to the predicted street flooding, below-grade loading docks and building entrances at the University of Michigan's School of Social Work Building are affected.

Alternative 1A – Engineered Storage and Green Streets

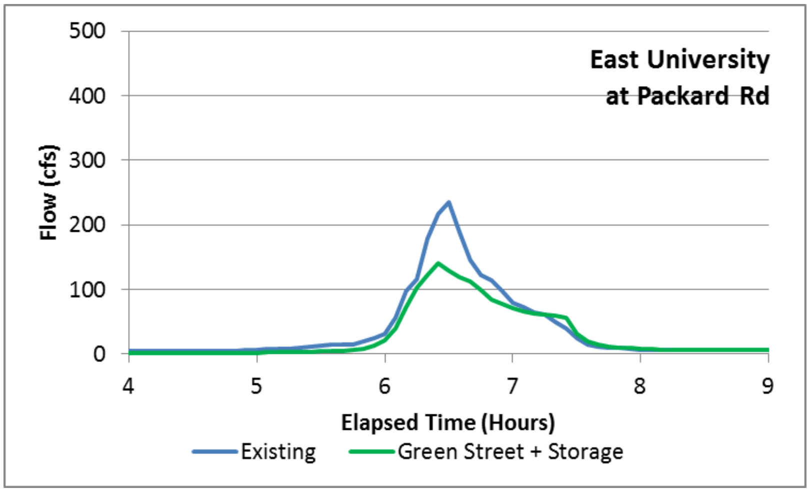
To complement streets that have already been reconstructed according to the Green Streets policy, this alternative considered implementation of the policy along similar streets in the tributary area to this study location. Washtenaw Avenue was not included because it is an MDOT roadway. Streets east of Washtenaw were not included because they are not likely to be on the same reconstruction schedule as the streets west of Washtenaw. With these assumptions for BMP implementation, some localized stormwater storage along the Monroe Pedestrian Mall and under East University north of Hill would be required to meet the 10% AEP design standard. This conceptual layout is shown in **Figure 4-20**.

Figure 4-20 – Conceptual Layout for Green Streets Alternative for East University



The model evaluation of this alternative indicates that flows would be reduced significantly at the neighborhood outlet where East University meets Packard Road, as shown in **Figure 4-21**.

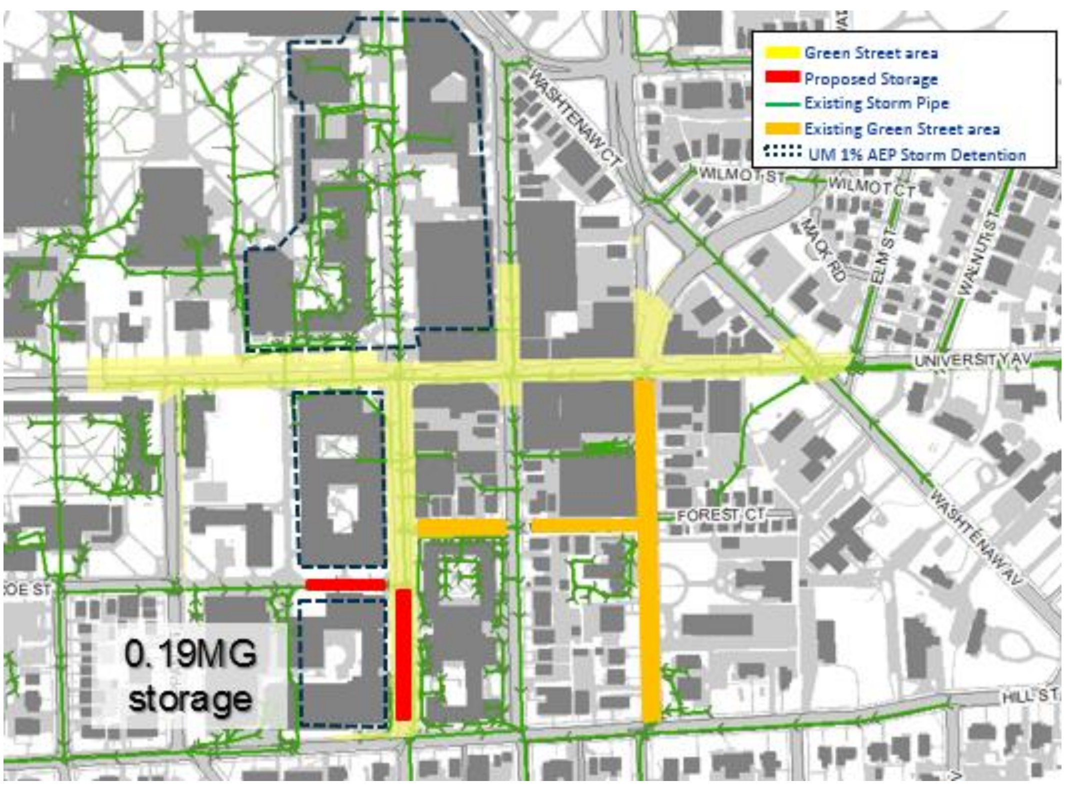
Figure 4-21 – Flow Hydrograph Comparison for Green Streets Alternative for East University



Alternative 1B – Engineered Storage and Green Streets with UM 1% AEP Detention

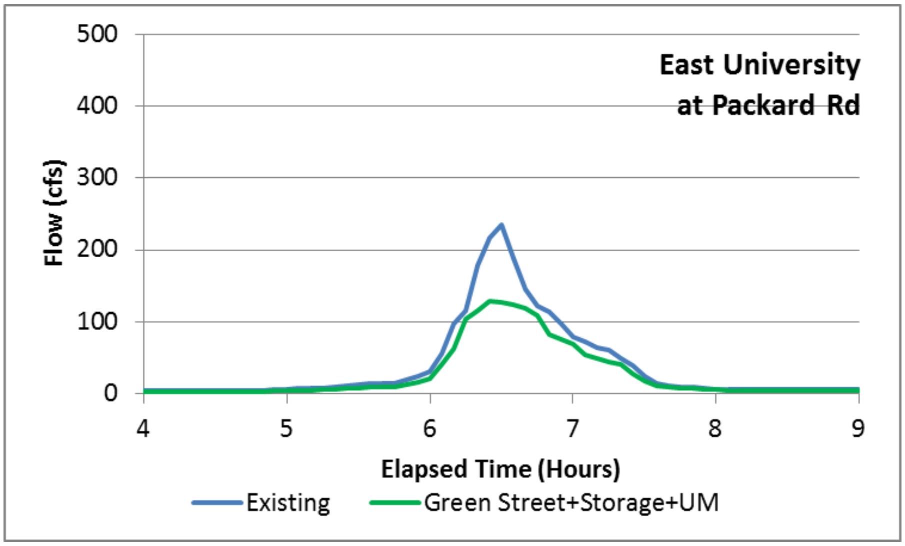
As a point of comparison for the relative impacts of ROW stormwater runoff and University property runoff, this alternative includes the same ROW improvements as Alternative 1A, but also includes 1% storm detention for University of Michigan properties located in the tributary area to this study location, as shown in **Figure 4-22**. This detention requirement would be consistent with the requirements for a new development in Washtenaw County.

Figure 4-22 – Conceptual Layout for Green Streets/UM Detention Alternative for East University



As shown in **Figure 4-23**, there would be some slight reductions in flows and volumes (when compared to alternative 1A) and the storage volume required at Monroe Mall and under East University would be reduced by 30% to 0.19 MG.

Figure 4-23 – Flow Hydrograph Comparison for UM Detention Alternative for East University

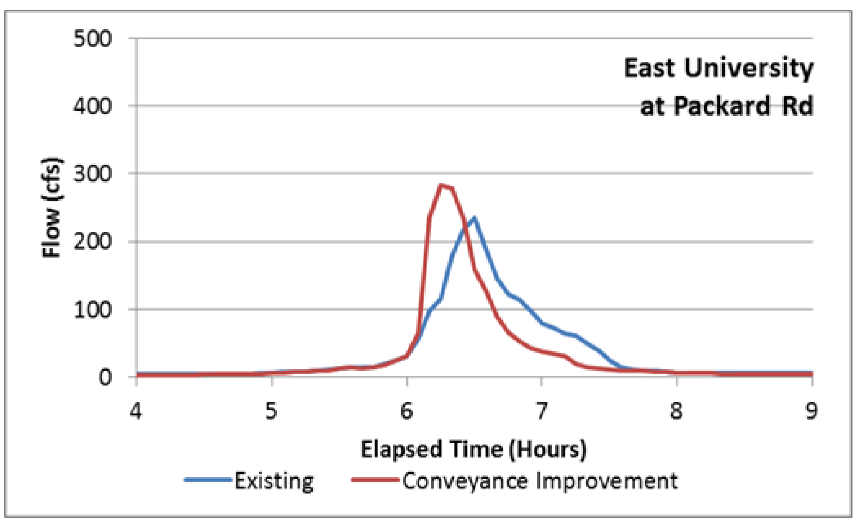


Alternative 2 – Conveyance Improvement

The model was used to evaluate a conveyance improvement for the East University study area, but with no local storage location to mitigate the increased flow, this option is not feasible. **Figures 4-24** and **4-25** show the conceptual layout and resulting flow hydrograph for this alternative.

Figure 4-24 – Conceptual Layout for Conveyance Alternative for East University

Figure 4-25 – Flow Hydrograph for Conveyance Alternative for East University



Recommendation

The Green Streets improvements in combination with local storage are recommended for this study area. Partnering with the University of Michigan to further reduce flows through local stormwater management initiatives would reduce the storage volume requirements and should be pursued.

Table 4-5 – Recommended East University/South University Solution

Alternative	Probable Cost
Green Streets + Engineered Storage	$3.4m - $3.8m
Green Streets + Engineered Storage + UM 1% AEP Storm Detention	$3.2m - $3.6m
Conveyance Improvement	$1.8m - $2.9m

Evaluation Matrix Criteria	
System Influence/Capacity	2 structures with below grade loading docks at reduced risk of flooding
Water Quality	50% decrease in peak flow; some reduction in volume
Funding	$3.6m capital cost; $17k annual O&M cost increase
Level of Service	LOS improves from 50% AEP storm to 10% AEP storm
Other Criteria	Meets sustainability goals; improved vehicle access; Possible partnership with UM

vi. Mulholland Avenue

This study location reviewed the Murray-Washington branch of Allen Creek between S. Seventh Street and W. Washington. Surface flooding has been reported historically at Mulholland Avenue and at Murray Avenue, with surcharging through the manhole on Mulholland reported most frequently. The model analysis of existing conditions showed that the pipe capacity in this area is reached during the 50% AEP storm, with a flat pipe between Murray and Washington causing the worst bottleneck. Once surface flooding begins at either Mulholland or Murray, overland flow is predicted between houses and in backyards. This is shown in **Figure 4-26**.

Figure 4-26 – Existing conditions results for Murray-Washington Drain at Mulholland Avenue

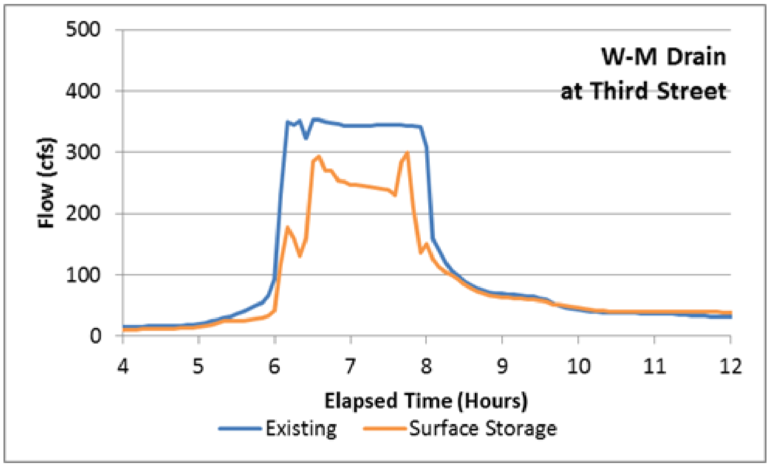
Alternative 1A – Surface Storage at Slauson Field

Reduction of peak flows with upstream storage was evaluated for this location. In alternative 1A, a shallow surface storage basin would be constructed in the open field adjacent to Slauson Middle School, between Eighth Street and Crest Avenue, as shown in **Figure 4-27**. A control structure would be required to restrict flows at this location and direct flow into the surface storage, and a low berm would be required along Eighth Street to retain the flows in the field area. Other considerations to limit the duration of flooding and to allow for proper post-event drainage would also be needed.

Figure 4-27 – Conceptual Layout for Surface Storage Alternative for Mulholland Ave

The location would allow for up to 2.2 MG of storage with an average depth of 2 feet. This volume would delay the downstream peak by approximately 2 hours, reducing peak flows by 15%, as shown in **Figure 4-28**.

Figure 4-28 – Flow Hydrograph for Surface Storage Alternative for Mulholland Avenue



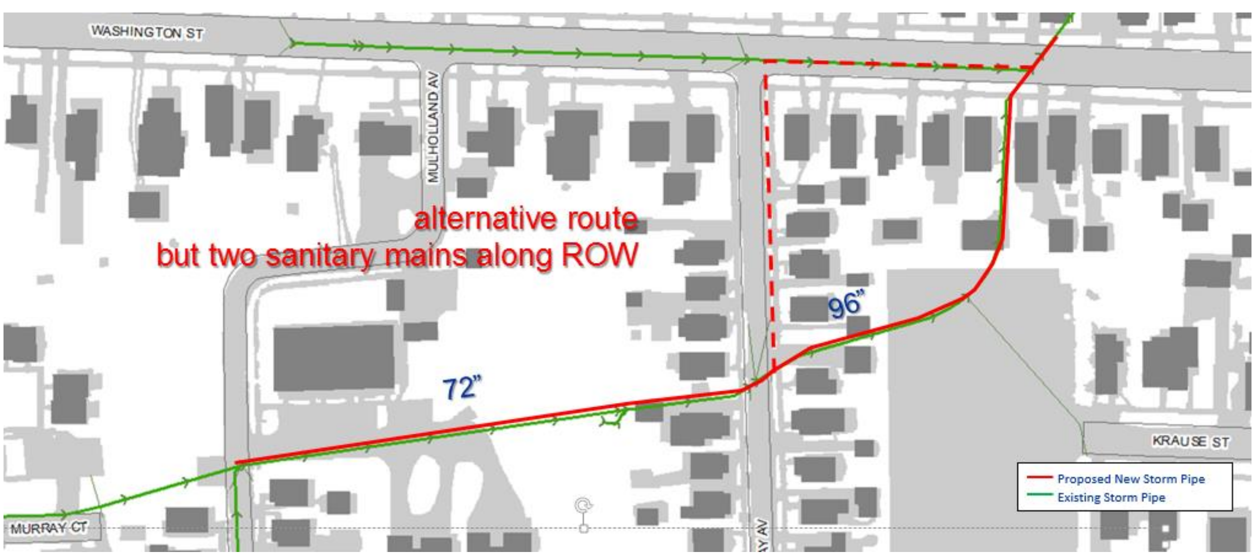
Alternative 1B – Above Grade Storage Tank

This alternative would be similar to Alternative 1A, but it would put the storage volume into an above grade storage tank near Crest Avenue. This would avoid issues with open surface storage but would take up space that is currently used for soccer, sledding, and other recreational activities. Impacts on flows would be similar to what is shown for Alternative 1A.

Alternative 2 – Conveyance Improvements

To address the localized flow restrictions, pipe upsizing could be performed between Mulholland and Washington to meet the 10% design storm flow rates. As shown in **Figure 4-29**, this would require construction in an older neighborhood, without much room to work, and large-diameter pipes. An alternative routing along Murray to Washington could be considered but would also likely have conflicts with other existing utilities, including sanitary sewer mains.

