Geotechnical Investigation and Drilled Shaft Foundation Design for a Variable Message Sign

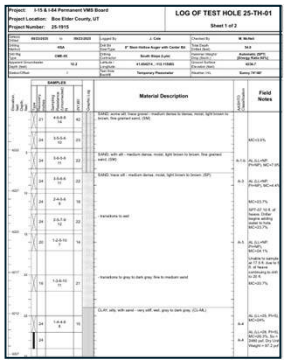
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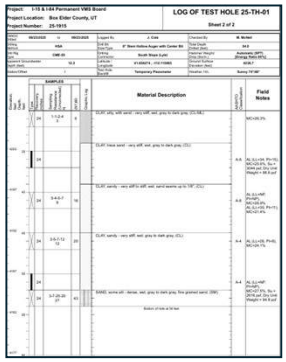
Project Overview

- Geotechnical investigation for a proposed VMS near I-15 MP 374.6, Tremonton, Utah.
- Field work included a drilled test hole, groundwater measurements, and laboratory testing.
- Subsurface conditions were evaluated to support foundation design.
- Axial and lateral design parameters were developed for a drilled shaft foundation.

Field Investigation

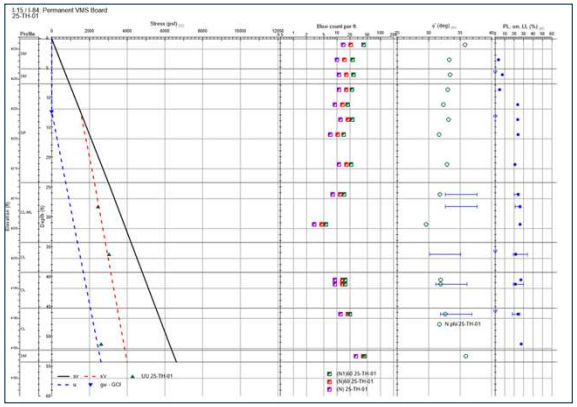




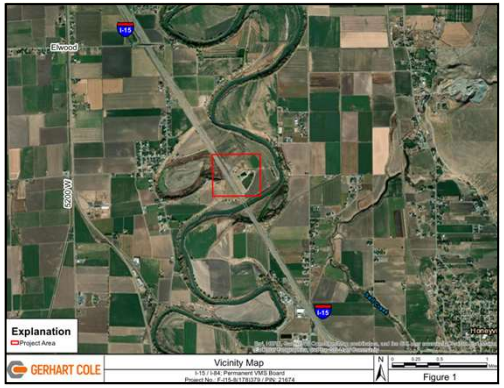


Test hole 25-TH-01 was drilled to a depth of 54 ft. Standard Penetration Test (SPT) samples were collected in coarse-grained soils, and Shelby tube samples were pushed in fine-grained soils.

Site Characterization

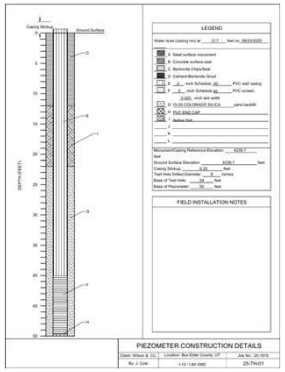


Vicinity and Field Studies





Piezometer and Groundwater Measurements



The depth to groundwater was measured on 3 separate dates

Table 2: Groundwater Summary
I-15 / I-84; Permanent VMS Board
Project No.: F-I15-8(178)379 / PIN: 21674

Location ID	Test Hole Ground Surface Elev. (ft)[a]	Screened Depth Interval (ft)	Sand Depth Interval (ft)	Groundwater depth on date measured (2025) (feet)		
				9/23[b]	10/3[c]	10/13
25-TH-01	4236.7	40-50	22-50	12.7	12.7	12.2

Notes:
a) Elevation obtained by survey by Wilson & Company (NAVD88 vertical datum).
b) Measurement taken at time of drilling.
c) Measurement taken before piezometer development.

Laboratory Test Results

Laboratory testing included moisture contents, grain size distributions, Atterberg limits, unconsolidated undrained (UU) triaxial testing, and resistivity and corrosion evaluation.

Table 3: Laboratory Test Results Summary
I-15 / I-84; Permanent VMS Board
Project No.: F-I15-8(178)379 / PIN: 21674

