ADDENDUM NO. 1

OCTOBER 9, 2026

CITY OF HIGHLAND VILLAGE

HIGHLAND SHORES BOULEVARD
RECONSTRUCTION PROJECT
From Twin Coves Drive/Hillside Drive to 200'± West of Lake Cove

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SPECIFICATIONS

1. Delete the Bid Schedule and replace with the attached Bid Schedule.

2. Add the attached Geotechnical Engineering Report to the Appendix.

PLANS

3. On Sheet No. 106 and Sheet No. 109, add the following note:

   "6. COMMON STONE GROUTED RIP RAP TOEWALL SHALL BE CONSIDERED SUBSIDARY TO COMMON STONE RIP RAP. (NO SEPRATE PAY)"

CLEARIFICATIONS

4. The City will require the majority of the pavement to be placed by a mechanical method. Hand placed concrete will be limited to transition areas where mechanical methods will not work. Pavement shall also conform with NCTCOG Ride Quality and finish pavement shall be satisfactory to City. Pavement must also conform with NCTOCG.

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
SCHEDULE 'A' - CONTROLS/DEMOLITION/PREPARATION					
1	1	L.S.	Mobilization, Bonds, Insurance and all Permitting (entire project), complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
2	1	L.S.	All Traffic Control Measures, including, but not limited to, construction sequencing, barricading, traffic control design, panels, signs, and temporary pavement markings, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
3	1	L.S.	Temporary Erosion Control, including providing SWPPP, NOI, and filing with TCEQ, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
4	2	EA.	Project Sign, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
5	21,800	S.Y.	Sawcut, Remove and Dispose of Existing Concrete Street/Driveway Pavement, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
6	2,000	S.Y.	Sawcut, Remove and Dispose of Existing Concrete Sidewalk Pavement, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
7	3,100	S.Y.	Sawcut, Remove and Dispose of Existing Asphalt Pavement, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
8	15	L.F.	Sawcut, Remove and Dispose of Existing Concrete Curb and Gutter, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
9	1,200	S.F.	Remove and Dispose of Existing Brick Pavers, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
10	35	S.Y.	Remove and Dispose of Existing Cinder Block Trail Pavers, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
11	18	EA.	Remove and Dispose of Existing Crape Myrtle, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
12	24	EA.	Remove and Dispose of Existing Trees (Over 6" dia.), complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
13	350	L.F.	Remove and Dispose of Existing CPP (Corrugated Plastic Pipe), complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
14	50	L.F.	Remove and Dispose of Existing CMP, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
15	140	L.F.	Remove and Dispose of Existing RCP, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
16	8	EA.	Remove and Dispose of Existing Headwall, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
17	30	S.Y.	Remove and Dispose of Existing Concrete Riprap, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
18	2	EA.	Remove and Dispose of Existing Curb Inlet, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
19	4	EA.	Remove and Dispose of Existing Grate Inlet, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
20	110	L.F.	Remove and Dispose of Existing Guard Rail, including post, rail, etc., complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
21	1	L.S.	Remove Existing Enhanced LED Crosswalk Signage, including crosswalk pole, foundation, ped. button, cabinet, and all appurtenances, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
22	39	EA.	Remove Existing Road Sign, Foundation, Post, and Panel, and return sign to City, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
23	3	EA.	Remove and Dispose of Existing Upright Reflectors, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
24	650	L.F.	Remove and Dispose of Existing Free Standing Stone Wall, including foundation, stones, etc., complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
25	50	L.F.	Remove and Dispose of Existing Retaining Sack Wall, including foundations, etc., complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
26	40	L.F.	Remove and Dispose of Existing Landscape Edger, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
27	25	L.F.	Remove and Dispose of Existing Landscape Stone Wall, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
28	78	EA.	Remove and Relocated Existing Irrigation Valve, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
29	6	EA.	Remove Relocated Fire Hydrant, including storage, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
30	2	EA.	Remove and Relocated Existing Water Meter, including installation, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
31	4	EA.	Remove and Relocated Existing Underground Utility Sign, including installation, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
			SCHEDULE "A" TOTAL:	$_____	
SCHEDULE 'B' - PAVING					
32	17,400	C.Y.	Unclassified Street Excavation, complete per unit _____ _____Dollars & _____Cents	$_____	$_____
33	13,250	C.Y.	Borrow, including compaction, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
34	24,500	S.Y.	Furnish and Place 8" Thick (4000 PSI) Reinforced Concrete Street Pavement with 6" Curb, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
35	30	S.Y.	Furnish and Place 6" Thick (4000 PSI) Reinforced Concrete Driveways, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
36	700	S.Y.	Furnish and Place 4" Thick (3000 PSI) Reinforced Stamped and Colored Concrete Median Pavement, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
37	820	S.Y.	Furnish and Place 6" Thick (3000 PSI) Reinforced Concrete Sidewalk Pavement, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
38	60	S.Y.	Furnish and Place 5" Thick (3000 PSI) Reinforced Concrete Sidewalk Pavement, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
39	3,800	S.Y.	Furnish and Place 4" Thick (3000 PSI) Reinforced Concrete Sidewalk Pavement, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
40	40	S.Y.	Furnish and Place 6" Thick (3000 PSI) Reinforced Concrete Flume Pavement, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
41	765	L.F.	Longitudinal Butt Joint, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
42	90	L.F.	Construct Asphalt Street Header, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
43	9,950	L.F.	Furnish and Place 6" Tall Integral Curb, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
44	425	L.F.	Furnish and Place 12" Tall Sidewalk Curb, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
45	125	L.F.	Furnish and Place 6" Tall Sidewalk Curb, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
46	1,100	L.F.	Furnish and Place Sidewalk Toe Wall, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
47	100	L.F.	Furnish and Place Sidewalk Fill Wall, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
48	27,150	S.Y.	Construct 8" Thick Cement Treated Base, including placement, mixing, and compaction, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
49	490	Ton	Furnish Cement (@ 6% Cement by Dry Weight), complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
50	4	EA.	Furnish and Install Flume Crossing, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
51	32	EA.	Furnish and Place Barrier Free Ramp, including detectable warning surface, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
52	365	L.F.	Furnish and Install 42" Hand Rail, including foundation, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
53	210	L.F.	Furnish and Install 8" SCH-80 PVC Sleeves, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
54	10	EA.	Adjust Existing Manhole Frame and Cover to Final Grade, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
55	22	EA.	Adjust Existing Water Valve to Final Grade, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
			SCHEDULE "B" TOTAL:	$_____	

SCHEDULE 'C' - DRAINAGE

56	1,100	L.F.	Trench Safety, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
57	10	EA.	Construct C.O.H. STD. 8' Curb Inlet, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
58	2	EA.	Construct C.O.H. STD. 2'x2' Wye Inlet with 2' Concrete Apron, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
59	1	EA.	Construct C.O.H. STD. 3'x3' Wye Inlet, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
60	6	EA.	Construct C.O.H. STD. 3'x3' Wye Inlet with 2' Concrete Apron, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
61	4	EA.	Furnish and Install 8" Landscape Grate Inlet, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
62	1	EA.	Furnish and Install NDS FLO-WELL, including embedment, filter fabric, drain rock, etc., complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
63	70	L.F.	Furnish and Install 18" RCP CL. IV, including embedment, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
64	130	L.F.	Furnish and Install 24" RCP CL. IV, including embedment, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
65	500	L.F.	Furnish and Install 18" RCP CL. III, including embedment, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
66	20	L.F.	Furnish and Install 21" RCP CL. III, including embedment, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
67	110	L.F.	Furnish and Install 24" RCP CL. III, including embedment, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
68	45	L.F.	Furnish and Install 8" HDPE, including embedment, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
69	25	L.F.	Furnish and Install 15" HDPE, including embedment, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
70	5	L.F.	Furnish and Install 6" PVC SDR 35, including embedment, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
71	45	L.F.	Furnish and Install 8" PVC SDR 35, including embedment, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
72	170	L.F.	Furnish and Install 8" Perforated PVC SDR 35, including embedment, filter fabric, drain rock, etc., complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
73	16	EA.	Furnish and Install Concrete Collar, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
74	1	EA.	Furnish and Install 8" HDPE to 36" RCP Concrete Collar, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
75	4	EA.	Furnish and Install Wye Connection, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
76	1	EA.	Furnish and Install TxDOT 2-15" PSET (@ 7.5 degree Skew), complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
77	6	EA.	Furnish and Install TxDOT 18" PSET, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
78	1	EA.	Furnish and Install TxDOT 21" PSET, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
79	3	EA.	Furnish and Install TxDOT 24" PSET, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
80	2	EA.	Furnish and Install 18" RCP Plug, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
81	1	EA.	Furnish and Install 8" PVC 22.5 Degree Bend, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
82	4	EA.	Furnish and Install 18" RCP 30 Degree Bend, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
83	1	EA.	Furnish and Install 18" RCP 60 Degree Bend, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
84	10	L.F.	Furnish and Install TxDOT Extended Curb on Existing Headwall, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
85	1	EA.	Connect to Existing Wye Inlet, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
86	2	EA.	Connect to Existing Curb Inlet, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
87	20	S.Y.	Construct 12" Grouted Rip Rap with Toewall, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
88	1,825	L.F.	Grade-to-Drain Proposed Swale, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
			SCHEDULE "C" TOTAL:	$_____	
SCHEDULE 'D' - WATER					
89	1	L.S.	16" Water Line Lowering, including all appurtenances, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
90	210	L.F.	Trench Safety, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
91	2	EA.	Cut and Plug 16" Water Line, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
92	3	EA.	Close Existing Valve and Remove Stack, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
93	3	EA.	Connect to Existing 6" Water Line at Existing Valve Location and Install Relocated Fire Hydrant, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
94	1	EA.	Cut Out and Remove Existing 16" Water Line to Install 16" 45 Degree Bend, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
95	1	EA.	Cut Out and Remove Existing 16" Water Line to Connect 16" Water Line, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
96	3	EA.	Cut Out and Remove Existing 16" Water Line to Install 16"x6" Tee, 6" Valve, and Relocated Fire Hydrant, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
97	45	L.F.	Furnish and Install 6" AWWA C900 (DR-18) PVC with B-1 Embedment, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
98	140	L.F.	Furnish and Install 16" AWWA C905 (DR-18) PVC with B-1 Embedment, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
99	60	L.F.	Furnish and Install 16" AWWA C905 (DR-18) PVC with G Embedment, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
100	1	EA.	Furnish and Install 16" 45 Degree Bend, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