Figure 4-29 – Conceptual Layout for Conveyance Alternative for Mulholland Ave



The conveyance alternative would provide a significant improvement in reducing the frequency of surface flooding, from the 20% storm to the 2% AEP storm. However, peak flows would increase downstream in the Allen Creek watershed so mitigation of the peak flows would be recommended. This could potentially be accomplished with a storage basin at the University of Michigan Parking lot at the end of Krause Street but the proximity to the 100-year floodplain, and potentially high groundwater levels, could limit the capabilities of this site. A storage volume of 1.6 MG would be needed for the 10% AEP storm, which would be difficult to achieve.

Recommendation

Despite the potential difficulties of establishing an agreement to utilize an Ann Arbor Public Schools property, the location characteristics and available space at Slauson Middle School make the surface storage alternative the recommended solution. The probable cost for this location is potentially lower than what is shown in **Table 4-6** below since the engineering work and construciton required would be minimal, but there would also be significant unknowns with requirements for safely and sustainably storing stormwater at the site and for providing operations and maintenance support.

Table 4-6 – Recommended Mulholland Drive Solution

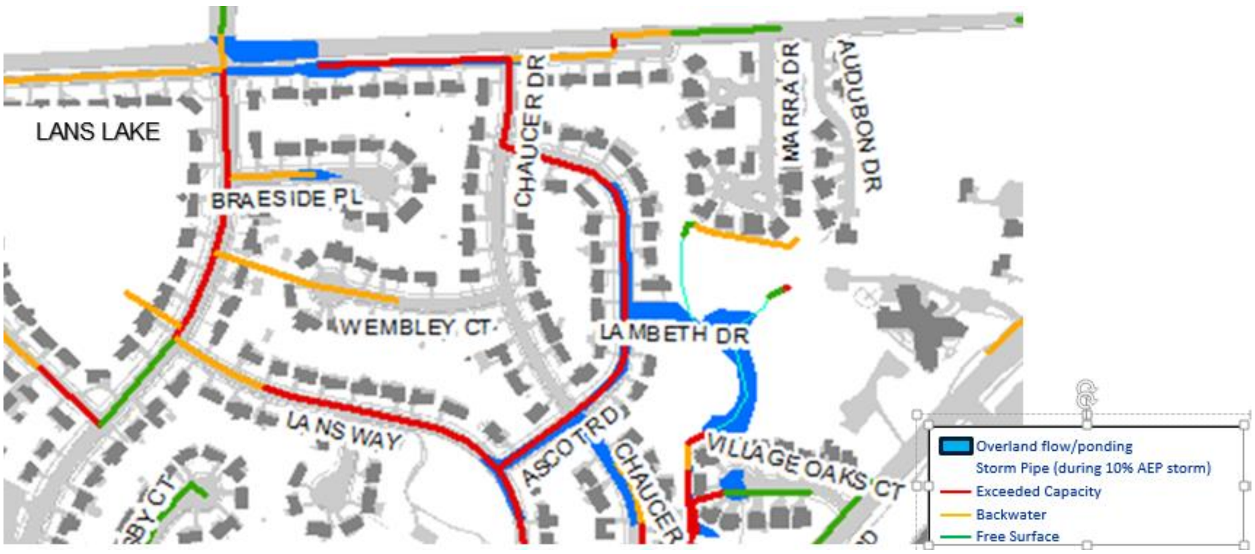
Alternative	Probable Cost
Surface Storage (AAPS property)	$1.7m - $1.9m
Above-Grade Engineered Storage	$7.8m - $9.3m
Conveyance Improvement	$3.0m - $4.1m

Evaluation Matrix Criteria	
System Influence/Capacity	12 parcels w/ improved drainage; 7 structures at reduced risk of flooding
Water Quality	15% decrease in peak flow; possible reduction in volume if infiltration BMPs are included
Funding	$1.9m capital cost; potential increase in annual O&M cost
Level of Service	LOS improves from 20% AEP storm to 10% AEP storm
Other Criteria	Safety concerns with stormwater in a recreational space; Partnership with AAPS; Supports sustainability and master plan goals for Allen Creekshed

vii. Scio Church / S. Seventh Street

Although this study location is also part of the Upper Malletts Creek area (along with the Churchill Downs area described in section 4-C.4), the stormwater system is impacted by a separate tributary area so it was analyzed separately. The existing stormwater conveyance system reaches capacity during the 50% AEP storm and surface flooding is predicted for the 10% AEP storm, for which overland flow is predicted along Scio Church Road, Ascot Road, and Chaucer Court. These model findings were validated during storms in 2010 and 2012, when surface flooding was experienced along Scio Church Road, Ascot, and Chaucer, as shown in **Figure 4-30**. Some of these issues are also inter-related with overland flow in the Village Oaks-Chaucer drain that can be affected by overland flow down Lambeth Drive.

Figure 4-30 – Existing conditions results for Scio Church / S. Seventh Street



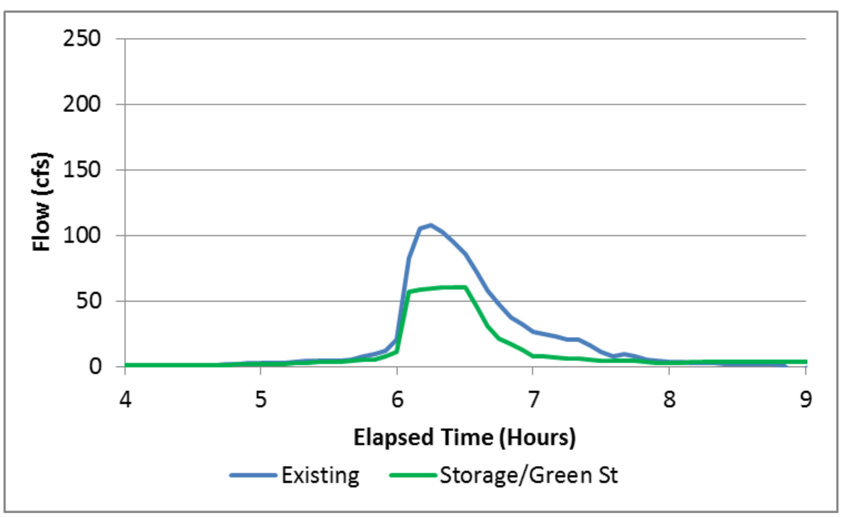
Alternative 1 – BMPs / Engineered Storage

Because the soils in this area are not expected to be favorable for infiltration, any ROW stormwater BMPs would function like local storage features. Specific locations were not identified for this study as the impacts on the stormwater conveyance system would be similar and the most efficient locations could be determined based on soil investigations and with input from the public. Potential storage locations are shown in **Figure 4-31**, and these could be located under the pavement, in the ROW, or in adjacent properties depending on all design considerations. Portions of the storage volume could also be moved to other portions of the tributary area as roadway reconstruction projects are implemented.

Figure 4-31 – Conceptual Layout for Storage Alternative for Scio Church / S. Seventh Street

The impacts of this alternative on flow rates were evaluated at the outlet of the Lans Way storm sewer into Malletts Creek. As shown in **Figure 4-32**, the peak flow is reduced by almost 50% and the volume is released much more slowly over time.

Figure 4-32 – Flow Hydrograph for Storage Alternative for Scio Church / S. Seventh Street



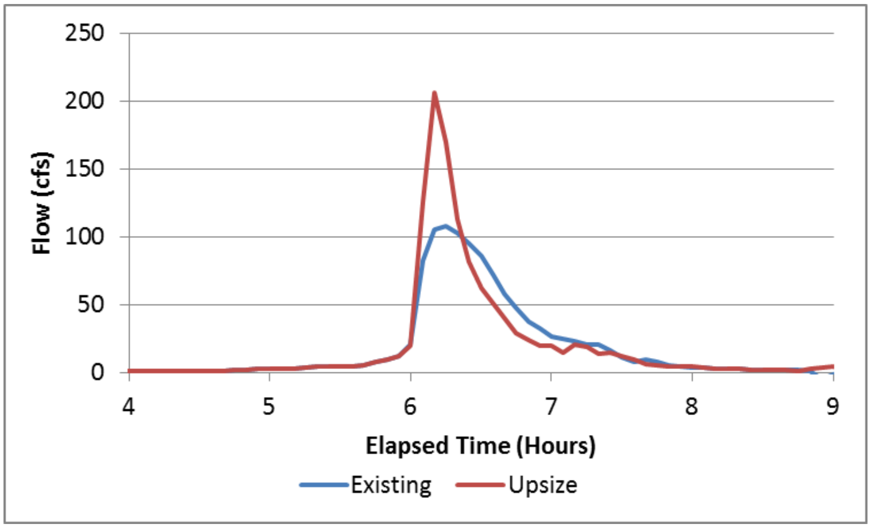
Alternative 2 – Conveyance Improvements

For comparison with the local storage option presented in alternative 1, pipe upsizing would be required along South Seventh, and all of Lans Way and all of Ascot Road to meet 10% AEP storm design standards, as shown in **Figure 4-33**.

Figure 4-33 – Conceptual Layout for Conveyance Alternative for Scio Church / S. Seventh Street

While the cost of this alternative would be lower, it would increase peak flows to Malletts Creek by nearly 100%, as shown in **Figure 4-34**.

Figure 4-34 – Flow Hydrograph for Conveyance Alternative for Scio Church / S. Seventh Street



Recommendation

To bring this study area to current stormwater design standards, a combination of engineered localized storage and BMPs could be provided. While this approach is more costly than a pipe upsizing approach, it would have the advantages of reducing peak flows to Malletts Creek, which better aligns with the watershed's Total Maximum Daily Load (TMDL) requirements and with the City's goals for sustainability.

Alternative	Probable Cost
Engineered Storage/BMP	\$2.1m - \$2.4m
Conveyance Improvement	\$1.3m - \$1.7m

Evaluation Matrix Criteria	
System Influence/Capacity	10 parcels at reduced risk of flooding
Water Quality	45% decrease in peak flow
Funding	\$2.4m capital cost; \$12k annual O&M cost increase
Level of Service	LOS improves from 20% AEP storm to 10% AEP storm
Other Criteria	Improved vehicle access; low infiltration potential

viii. Glendale/Charlton

This study area was identified by local residents during the Phase I public meeting series, where it was noted that street flooding and other stormwater and sanitary sewer issues have been experienced during large storms. The existing conditions modeling for the area shows that the stormwater pipes are at capacity during the 50% to 100% AEP storms, but surface flooding is generally limited to street overland flow along Charlton Avenue, where there is no storm sewer currently, and street ponding at low spots on Orchard Street and Glendale Drive. This is shown in **Figure 4-35**.

Figure 4-35 – Existing conditions results for Glendale/Charlton

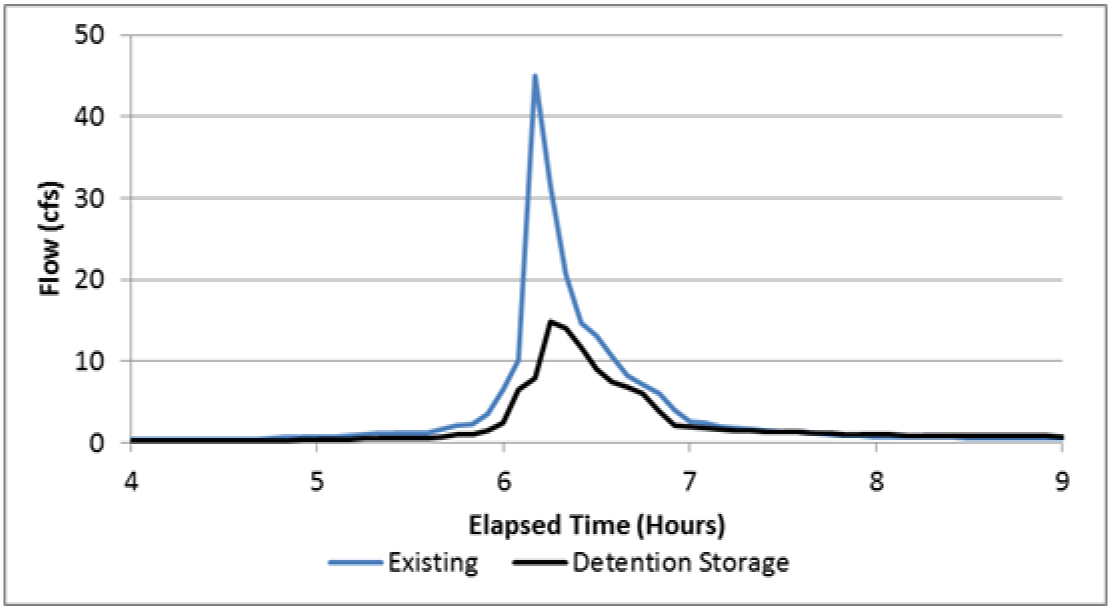
Alternative 1 – Detention for upstream multi-family properties

Because the upstream area has a very small ROW area, when compared to the size of multi-family properties, a ROW BMP option was not considered for this study area. Instead, a redevelopment scenario was considered for the Charlton Apartments and Hillside Terrace properties. This alternative assumes that 1% AEP storm detention would be provided for these two properties, which would align with new development requirements. For the total area of approximately 8 acres as shown in **Figure 4-36**, a storage volume of 0.44 MG would be required.

Figure 4-36 – Conceptual Layout for Upstream Detention Alternative for Glendale/Charlton

The impacts on flows in the downstream stormwater system would be dramatic for this alternative. As shown in **Figure 4-37** below, the detention storage reduces peak flows from 45 cubic feet per second (cfs) to 15 cfs at Glendale Drive. This decrease in peak flows would eliminate street flooding for the study area for the 10% AEP storm.

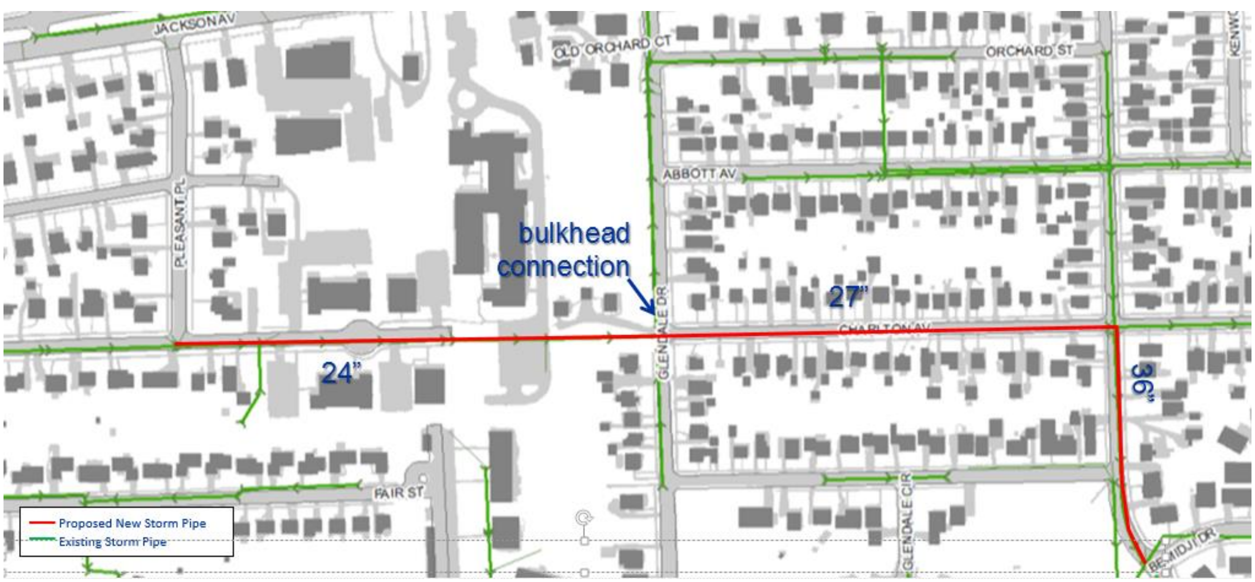
Figure 4-37 – Flow Hydrograph for Upstream Detention Alternative for Glendale/Charlton



Alternative 2 – Conveyance Improvement

This alternative considered an increase in system conveyance capacity by upsizing the existing storm sewer from Pleasant Place to Glendale Drive, bulkheading the current connection to the Glendale Drive storm sewer, and constructing a new storm pipe along Charlton to Virginia Avenue. Pipe upsizing would also be needed along Virginia to Bemidji Drive. This conceptual layout is shown in **Figure 4-38**.