Test Hole	Depth (ft)	Moisture content (%)	Dry unit weight (pcf)	Moist / Sat. unit weight (pcf)	Atterberg Limits			Grain-Size		Grain-Size Analysis (Percent Finer)										Strength Parameters		Corrosion				Other Tests
					LL (%)	PL (%)	PI (%)	GRAVEL (No.4 - 3")	SAND (No.200 - No.4)	FINES (No.200)	3in (75 mm)	3-in (37.5 mm)	3/4-in (19 mm)	3/8-in (9.5 mm)	No.4 (4.75 mm)	No.10 (2 mm)	No.20 (0.85 mm)	No.40 (0.425 mm)	No.60 (0.25 mm)	No.100 (0.15 mm)	No.200 (0.075 mm)	Peak shear stress, σ_1-σ_3/2 (psf)	Confining stress, σ_3 (psf)	Resistivity (ohm-cm)	pH	Soluble chlorids (ppm)	Soluble sulfate (ppm)	
25-TH-01	2.5-4.5	3.5						1	90	9	100	100	100	100	99	99	99	91	71	42	9							
25-TH-01	5-7	7.6			NP	NP	NP	0	81	19	100	100	100	100	100	100	99	93	66	35	19							
25-TH-01	7.5-9.5	4.4			NP	NP	NP	0	96	4	100	100	100	100	100	100	99	86	35	9.5	4.5			7,700	8.6	10	ND	
25-TH-01	10-12	23.7						0	95	5	100	100	100	100	100	100	95	78	33	10	4.6							
25-TH-01	12.5-14.5	23.7																										
25-TH-01	15-17	24.1			NP	NP	NP	0	98	1	100	100	100	100	100	100	98	74	20	3.5	1.5							
25-TH-01	20-22	20.7						6	90	4	100	100	100	99	94	81	62	36	15	7.2	4.1			2,700	8.2	23	46	
25-TH-01	25-27	24.0			25	20	5	0	15	85	100	100	100	100	100	100	100	100	99	98	85							
25-TH-01	27-29	26.3	97.2	122.7	26	21	5	0	13	87	100	100	100	100	100	100	100	100	100	99	87	2,460	2,664					
25-TH-01	30-32	26.3																						930	10	87	55	
25-TH-01	35-37	25.6	98.6	123.8	34	19	15	0	3	97	100	100	100	100	100	100	100	100	100	99	97	3,044	3,024					
25-TH-01	40-40.5	26.9			NP	NP	NP	0	41	59	100	100	100	100	100	100	100	100	100	99	59							
25-TH-01	40.5-41.5	21.4			30	19	11	0	9	91	100	100	100	100	100	100	100	100	100	99	91							
25-TH-01	45-47	24.1			26	18	8	0	14	86	100	100	100	100	100	100	100	100	99	97	86							
25-TH-01	50-52	27.5	98.6	120.9	NP	NP	NP	0	33	67	100	100	100	100	100	100	100	99	98	67		2,616	4,032					

Note: ND = Non Detect

Lateral Pile Capacity

Table 4: Generalized Soil Profile for Lateral Pile Capacity Analyses
I-15 / I-84; Permanent VMS Board
Project No.: F-I15-8(178)379 / PIN: 21674

Soil layer	Bottom of layer elevation (ft)	Effective unit weight (pcf)	P-Y curve	Initial soil modulus, k (pci)	Drained friction angle, ϕ' (deg)	Undrained shear strength (psf)	Reference strain for 50% strength, ε_{50}
1 - Sand with varying amounts of silt and gravel above the water table	4225	125	API Sand	115	34	---	---
2 - Sand trace silt below the water table	4213	63	API Sand	70	34	---	---
3 - Clay silty with sand below the water table	4203	58	Stiff Clay (Reese)	---	---	2400	0.005
4 - Clay trace sand below the water table	4198	58	Stiff Clay (Reese)	---	---	3000	0.005
5 - Clay sandy below the water table	4185	58	Stiff Clay (Reese)	---	---	2600	0.005
6 - Sand some silt below the water table	4183	63	API Sand	70	34	---	---

Generalized Soil Profile for Drilled Shaft Design

Table 5: Generalized Soil Profile for Drilled Shaft Side Resistance
I-15 / I-84; Permanent VMS Board
Project No.: F-I15-8(178)379 / PIN: 21674

Soil layer	Top of layer elevation (ft)	Ultimate [unfactored] shaft unit side resistance, q_s (ksf)	Working [allowable] shaft unit side resistance, $q_{s,all}$ (ksf)[2]
1 - Sand some silt trace gravel above the water table	4232	0.36	0.14
2 - Sand with silt above the water table	4229	0.92	0.37
3 - Sand trace silt above the water table	4225	1.40	0.56
4 - Sand trace silt below the water table	4213	1.76	0.70
5 - Clay silty with sand below the water table	4203	1.32	0.53
6 - Clay trace sand below the water table	4198	1.65	0.66
7 - Clay sandy below the water table	4192	1.43	0.57
8 - Clay sandy below the water table	4185	1.43	0.57
9 - Sand some silt below the water table	4183	2.07	0.83

Notes
(1) Drilled shaft resistances computed following AASHTO 2002 Standard Specifications for Highway Bridges 17th Edition; See section 4.6.5 for additional information and background
(2) safi based on Factor of Safety of 2.5 after AASHTO Standard Specifications for Highway Bridges (17th Edition) Section 4.6.5 (AASHTO, 2002)
(3) For soil layers, side resistance in the top 5 five feet should be neglected (AASHTO, 2002)
(4) For soil layers, side resistance at the bottom of the shaft should be neglected for 1 shaft diameter (AASHTO, 2002)
(5) For clay soil layers, side resistance in any belled section of the shaft should be neglected, as well as for 1 diameter above the bell (AASHTO, 2002)