SCHEDULE "D" TOTAL: $_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
SCHEDULE 'E' - STRIPING					
101	1	L.S.	Remove Existing Pavement Markings and Striping, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
102	520	L.F.	Furnish and Place 4" White Thermoplastic Solid Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
103	300	L.F.	Furnish and Place 4" Yellow Solid Thermoplastic Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
104	120	L.F.	Furnish and Place 4" Double Yellow Solid Thermoplastic Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
105	740	L.F.	Furnish and Place 18" White Thermoplastic Stop Bar, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
106	210	L.F.	Furnish and Place 4" White Thermoplastic Dash Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
107	150	L.F.	Furnish and Place 4" White Thermoplastic Broken Lane Line Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
108	320	L.F.	Furnish and Place 4" Yellow Thermoplastic Dash Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
109	160	L.F.	Furnish and Place 4" Double Yellow Thermoplastic Dash Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
110	1,930	L.F.	Furnish and Place 8" White Solid Thermoplastic Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
111	11,450	L.F.	Furnish and Place Bike Lane Line (Stripe/Button), complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
112	250	L.F.	Furnish and Place Broken Bike Lane Line, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
113	25	L.F.	Furnish and Place 12" White Solid Thermoplastic Diagonal Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
114	130	L.F.	Furnish and Place 12" Yellow Solid Thermoplastic Diagonal Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
115	3,000	S.F.	Furnish and Place Green Thermoplastic Bike Lane, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
116	1,370	L.F.	Furnish and Place 12" White Solid Thermoplastic Crosswalk Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
117	38	EA.	Furnish and Install Pavement Directional Marking, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
118	48	EA.	Furnish and Install Bicycle Pavement Marker W/Directional Marker, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
119	45	EA.	Furnish and Install Traffic Sign, including foundation, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
120	2	EA.	Furnish and Install Radar Sign, including foundation, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
121	1	L.S.	Furnish and Install LED Pedestrian warning system, including signs, posts, solar panels, sensors and all appurtenances, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

SCHEDULE "E" TOTAL: $_____

CITY OF HIGHLAND VILLAGE
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(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

BASE BID SCHEDULE

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
SCHEDULE 'F' - MISCELLANEOUS					
122	1	L.S.	Furnish and Construct Block Retaining Wall, including all appurtenances, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
123	10,000	S.Y.	Furnish and Place Hydromulch, including watering and fertilizer until established, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
124	15,000	S.Y.	Furnish and Place Block Sodding, including 4" topsoil, watering and fertilizer until established, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
			SCHEDULE "F" TOTAL:	$_____	

CITY OF HIGHLAND VILLAGE
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BASE BID SCHEDULE

SCHEDULE "A" TOTAL: $_____

SCHEDULE "B" TOTAL: $_____

SCHEDULE "C" TOTAL: $_____

SCHEDULE "D" TOTAL: $_____

SCHEDULE "E" TOTAL: $_____

SCHEDULE "F" TOTAL: $_____

TOTAL AMOUNT BID, ITEMS 1 THROUGH 124 INCLUSIVE: $_____

TOTAL AMOUNT BID, ITEMS 1 THROUGH 124 INCLUSIVE (IN WORDS):

_____

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BREAKDOWN OF TOTAL AMOUNT BID IN MATERIAL AND LABOR:

TOTAL MATERIAL AMOUNT BID, ITEMS 1 THROUGH 124, INCLUSIVE: $_____

TOTAL LABOR AMOUNT BID, ITEMS 1 THROUGH 124, INCLUSIVE: $_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

ADD ALTERNATE 1 BID SCHEDULE

Items A1-1 through A1-16 represent an Add Alternate 1 Bid
The Owner reserves the right to select this Add Alternate Bid at the Owner's discretion.

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
A1-1	60	S.Y.	Sawcut, Remove and Dispose of Existing Concrete Sidewalk Pavement, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
A1-2	30	S.Y.	Sawcut, Remove and Dispose of Existing Asphalt Pavement, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
A1-3	2	EA.	Remove and Dispose Bollards, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
A1-4	35	L.F.	Remove and Dispose Wood Fence, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
A1-5	1	EA.	Remove Existing Road Sign, Foundation and Post, and return sign to City, complete, per unit _____ _____Dollars & _____Cents	$_____	$_____
A1-6	45	S.Y.	Furnish and Place 8" Thick (4000 PSI) Reinforced Concrete Street Pavement with 6" Curb, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A1-7	15	S.Y.	Furnish and Place 6" Thick (4000 PSI) Reinforced Concrete Driveways, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

ADD ALTERNATE 1 BID SCHEDULE

Items A1-1 through A1-16 represent an Add Alternate 1 Bid
The Owner reserves the right to select this Add Alternate Bid at the Owner's discretion.

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
A1-8	180	S.Y.	Furnish and Place 2" Type 'D' HMAC Surface Course, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A1-9	180	S.Y.	Furnish and Place 2" Type 'B' HMAC Binder Course, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A1-10	33	L.F.	Furnish and Place 6" Tall integral Curb, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A1-11	20	GAL.	Furnish and Place Tack Coat (@ 0.05 Gal/S.Y.), complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A1-12	55	GAL.	Furnish and Place Prime Coat (@ 0.30 Gal/S.Y.), complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A1-13	270	S.Y.	Construct 8" Thick Cement Treated Base, including placement, mixing, and compaction, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A1-14	15	L.F.	Construct Asphalt Street Header, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

ADD ALTERNATE 1 BID SCHEDULE

Items A1-1 through A1-16 represent an Add Alternate 1 Bid
The Owner reserves the right to select this Add Alternate Bid at the Owner's discretion.

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
A1-15	1	EA.	Furnish and Install Traffic Sign, including foundation, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A1-16	100	L.F.	Furnish and Place 4" White Thermoplastic Solid Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

ADD ALTERANTE 1 TOTAL: $_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

ADD ALTERNATE 1 BID SCHEDULE

TOTAL AMOUNT BID, ITEMS A1-1 THROUGH A1-16 INCLUSIVE: $_____

TOTAL AMOUNT BID, ITEMS A1-1 THROUGH A1-16 INCLUSIVE (IN WORDS):

_____

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BREAKDOWN OF TOTAL AMOUNT BID IN MATERIAL AND LABOR:

TOTAL MATERIAL AMOUNT BID, ITEMS A1-1 THROUGH A1-16, INCLUSIVE: $_____

TOTAL LABOR AMOUNT BID, ITEMS A1-1 THROUGH A1-16, INCLUSIVE: $_____

The Owner reserves the right to select this Add Alternate Bid at the Owner's discretion.

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

ADD ALTERNATE 2 BID SCHEDULE

Items A2-1 through A2-9 represent an Add Alternate 2 Bid
The Owner reserves the right to select this Add Alternate Bid at the Owner's discretion.

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
A2-1	640	L.F.	Furnish and Place 4" White Thermoplastic Solid Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A2-2	35	L.F.	Furnish and Place 12" White Thermoplastic Stop Bar, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A2-3	240	L.F.	Furnish and Place 8" White Solid Thermoplastic Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A2-4	20	L.F.	Furnish and Place 12" White Solid Thermoplastic Diagonal Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A2-5	75	L.F.	Furnish and Place 12" Yellow Solid Thermoplastic Diagonal Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A2-6	80	L.F.	Furnish and Place 12" White Solid Thermoplastic Crosswalk Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A2-7	8	EA.	Furnish and Install Pavement Directional Marking, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

ADD ALTERNATE 2 BID SCHEDULE

Items A2-1 through A2-9 represent an Add Alternate 2 Bid
The Owner reserves the right to select this Add Alternate Bid at the Owner's discretion.

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
A2-8	6	EA.	Furnish and Install Pavement Words, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A2-9	450	L.F.	Furnish and Place 4" Double Yellow Thermoplastic Solid Stripe, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

ADD ALTERANTE 2 TOTAL: $_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

ADD ALTERNATE 2 BID SCHEDULE

TOTAL AMOUNT BID, ITEMS A2-1 THROUGH A2-9 INCLUSIVE: $_____

TOTAL AMOUNT BID, ITEMS A2-1 THROUGH A2-9 INCLUSIVE (IN WORDS):

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BREAKDOWN OF TOTAL AMOUNT BID IN MATERIAL AND LABOR:

TOTAL MATERIAL AMOUNT BID, ITEMS A2-1 THROUGH A2-9, INCLUSIVE: $_____

TOTAL LABOR AMOUNT BID, ITEMS A2-1 THROUGH A2-9, INCLUSIVE: $_____

The Owner reserves the right to select this Add Alternate Bid at the Owner's discretion.

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

ADD ALTERNATE 3 BID SCHEDULE

Items A3-1 through A3-2 represent an Add Alternate 3 Bid
The Owner reserves the right to select this Add Alternate Bid at the Owner's discretion.

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
A3-1	26	EA.	Furnish and Install Street Signs, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A3-2	33	EA.	Furnish and Install Decorative Sign Post, including all appurtenances, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

ADD ALTERANTE 3 TOTAL: $_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

ADD ALTERNATE 3 BID SCHEDULE

TOTAL AMOUNT BID, ITEMS A3-1 THROUGH A3-2 INCLUSIVE: $_____

TOTAL AMOUNT BID, ITEMS A3-1 THROUGH A3-2 INCLUSIVE (IN WORDS):

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BREAKDOWN OF TOTAL AMOUNT BID IN MATERIAL AND LABOR:

TOTAL MATERIAL AMOUNT BID, ITEMS A3-1 THROUGH A3-2, INCLUSIVE: $_____

TOTAL LABOR AMOUNT BID, ITEMS A3-1 THROUGH A3-2, INCLUSIVE: $_____

The Owner reserves the right to select this Add Alternate Bid at the Owner's discretion.

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

ADD ALTERNATE 4 BID SCHEDULE

Items A4-1 represent an Add Alternate 4 Bid
The Owner reserves the right to select this Add Alternate Bid at the Owner's discretion.

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
A4-1	40	EA.	Furnish and Install Decorative Sign Post, including all appurtenances, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

ADD ALTERANTE 4 TOTAL: $_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

ADD ALTERNATE 4 BID SCHEDULE

TOTAL AMOUNT BID, ITEM A4-1 INCLUSIVE: $_____

TOTAL AMOUNT BID, ITEM A4-1 INCLUSIVE (IN WORDS):

_____

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_____

BREAKDOWN OF TOTAL AMOUNT BID IN MATERIAL AND LABOR:

TOTAL MATERIAL AMOUNT BID, ITEM A4-1 INCLUSIVE: $_____

TOTAL LABOR AMOUNT BID, ITEM A4-1 INCLUSIVE: $_____

The Owner reserves the right to select this Add Alternate Bid at the Owner's discretion.

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

ADD ALTERNATE 5 BID SCHEDULE

Items A5-1 through A5-3 represent an Add Alternate 5 Bid
The Owner reserves the right to select this Add Alternate Bid at the Owner's discretion.