Figure 4-38 – Conceptual Layout for Conveyance Alternative for Glendale/Charlton



The conveyance improvement would generally be re-routing overland flow into a storm pipe so there is no significant change in peak flow in the Murray-Washington Drain.

Recommendation

Either alternative would be feasible and effective at improving the stormwater system performance for the Glendale/Charlton study area. The upstream detention storage would be consistent with the City's sustainability goals and the cost would be the responsibility of the property owners if the improvements can be required as part of property redevelopment. However, to allow comparison with other alternatives and study areas, the overall project cost is shown in **Table 4-7**.

Table 4-7 – Recommended Glendale/Charlton Solution

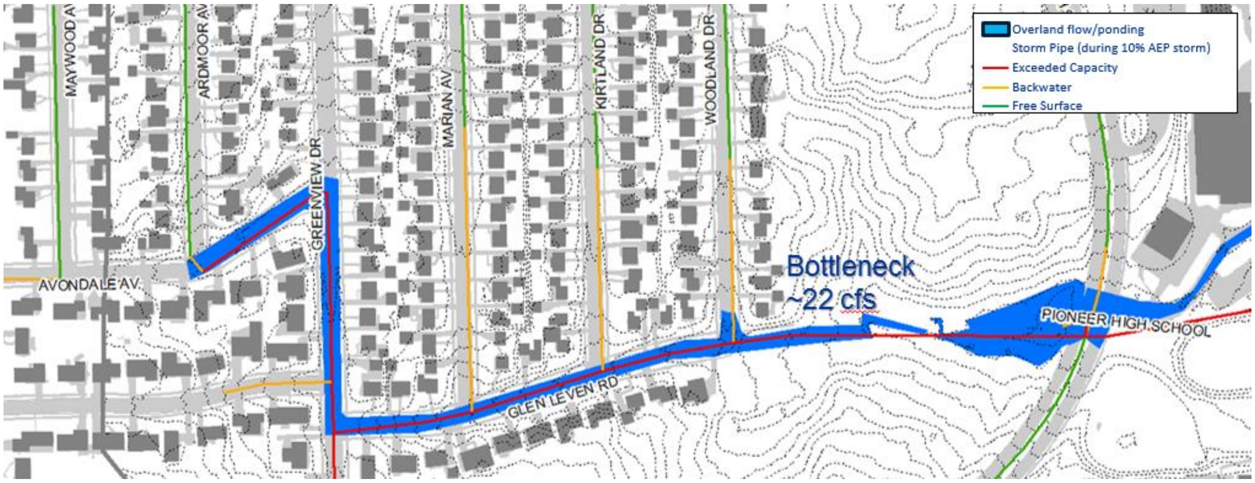
Alternative	Probable Cost
Upstream Detention Storage	\$1m - \$1.2m
Conveyance Improvement	\$0.6m - \$0.7m

Evaluation Matrix Criteria	
System Influence/Capacity	Reduces street flooding only
Water Quality	65% decrease in peak flow
Funding	\$1.2m capital cost; \$6k annual O&M cost increase
Level of Service	LOS improves from 50% AEP storm to 10% AEP storm
Other Criteria	Improved vehicle access; May be addressed by redevelopment requirements

ix. Glen Leven

Existing conditions modeling for the Glen Leven area predicts storm pipe capacity issues for the 50% AEP storm and greater. Surface flooding is predicted for the 10% AEP storm, although the flows are generally confined to the streets and Pioneer Woods as shown in **Figure 4-39**.

Figure 4-39 – Existing conditions results for Glen Leven



A conveyance improvement with surface storage in Pioneer Woods was considered for this area but further consideration is needed to better understand why local observations do not match with the model predictions. It has been noted that sanitary sewer modeling for this area has found more flows than expected so the hydrology for this area, including runoff and inflow/infiltration mechanisms, needs to be better understood before any stormwater improvements are recommended.

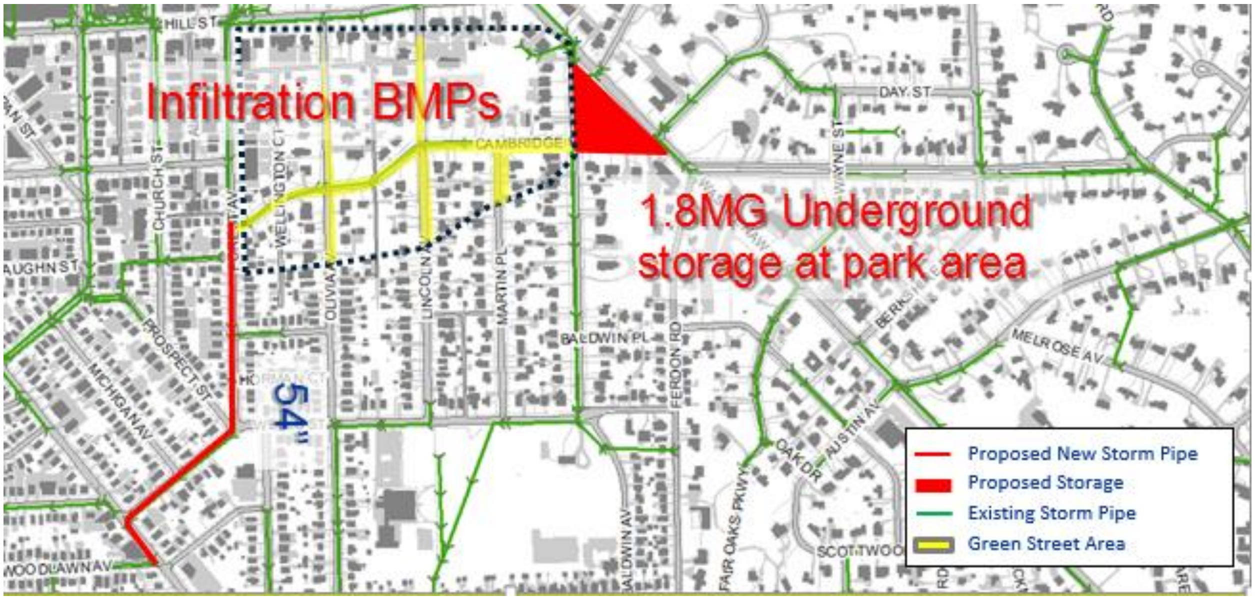
x. Church Street / Cambridge Road

This study area was identified from the existing conditions modeling because the pipe capacity is predicted to be reached during the 50% AEP storm. Street flooding and overland flow is predicted for the 10% AEP storm along Baldwin Avenue, Cambridge Road, S. Forest Avenue, and Church Street, as shown in **Figure 4-40**.

Figure 4-40 – Existing conditions results for Church Street / Cambridge Road

As with the Glen Leven area previously, the street flooding predicted by the model has not been validated by observations. Alternatives are available for both conveyance and storage/BMP improvements (see **Figure 4-41** below) but they would require a significant capital cost and would be addressing a problem that has not been shown to significantly impact properties. No stormwater improvements are recommended for this study area.

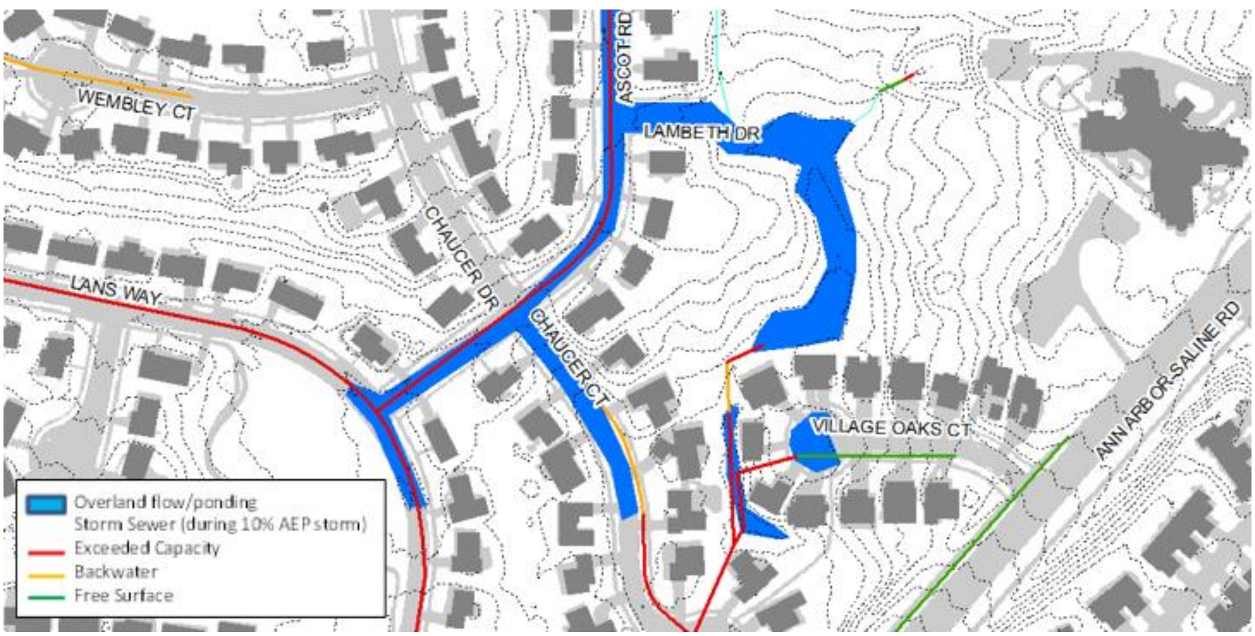
Figure 4-41 – Conceptual Stormwater Improvements Layout for Church Street / Cambridge Road



xi. Village Oaks / Chaucer Court

This location was identified from existing conditions modeling because the pipe capacity is reached during the 50% AEP storm. Backyard flooding between Village Oaks Court and Chaucer Court is predicted during the 10% AEP storm, along with street flooding in the cul-de-sac of Village Oaks Court, as shown in **Figure 4-42**.

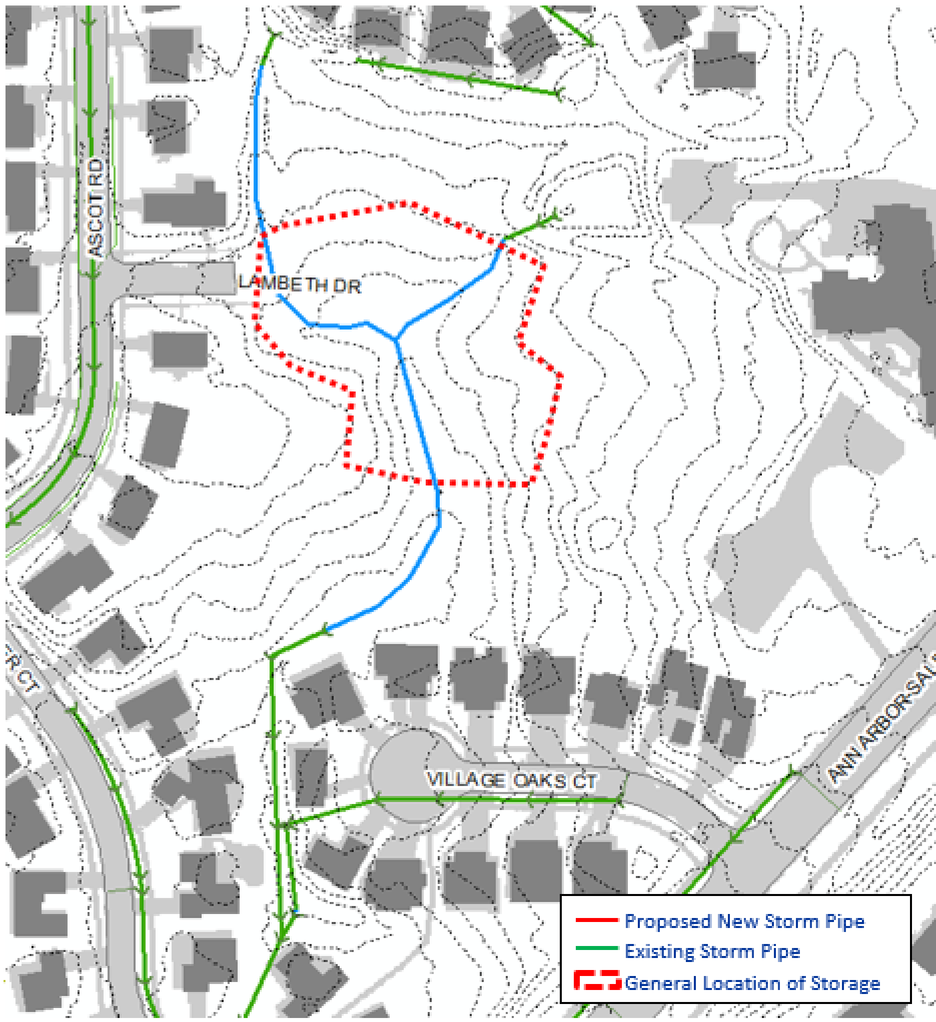
Figure 4-42 – Existing conditions results for Village Oaks / Chaucer Court



A detailed study of this area was performed in 2013 and a regional detention basin was recommended for the area north of Village Oaks Court. The alternatives analysis for this area consisted of verifying the performance of the proposed basin using the current version of the stormwater mode, as shown in **Figure 4-43.**

Under the proposed alternative, the peak flow coming from the basin would be reduced from 40 cfs to 1 cfs. The flows from Village Oaks Court would not be affected but the backyard flooding would be reduced in frequency from the 10% AEP storm to the 2% AEP storm.

