Wang Engineering

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Technical Memorandum

To:	Amish Bhatt, S.E., AECOM
From:	Andri Kurnia, P.E., Wang Engineering, Inc.
Date:	November 1, 2019
Subject:	NB-15 Micropiles Contract 62A76
Project:	Circle Interchange Reconstruction IDOT Job Nos. D-91-227-13, IDOT PTB 163, Item 01 Wang Project No. 1100-04-01

Wang Engineering Inc. (Wang) understands that one of the foundations for sign structure NB-15 included in Contract 62A76 will require micropiles. As given by HBM Engineering Group, LLC (HBM) the total estimated maximum compressive load is 76 kips and the total maximum tensile load is 48 kips for each micropile. We understand the micropiles diameter is anticipated to be 9.625 inches. This memorandum provides geotechnical recommendations for the micropiles. We understand the design will follow AASHTO 2017 LRFD method.

Wang performed preliminary geotechnical design for several micropile diameter sizes. Boring NB-15 was performed near the proposed sign structure location but was only conducted to a depth of 50 feet below the ground surface (bgs). To provide soil information below 50 feet bgs, Boring 1705-B-02 was considered in our analyses. Boring locations in reference to the sign structure location are shown in Exhibit 1. A soil profile is shown in Exhibit 2. Based on soil conditions encountered, our preliminary design recommendations for Type A and B micropiles are presented in Tables 1 through 4. Since the grout to ground bond resistance is influenced by soil conditions and method of micropile drilling and installation, final design should be performed by a specialty contractor qualified to perform micropile design and construction and submit to the IDOT for review and approval. IDOT special provision for Micropiles should be included with the contract plans. The axial pile capacity should be checked against the structural resistance of the micropile.

The bond for the Type B micropile is considered for granular soils consisting of dense to very dense gravelly sandy loam to gravel starting at elevation 524.0 feet. The bond for Type A micropile is considered for bedrock starting at elevation 497.0 feet. The final elevations of the layers providing the bond will need to be determined during micropile installation.

The following design parameters were considered in estimating bond lengths.

1. The factored resistance was based on a resistance factor of 0.55 assuming no load test is specified (Table 10.5.5.2.5-1, 2017 LRFD AASHTO);
2. Grout to ground nominal compressive resistances are 5.0 ksf and 30.0 ksf for soil and rock, respectively;
3. Tip resistance was ignored due to relatively small diameter and high grout-to-ground bond resistance;
4. The tension resistance is estimated as 50 percent of the compression resistance.

Table 1: Preliminary Micropile Geotechnical Design Data for 76 kips compressive load
Bond Zone in Soil, Micropile Type B

Micropile Bond Diameter (inches)	Nominal Resistance (kips)	Factored Resistance (kips)	Estimated Bond Length (feet)
5.500	138	76	19.5
6.000	138	76	18.0
7.000	138	76	15.5
8.000	138	76	13.5
9.625	138	76	11.0

Table 2: Preliminary Micropile Geotechnical Design Data for 48 kips tension load
Bond Zone in Soil, Micropile Type B

Micropile Bond Diameter (inches)	Nominal Resistance (kips)	Factored Resistance (kips)	Estimated Bond Length (feet)
5.500	87	48	25.0
6.000	87	48	23.0
7.000	87	48	20.0
8.000	87	48	17.0
9.625	87	48	14.0

Table 3: Preliminary Micropile Geotechnical Design Data for 76 kips compressive load
Bond Zone in Rock, Micropile Type A

Micropile Bond Diameter [1] (inches)	Nominal Resistance (kips)	Factored Resistance (kips)	Estimated Bond Length (feet)
5.500	138	76	3.3
6.000	138	76	3.0
7.000	138	76	2.6
8.000	138	76	2.3
9.625	138	76	1.9