Item No.	Est. Quantity	Unit	Description & Unit Price in Words	Unit Price in Figures	Extended Amount
A5-1	-1	L.S.	Furnish and Construct Block Retaining Wall, including all appurtenances, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A5-2	-10	L.F.	Furnish and Install TxDOT Extended Curb on Existing Headwall, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____
A5-3	1	L.S.	Furnish and Construct Reinforced Concrete Retaining Wall (TxDOT Type C), including all appurtenances, complete in place, per unit _____ _____Dollars & _____Cents	$_____	$_____

ADD ALTERANTE 5 TOTAL: $_____

CITY OF HIGHLAND VILLAGE
HIGHLAND SHORES BLVD RECONSTRUCTION PROJECT
(Twin Cove Drive/Hillside Drive To 200' West of Lake Cove)

ADD ALTERNATE 5 BID SCHEDULE

TOTAL AMOUNT BID, ITEMS A5-1 THROUGH A5-3 INCLUSIVE: $_____

TOTAL AMOUNT BID, ITEMS A5-1 THROUGH A5-3 INCLUSIVE (IN WORDS):

_____

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BREAKDOWN OF TOTAL AMOUNT BID IN MATERIAL AND LABOR:

TOTAL MATERIAL AMOUNT BID, ITEMS A5-1 THROUGH A5-3, INCLUSIVE: $_____

TOTAL LABOR AMOUNT BID, ITEMS A5-1 THROUGH A5-3, INCLUSIVE: $_____

The Owner reserves the right to select this Add Alternate Bid at the Owner's discretion.

Geotechnical Engineering Report

Highland Shores Boulevard
Pavement Improvements
Highland Village, Texas

July 13, 2022

D&S ENGINEERING LABS

July 13, 2022

D&S ENGINEERING LABS

Scott Kriston
Director of Public Works
City of Highland Village
948A Highland Village Road
Highland Village, TX 75034
Phone: 972-317-2989
Email:skriston@highlandvillage.org

GEOTECHNICAL INVESTIGATION
D&S ENGINEERING #G22-2124
HIGHLAND VILLAGE BLVD ROAD IMPROVEMENTS
HIGHLAND VILLAGE, TEXAS

Mr. Kriston,

As requested, D&S Engineering Labs, LLC has completed the geotechnical investigation for the above-referenced project. This exploration was conducted in accordance with Proposal No. GP22-2124, dated May 4, 2021. Notice to proceed was received on May 9, 2022.

We appreciate the opportunity to provide professional geotechnical engineering services for this project. At your request, we are available to discuss any questions which may arise regarding this report. Please do not hesitate to call if we can provide any additional services.

Sincerely,

D&S Engineering Labs, LLC

7-13-2022

STATE OF TEXAS
IBRAHIM A. BAAYEH
132175
LICENSED
PROFESSIONAL ENGINEER

Saurav Sinha, P.E.
Senior Geotechnical Engineer

Ibrahim A. Baayeh, P.E.
Director of Geotechnical Engineering

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GEOTECHNICAL INVESTIGATION
HIGHLAND VILLAGE BOULEVARD PAVEMENT IMPROVEMENTS
HIGHLAND VILLAGE, TEXAS

1.0 PROJECT DESCRIPTION

This report presents the results of the geotechnical investigation conducted for planned pavement improvements along Highland Shores Boulevard in Highland Village, Texas. We understand that the project corridor encompasses a total of approximately 1.8 miles of roadway starting at its intersection with Village Parkway and ending at its intersection with Highland Shores Road. The roadway is currently a two-lane asphalt and concrete pavement. The improved roadway will be in accordance with the City of Highland pavement standards. We expect that new pavement grades will match the existing grades.

2.0 PURPOSE AND SCOPE

The purpose of this investigation was to:

- Identify the subsurface stratigraphy and groundwater conditions present at the site.
- Evaluate the physical and engineering properties of the subsurface soils for use in the geotechnical analyses.
- Provide geotechnical recommendations for use in design and construction of the proposed pavements.

The scope of this investigation consisted of:

- Drilling and sampling a total of ten (10) borings to depths of about 10 to 15 feet within the proposed roadway improvement alignment.
- Laboratory testing of selected soil samples obtained during the field investigation.
- Preparation of a Geotechnical Report that includes:
    - Evaluation of Potential Vertical Movement (PVM).
    - Recommendations for excavations.
    - Recommendations for pavement subgrade preparation and pavement sections in consideration of the City of Highland Village Standards and Specifications.

3.0 FIELD AND LABORATORY INVESTIGATION

3.1 General

The borings were advanced using a truck-mounted drilling rig, which was equipped with continuous flight augers. Undisturbed samples of cohesive soils were obtained using 3-inch diameter tube samplers, which were advanced into the soils in 1-foot increments by the continuous thrust of a hydraulic ram located on the drilling equipment. After sample extrusion, a hand penetrometer measurement was performed on each sample of cohesive soil to provide an estimate of soil stiffness.

Subsurface materials were also intermittently tested in-situ using cone penetration tests in order to determine their resistance to penetration. For this test, a 3-inch diameter steel cone is driven by the energy of a 170-pound hammer falling freely from a height of 24 inches and striking an anvil located at the top of the drill string. Depending on the resistance of the soil materials, either the number of blows of the hammer required to provide 12 inches of penetration is recorded (as two increments of 6 inches each), or the inches of penetration of the cone resulting from 100 blows of the hammer are recorded (as two increments of 50 blows each).

Additionally, Dynamic Cone Penetrometer (DCP) tests were conducted at each boring location to depths of about 3 feet below the bottom of the existing roadway in general accordance with ASTM D6951. Results of these tests are presented in Appendix A.

All samples obtained were extruded in the field, placed in plastic bags to minimize changes in the natural moisture condition, labeled according to the appropriate boring number and depth, and placed in protective cardboard boxes for transportation to the laboratory. The approximate locations of the borings performed at the site are shown on the boring location map that is included in Appendix A. The surface elevations shown on the boring logs were interpolated from available NCTCOG (www.dfwmaps.com) website, which provide contours at 2-feet interval. The specific depths, thicknesses and descriptions of the strata encountered are presented on the individual Boring Log illustrations, which are also included in Appendix A. Strata boundaries shown on the boring logs are approximate.

3.2 Laboratory Testing

Laboratory tests were performed to identify the relevant engineering characteristics of the subsurface materials encountered and to provide data for developing engineering design parameters. The subsurface materials recovered during the field exploration were initially logged by the drill crew, then were described by a Geotechnical Engineer in the laboratory. These descriptions were later refined by a Geotechnical Engineer based on the results of the laboratory tests performed. All recovered soil samples were classified and described in part using the Unified Soil

Classification System (USCS) and other accepted procedures. Bedrock strata were described using standard geologic nomenclature.

In order to determine soil characteristics and to aid in classifying the materials, classification testing was performed on selected samples as requested by the Geotechnical Engineer. Classification testing was performed in general accordance with the following ASTM testing standards:

- Moisture Content ASTM D2216
- Atterberg Limits ASTM D4318

Additional tests were performed to aid in evaluating soil strength, chemical and volume change characteristics, including:

- Soluble Sulfates TEX-145-E
- Overburden Swell Testing ASTM D4546
- Unconfined Compressive Strength ASTM D2166
- Direct Shear of Soils ASTM D3080
- Soil-Cement Proctors ASTM D1633

The results of index property, chemical, and swell tests are presented at the corresponding sample depths on the appropriate Boring Log illustrations. The index property and classification testing procedures are described in more detail in Appendix B.

3.2.1 Soluble Sulfates

Soluble sulfate tests were performed on representative samples obtained. The results of these tests are provided in Appendix A.

Subgrade materials in some areas of Texas have experienced sulfate-induced heave after treatment with calcium-based additives such as lime, cement, cement kiln dust and other calcium-rich materials. Sulfates can occur in any type of soil, particularly soils with high plasticity, but also can occur in granular soils found in arid regions. Typically, high sulfate concentrations occur in localized areas and not uniformly distributed but in seams or veins.

In general, sulfate concentrations less than 3,000 ppm are considered to have an acceptably low potential for sulfate induced heaving and conventional lime/cement treatment is adequate.

A sulfate concentration from 3,000 ppm to 8,000 ppm is considered to have a moderate to high risk for both lime and cement treatment. For lime treatment an extended mellowing time of 2 to 5 days and a mellowing moisture content at 2 to 5 percent above optimum is recommended. Mellowing is the process

whereby the lime reacts with the sulfate rich uncompacted soil. A single lime application is recommended. After the mellowing period the lime treated soil should be reworked to bring the moisture content down close to optimum and achieve 95% of the maximum dry density.

The results of the sulfate tests performed on representative near-surface soil samples from test borings in this study indicate low (100 ppm) to moderate (3,293 ppm) sulfate concentrations and are therefore considered to pose a moderate risk of sulfate-induced heaving after lime or cement treatment of the on-site soils.

3.2.2 Overburden Swell Tests

Selected samples of the near-surface soil were subjected to overburden swell testing. For this test, a sample is placed in a consolidometer and subjected to the estimated overburden pressure. The sample is then inundated with water and is allowed to swell. The moisture content of the sample is determined both before and after completion of the test. Test results are recorded, including the percent swell and the initial and final moisture contents.

3.2.3 Direct Shear of Soils

A direct shear test was performed on a selected soil sample. The test was performed in general accordance with ASTM D3080. The direct shear test consists of placing a sample of relatively undisturbed soil and subjecting it to full saturation and consolidation. A shear force is then applied on the sample at a rate appropriate to maintain drained soil conditions. Test results are recorded and plotted in a shear stress vs. horizontal deformation graph, from where peak stress is calculated. A graph of shear stress vs. normal stress allows computation of cohesion and angle of internal friction values.

3.3 Stratigraphy

Based upon a review of the recovered samples as well as the Geologic Atlas of Texas, Dallas Sheet, this site is in an area characterized of soil and bedrock strata associated with the Woodbine Formation. The Woodbine Formation is considered to have formed in a deltaic depositional environment, and as a result, it is highly variable in composition, both laterally and vertically. This formation is typically composed of overburden sand and clay soils overlying shale and sandstone bedrock.

Concrete pavement with thickness ranging from 6 to 9.5 inches was present at the surface within Borings B1 through B7. Asphalt pavement of about 8.5 to 11 inches in thickness was present at the surface of within the remaining borings. Beneath the roadway pavement within all borings except Borings B2, B7 and B10, lean clay and fat clay soils are present. The lean clay and fat clay are generally stiff to very stiff in

consistency, various shades of brown and reddish brown in color and contain varying amounts of limestone fragments, iron oxide stains, and sand seams.

Below the pavement sections in Borings B2, B7 and B10, clayey sands are present. The clayey sands are reddish brown in color and medium dense to dense in condition. The sand strata extend to depths of about 13 to 15 feet below existing pavement grades.

The overburden soils are underlain with weathered shale bedrock strata. The weathered shale strata present are generally very soft to soft in rock hardness, are various shades of brown and gray in color, contain varying amounts of iron oxide stains, ferrous laminations and sand seams.

3.4 Groundwater

Groundwater seepage was encountered within Borings B2, B8, B9 at depths of about 13 to 15 feet during drilling operations and was measured at 15 feet up completion of drilling activities. Groundwater seepage was not encountered either during drilling or upon the completion of drilling operations in the remaining borings. Groundwater levels may be anticipated to fluctuate with seasonal and annual variations in rainfall and may vary as a result of development and landscape irrigation and is often contained within the joints, fractures and other rock mass defects present in bedrock strata. When intercepted, these defects can produce appreciable amounts of water for a period of time, especially if those defects are extensive and well inter-connected.