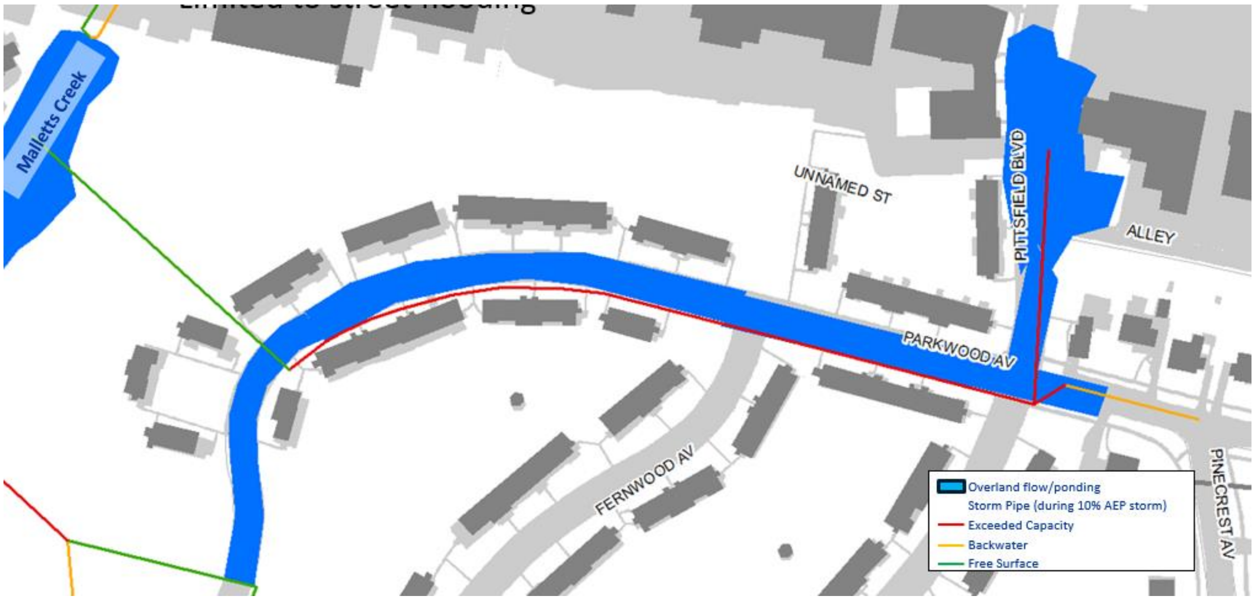
Figure 4-43 – Conceptual Layout for Detention Alternative at Village Oaks/Chaucer Court



xii. Parkwood/Pittsfield Village

This study area was identified during the public meetings in Phase I of the project. Residents reported street flooding during large storms and overland flow into the open space between buildings between Fernwood and Parkwood. The existing conditions modeling showed a pipe along Parkwood with a capacity of less than 3 cfs, which is not sufficient to convey the 100% AEP storm. The model predicts that flooding would be confined to the street area as shown in **Figure 4-44**, but other factors such as inlet blockages could lead to more extensive surface flooding.

Figure 4-44 – Existing conditions results for Parkwood / Pittsfield



Alternative 1 – Conveyance and Storage

Because of the relatively small tributary area, and the capacity issue with the existing pipe, some conveyance improvements are recommended along Pittsfield and Parkwood. Alternative 1 includes the recommended pipe upsizing as shown in **Figure 4-45**, but it also includes a new connection to the surface depression area off of Parkwood Avenue to store excess runoff so flows are not increased to Malletts Creek. The predicted outflow hydrograph is shown in **Figure 4-46**.

Figure 4-45 – Conceptual Layout for Pittsfield/Parkwood Storage/Conveyance

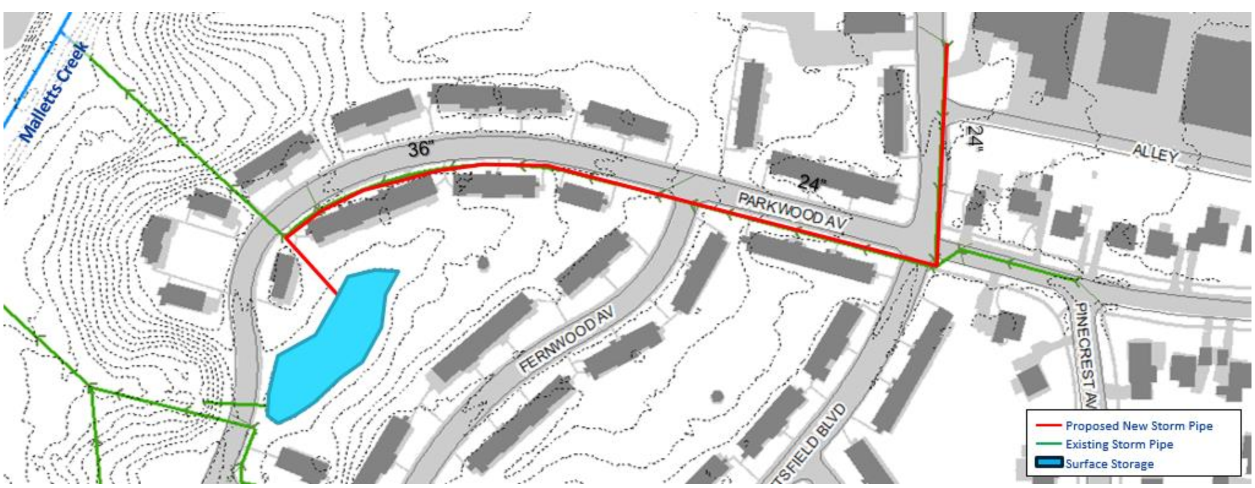
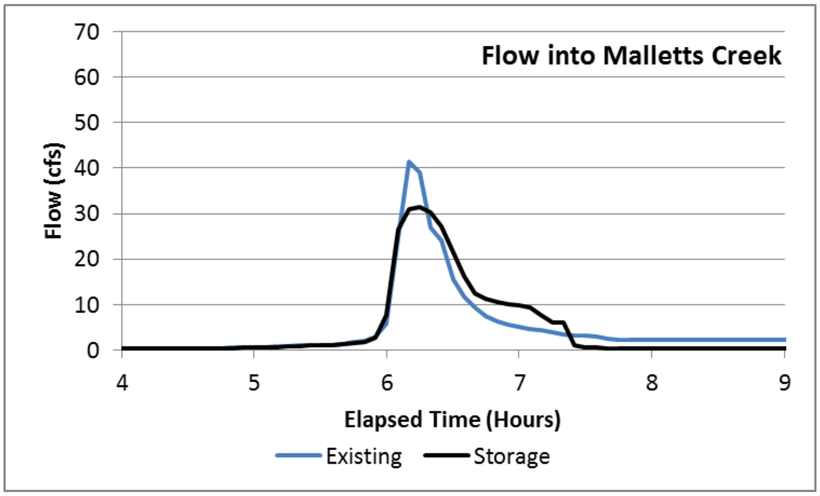


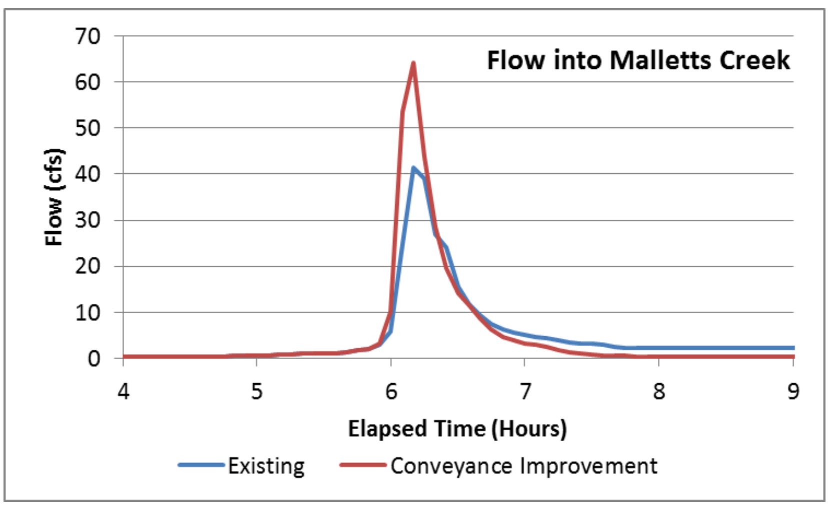
Figure 4-46 – Flow Hydrograph for Conveyance/Storage Alternative at Pittsfield/Parkwood



Alternative 2 – Conveyance Improvement

Alternative 2 would include the pipe upsizing only. This would result in a 50% increase in peak flows to Malletts Creek, although there would be no change in the predicted water surface elevation. This result is shown in **Figure 4-47**.

Figure 4-47 – Flow Hydrograph for Conveyance Alternative at Pittsfield/Parkwood



Recommendation

The property on Washtenaw Avenue between Pittsfield Blvd. and Yost Blvd. contributes approximately 25% of the runoff to this study area so redevelopment of that property with stormwater controls should be a priority. Even with detention at that site, however, pipe upsizing would be necessary along Pittsfield and Parkwood to convey the 10% AEP storm. Either of the proposed alternatives would be effective at addressing the stormwater system performance issues and selection should be made based on the willingness of Pittsfield Village property management to allow surface storage. The surface storage solution in the lawn areas between units could be adapted to other portions of the property to address other stormwater issues. This is presented in **Table 4-8**.

Table 4-8 – Recommended Parkwood/Pittsfield Village Solution

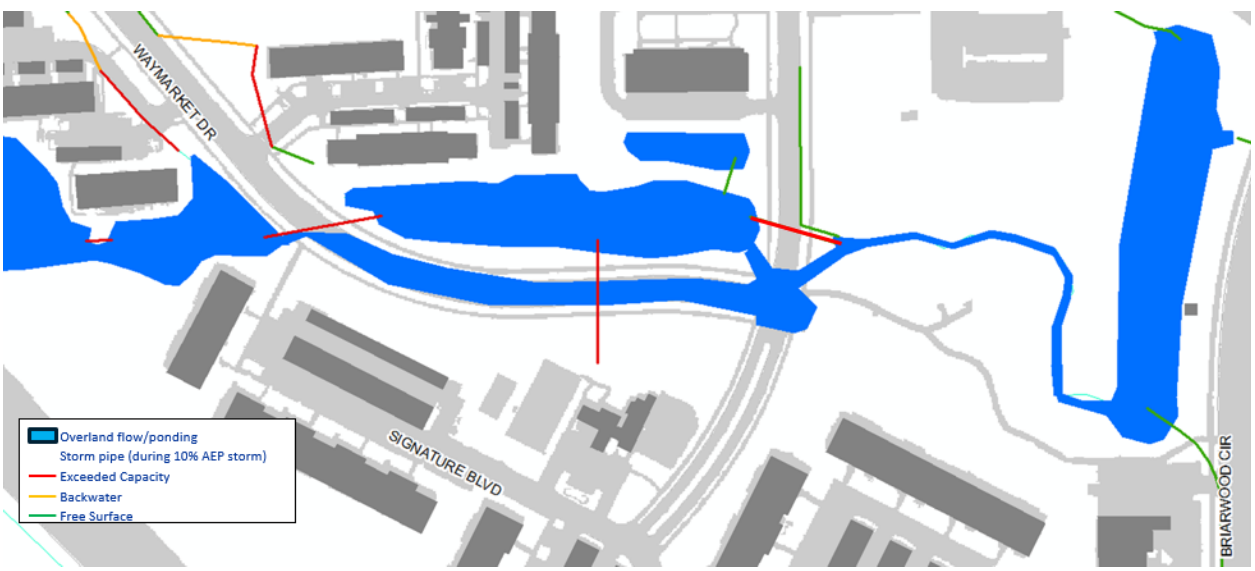
Alternative	Probable Cost
Conveyance Improvement + Surface Storage	\$0.4m - \$0.5m
Conveyance Improvement	\$0.4m - \$0.5m

Evaluation Matrix Criteria	
System Influence/Capacity	Primarily street flooding
Water Quality	25% reduction in peak flow
Funding	\$0.5m capital cost; \$1k annual O&M cost increase
Level of Service	LOS improves from 100% AEP storm to 10% AEP storm
Other Criteria	Potential partnership with Village Co-op; scalable solution

xiii. Signature Drive

This study location was identified from the existing conditions model results screening. The culvert under Signature Drive just north of Waymarket is undersized, causing surface ponding in the intersection and in the detention area to the north of Waymarket Drive during the 10% AEP storm. The surface flooding also affects Waymarket Drive to the west of Signature Drive and other connecting detention basins at nearby properties, as shown in **Figure 4-48**.

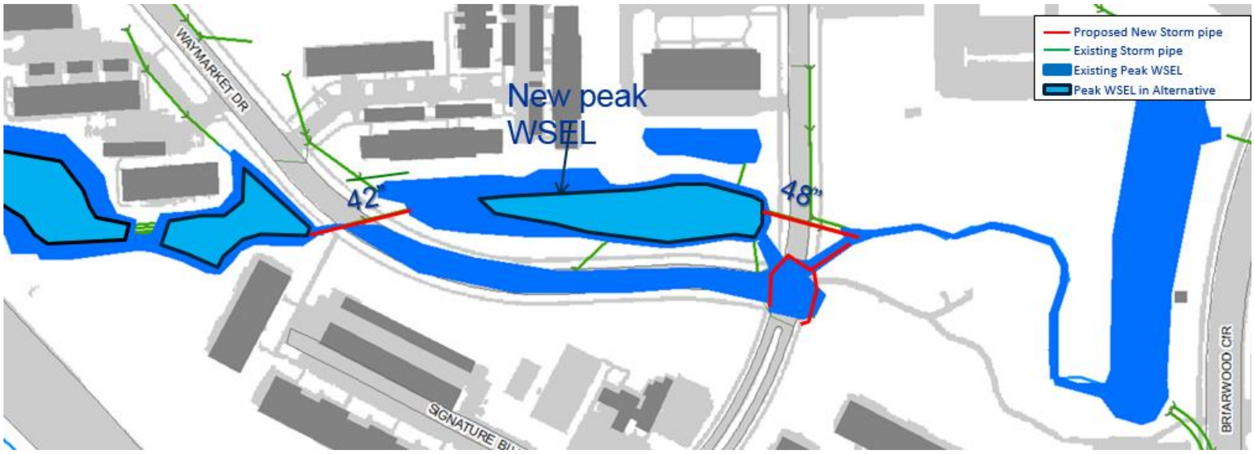
Figure 4-48 – Existing conditions results for Signature Drive



Recommendation

Because the existing detention basins are functioning as designed and the flow restrictions are limited to short pipe sections, a conveyance improvement alternative was the only approach considered for this location. As shown below in **Figure 4-49**, the culverts under Signature Drive and Waymarket Drive should be upsized and new catch basins should be installed at the intersection to convey flows downstream.

Figure 4-49 – Signature Drive Alternative Configuration



The increased flows will be handled by the existing detention pond at Briarwood Circle with a resulting increase in water surface elevation (WSEL) of only 0.1 feet. The street flooding will be eliminated along Signature and Waymarket and the peak WSEL in the existing detention basins will be reduced.

Table 4-9 – Recommended Signature and Waymarket Solution

Alternative	Probable Cost
Conveyance Improvement	$127K - $153K

Evaluation Matrix Criteria	
System Influence/Capacity	Reduces intersection flooding
Water Quality	30% increase in peak flow; no change in volume
Funding	$0.2m capital cost; no increase in annual O&M cost
Level of Service	LOS improves from 20% AEP storm to 10% AEP storm
Other Criteria	

xiv. South Industrial/Packard Road Area

This neighborhood was identified during the existing conditions model results screening, showing up as one of the few areas of the City where the sewer system is at capacity during the 20% AEP, 1-hour storm. While overland flow is predicted starting with the 50% storm in some locations, and during the 10% storm for almost the entire area, these flows are generally confined to the streets. There were not any notable reports of flooding from the residents of this area during the public engagement process, although some City staff noted the area of Harpst/Rosewood/Tremel as a known street flooding location, as shown in **Figure 4-50**.

Figure 4-50 – Existing conditions results for South Industrial Area

Alternative 1 – Green Streets Implementation

Although the soils in this area have low infiltration potential due to clay soil and high groundwater, there is a large upstream tributary area with residential ROW areas that would be suitable for localized storage BMPs. These areas are shown in **Figure 4-51**.

Figure 4-51 – Conceptual Layout for Green Streets Alternative for S. Industrial Area

The reduced runoff resulting from these improvements would minimize street flooding and overland flow for the 20% AEP storm. The pipe capacity would still be exceeded in the 10% AEP storm in most locations. Model results for the Green Streets alternative under the 20% AEP storm are shown in **Figure 4-52**.