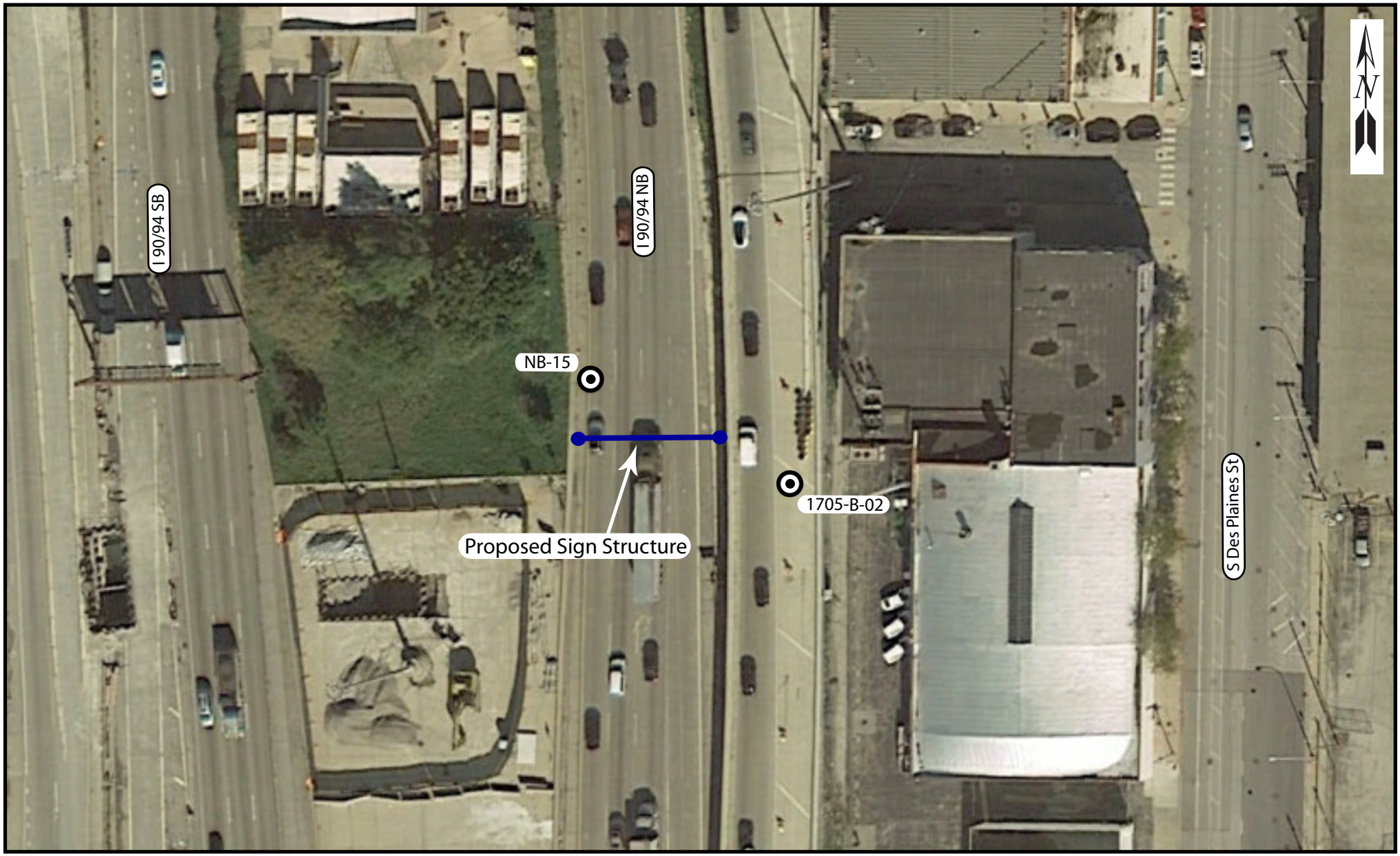
Table 4: Preliminary Micropile Geotechnical Design Data for 48 kips tension load
Bond Zone in Rock, Micropile Type A

Micropile Bond Diameter [1] (inches)	Nominal Resistance (kips)	Factored Resistance (kips)	Estimated Bond Length (feet)
5.5	87	48	4.1
6.0	87	48	3.8
7.0	87	48	3.2
8.0	87	48	2.8
9.625	87	48	2.4

The design, construction, and method of installation of micropiles should consider the granular nature of the soil below elevation 524 feet. Moreover, the granular soil layers within and below the clay layers are expected to be saturated and groundwater in granular soils above the bedrock is expected to be under hydrostatic pressure.