Table 1. Depth to Groundwater

Boring No.	Groundwater seepage during drilling (ft.)	Depth to Groundwater at Completion of Drilling (ft.)
B1	dry	dry
B2	15	15
B3	dry	dry
B4	dry	dry
B5	dry	dry
B6	dry	dry
B7	dry	dry
B8	15	15
B9	13	15
B10	dry	dry

4.0 ENGINEERING ANALYSIS

4.1 Estimated Potential Vertical Movement (PVM)

Potential Vertical Movement (PVM) was evaluated utilizing different methods for predicting movement, as described in Appendix B, and based on our experience and professional opinion.

At the time of our field investigation, the near-surface soils were generally found to be in a dry moisture condition. Based upon the results of our analysis, this site is estimated to possess a Potential Vertical Movement from dry to wet conditions on the order of 1 to 2 inches at the soil moisture conditions existing at the time of the field investigation. If the near-surface soils are allowed to dry appreciably to significant depth prior to or during construction, the potential for post-construction vertical movement will increase. Please note that dry, average, and wet are relative terms based on moisture content and plasticity.

5.0 PAVEMENT RECOMMENDATIONS

5.1 General

The pavement design recommendations provided herein are derived from the subgrade information that was obtained from our geotechnical investigation, design assumptions based on project information, our experience with similar projects in this area, on the guidelines and recommendations of the American Concrete Pavement Association (ACPA), and City of Highland Village Standards and Specifications. It is ultimately the responsibility of the Civil Engineer of Record and/or other design professionals who are responsible for pavement design to seal the final pavement design and associated specifications for this project.

5.2 Behavior Characteristics of Expansive Soils beneath Pavement

Near-surface soils at this site are considered to have potential for volume change with changes in soil moisture content. The moisture content can be “stabilized” to some degree in these soils by covering them with an impermeable surface, such as pavement. However, if moisture is introduced by surface or subsurface water, poor drainage, or the addition of excessive irrigation after periods of no moisture, or if moisture is removed by desiccation from vegetation (especially trees), the soils can swell or shrink causing distress to pavements in contact with the soil in the form of cracks.

The edges of pavements are particularly prone to moisture variations, therefore, these areas often experience the most distress (cracking, displacement, etc.). When cracks appear on the surface of the pavement, these openings can allow moisture to enter the pavement subgrade, which can lead to further weakening of the pavement section as well as accelerated failure of the pavement surface.

In order to minimize the potential impacts of expansive soil on paved areas and to improve the long-term performance of the pavement, we have the following recommendations:

- Design a crowned or sloped pavement which provides maximum drainage away from the pavement. A minimum slope of 5 percent within the first 5 feet is considered ideal.

- Subgrade treatments intended to reduce the soil's potential for vertical movement or to increase the subgrade stability should extend to at least 48 inches beyond the back of curbs or edges of pavements. In addition, a moisture barrier be placed at least 72 inches beyond the back of curbs or edges of pavements. The moisture barrier should slope away from the pavement edge.

5.3 Subgrade Preparation Recommendations

The anticipated subgrade soils will be imported low to moderate sulfate lean clay and fat clay soils in the proposed paving areas which can become weak and pump with appreciable increases in moisture content. A commonly used method to improve the strength properties of the subgrade soils, provide a working platform, reduce the potential for pumping by providing a barrier to the native soils, reduces the contact pressure on the native subgrade and provides for a more uniform subgrade is to provide a lime or cement treated layer beneath the paving depending on the PI of the typical soil to be encountered. For PI's greater than about 15, lime is generally preferred. For PI's less than about 15 and are predominantly sandy soils, cement is generally preferred. For this site, PI's within the soils are generally in a range from 11 to 27 with an average of 16. As such, cement treatment is recommended. As an alternative to cement treatment, a layer of compacted aggregate base may be used. Lime treatment is also provided in the following sections. To that end, we have the following recommendations for subgrade preparation and subgrade improvement alternatives:

- Strip the sites of all existing pavement, base, and grass or other surface vegetation within the planned paved areas.

- Cut as needed to required pavement subgrade elevation to accommodate the new pavement sections.

- After stripping and performing necessary cuts, the exposed subgrade should be proof rolled. Proof rolling should consist of rolling the entire pavement subgrade in mutually perpendicular directions with a heavily loaded, tandem-axle dump truck weighing at least 25 tons or other approved equipment capable of applying similar loading conditions. Any soft, wet, or weak soils that are observed to rut more than about 1/2-inch or pump excessively (exhibiting “waving” action) during proof rolling should be removed and replaced with well-compacted, on-site clayey material or allowed to dry as outlined below. The proof rolling operation should be performed under the observation of a qualified geotechnical engineer. D&S would welcome the opportunity to perform these services for this project.

- After proof rolling, areas to receive fill should be scarified and reworked to a depth of 12 inches. The soils should then be recompacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D698 (standard Proctor) and be placed at a moisture content between optimum and four (4) percent above optimum moisture content.

- In areas to receive fill, fill may be derived from on-site or may be imported. The fill should be placed in maximum 8-inch loose lifts, compacted to at least 95 percent of the maximum dry density, as determined by ASTM D698 (standard Proctor), and be placed at a moisture content between optimum and four (4) percent above optimum moisture content. Prior to compaction, each lift of fill should first be processed throughout its thickness to break up and reduce clod sizes and blended to achieve a material of uniform density and moisture content. Once blended, compaction should be performed with a heavy tamping foot roller. Once compacted, if the surface of the embankment is too smooth, it may not bond properly with the succeeding layer. If this occurs, the surface of the compacted lift should be roughened and loosened by dicing before the succeeding layer is placed.

- Water required to bring the fill material to the proper moisture content should be applied evenly through each layer. Any layers that become significantly altered by weather conditions should be reprocessed in order to meet recommended requirements. On hot or windy days, the use of water spraying methods may be required in order to keep each lift moist prior to placement of the subsequent lift. Furthermore, the subsurface soils should be kept moist prior to placing the pavement by water sprinkling or spraying methods.

- Fill materials should be placed on a properly prepared subgrade as outlined above. The combined excavation, placement, and spreading operation should be performed in such a manner as to obtain blending of the material, and to assure that, once compacted, the materials, will have the most practicable degree of compaction and stability. Materials obtained from on-site must be mixed and not segregated.

- Soil imported from off-site sources should be tested for compliance with the recommendations herein and approved by the project geotechnical engineer prior to being used as fill. Imported materials shall have a Liquid Limit (LL) less than 40, plasticity index (PI) less than 20, and be essentially free of particles in excess of 4 inches in their longest direction.

- Water should not be allowed to pond on or adjacent to the pavement area, particularly once grading has begun and/or aggregate base has been placed. To that end, the pavement subgrade surface should be shaped in a way that will allow water to shed from one or more edges of the prepared subgrade.

- Field density and moisture content testing should be performed at a minimum rate of one (1) test per lift per 100 linear feet of roadway.

5.3.1 Cement Treatment Recommendations

Once the subgrade is brought to the required finished subgrade elevation, the subgrade soils may be treated with cement to the required depth. We have the following recommendations for subgrade cement treatment.

- Cement treated subgrade should be prepared in accordance with TxDOT Item 275 to subgrade using an estimated four to six (4 to 6) percent cement by dry weight measure of the subgrade soil. The actual percentage to be used should be determined once the subgrade is at rough grade elevation. The amount of cement used should be the minimum amount required to achieve a minimum 7-day cured unconfined compressive strength of 100 pounds per square inch.

- Cement should be applied such that mixing operations for a given area can be completed during the same working day.

- The cement may be placed dry or by the slurry method (meaning that the cement should be mixed with water in trucks or in tanks and applied as a thin slurry).

- After mixing, the soil-cement mixture should be tested for sufficient pulverization and mixing in accordance with TxDOT Item 275. The mixed material should meet the following requirements when tested dry by laboratory sieves:

    - Minimum passing 1¾" sieve: 100%
    - Minimum passing ¾” sieve: 85%
    - Minimum passing No. 4 sieve: 60%

- After sufficient mixing, the soil / cement mixture should be compacted to a minimum of 95% of Standard Proctor (ASTM D698) and to a moisture content that is at or above the optimum moisture, as

determined by that same test. Compaction should be completed within 2 hours after the application of water to the mixture of soil and cement.

- Cure for at least 3 days by “sprinkling” as described in TxDOT Item 204.
- To reduce the potential for subgrade soil moisture changes at the edges of pavements, the cement stabilized subgrade should extend a minimum of 18-inches past the back of the roadway curbs or edges of pavements.
- In order to reduce the potential for reflective cracking up through the pavement, particularly with asphalt pavement, the cement treated subgrade should be rolled with a vibratory roller 1 to 2 days after final compaction to create a network of hairline cracks (microcracking). Cure for at least 2 days by “sprinkling” as described in TxDOT Item 204 after completion of microcracking.
- Field density and moisture content testing should be performed on all pavement subgrade and base materials at a rate of one (1) test per lift per 3,000 square feet of parking area, and one (1) test per lift per 100 linear feet of roadway. These tests are necessary to determine if the recommended moisture and compaction requirements have been attained.

5.3.2 Aggregate Base

As an alternative to, or in conjunction with, cement treatment, aggregate base may be placed over the prepared subgrades in accordance with the following recommendations prior to placing the pavements.

- After proof rolling, and prior to the placement of aggregate base, the exposed subgrade beneath pavement areas should be scarified and reworked to a depth of 12 inches, moisture added or removed as required, and the subgrade soils recompacted to a minimum of 95 percent of the maximum dry density of the materials obtained in accordance with ASTM D698 (standard Proctor test), and at a moisture content that is within two (2) percentage points of the optimum moisture content, as determined by the same test ($\pm$2%). The rework and aggregate base should extend to at least 18-inches beyond the outside edges of curbs.
- Aggregate base should be TxDOT Type A or D and meet the gradation, durability, and plasticity requirements of TxDOT Item 247 Grade 1-2 or better (2014). Aggregate base material should be uniformly compacted in maximum 4 to 6-inch compacted lifts to a minimum of 95% of the

maximum standard Proctor dry density (ASTM D698) and placed at a moisture content that is sufficient to achieve density.

- Field density and moisture content testing should be performed at the rate of one (1) test per lift per 100 linear feet of road and one (1) test per lift per 100 linear feet of utility trenches. These tests are necessary to determine if the recommended moisture and compaction requirements have been attained.