Figure 4-52 – Green Streets Alternative Pipe Capacity Results for S. Industrial Area

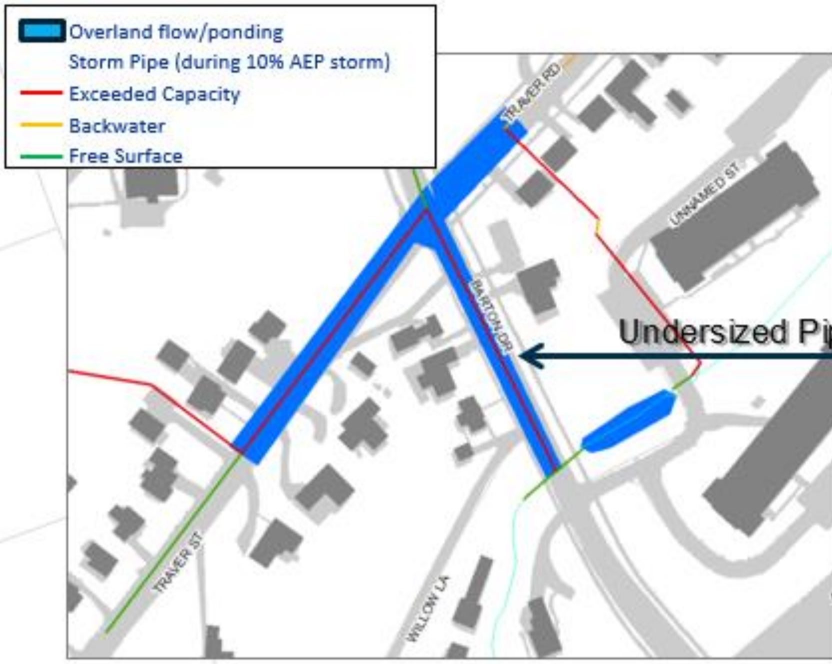
Recommendation

Because of the minimal impacts and the extensive scope of work, this area is not recommended as a priority for stormwater improvements. As conditions allow for Green Streets implementation as part of other neighborhood improvements, however, these efforts should be made to help reduce runoff flows and minimize the frequency of flooding in downstream areas.

xv. Traver/Barton

This study location has one pipe segment along Barton Drive south of Traver Road that was identified as undersized during existing conditions modeling. Currently, the pipe capacity is reached during the 100% AEP storm, and the collection system can be overwhelmed by overland flow coming downhill along Traver. The curbs along Barton and the current placement of catch basins also prevent street flow from leaving the roadway in some locations as shown in **Figure 4-53**.

Figure 4-53 – Existing conditions results for Traver/Barton



Recommendation

Due to surface grades, and a low potential for runoff infiltration, a conveyance alternative is recommended for this location. The existing pipes along Traver and Barton should be substantially upsized from 12” diameter to 30” and 36”, respectively, as shown in **Figure 4-54**. In addition, curb cuts at the Traver Creek crossing should be built to allow for overland drainage into Traver Creek during intense rainfall events. These improvements would have a negligible increase in WSEL and peak flows in Traver Creek. This recommendation is shown in **Table 4-10**.

Figure 4-54 – Conceptual Layout for Conveyance Improvement Alternative for Traver/Barton

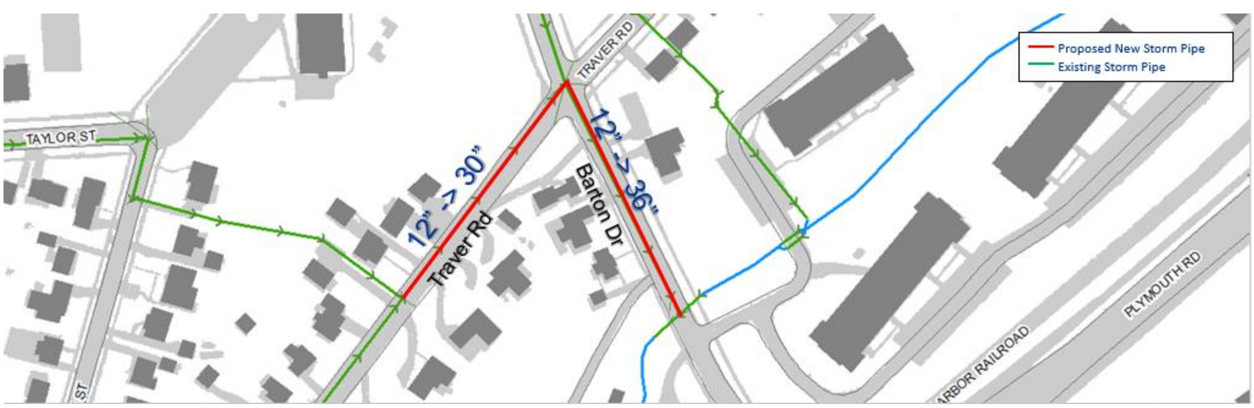


Table 4-10 – Recommended Traver/Barton Solution

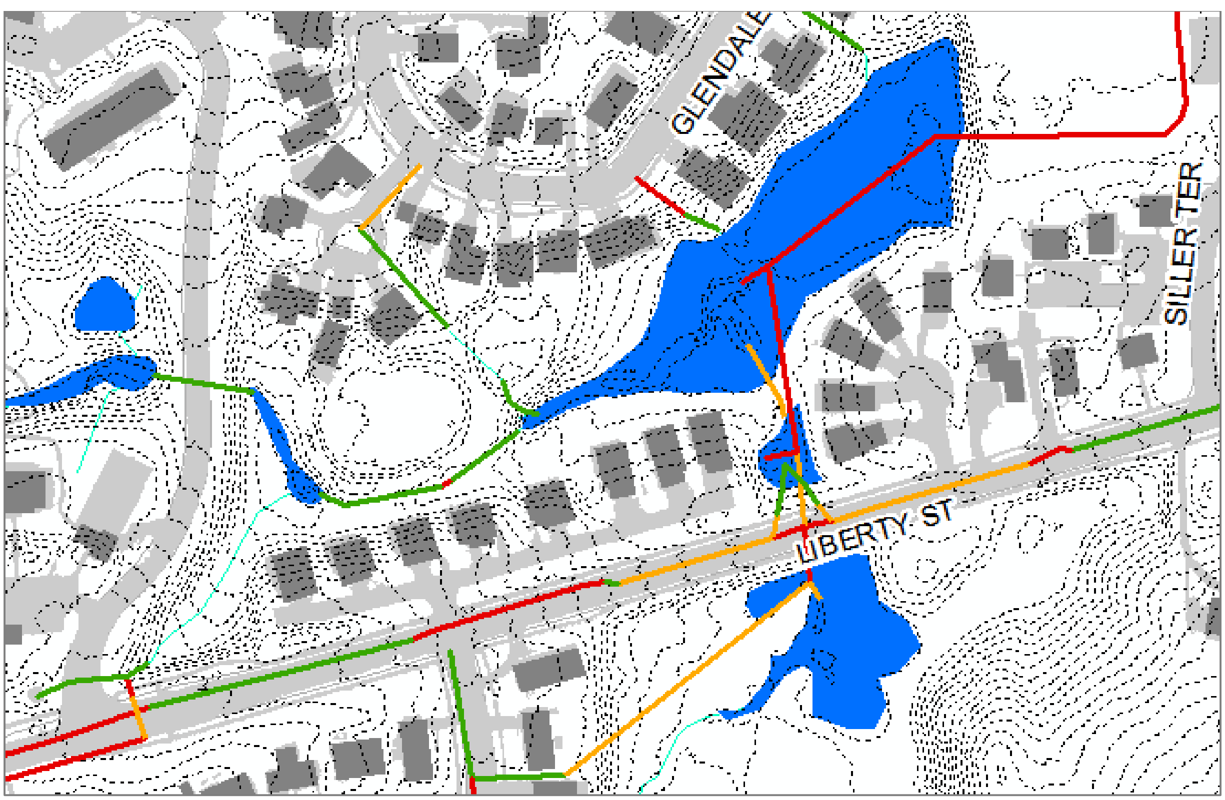
Alternative	Probable Cost
Conveyance Improvement	$200K - $250K

Evaluation Matrix Criteria	
System Influence/Capacity	Reduces roadway flooding
Water Quality	Negligible increase in peak flow
Funding	$0.2m capital cost; no increase in annual O&M cost
Level of Service	LOS improves from 20% AEP storm to 10% AEP storm
Other Criteria	

xvi. Glendale Circle at Virginia Park

Noted in section 4-A, this site was not originally included as part of the preliminary screening since the flooding area is part of an open channel drainage that offers natural detention storage, and structures have not historically been affected. Also, this site is only 3,500 feet upstream of the Mulholland site (**Section 4-C.6**). However, the 54" storm pipe that passes beneath Virginia Park did not have sufficient capacity to handle peak flow during the 20% AEP storm, and some property owners along Glendale Circle have noted that flooding encroaches onto their properties, as shown in the **Figure 4-55**.

Figure 4-55 – Ponding at Wooded Area behind Glendale Circle



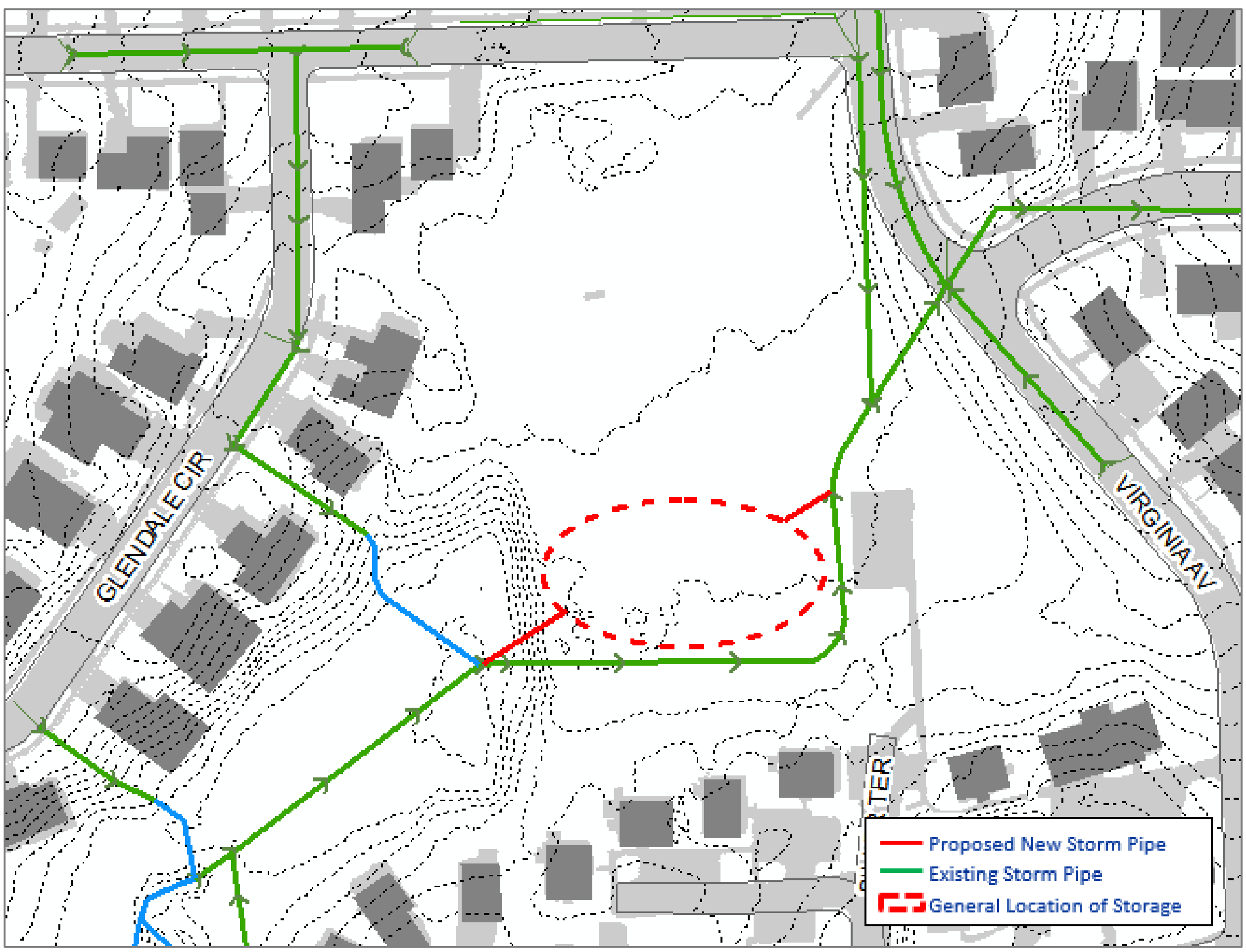
Two storage alternatives were considered for this site. A conveyance improvement alternative is prohibitive because of existing flooding issues at Mulholland Drive downstream. Similar to the analysis for that site, implementation of the Green Streets policy alone would not eliminate flooding issues for the 10% AEP storm. Ponding at the wooded area behind Glendale Circle would drop by 3 inches at most. The current peak flood depth in existing conditions for the 10% storm is predicted to be 4'.

The impacts of other stormwater management activities in tandem with the Green Streets policy are evaluated in Alternative 3.

Alternative 1 – Deep Underground Storage at Virginia Park

This alternative includes moving existing surface storage volume to an underground storage tank at Virginia Park. Due to the significant difference in elevation between the wooded area and Virginia Park, the tank would have to be installed nearly 30 feet below grade. The size of the tank would be 2.7 MG to reduce ponding at the wooded area to below 1 foot in depth. The storage would include a pipe connecting to inlet (88-64592) at the wooded area and a restricted outlet control structure connecting to the adjacent storm sewer. Runoff would be diverted to the storage once the 54" storm sewer downstream is surcharged. **Figure 4-56** shows the general location and configuration of the underground storage tank.

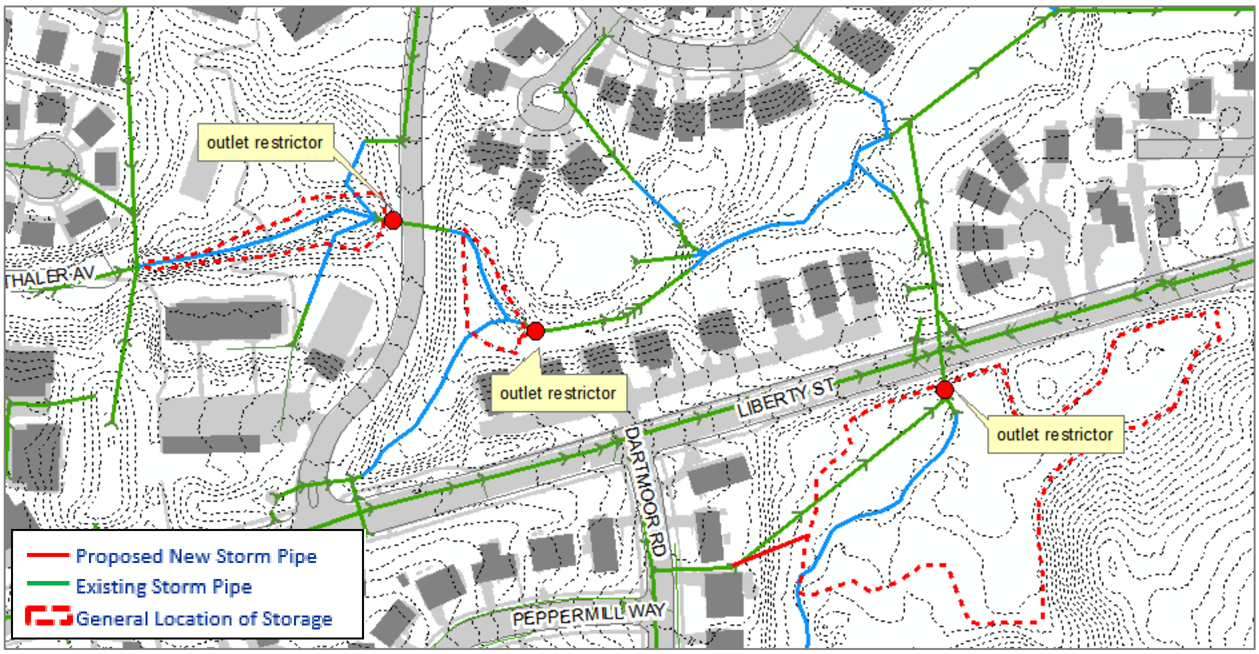
Figure 4-56 – Location of Underground Storage at Virginia Park



Alternative 2 – Surface Storage Upstream

This alternative aims at reducing peak flows entering the Glendale Circle backyard area by detaining additional volumes in open channel storage at Westwood Apartments to the west and in localized depression storage in Eberwhite Woods. Outlet restrictors would be installed at these locations to reduce the overall peak flow to below 270 cfs. **Figure 4-57** shows the locations of the additional upstream storage areas and outlet restriction devices. While this alternative would reduce potential flooding risk for properties on Glendale Circle, it would effectively move surface flooding to other areas. Eberwhite Woods is a sensitive nature area and increasing the frequency and extent of surface flooding could be problematic.