Attachments:
Exhibit 1: Boring Locations Plan
Exhibit 2: Soil Profile
Boring Logs

cc: Corina Farez, Wang Engineering, Inc.



Legend

Boring Location

Scale

0 100 200 Feet

BORING LOCATION PLAN: CIRCLE INTERCHANGE RECONSTRCTION, IDOT JOB NOS. D-91-227-13, IDOT PTB 163, ITEM 01, COOK COUNTY, IL

SCALE: GRAPHICAL	EXHIBIT 1	DRAWN BY: RKC CHECKED BY: A. Kurnia

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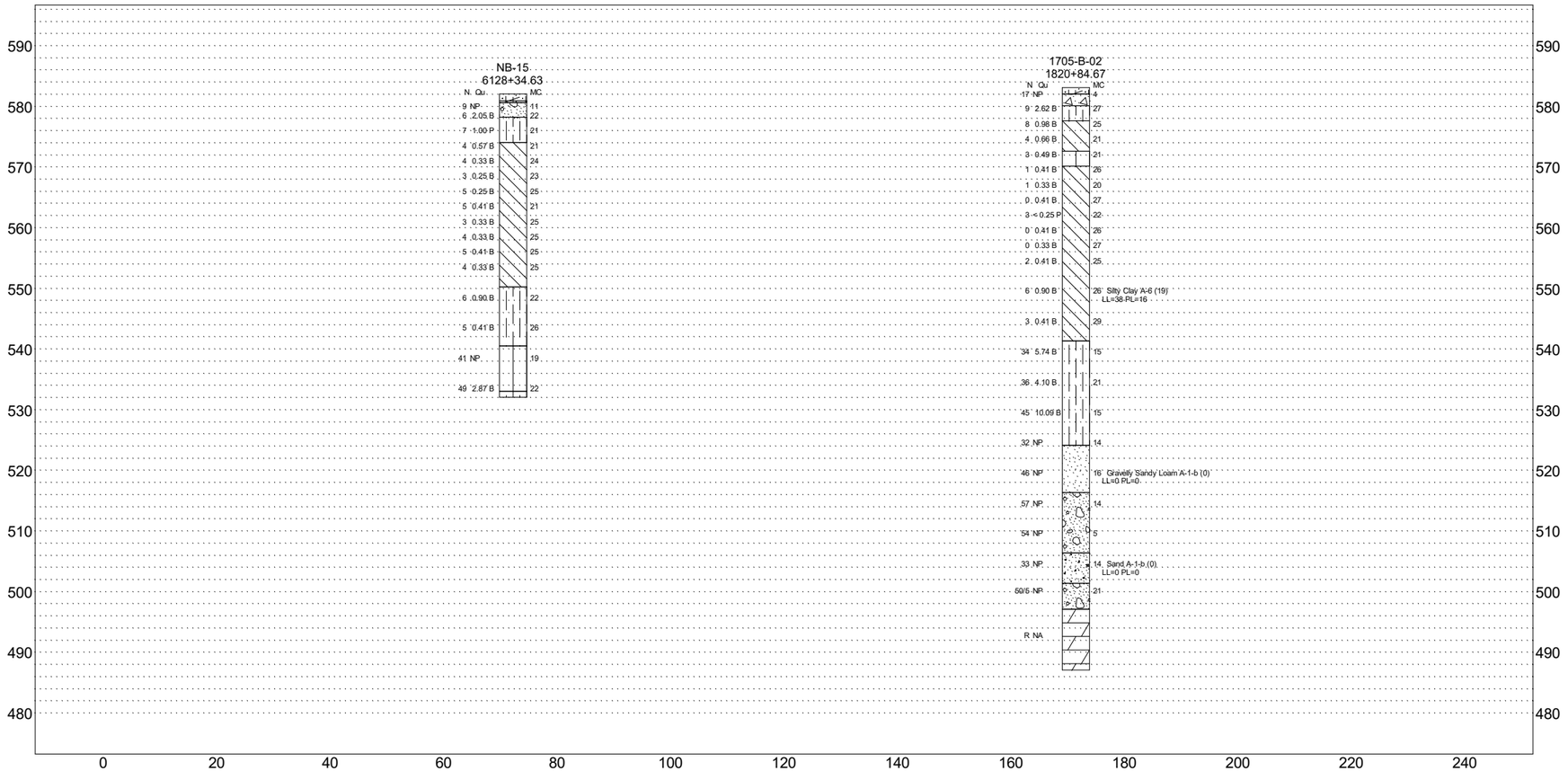
FOR AECOM	1100-04-01