5.3.3 Lime Treatment

- After completion of proof rolling and any grade raise fills, mix lime slurry into the prepared subgrade soil after scarifying to the lime treatment depth to achieve a treated subgrade with an estimated 6 percent lime by dry weight measure. However, the final amount of lime used should be determined once subgrade preparation is nearly complete. The amount of lime used should be sufficient to reduce the Plasticity Index of the soil to 15 or below (Atterberg Lime series) or to increase pH of the soil-lime mixture to 12.4 (pH series). The hydrated lime should be applied only in an area where the initial mixing operations can be completed the same working day. The area of lime treated subgrade should extend a minimum of 2 feet beyond the back of curbs or edges.

- Hydrated lime should be applied such that mixing operations can be completed during the same working day. The hydrated lime should be placed by the slurry method, meaning that the hydrated lime should be mixed with water in trucks or in tanks and applied as a thin water suspension or slurry. The distributor truck or tank should be equipped with an agitator, which will maintain the lime and water in a uniform mixture. The material and hydrated lime should be thoroughly mixed by a rotary mixer or other device to obtain a homogeneous, friable mixture of material and lime that is free from clods and left to cure from one to seven days.

- Within our experience, we have found that a curing period of 5 to 7 days is adequate for these sulfate bearing soils at this site. During the curing period, the material should be kept moist at least 3 to 5% above optimum. After the specified “mellowing duration”, the soil-lime mixture should be remixed and tested for sufficient pulverization and mixing in accordance with TxDOT Item 260. After the required curing time, the material should be uniformly mixed using a rotary mixer capable of reducing the size of the particles so that, when all non-slaking aggregates retained on a no. 4 sieve are removed, the remainder of the material shall meet the following requirements when tested dry by laboratory sieves:

    - Minimum passing 1-3/4 inch sieve = 100%

- Minimum passing no. 4 sieve = 60%

- After achieving the required gradation, the treated soil-lime mixture should then be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D698 (standard Proctor), and placed at a moisture content that is above and close to the optimum moisture content, as determined by the same test. During compaction, it may be necessary to allow the lime treated soils to dry to achieve density.

- During the interval of time between application and mixing, the hydrated lime should not be exposed to the open air for a period exceeding six hours.

- To reduce the potential for subgrade soil moisture changes at the edges of pavements, the lime treated subgrade should extend a minimum of 2 feet past the back of the roadway curbs.

- Field density and moisture content testing should be performed at the rate of one (1) test per lift per 5,000 square feet of lime treated soils in pavement areas.

5.4 Rigid Pavement

Specific axle loading and traffic volume characteristics have not been provided at this time. After reviewing available traffic counts for Highland Shores Blvd using NCTCOG and TxDOT data , the recent, average daily traffic (ADT) ranges from about 3,100 to 6,930 (2019) vehicles per day and 3,122 West (2020) and 3,369 East (2019). For the purposes of this design, we have assumed an ADT of 5,000 for the proposed alignment of improvement.

The following assumptions have been made in the calculation of traffic loading:

Design Life	Equivalent Single Axle Loads (ESAL's)
40 years	4,684,929
30 years	3,146,562
20 years	1,884,565

- Average Daily Traffic (ADT): 5,000
- Directional Distribution Factor: 50%
- Design Lane Distribution Factor: 100%
- Growth Rate: 2.0%
- Percent Trucks: 5.0%

Please contact this office if significant deviations from the assumptions above are anticipated.

In determination of the thickness of concrete pavement section, we used WinPAS 12 software, and the following assumptions were made. The proposed street classification is a residential street; therefore, we have assumed a reliability factor of 90%. If a higher value of reliability is required, the required overall section will increase. Please contact this office if significant deviations from the assumptions above are anticipated.

- Reliability: 90%
- Overall Standard Deviation: 0.35
- Composite Modulus of Subgrade Reaction (k): 220 pci
- Drainage Coefficient: 1.0
- Initial Serviceability: 4.0
- Terminal Serviceability: 2.25
- Load Transfer Coefficient: 3.0
- Minimum 28-day Concrete Flexural Strength: 570 psi
- Concrete Modulus of Elasticity: 3,800,000 psi

Minimizing subgrade saturation is an important factor in maintaining subgrade strength. Water should not be allowed to pond on or adjacent to the pavement that could saturate the pavement and lead to premature pavement deterioration. We recommend that all pavement surfaces be sloped to provide rapid surface drainage. Positive surface drainage away from the edge of the paved areas should be maintained.

Based on traffic count of 5,000 ADT, the minimum concrete thicknesses are presented in the tables below:

Table 2. Design Life : 40 years

9-inches of Portland Cement Concrete
8-inches of lime and/or cement treated subgrade or 8-inches of Type A or D TxDOT Item 247 Grade 1-2 or better (2014) aggregate base
over the prepared subgrade

Table 3. Design Life : 30 years

8.5-inches of Portland Cement Concrete
8-inches of lime and/or cement treated subgrade or 8-inches of Type A or D TxDOT Item 247 Grade 1-2 or better (2014) aggregate base
over the prepared subgrade

Table 4. Design Life : 20 years

8-inches of Portland Cement Concrete
8-inches of lime and/or cement treated subgrade or 8-inches of Type A or D TxDOT Item 247 Grade 1-2 or better (2014) aggregate base
over the prepared subgrade

We have the following concrete mix design recommendations:

- Recommended minimum design compressive strength: 4,000 psi.
- 15 to 20 percent fly ash may be used with the approval of the Civil Engineer of record
- Curing compound should be applied within one hour of finishing operations

5.4.1 Pavement Joints and Cutting

The performance of concrete pavement depends to a large degree on the design, construction, and long-term maintenance of concrete joints. The following recommendations and observations are offered for consideration by the Civil Engineer and/or pavement Designer-of-Record.

The concrete pavements should have adequately spaced contraction joints to control shrinkage cracking. Experience indicates that reinforced concrete pavements with sealed contraction joints on a 12 to 15-foot spacing, cut to a depth of one-quarter to one-third of the pavement thickness, have generally exhibited less uncontrolled post-construction cracking than pavements with wider spacing. The contraction joint pattern should divide the pavement into panels that are approximately square where the panel length should not exceed 25 percent more than the panel width. Saw cut, post placement formed contraction joints should be saw cut as soon as the concrete can support the saw cutting equipment and personnel and before shrinkage cracks appear, on the order of 4 to 6 hours after concrete placement.

Isolation joints should be used wherever the pavement will abut a structural element subject to a different magnitude of movement, e.g., light poles, retaining walls, existing pavement, stairways, entryway piers, building walls, or manholes.

In order to minimize the potential differential movement across the pavement areas, all joints including contraction, expansion, isolation, and construction joints should be sealed to minimize the potential for infiltration of surface water. Rubberized asphalt, silicone or another suitable flexible sealant may be used to seal the joints. Maintenance should include periodic inspection of these joints and the joints resealed as necessary.

The recommendations provided herein regarding expansion joints for jointed reinforced concrete pavement (JRCP) are derived from our experience and on the guidelines and recommendations of the American Concrete Institute (ACI), Federal Highway Administration (FHWA) and Texas Department of Transportation (TXDOT). The following recommendations and observations are offered for consideration by the Civil Engineer and/or pavement Designer-of-Record who are responsible to seal the final pavement plans and associated specifications for the project:

An expansion joint is provided to allow for thermal expansion of the concrete pavement in order to prevent spalling at the joints. Where provided the joint is full pavement depth with dowel bars at the mid-section of the joint. It can be argued that the closely spaced contraction joints allow for this potential thermal expansion and therefore there is no requirement for expansion joints. This has the benefit of strengthening the contraction joints and not allowing the joints to open up causing premature failure of the joint sealant. Isolation joints however should be provided at the edges of the pavement where the pavement abuts a structural element. However, due to the potential for excessive thermal expansion caused by high temperatures encountered in the DFW Metroplex it can also be argued to provide expansion joints with maximum spacing on the order of 60 to 600 feet depending on the author.

5.4.2 Pavement Reinforcing Steel

We recommend that a minimum of 0.1 percent of steel be used for all concrete pavements. We recommend that a minimum of No. 4 bars spaced at 18-inches center-to-center both ways should be utilized.

However, reinforcement requirements may increase depending on specific traffic loading and design life parameters.

6.0 CULVERTS

A culvert drainage crossing is originally planned along the proposed alignment of the proposed roadway near Boring B8.

We understand that culverts may be provided at various locations to convey runoff from one side of the roadway to the other. We anticipate that the culverts will be placed on a conventionally reinforced concrete mat foundation (base slab).

Recommendations for subgrade preparation to provide a working surface for construction and reduce the potential for bearing on soft soils are described below. The culverts mat foundation may be designed using an allowable bearing capacity of 1,800 pounds per square foot when placed on the prepared subgrade as described below.

The prepared subgrades for the culverts should be essentially free of any loose or soft material prior to the placement of the culvert.

For the culvert's subgrades, we have the following recommendations for earthwork.

- Strip the site of all vegetation, organic soil, and deleterious material within the new culvert area. Typically, 6 to 12 inches is sufficient for this purpose.
- After stripping and performing any necessary cuts, excavate the culvert area to a depth of 1 foot below the underside of the base slab. The excavation should extend at least 5 feet beyond the edges of the new structure.
- Place a filter fabric on top of the excavated subgrade followed by a geogrid. The geotextile may be US Fabrics US 315 or approved equivalent. Geogrid may be Tensar TX5 or approved equivalent. The fabric and grid should extend to the limits of the excavation.
- Provide a minimum of 12-inches of flexible base on top of the geogrid. Flexible base should meet the gradation, plasticity, and durability requirements of TxDOT Standard Specification Item 247, Type A or D, Grade 3 or better (TxDOT 2014 specifications). These materials should be placed in maximum 4-inch-thick compacted lifts and should be compacted to at least 95 percent of the maximum density as determined by the Standard Moisture Density Relationship test (ASTM D 698) and should be placed at a moisture content sufficient to achieve the required density.
- Water should not be allowed to pond on the prepared subgrade either during fill placement or after reaching final subgrade elevation. To that end, the subgrade surfaces should be shaped to shed water to the edges of the excavation.
- Following placement of the culverts, in order to prevent a hard point with reference to the road surfacing, we recommend a minimum of 15 inches of compacted soil be provided over the top of the culverts and below the cement treated subgrade. The compacted soil should be placed as described in Section 7.4.
- Consideration should be given to streambed and bank erosion protection on both sides of the roadway. Erosion protection may be accomplished with gabion mattresses, concrete rip rap, or other large stone rip rap. Regardless of the final protective layer, a filter fabric be placed between the natural soil and the protective layer.
- Each lift of fill placed should be tested for moisture content and degree of compaction by a testing laboratory at the rate of two (2) tests performed per lift within the culvert pad. D&S would be pleased to provide these services in support of this project.

7.0 RETAINING WALLS

We understand that retaining walls will be provided for culvert headwall and wing walls within the drainage crossing. We anticipate that the retaining walls will be placed on a conventionally reinforced concrete footing. The footing may be designed using an allowable bearing capacity of 1,800 pounds per square foot when placed on the prepared subgrade as described below.