Figure 4-57 – Location of Upstream Surface Storage for Glendale Circle / Virginia Park



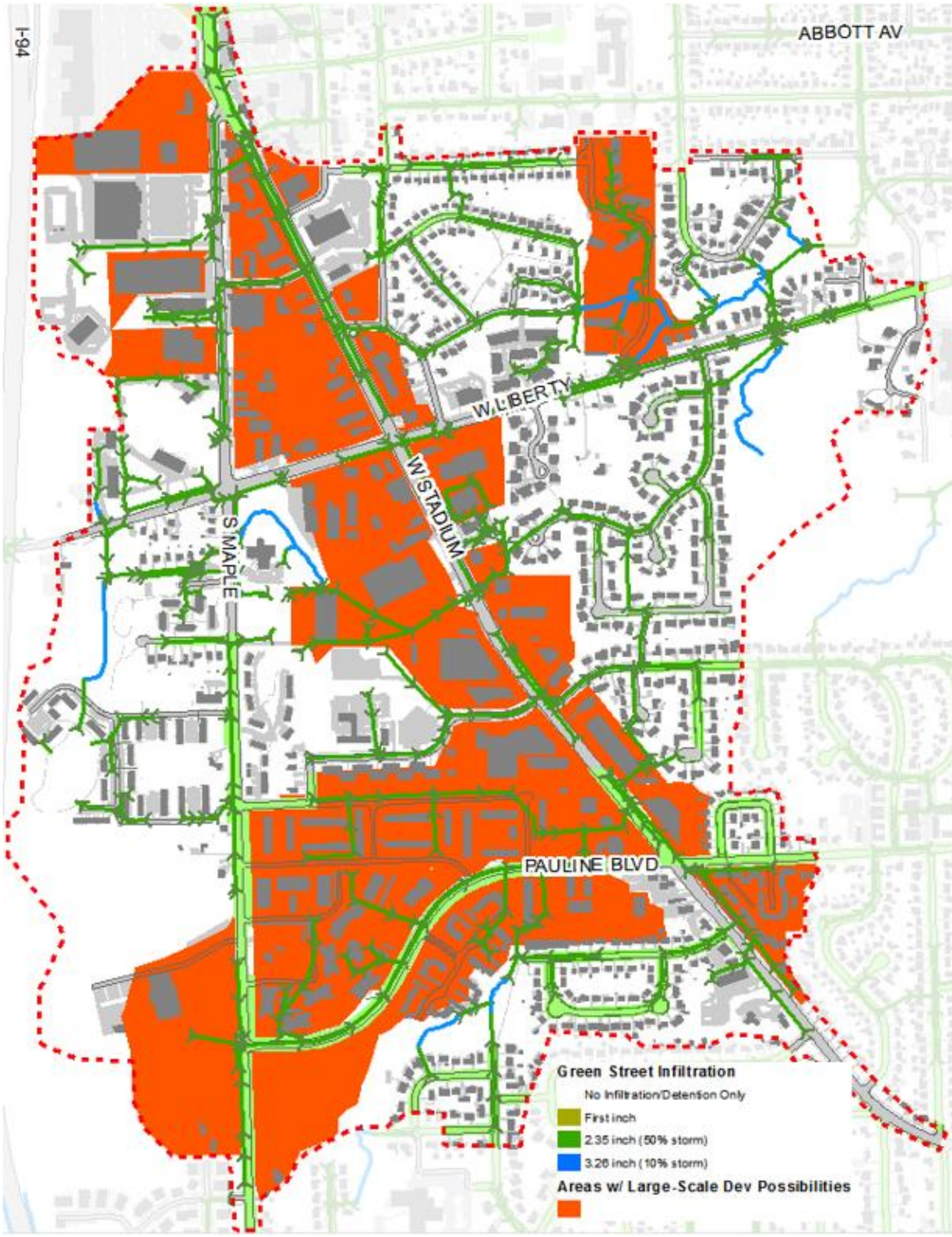
Alternative 3 – Stormwater Management

Ponding at the wooded area could be reduced to less than 6 inches in the 10% AEP storm if the following stormwater management activities were implemented altogether in upstream areas.

- 1% storm on-site detention for all redevelopment of commercial properties on W Stadium Blvd and S Maple Road
- Storage of 1-inch runoff from impervious surface of residential properties
- Green Streets with on-site infiltration for City ROW areas upstream

The most effective of these activities would be the on-site detention for commercial and multi-family residential properties. As shown in **Figure 4-58** below, the W. Stadium and S. Maple/Pauline areas have some large properties that were built without stormwater controls.

Figure 4-58 – Commercial and Multi-Family Residential Parcels with Redevelopment Potential



Recommendation

Each of the storage alternatives would effectively be moving the volume that is currently in the Glendale Circle backyard area to other locations where the storage may have reduced impacts on property owners. Since these other impacts have not been evaluated in detail, a long term stormwater management strategy is the recommended approach to incrementally reduce flooding at this location. These improvements would spread the cost impacts out over time and would benefit both this location and the Allen Creek watershed overall. Where a portion of the surface storage features in alternative 2 are shown to be feasible, these could be implemented to provide additional surface flooding mitigation. The recommended solution is shown in **Table 4-11**.

The stormwater system improvement alternatives presented for this location assumed ponding in the Glendale Circle backyard area would be reduced to less than 1 foot. Further studies should determine the acceptable level of ponding at the backyard to utilize the already-available natural surface storage. The proposed alternatives could all be scaled back accordingly.

Table 4-11 – Recommended Glendale Circle at Virginia Park Solution

Alternative	Probable Cost
Underground Storage	\$10 - \$11m
Surface Storage	\$1.7 - \$1.8m
Long-term Stormwater Management	\$5.1 - \$5.8m + private funding

Evaluation Matrix Criteria	
System Influence/Capacity	Reduces surface flooding that impacts private properties
Water Quality	20% reduction in peak flow
Funding	\$6M capital cost for ROW areas; Additional cost for redevelopment and residential rain gardens
Level of Service	Improves from 20% AEP to 10% AEP storm
Other Criteria	Stormwater management meets sustainability goals; partnership opportunities with private property owners

xvii. Westgate and Maple Village Redevelopment

During review of existing conditions model results, it was suggested that the impacts of detention for properties with large areas of impervious surface should be considered. In the Allen Creek watershed, the Westgate and Maple Village shopping centers were built prior to stormwater detention requirements, and as a result have large roof areas and parking lots that discharge to the stormwater system without any runoff controls. In total, the impervious area of these two parcels is greater than 50 acres in size.

The existing conditions model results for the stormwater network in the Westgate and Maple Village shopping centers are shown in **Figure 4-59**.

Figure 4-59 – Existing conditions results for Westgate/Maple Village

For this evaluation, the model was adjusted to include 1% AEP storm detention for these parcels. The northern portion of Westgate (which drains to the north) would require a detention volume of 0.91 MG. Maple Village would require a detention volume of 2.82 MG.

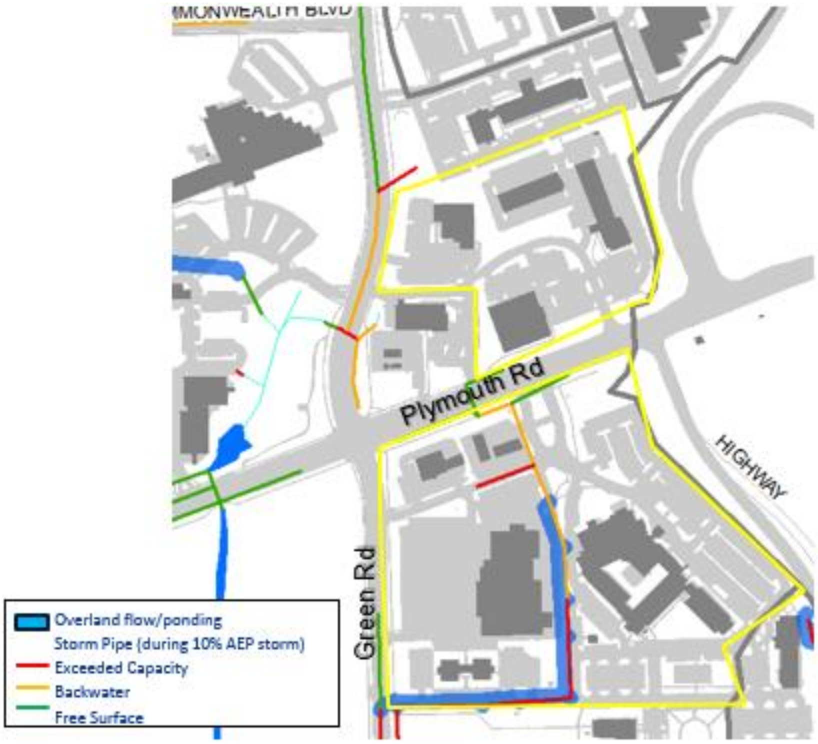
Under the 10% AEP storm, most of the impacts of the redevelopment would be seen immediately downstream of the new detention at Vets Park. Under existing conditions, the 10% storm causes surface flooding through much of the park area, and this flooding would be substantially reduced by the upstream detention, as shown in **Figure 4-60** below. However, because Vets Park is currently providing this storage, the impacts of new detention farther downstream are minimal. Surface flooding depths at depression areas along the West Park-Miller drain would be reduced by less than 0.5 feet and there would be negligible changes in water levels and flow rates at Revena Blvd. and at locations downstream. These impacts are shown in **Figure 4-60**. There would also be negligible impacts on FEMA floodplain elevations under 1% AEP storm simulations.

Figure 4-60 – Model results for Redevelopment Scenario for Westgate/Maple Village

xviii. Plymouth and Green Road Redevelopment

Similar to the evaluation in the previous section, a redevelopment scenario was considered for the commercial properties at Plymouth Road and Green Road. This includes the Red Roof Inn property and the office complexes on the northeast corner, and the Holiday Inn, shopping center, and office complex located on the southeast corner, as outlined in yellow in the figure below. The configuration in this area is shown in **Figure 4-61**.

Figure 4-61 – Existing conditions results for Plymouth and Green Road



1% AEP storm detention for these properties, which total around 27 acres in area, would require a 2 MG detention volume. Because of the nature of the Millers Creek watershed, this area is not generally prone to flooding issues, but the properties themselves would have improved drainage and street flooding would be minimized on Green Road and at the Green Road commuter parking lot. There would be negligible changes in WSEL at and downstream of Baxter Road. The reduction in peak flows would be beneficial in reducing channel erosion issues.

Additional analysis of the impacts of applying new detention requirements during redevelopment is described in Section 5, when it is included with broader stormwater management activities in future condition analysis.

D. Stormwater Improvement Conclusions

The stormwater improvements evaluation generated a list of recommended improvements to address study areas where stormwater system performance is not meeting the current design standards. It has been noted that some of the study locations have not been validated by actual observations, but it is important to recognize that the 10% AEP, 12-hour storm is a large rain event, and that some portions of the City may not have experienced a storm of this size under current development conditions.

A summary of the study areas and the recommended stormwater management alternatives is shown in the following **Table 4-12**.

Table 4-12 – Summary of Recommended Stormwater Management Alternatives

Site	Watershed	Recommendation	Cost Estimate
1. Lower Allen Creek – Main Branch	Allen	BMP-Combination	$80m - $120m*
2. Edgewood/Snyder	Allen	Conveyance-Storage	$4.1m
3. Park Place Apartments	Allen	Conveyance	$1.0m
4. Churchill Downs/Lansdowne	Malletts	Conveyance-Storage	$16m
5. S. University/E. University	Allen	BMP-Storage	$3.6m
6. Mulholland Drive	Allen	Storage	$1.9m
7. Scio Church/S. Seventh	Malletts	BMP-Storage	$2.4m
8. Glendale/Charlton	Allen	Storage	$1.2m
9. Glen Leven	Allen	Further Study	--
10. Church St./Cambridge	Malletts	None	--
11. Village Oaks/Chaucer Ct.	Malletts	Storage	$1.2m
12. Parkwood/Pittsfield Village	Malletts	Storage	$0.5m
13. Signature Drive	Malletts	Conveyance	$0.2m
14. S. Industrial/Packard Rd.	Malletts	None	--
15. Traver/Barton	Traver	Conveyance	$0.2m
16. Glendale Circle / Virginia Park	Allen	BMP-Storage	$5.1m*

**Cost estimates for these sites are based on Green Streets policy implementation only. Other portions of the recommended stormwater management improvements would take place on private property and would not be funded by the City.*

In total, the recommended improvements are projected to cost approximately $34 million in year 2017 dollars. This does not include long term stormwater management improvements which have been recommended for the Lower Allen Creek and for the Glendale Circle/Virginia Park study areas.

Prioritization of the recommended improvements will be considered as part of the City's Capital Improvements Programming process.

5. Stormwater Management Scenarios

A. Citywide Stormwater Management Scenarios

The stormwater model was utilized to evaluate the potential impacts of expanding low-impact development (LID) and green infrastructure (GI) concepts citywide to the stormwater system. LID and GI are decentralized stormwater best management practices (BMPs) that infiltrate and/or detain runoff close to its source. By reducing site runoff and peak flow rates, these features can improve the level of service provided by the existing stormwater system. In this study, the following stormwater strategies were considered:

- *Green Streets:* The City's Green Streets policy includes on-site infiltration standards for public roadway and right-of-way (ROW) construction and reconstruction projects. The policy calls for infiltration of 1 inch (1st flush), 2.35 inches (50% annual chance 24-hour storm) or 3.26 inches (10% annual chance 24-hour storm) of total precipitation volume that falls on the ROW, depending on site soil conditions, slope and proximity to floodplain (**Table 5-1**).