◄ W

A

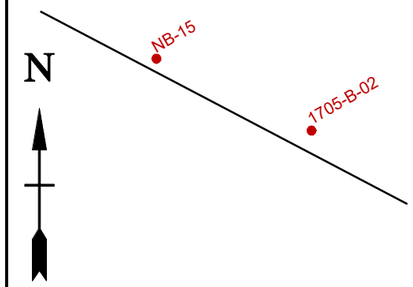
E ►

A'



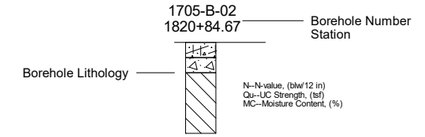
Lithology Graphics

- Pavement
- Crushed stone
- IDH Silty Clay, Silty Clay Loam
- IDH Clay
- IDH Silt, Silty Loam
- IDH Sand, Sandy Loam
- Gravelly sand, sandy gravel
- Coarse sand
- Dolomite or Dolomitic Limestone



Site Map Scale 1 inch equals 90 feet

Explanation:



Water Level Reading at time of drilling.

Water Level Reading 24-hr after drilling or at end of drilling

Horizontal Scale (feet)

Vertical Exaggeration: 1x

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Soil Profile
Jane Byrne Interchange, NB-15 Micropiles

WEI SINCE 1982

Jane Byrne Interchange
Section 16, T39N, R14E of 3rd PM

JOB NUMBER	PLATE NUMBER
1100-04-01	EXHIBIT 2

WEI 11X17 1100401.GPJ WANGENG.GDT 10/31/19

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BORING LOG LEGEND

Relative Drilling Resistance		
RDR	**Term**	**Criterion**
1	Very Easy	No chatter, very little resistance, very fast and steady drill advance
2	Easy	No chatter, some resistance, fast and steady drill advance rate
3	Moderate	Some chatter, firm drill resistance, moderate advance
4	Hard	Frequent chatter, variable drill resistance, slow advance rate
5	Very Hard	Constant chatter, variable and very slow drill advance, nearly refusal

Coarse Gradation (mm) (ASTM D2488)	
Gravel	4.75 to 75
Cobbles	75 to 300
Boulders	> 300

Proportional Terms (%) (ASTM D2488)	
Trace	< 5
Few	5 to 10
Little	15 to 25
Some	30 to 45
Mostly	50 to 100

Relative Density of Non-Cohesive Soils (ASTM D1586)	
No. of Blows/ft	Relative Density
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
> 50	Very Dense

Soil Moisture Conditions	
Term	**Appearance and Feel**
Dry	Soil sample looks and feels powdery or dusty; no indication of moisture. Free-running granular soils.
Damp	Cohesive soils cannot be molded easily without adding water. Granular soil may not flow very easily.
Moist	Soil is near the optimum moisture content. Cohesive soils are near the plastic limit. Soil changes color slightly when exposed to air for a short period.
Wet	One may feel a high degree of moisture, yet no free water is visible. Water may become visible if the sample is squeezed. Cohesive soil appears weak and sticks to and/or stains hands. Granular soils tend to cohere.
Saturated	Applied to granular soils that have free surface water; water drains freely from the sample.