7.1 Lateral Earth Pressures

Retaining walls will be subjected to lateral earth pressures and should be designed in consideration of these forces. Earth pressures will be influenced by the structural design of the walls, conditions of wall restraint, methods of construction and/or compaction, the strength of the materials being restrained, and drainage conditions.

Two wall restraint conditions are typically considered. Active earth pressure is commonly used for the design of free-standing cantilever retaining walls and assumes some small outward rotation of the wall. This condition is applicable to site retaining walls. The "at-rest" condition assumes that no wall rotation or movement will occur. This condition is typically considered where minimal movement of the wall is desired, for movement-sensitive walls, basement walls and walls rigidly connected to lower and upper floors (or roofs). “At-rest” condition would be applicable for the retaining wall.

The design lateral earth pressures recommended herein do not include a Factor of Safety and do not provide for dynamic pressures on the walls.

Lateral loads due to surcharge should be calculated as shown in Table 5. A coefficient of friction against sliding may be taken as 0.35 (ultimate) for concrete cast against compacted aggregate base. A passive pressure value of 230 psf may be used below a depth of 2 feet from final grade.

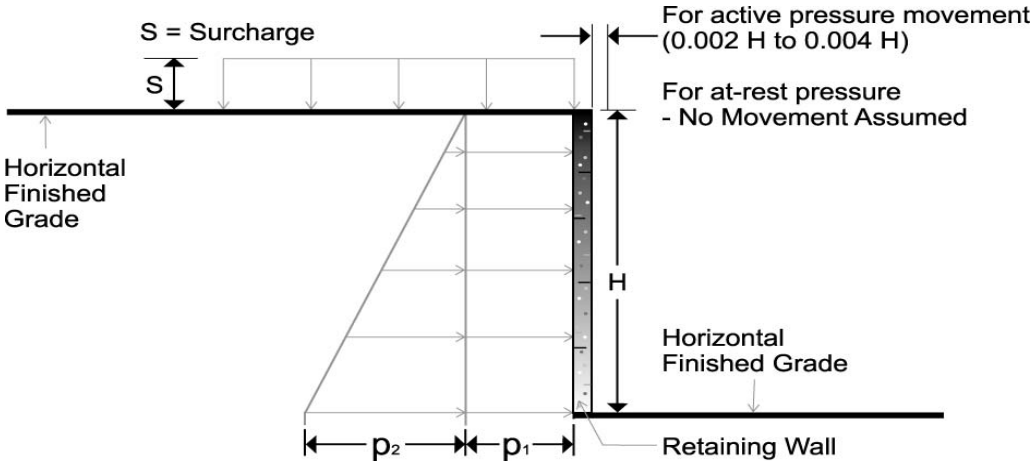


Figure 1: Lateral Earth Pressure

Table 5. Lateral Earth Pressures

Earth Pressure Conditions	Coefficient for Backfill Type	Undrained Equivalent Fluid Density (pcf)	Surcharge Pressure (psf) p1	Earth Pressure (psf) p2
At-Rest (K_o)	On-Site Soils - 0.58	99	(0.58) S[1]	(99) H[2]

Notes: [(1)] S = surcharge pressure
[(2)] H = wall height

Applicable conditions to Table 5 above include:

- Horizontal backfill, compacted to 95 to 98 percent of Standard Proctor maximum dry density for cohesive soils horizontal finished grades at the top and bottom of the retaining wall
- Uniform surcharge, where S is surcharge pressure
- A maximum in situ soil total unit weight of 125 pcf
- No loading contribution from compaction equipment

Heavy compactors should not be allowed to operate within 5 feet of the walls during backfilling to avoid developing excessive temporary or long-term lateral soil pressures. A qualified geotechnical engineer or geotechnical representative should be present to monitor all foundation excavations and fill placement. D&S would be pleased to provide these services in support of this project.

Table 6. Effective Friction Angle and Unit Weight

Backfill Type	Effective Friction Angle	Effective Unit Weight (pcf)
Select Fill Soils	25°	125

For the retaining wall subgrade, we have the following recommendations for earthwork.

- Strip the site of all vegetation, organic soil, and deleterious material within the new retaining walls area. Typically, 6 to 12 inches are sufficient for this purpose.
- After stripping and performing any necessary cuts, excavate the retaining wall area to a depth of 1 foot below the underside of the retaining wall footing.
- Place a filter fabric on top of the excavated subgrade. The geotextile may be US Fabrics US 315 or approved equivalent.

- Provide a minimum of 12-inches of flexible base on top of the filter fabric. Flexible base should meet the gradation, plasticity, and durability requirements of TxDOT Standard Specification Item 247, Type A or D, Grade 3 or better (TxDOT 2014 specifications). These materials should be placed in maximum 4-inch thick compacted lifts and should be compacted to at least 95 percent of the maximum density as determined by the Standard Moisture Density Relationship test (ASTM D698) and should be placed at a moisture content sufficient to achieve the required density.

- Water should not be allowed to pond on the prepared subgrade either during fill placement, or after reaching final subgrade elevation. To that end, the subgrade surfaces should be shaped to shed water to the edges of the excavation.

- Each lift of fill placed should be tested for moisture content and degree of compaction by a testing laboratory at the rate of two (2) tests performed per lift within the culvert pad. D&S would be pleased to provide these services in support of this project.

8.0 OTHER CONSTRUCTION

8.1 Surface Drainage

Proper drainage is critical to the performance of the paved areas. Positive surface drainage should be provided that directs surface water away from pavement edges. Where possible, we recommend that a slope of at least 5 percent in the first 5 feet be provided, but in no case should the slope be less than 2 percent unless curbs and gutters are provided along with adequate storm drainage. The slopes should direct water away from the pavement edges and should be maintained throughout construction and the life of the structure.

Construction joints must be maintained and any cracks that develop must be sealed. Inspection and resealing (as needed) should be part of the maintenance program.

8.2 Landscaping

Trees (if planned) should not be placed in proximity to the pavements, as trees are known to cause in localized soil shrinkage due to desiccation of the soil by the root system, possibly leading to pavement distress. Root barriers should be used if trees and other plants are provided close to pavements.

Note: A moist but not overly wet soil condition should be maintained at all times in all landscaped areas near the pavement after construction to minimize soil volume changes caused by changing soil moisture conditions.

8.3 Utility and Service Lines

Backfill for utility lines should consist of on-site material and should be placed in accordance with the following recommendations. The on-site fill soil should be placed in maximum 6-inch compacted lifts, compacted to a minimum of 95 percent of the maximum dry density, as determined by ASTM D698 (standard Proctor), and placed at a moisture content that is at least the optimum moisture content to four (4) percent above optimum moisture content., as determined by that same test. It is not uncommon to realize some settlement along the trench backfill. We also recommend that the utility trenches be visually inspected during the excavation process to ensure that undesirable fill that was not detected by the test borings does not exist at the site. This office should be notified immediately if any such fill is detected.

Utility lines connected to the structure may experience differential movement in response to changing moisture conditions in expansive soil. These movements may result in damage to the lines, especially at connections. Flexible connections may be considered to account for potential differential movement between the building and utilities.

Utility excavations should be sloped so that water within excavations will flow to a low point away from the active construction where it can be removed before backfilling. Compaction of bedding material should not be water jetted. Compacted backfill above the utilities should be on-site clays to limit the percolation of surface water.

8.4 Excavations and Excavation Difficulties

Excavations greater than 5 feet in height/depth should be in accordance with OSHA 29CFR 1926, Subpart P. Temporary construction slopes should incorporate excavation protection systems or should be sloped back. Where the excavation does not extend close to building lines, these areas may be laid back. Borings from this investigation indicated that the soils may be classified as Type B per OSHA regulations up to 10 feet from existing grades. Where space allows, temporary slopes should be sloped at 1 horizontal to 1 vertical (1H: 1V) or flatter.

Where excavation slopes greater than five (5) feet in height cannot be laid back, these areas will require installation of a temporary retention system or shoring to protect the existing construction, restrain the subsurface soils and maintain the integrity of the excavation. We recommend that monitoring points be established around the retention system and that these locations be monitored during and after the excavation activities to confirm the integrity of the retention system.

The slopes and temporary retention system should be verified by and designed by the contractor's engineer and should not be surcharged by traffic, construction equipment, or permanent structures. The slopes and temporary retention system should be adequately maintained and periodically inspected to ensure the safety of the excavation and surrounding property.

8.5 Exterior Flatwork (Sidewalks)

Concrete flatwork should include high tensile steel reinforcement to reduce the formation and size of cracks. Flatwork should also include frequent and regularly spaced expansion/control joints and dowels to limit vertical offsets between neighboring flatwork slabs. The moisture content of the subgrade should be maintained up to the time of concrete placement. If subgrade soils are allowed to dry below the levels recommended herein, additional moisture conditioning of the soils may be required. These recommendations are intended to reduce possible distress to exterior flatwork but will not prevent movement and/or vertical offsets between slabs.

The concrete flatwork should have adequately spaced contraction joints to control shrinkage cracking. Past experience indicates that reinforced concrete pavements with sealed contraction joints on a 5 to 6-foot spacing (for 5-foot-wide sidewalks), cut to a depth of one-quarter to one-third of the pavement thickness, have generally exhibited less uncontrolled post-construction cracking than pavements with wider spacing. The contraction joint pattern should divide the pavement into panels that are approximately square where the panel length should not exceed 25 percent more than the panel width. Saw cut, post placement formed contraction joints should be saw cut as soon as the concrete can support the saw cutting equipment and personnel and before shrinkage cracks appear, on the order of 6 to 12 hours after concrete placement. Rubberized asphalt, silicone or other suitable flexible sealant could be used to seal the joints. Isolation joints should be used wherever the pavement will abut a structural element subject to a different magnitude of movement, e.g., light poles, retaining walls, existing pavement, stairways, entryway piers, building walls, or manholes.

Consideration may be given to improving the subgrade beneath the ground supported flatwork. One option is to incorporate a 12-inch layer of select fill placed atop the subgrade soils. This would improve the strength properties of the subgrade soils, provide a working platform, reduce the PVM and provide a more uniform subgrade. Select fill should have a Liquid Limit (LL) of less than 35, a Plasticity Index (PI) between 6 and 18 and a minimum of 35% of the material passing a No. 200 mesh sieve and be essentially free of particles in excess of 4 inches in their longest direction. The select fill should be placed in maximum 6-inch compacted lifts, compacted to at least 95 percent of the maximum density as determined by the Standard Moisture Density Relationship test (ASTM D698), and should be placed at a moisture content that is at least the optimum moisture content, as determined by that same test.

9.0 LIMITATIONS

The professional geotechnical engineering services performed for this project, the findings obtained, and the recommendations prepared were accomplished in accordance with currently accepted geotechnical engineering principles and practices.

Variations in the subsurface conditions are noted at the specific boring locations for this study. As such, all users of this report should be aware that differences in depths and thicknesses of strata encountered can vary between the boring locations. Statements in the report as to subsurface conditions across the site are extrapolated from the data obtained at the specific boring locations. The number and spacing of the exploration borings were chosen to obtain geotechnical information for the design and construction of pavements. If there are any conditions differing significantly from those described herein, D&S should be notified to re-evaluate the recommendations contained in this report.