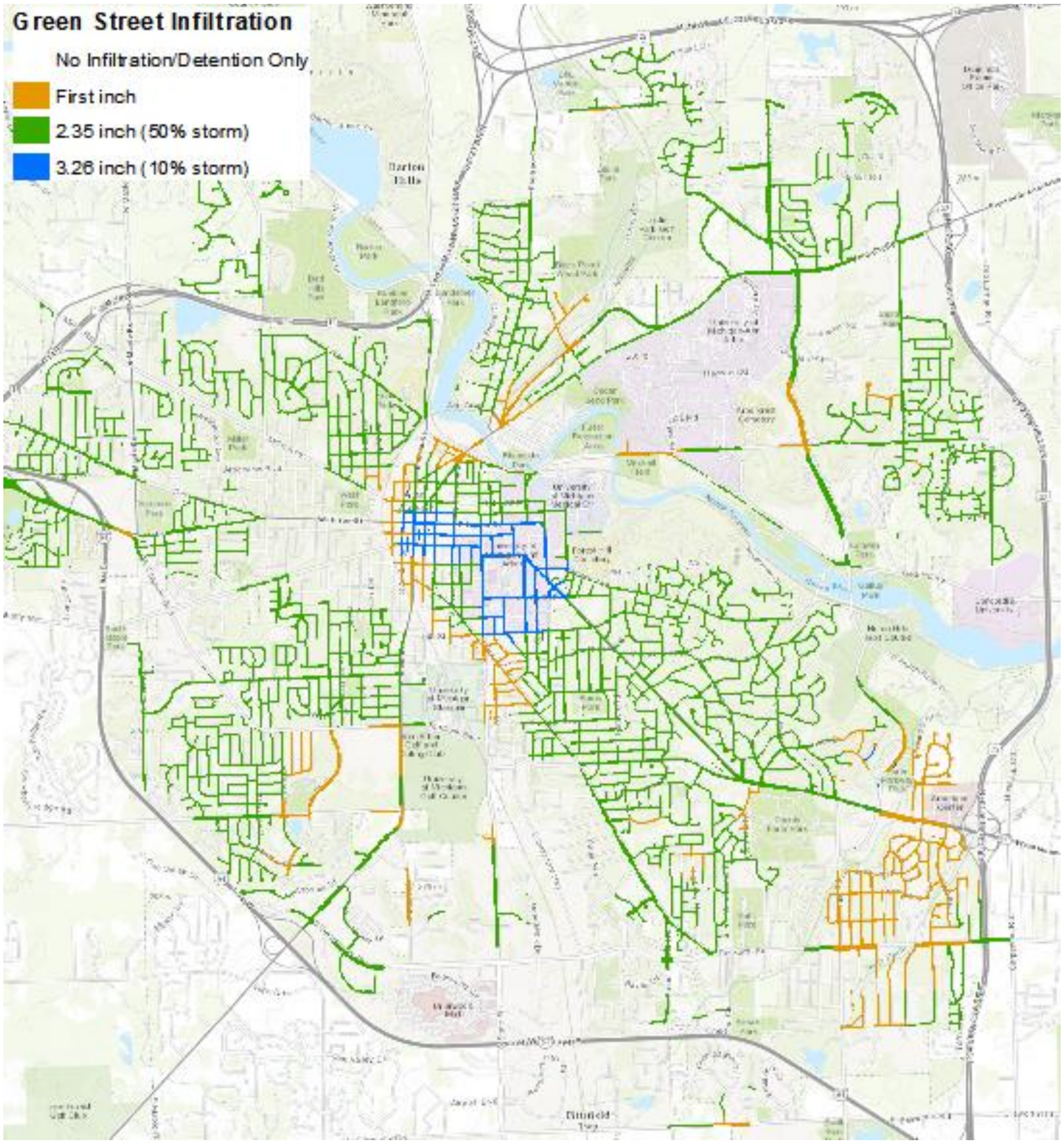
Table 5-1 – Infiltration Standard Excerpted from Green Streets Policy

Site Conditions	Infiltration Standard
• Within the floodplain, or • Slopes > than 20%, or • Soil infiltration rate < 0.6 in/hr	First 1 inch
• Not in the floodplain, and • Slopes < than 20%, and • Soil infiltration rate between 0.6 in/hr – 2.0 in/hr	50% annual chance - 24 hour event (2.35")
• Not in the floodplain, and • Slopes < than 20%, and • Soil infiltration rate >2.0 in/hr	10% annual chance – 24 hour event (3.26")

Notes: Soil Infiltrations Rates are based on A and B soil classifications in the Soil Survey of Washtenaw County, Michigan (1977).
Rainfall frequency estimates are derived from NOAA Atlas 14 Volume 8 (2013).

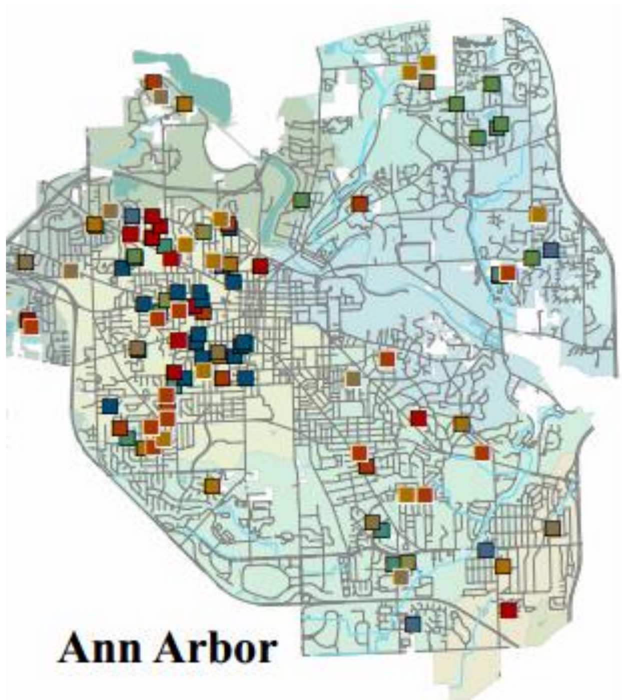
Figure 5-1 shows the applicable infiltration standard with streets color-coded based on soil map information. It is assumed that on-site infiltration is not available in areas with groundwater levels within 5 feet of the ground surface. Streets already reconstructed with Green Street concepts were not included in the mapping and the model analysis of this approach.

Figure 5-1 – Potential Infiltration for Green Street Application



- *Rain Gardens for Single-/Two-Family Homes:* Currently the City requires storage of 1st flush (1 inch) of runoff for new impervious area on an individual single- or two-family parcel if the net increase in impervious area exceeds 200 sf. There are residential stormwater credits available for customers that become RiverSafe Home Partners, install rain barrels, or create a rain garden, cistern, or drywell. Support for rain garden design and construction is available through Washtenaw County's Rain Garden Assistance Program, and rain gardens have already been installed through many areas of the City, as shown in **Figure 5-2**. This scenario assumes that these rain garden initiatives were applied broadly to allow for storage of first flush for all impervious surface areas for all single- and two-family homes citywide. For a typical parcel, this would require a rain garden with a capacity of approximately 1500 gallons. This would add up to 67MG of rain garden storage if applied citywide.

Figure 5-2 – Residential Rain Gardens in the City of Ann Arbor



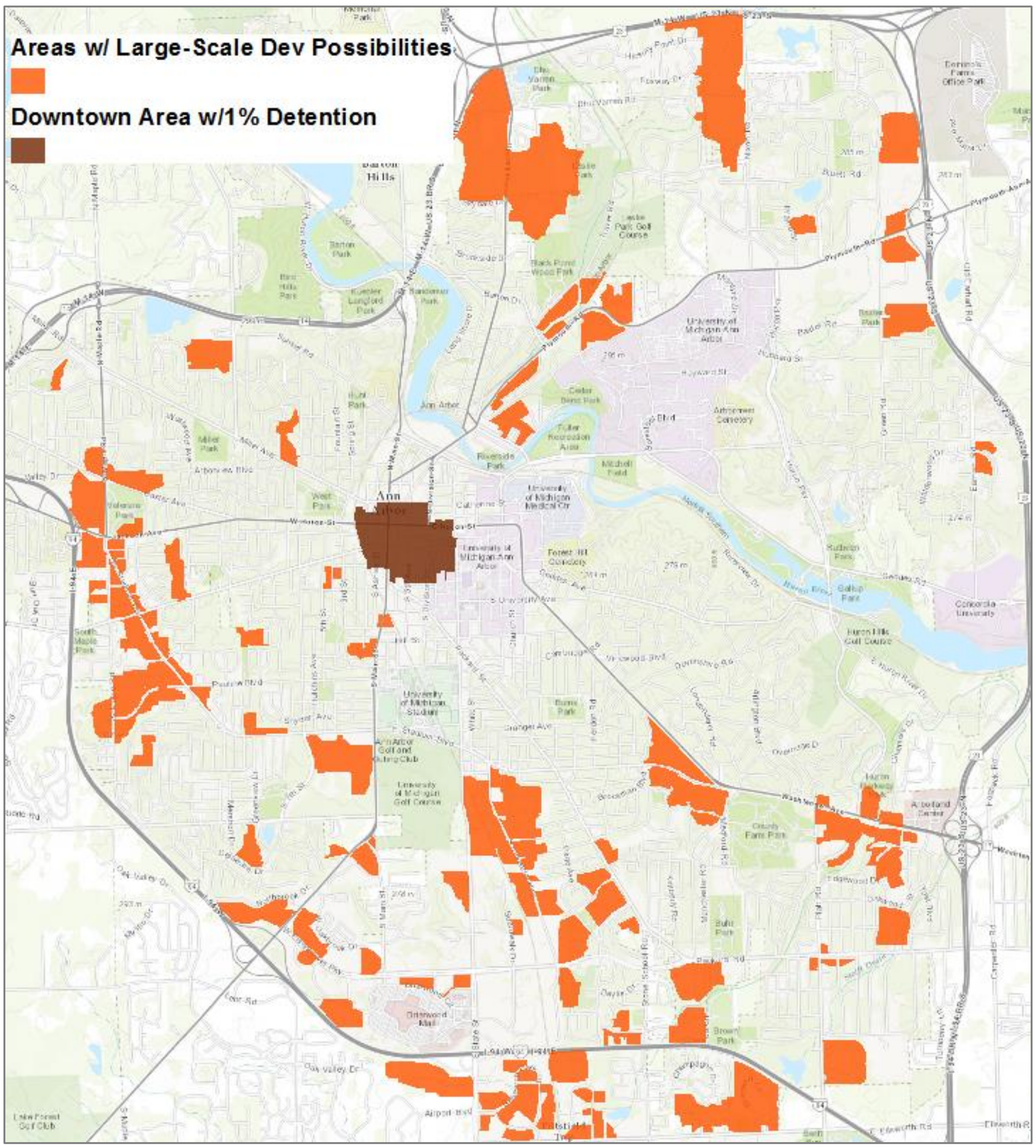
(Source: Washtenaw County Rain Garden Assistance Program, colors indicate different years of rain garden installations)

- *University of Michigan Redevelopment*: This scenario assumes that the University of Michigan's stormwater management strategy would align with new development requirements of the City and Washtenaw County Water Resources Commissioner's Office (WCWRC). This would include infiltrating at least the 1st inch of runoff (1st flush) and detaining runoff from 1% AEP 24-hour storm events for all University properties discharging into County drains or the City's storm sewer system. Most of Central and Athletic Campus areas drain to Allen Creek while the eastern part of North Campus drains to Millers Creek.

- *Downtown Stormwater Management*: On top of Green Streets in the downtown area, this scenario assumes 1% AEP storm detention would be provided for the entire tributary area between Catherine Street to the north, State Street to the east, Jefferson Street to the south and railroad to the west. This strategy is based on recent experience with stormwater management work on South Fourth Avenue, and other soil testing in downtown areas, which indicated that 1% AEP storm detention and infiltration can be achieved. These areas are all tributary to Allen Creek and are shown in brown in **Figure 5-3**.

- *New Development and Redevelopment of Commercial and Multi-Family Parcels*: This stormwater management approach accounts for redevelopment of commercial, multi-family and public properties larger than 1 acre that are currently without any existing on-site stormwater control. Following the latest WCWRC's stormwater design standards, 1% storm detention would be provided along with storage/infiltration of at least the first flush. **Figure 5-3** maps the locations of these properties in orange. These properties are concentrated around W. Stadium Blvd in the upper tributary area of Allen Creek, S. Industrial, Research Park, and Washtenaw/Huron Parkway areas in Malletts Creek. This also includes undeveloped areas at Dhu Varren/Pontiac Trail and Dhu Varren/Nixon Road that are expected to have future large-scale residential development.

Figure 5-3 – Potential Infiltration and 1% Storm Detention Areas



These different stormwater management strategies were evaluated in the modeling for Lower Allen Creek, which was presented in Section 4C of this report. That analysis compared the relative impacts of the different strategies at different locations along Allen Creek and under different design storm scenarios. The next section presents our analysis of city-wide application of combined strategies under future condition scenarios.

B. Future Conditions

The stormwater management strategies described in the previous section are to be broadly applied and should be considered as long-term stormwater management initiatives. Three (3) future scenarios were included: 2040, 2065 and 2115 to show potential progress over time. It was assumed that all of these strategies would be completed citywide by 2115 (in 100 years), and the levels of completion were determined based roughly on the redevelopment/reconstruction interval for each type of property. The commercial and multi-family percentages were weighted between the downtown properties and those outside of the downtown area. The actual implementation schedule for each scenario would vary depending on feasibility, funding availability, and changes in stormwater management policies. For the purposes of this evaluation, **Table 5-2** shows the assumption of percent completion for each of the future conditions scenarios.

Table 5-2 – Future Scenarios Assumptions for Stormwater Management Strategies

Future Scenario	2040	2065	2115
Green Streets	25%	50%	100%
Residential Rain Gardens	50%	100%	100%
University Redevelopment	50%	100%	100%
Downtown Storage and Infiltration	25%	50%	100%
Commercial and Multi-Family Redevelopment	45%	85%	100%

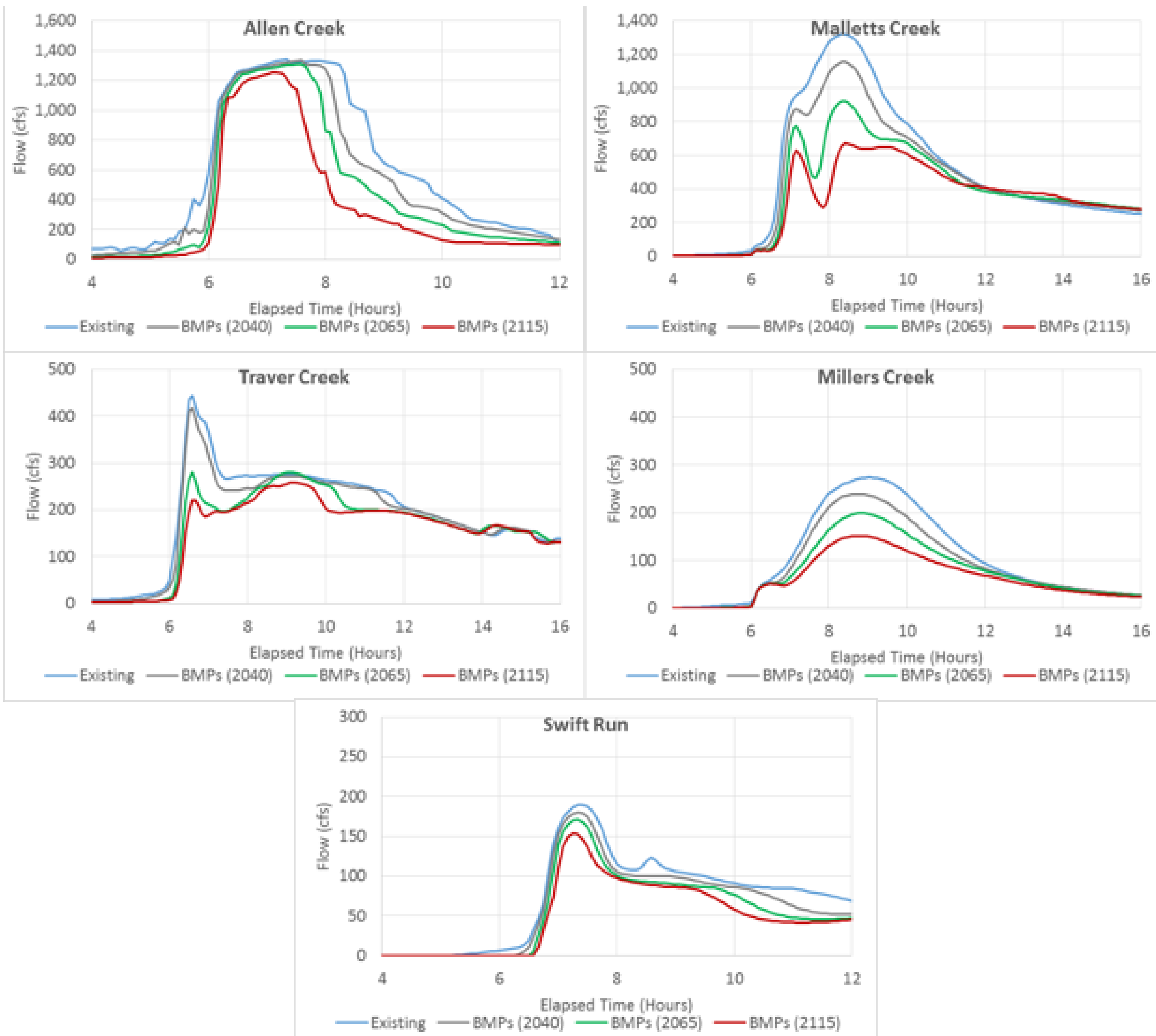
Appendix B contains a series of maps showing the combined impact of all stormwater strategies in 2040, 2065 and 20115 scenarios under current 20% AEP 1-hour and 10% AEP 12-hour design storms for each watershed.