Consistency of Cohesive Soils (ASTM D1586)	
Qu (tsf)	Consistency
< 0.25	Very Soft
0.25 - 0.50	Soft
0.50 - 1.00	Medium Stiff
1.00 - 2.00	Stiff
2.00 - 4.00	Very Stiff
> 4.00	Hard

Rock Quality Designation (ASTM D6032)	
RQD (%)	Classification
0 - 25	Very Poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

Sample Type Symbols


Split Spoon


Shelby Tube


No Recovery (NR)


Pitcher


Auger Cuttings


Rock Core

Drill Rig:

17 D50 A [87%]

- 17 → Calibration Year
- D50 → Rig Model
- A → Rig Type (A or T)
- [87%] → SPT Hammer Efficiency

A = All Terrain Vehicle Rig
T = Truck Mounted Rig

SPT = Standard Penetration Test
Q_u = Unconfined Compressive Strength Test
P = Pocket Penetrometer
S = Shear failure (Rimac)
B = Bulge failure (Rimac)
SSA = Solid Stem Auger
HSA = Hollow Stem Auger

03/12/2019

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BORING LOG 1705-B-02

WEI Job No.: 1100-04-01

Client: **AECOM**
Project: **Jane Byrne Interchange**
Location: **Section 16, T39N, R14E of 3rd PM**

Datum: NAVD 88
Elevation: 583.14 ft
North: 1897114.28 ft
East: 1171830.86 ft
Station: 1820+84.67
Offset: 1.9068 RT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	582.0	13-inch thick CONCRETE --PAVEMENT--						
	580.1	Medium dense, gray CRUSHED STONE --FILL--			1	14 11 6	NP	4
	577.6	Very stiff, gray SILTY CLAY, trace gravel	5		2	2 4 5	2.62 B	27
	572.6	Medium stiff, gray CLAY to SILTY CLAY, trace gravel	10		3	1 3 5	0.98 B	25
	570.1	Soft, gray SILTY LOAM, trace gravel			4	1 2 2	0.66 B	21
		Very soft to medium stiff, gray CLAY to SILTY CLAY, trace gravel	15		5	1 1 2	0.49 B	21
					6	0 0 1	0.41 B	26
					7	0 0 1	0.33 B	20
			20		8	0 0 0	0.41 B	27
			25		9	0 1 2	< 0.25 P	22
					10	0 0 0	0.41 B	26
					11	0 0 0	0.33 B	27
			30		12	0 0 2	0.41 B	25
		--L_L(%)=38, P_L(%)=16-- --%Gravel=1.9-- --%Sand=10.7-- --%Silt=49.3-- --%Clay=38.0-- --A-6 (19)--	35		13	1 3 3	0.90 B	26
			40		14	1 2 1	0.41 B	29

GENERAL NOTES

Begin Drilling: **06-20-2013** Complete Drilling: **06-21-2013**
Drilling Contractor: **Wang Testing Services** Drill Rig: **CME-55 TMR [85%]**
Driller: **P&N** Logger: **A. Happel** Checked by: **C. Marin**
Drilling Method: **2.25" SSA to 10', mud rotary thereafter, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **groundwater not observed**
At Completion of Drilling: **mud in the borehole**
Time After Drilling: **NA**
Depth to Water: **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