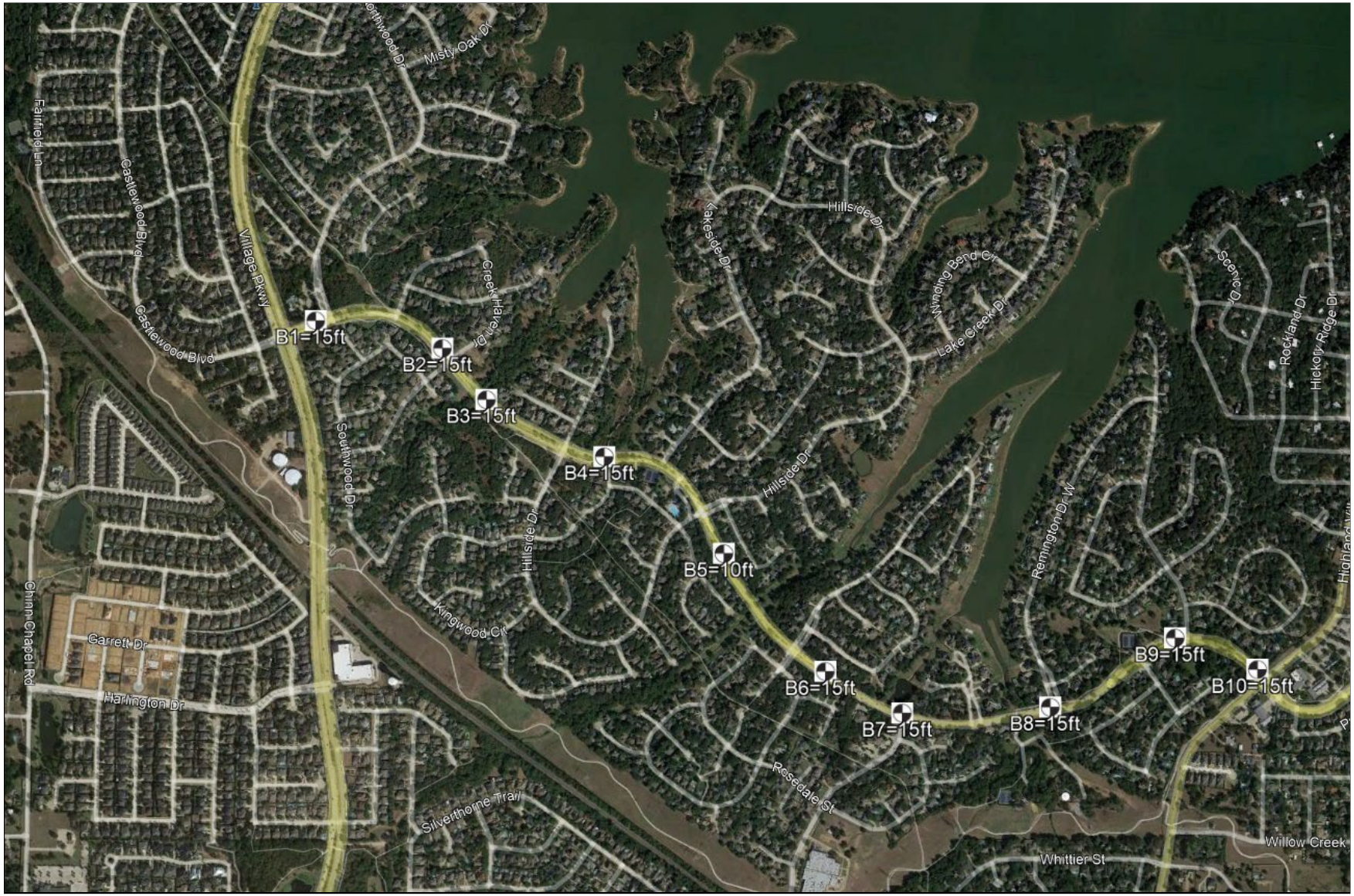
Recommendations contained herein are not considered applicable for an indefinite period. Our office must be contacted to re-evaluate the contents of this report if construction does not begin within a one-year period after completion of this report.

The scope of services provided herein does not include an environmental assessment of the site or investigation for the presence or absence of hazardous materials in the soil, surface water, or groundwater.

All contractors referring to this geotechnical report should draw their own conclusions regarding excavations, construction, etc. for bidding purposes. D&S is not responsible for conclusions, opinions or recommendations made by others based on these data. The report is intended to guide preparation of project specifications and should not be used as a substitute for the project specifications.

Recommendations provided in this report are based on our understanding of information provided by the Client to us regarding the scope of work for this project. If the Client notes any differences, our office should be contacted immediately since this may materially alter the recommendations.

APPENDIX A - BORING LOGS AND SUPPORTING DATA



BORING LOCATIONS ARE INTENDED FOR GRAPHICAL REFERENCE ONLY

D&S ENGINEERING LABS

N.T.S.

PLAN OF BORINGS

HIGHLAND SHOES BOULEVARD PAVEMENT IMPROVEMENTS

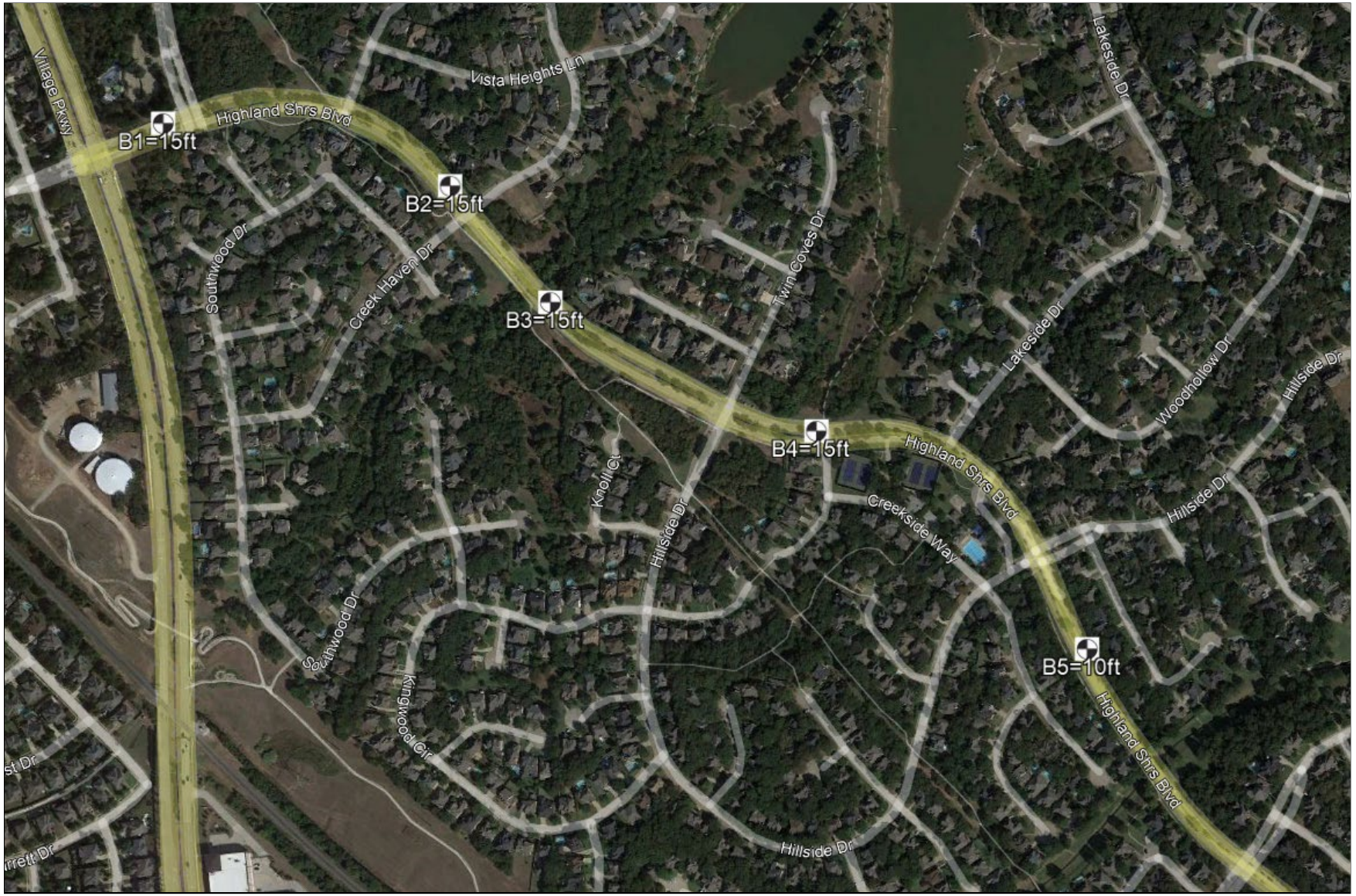
HIGHLAND VILLAGE TEXAS

SHEET NO.

G1

DATE DRILLED

June 7-9, 2022



BORING LOCATIONS ARE INTENDED FOR GRAPHICAL REFERENCE ONLY

D&S ENGINEERING LABS

N.T.S.