Figures 5-4 to **5-8 below** show hydrographs at the downstream end of each major creekshed under the 10% AEP storm for the different future condition scenarios, and are compared to the current conditions. These strategies could reduce both runoff volume and peak flow and improve the level of service in large portions of the drainage system. For example, peak flow exiting Malletts Creek could be dropped by more than 50% by 2115 because the Mary Beth Doyle Park regional detention basin would no longer be full and overflow during the 10% AEP storm.

However, as shown in the maps in **Appendix B,** all of these strategies combined could not completely eliminate flooding in the 1% AEP floodplain and in other frequent flooding areas. For example, ponding at Edgewood/Snyder would be reduced by almost 3 feet but not eliminated during the 10% AEP storm. BMPs like residential rain gardens, as well as those employed as part the Green Streets policy, are designed to be most effective in more frequent storms that are much smaller in size and less intense than the 10% and 20% AEP design storm events evaluated here.

Results of the stormwater management modeling indicate that the greatest impact of the combined strategies in terms of peak flow reduction would be seen in Malletts Creek, along with Traver Creek and Millers Creek. The peak flow impacts are less pronounced for Allen Creek and for Swift Run. The results for Allen Creek are noticeably unstable at lower flow rates. This instability in the model predictions is due to the location of the observation point at the mouth of Allen Creek, where it is affected by the assumed level of the Huron River.

Figures 5-4 to 5-8 – Flow Hydrographs for Current and Future Conditions (10% AEP, 12-Hr Storm)



The results shown in Figures 5-4 to 5-8 once again indicate that significant improvements in stormwater system performance can be achieved through stormwater management policies and programs. Section 4.C.i provides a comparison of the individual stormwater management strategies, and includes recommendations for future stormwater management policies in the Allen Creek watershed.

6. FEMA Floodplain Comparison

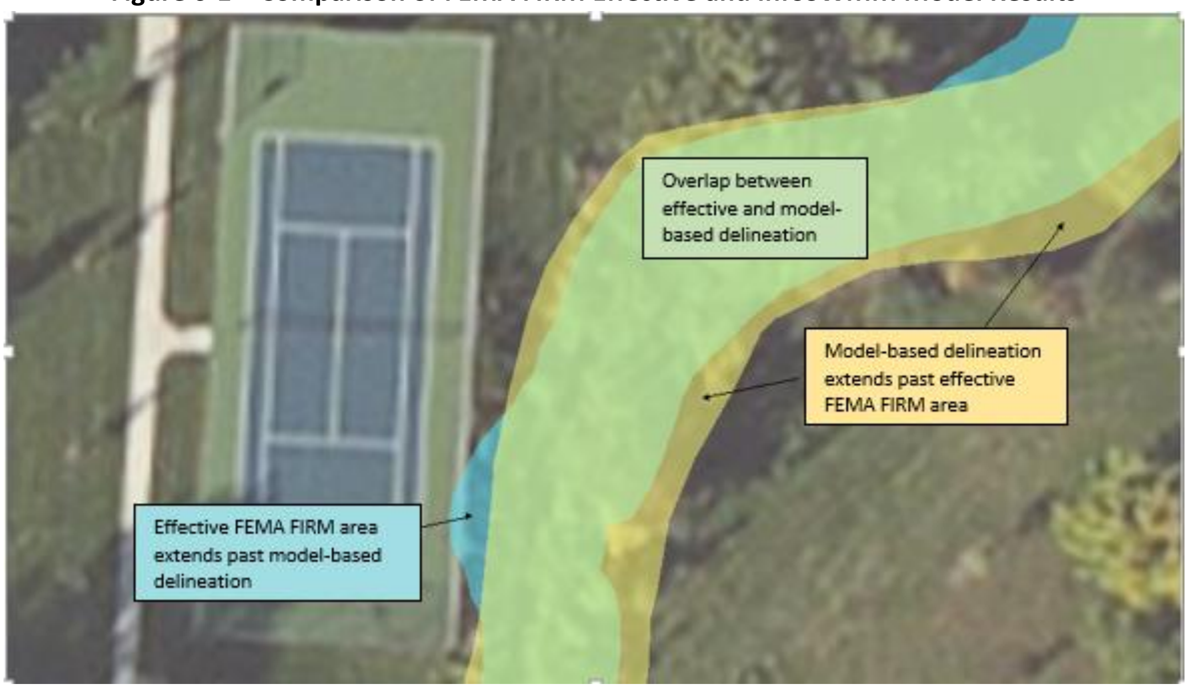
The objective of the FEMA floodplain comparison was to compare the calibrated InfoSWMM model results to existing FEMA Flood Insurance Rate map (FIRM) floodplain maps. The delineation based on the InfoSWMM model data would provide the City with an additional source of flood level data that could be used for future floodplain analysis and management.

The existing FEMA FIRM floodplain areas were delineated as part of a FEMA study in 2013, using HEC-RAS stormwater model results. Separate HEC-RAS models were developed for Allen Creek, Malletts Creek, Traver Creek, Millers Creek, and Swift Run. The calculation methods for each model varied between steady state and non-steady state models, and they each had different approaches to estimate runoff.

As part of this project, the InfoSWMM model was used to simulate a 1% AEP, 24-hour storm, and peak flows and peak water surface elevation (WSEL) data were generated. The water surface elevations from the model were then used to delineate floodplain contours using the latest LIDAR-based topographic data, and differences between the model-based contours and the FEMA floodplain contours were compiled.

An example of the comparison is shown in **Figure 6-1** below for the Swift Run Drain.

Figure 6-1 – Comparison of FEMA FIRM Effective and InfoSWMM Model Results



Complete maps showing the floodplain comparison by Creekshed are shown in Appendix C.

Table 6-1 provides a comparison of the different models and data sets used in the two delineations.

Table 6-1 – Floodplain Delineation Data Sources

	FEMA FIRM Maps	Model-Based
Model Software	HEC-RAS	InfoSWMM
Steady/Un-steady Flow	Steady (except for portions of Traver Creek study)	Unsteady
Storm Standard Source	TP-40/ISWS Bulletin 71	NOAA Atlas 14
Storm Volume	4.36”/4.75”	5.11”
Hydrologic Analysis / Response Representation	Various (Rainfall-Runoff Unit Hydrograph method, Brater’s Unit Hydrograph method, MDEQ SCS, SCS unit-hydrograph)	SCS Type II / Green-Ampt infiltration
Elevation Contour Data Source	DEM (1997), field survey	LiDAR (2009)

The comparison of the InfoSWMM model-based 1% floodplain area to the existing FEMA FIRM floodplain area was made using ArcGIS software. For each creekshed, tabulations were made for the modeled floodplain surface area (acres), and the number of parcels and buildings affected by the modeled floodplain area, in each case compared to the effective FEMA FIRM map area. These results are shown in **Table 6-2**.

Table 6-2 – Comparison of FEMA FIRM to Model-based Floodplain Data

		Total	Allen	Malletts	Millers	Swift	Traver
FEMA FIRM Effective (within City Limit)	Acres	462	123	151	51	76	62
	Buildings	499	390	55	4	28	22
	Parcels	887	483	219	24	101	60
Model Delineated (within City Limit)	Acres	514	145	173	55	79	62
	Buildings	565	404	88	6	57	10
	Parcels	1205	635	352	25	120	73
Model Delineated (within Effective Limit of Study)	Acres	425	98	143	55	79	50
	Buildings	427	307	47	6	57	10
	Parcels	841	404	233	25	119	60
Model Delineated (beyond Effective Limit of Study)	Acres	89	47	29	0	0	12
	Buildings	138	97	41	0	0	0
	Parcels	238	121	111	0	0	6

		Total	Allen	Malletts	Millers	Swift	Traver
Added during comparison	**Acres**	176	56	77	11	14	19
	Buildings	242	130	76	2	33	1
	Parcels	318	152	133	1	19	13
Removed during comparison	**Acres**	125	34	55	7	10	18
	Buildings	176	116	43	0	4	13
	Parcels	0	0	0	0	0	0

There were two notable areas of the delineation and comparison where the FEMA FIRM mapping study limits led to significant differences

- Allen Creek south of Hill Street – In the current FEMA floodplain, the area of Allen Creek located south of Hill Street is not included. Using the InfoSWMM model data, the floodplain delineation would extend south through Hoover and S. State Street, covering an additional 47 acres. The area outside of the FEMA FIRM effective area would include 97 buildings and 121 parcels.

- Upper Malletts Creek – The scope of the existing FEMA floodplain delineation did not extend west of South Seventh Street because of tributary area size limitations in the mapping procedure. Using the citywide stormwater model for stormwater data would not have this restriction so the Upper Malletts Creek area was included in the delineation. The model-based floodplain area beyond the FEMA FIRM Effective study area would include an additional 14 acres, with 41 additional buildings and 98 additional parcels.

During the floodplain delineation and comparison, it was noted that many of the differences were a result of using newer LiDAR based contour data. To better understand the source of differences in the predicted floodplain areas, the City asked for a delineation using the existing FEMA FIRM flood delineated areas, while adjusting to utilize updated LiDAR elevation contours.

Table 6-3 – Floodplain Comparison Using LiDAR Contour Data Only

		Total	Allen	Malletts	Millers	Swift	Traver
FEMA Effective	**Acres**	462	123	151	51	76	62
	Buildings	499	390	55	4	28	22
	Parcels	887	483	219	24	101	60
LiDAR Contour	**Acres**	519	131	191	40	77	80
	Buildings	604	440	79	4	55	26
	Parcels	946	521	223	20	118	64
Net Change	**Acres**	57	8	40	-10	1	18
	Buildings	105	50	24	0	27	4
	Parcels	59	38	4	-4	17	4

The same delineation process was used and the results of the comparison are shown below in **Table 6-3**. A portion of the overall net change in acreage, buildings, and parcels included in the floodplain areas can be attributed to the updated LiDAR elevation contours. However, the updated rainfall volume and resulting flow data, and the addition of previously excluded areas in Allen Creek south of Hill Street and in the Upper Malletts Creek area west of South Seventh Street were the major factors in the differences shown in the floodplain area comparison.

7. Project Conclusions

The overall goals of the City of Ann Arbor Stormwater Model Calibration and Analysis project were to develop the model as a stormwater analysis tool and to provide answers to the City's current stormwater system management questions. Upon completion of the project, the following outcomes and conclusions are reported.

- **The citywide stormwater model has been updated to reflect the current system configuration and it has been calibrated based on collected flow and rainfall data.**

  Model updates were made prior to preliminary calibration to add model functionality, including representation of overland flows. Preliminary calibration with 2007 data provided improvements in model performance but was limited by a lack of large storm data. Additional data collection was recommended to improve dormant season parameters, boundary condition information, and calibration accuracy overall.

  Additional model updates were made to reflect 2013 stormwater system configuration and to allow for 2D modeling as part of final calibration. The calibration and validation work performed with 2013 data had good agreement between model-predicted values and monitor-observed values for volume and flow rate. Adjustments were made to the preliminary model parameters to improve the model performance. In general, the model-predicted flows and volumes were within 15% of recorded data, which fall within the expected range of agreement for stormwater models of this size and level of detail.

- **The project was able to involve stakeholders and interested citizens in the project.**
  A number of public engagement initiatives were utilized during the project and the following items were noted:
  - A high level of public participation was observed in Phase I public meetings and in the online stormwater survey, especially from areas that have been affected by recent flooding.
  - Areas that had not been affected by recent flooding were not well represented in Phase I public meetings.
  - The large event data gathering (LEDG) program was a successful public engagement activity, attracting a "Citizen Storm Corps", made up of interested residents who were able to participate directly in stormwater management observations.
  - The Stormwater Advisory Group (SWAG) was formed primarily to provide review and guidance of public interactions, but ended up providing valuable technical input and feedback throughout the entire project. The SWAG was made up primarily of stormwater professionals, representatives from local watershed groups, and interested citizens.
  - Phase II public meetings were reasonably well-attended, reflecting an overall interest in stormwater management issues by Ann Arbor residents.
  - A stormwater video was developed as part of the project that will highlight the importance and relevance of stormwater management in the City of Ann Arbor.

- The project had input from the over-arching wet-weather projects Technical Oversight and Advisory Group (TOAG) at key technical milestones, including after final calibration and during the stormwater improvements evaluations.

- **The existing stormwater system performance was evaluated for a range of design storms, leading to a set of potential stormwater system improvements.**

  The stormwater system is performing at a consistent design level of service for most areas of the City. The 10% annual exceedance probability (AEP), 12-hour storm is the current design standard, which is a 2.9" storm using NOAA Atlas 14 rainfall volumes. In the Allen Creek watershed and in the Malletts Creek watershed, there are areas where surface flooding is predicted during the 10% AEP storm and in some cases during the 20% AEP storm. Sixteen study areas were evaluated for potential stormwater system improvements and these were presented in a series of public meetings in November 2014. The recommended improvements total over $34 million and will be considered as part of the City's CIP Programming. Implementation of longer term stormwater management strategies are recommended for the Allen Creek watershed. The Green Streets portion of these improvement strategies was estimated at $80 million to $120 million.

- **The model was used to evaluate the effectiveness of stormwater management strategies.**

  The evaluation of future stormwater management strategies indicated that the City should continue runoff reduction programs, including the Green Streets Policy and Residential Rain Garden Programs. There should also be significant efforts put into encouraging compliance with new development standards during redevelopment of commercial, multi-family, and school or University properties. Future condition modeling scenarios show the potential for significant improvements in stormwater system performance, especially during more frequent storm events.

- **New model data was produced, allowing for comparison with existing FEMA FIRM Map 100-year floodplain delineation.**

  A FEMA FIRM floodplain comparison was performed using updated LiDAR elevation contours and also using flow and water level data generated by the new InfoSWMM model for the 1% annual exceedance probability (AEP) storm. The 1% AEP floodplain was delineated using these two data sets for comparison with the existing FEMA FIRM floodplain contours. The improved refinement of 1% AEP floodplain data will be available for future FEMA floodplain mapping and will support better decision-making on floodplain management issues.

- **Supporting documentation was produced, which will allow the City to utilize the stormwater model as a system management tool.**

  Project documentation being provided to the City includes archives of project data files and model files. Training sessions and written procedures for model updates and storm scenario updates have been prepared that will enable a smooth transition of stormwater modeling responsibilities and capabilities to City Staff. The model will be capable of providing output for various applications, from green infrastructure planning and stormwater system design, to floodplain analysis and emergency management. In addition, the City can build in procedures for model adaptation so that adjustments can be made to reflect future stormwater system performance monitoring or to respond to new storms or storm standards.