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Offset: 1.9068 RT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	541.4	Hard, gray SILTY CLAY LOAM, trace gravel						
			45		15	10 14 20	5.74 B	15
			50		16	10 15 21	4.10 B	21
			55		17	12 18 27	10.09 B	15
	524.1	Dense, gray GRAVELLY SANDY LOAM	60		18	11 14 18	NP	14
		--%Gravel=28.5-- --%Sand=49.5-- --%Silt=19.2-- --%Clay=2.9-- --A-1-b (0)--	65		19	19 23 23	NP	16
	516.4	Dense, gray GRAVEL	70		20	16 26 31	NP	14
			75		21	5 20 34	NP	5
	506.4	Dense, gray, medium to coarse SAND, trace gravel						
		--%Gravel=14.4-- --%Sand=68.5-- --%Silt=14.9--	80		22	16 15 18	NP	14

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		--%Clay=2.2--						
		--A-1-b (0)--						
	501.4							
		Very dense, gray GRAVEL						
					23	50/5	NP	21
			85					
	497.1							
		Strong, excellent rock quality, light gray, fresh, joint breaks with little to no infill, slightly vuggy DOLOSTONE				CORE		
		--Run 1 - RECOVERY =100%--						
		--RQD=95%--						
			90					
					1			
			95					
	487.1							
		Boring terminated at 96.00 ft						
			100					

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BORING LOG NB-15

WEI Job No.: 1100-04-01

Client: **AECOM**
Project: **Jane Byrne Interchange**
Location: **Section 16, T39N, R14E of 3rd PM**

Datum: NAVD 88
Elevation: 582.07 ft
North: 1897156.09 ft
East: 1171740.80 ft
Station: 6128+34.63
Offset: 31.64 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	581.0	13.5-inch CONCRETE --PAVEMENT--						
	580.7	4-inch ASPHALT --PAVEMENT--						
		Loose, gray SANDY GRAVEL; moist --RDR 2--			1	6 5 4	NP	11
	578.3	Stiff to very stiff, gray SILTY CLAY, trace gravel; damp to moist --RDR 2--	5		2	8 3 3	2.05 B	22
					3	2 3 4	1.00 P	21
	574.1	Soft, gray CLAY to SILTY CLAY, trace gravel; moist			4	2 2 2	0.57 B	21
			10		5	1 2 2	0.33 B	24
			15		6	1 2 1	0.25 B	23
					7	1 2 3	0.25 B	25
		--sand seam--	20		8	3 2 3	0.41 B	21
			25		9	1 1 2	0.33 B	25
					10	1 2 2	0.33 B	25
					11	1 3 2	0.41 B	25
			30		12	1 2 2	0.33 B	25
	550.3	Soft to medium stiff, gray SILTY CLAY, trace gravel; moist --RDR 2--						
		--cobble--	35		13	2 3 3	0.90 B	22
			40		14	2 2 3	0.41 B	26

GENERAL NOTES

Begin Drilling: **08-26-2019** Complete Drilling: **08-26-2019**
Drilling Contractor: **Wang Testing Services** Drill Rig: **D-50 TMR (78%)**
Driller: **K&A** Logger: **I. Nenn** Checked by: **C. Marin**
Drilling Method: **2.25" HSA to 10', mud rotary thereafter, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **mud in the borehole**
Time After Drilling: **NA**
Depth to Water: **NA**

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BORING LOG NB-15

WEI Job No.: 1100-04-01

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Location **Section 16, T39N, R14E of 3rd PM**

Datum: NAVD 88
Elevation: 582.07 ft
North: 1897156.09 ft
East: 1171740.80 ft
Station: 6128+34.63
Offset: 31.64 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	540.6	Dense, gray SILTY LOAM, trace gravel; damp --RDR 2--			15	18 21 20	NP	19
	533.1	Very stiff, gray SILTY CLAY LOAM, little gravel; damp --RDR 2--	45		16	20 29 20	2.87 B	22
	532.1	Boring terminated at 50.00 ft	50					
			55					
			60					

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