PLAN OF BORINGS

HIGHLAND SHOES BOULEVARD PAVEMENT IMPROVEMENTS

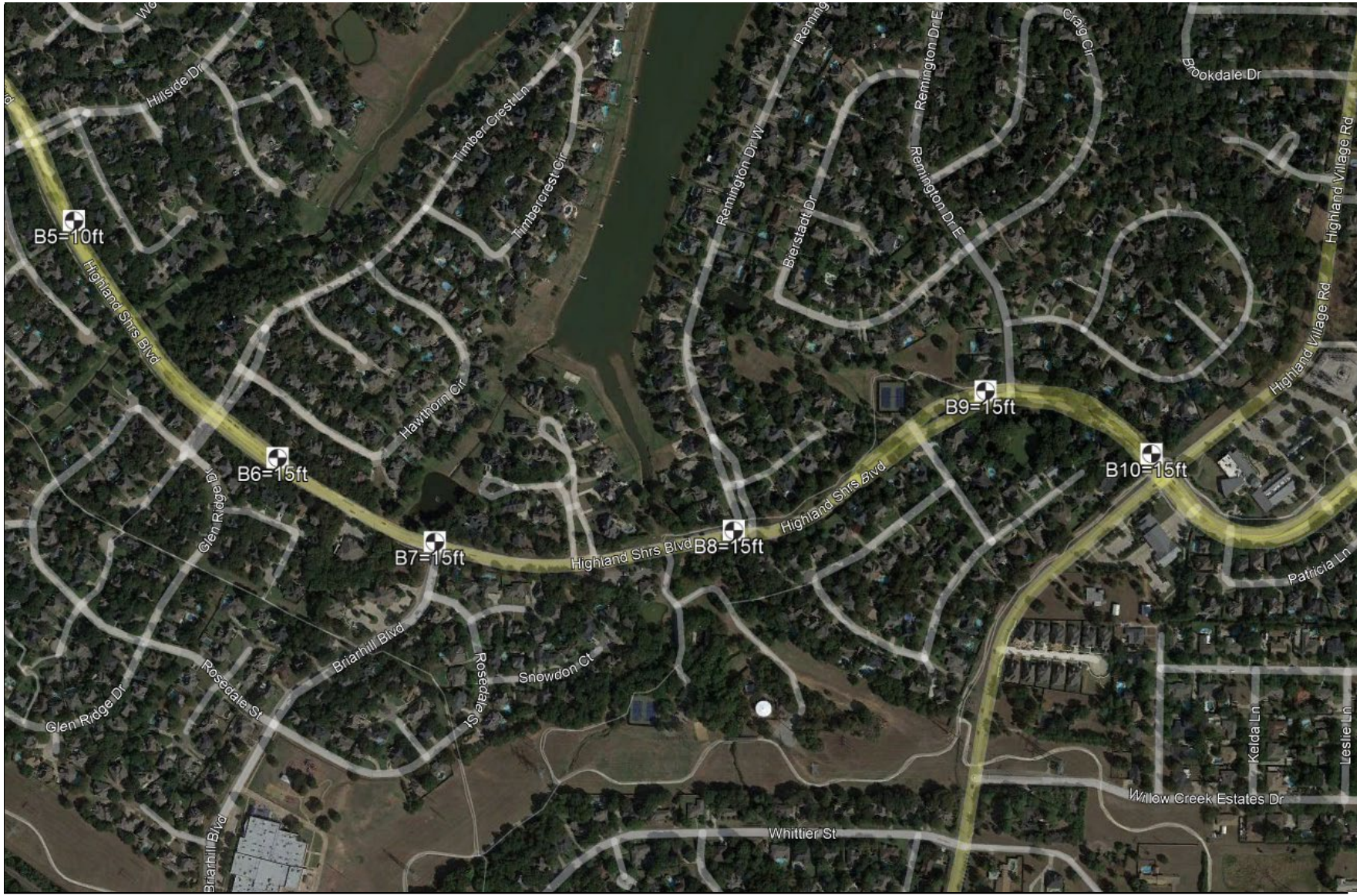
HIGHLAND VILLAGE TEXAS

SHEET NO.

G2

DATE DRILLED

June 7-9, 2022



BORING LOCATIONS ARE INTENDED FOR GRAPHICAL REFERENCE ONLY

D&S ENGINEERING LABS

N.T.S.

PLAN OF BORINGS

HIGHLAND SHOES BOULEVARD PAVEMENT IMPROVEMENTS

HIGHLAND VILLAGE TEXAS

SHEET NO.

G3

DATE DRILLED

June 7-9, 2022

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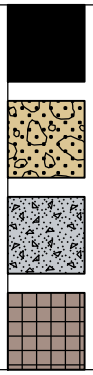
KEY TO SYMBOLS AND TERMS

LITHOLOGIC SYMBOLS

ARTIFICIAL



Asphalt

Aggregate Base

Concrete

Fill

SOIL

CH: High Plasticity Clay

CL: Low Plasticity Clay

GP: Poorly-graded Gravel

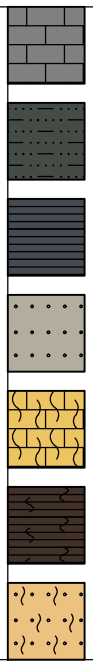
GW: Well-graded Gravel

SC: Clayey Sand

SP: Poorly-graded Sand

SW: Well-graded Sand

ROCK



Limestone

Mudstone

Shale

Sandstone

Weathered Limestone

Weathered Shale

Weathered Sandstone

CONSISTENCY OF SOILS

CONSISTENCY: FINE GRAINED SOILS		
Consistency	SPT (# blows/ft)	PP (tsf)
Very Soft	0 - 2	< 0.25
Soft	3 - 4	0.25 - 0.5
Medium Stiff	5 - 8	0.5 - 1.0
Stiff	9 - 15	1.0 - 2.0
Very Stiff	16 - 30	2.0 - 4.0
Hard	> 30	> 4.0

CONDITION OF SOILS

CONDITION: COARSE GRAINED SOILS			
Condition	SPT (blowcounts)	TCP (values)	Relative Density (%)
Very Loose	0 - 4	< 8	0 - 15
Loose	5 - 10	8 - 20	15 - 35
Medium Dense	11 - 30	20 - 80	35 - 65
Dense	31 - 50	80 - 5 in./100	65 - 85
Very Dense	> 50	0 in. - 5 in./100	85 - 100

SECONDARY COMPONENTS

QUANTITY DESCRIPTORS	
Trace	< 5% of sample
Few	5% to 10%
Little	10% to 25%
Some	25% to 35%
With	> 35%

RELATIVE HARDNESS OF ROCK MASS

Designation	Description
Very Soft	Can be carved with a knife. Can be excavated readily with point of pick. Pieces 1" or more in thickness can be broken by finger pressure. Readily scratched with fingernail.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows with the pick point. Small, thin pieces can be broken by finger pressure.
Medium Hard	Can be grooved or gouged 1/4" deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1" maximum size by hard blows with the point of a pick.
Moderately Hard	Can be scratched with knife or pick. Gouges or grooves 1/4" deep can be excavated by hard blow of the point of a pick. Hand specimens can be detached by a moderate blow.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach a hand specimen.
Very Hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows from a hammer or pick.

WEATHERING OF ROCK MASS

Designation	Description
Fresh	No visible sign of weathering
Slightly weathered	Penetrative weathering on open discontinuity surfaces, but only slight weathering of rock material
Moderately weathered	Weathering extends throughout rock mass, but the rock material is not friable
Highly weathered	Weathering extends throughout rock mass, and the rock material is partly friable
Completely weathered	Rock is wholly decomposed and in a friable condition but the rock texture and structure are preserved
Residual Soil	A soil material with the original texture, structure, and mineralogy of the rock completely destroyed

D&S ENGINEERING LABS

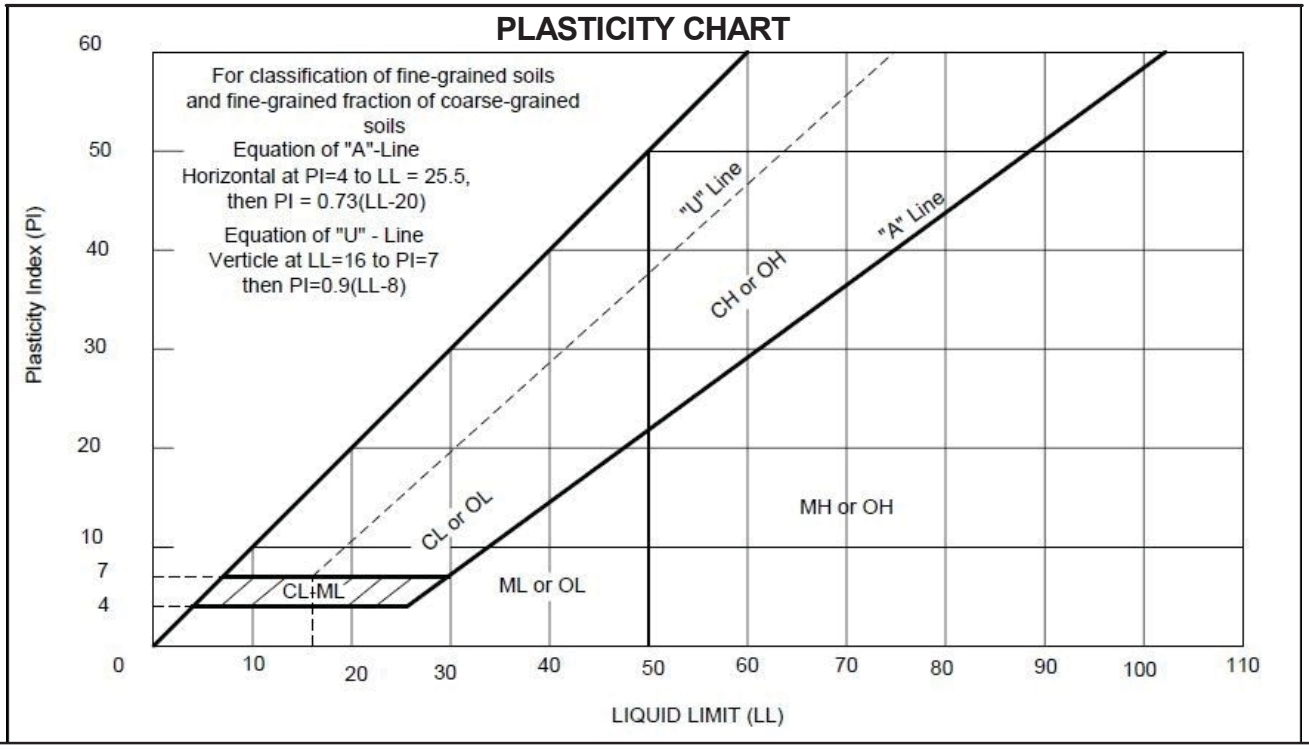
UNIFIED SOIL CLASSIFICATION SYSTEM

ADAPTED FROM ASTM D 2487

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS				GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS RETAINED ON THE NO. 200 SIEVE	GRAVELS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LESS THAN 5% FINES)	$Cu \geq 4$ and $1 \leq Cc \leq 3$	**GW**	WELL-GRADED GRAVEL
			$Cu < 4$ and/or $[Cc < 1$ or $Cc > 3]$	**GP**	POORLY-GRADED GRAVEL
		GRAVELS WITH FINES (MORE THAN 12% FINES)	Fines classify as ML or MH	**GM**	SILTY GRAVEL
			Fines classify as CL or CH	**GC**	CLAYEY GRAVEL
	SANDS MORE THAN 50% OF COARSE FRACTION PASSING THE NO. 4 SIEVE	CLEAN SANDS (LESS THAN 5% FINES)	$Cu \geq 6$ and $1 \leq Cc \leq 3$	**SW**	WELL-GRADED SAND
			$Cu < 6$ and/or $[Cc < 1$ or $Cc > 3]$	**SP**	POORLY-GRADED SAND
		SANDS WITH FINES (MORE THAN 12% FINES)	Fines classify as ML or MH	**SM**	SILTY SAND
			Fines classify as CL or CH	**SC**	CLAYEY SAND
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL PASSES THROUGH THE NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50	INORGANIC	PI > 7 and plots on or above "A" line	**CL**	LEAN CLAY
			PI < 4 or plots below "A" line	**ML**	SILT
		ORGANIC	$\frac{Liquid\ limit - oven\ dried}{Liquid\ limit - not\ dried} < 0.75$	**OL**	ORGANIC CLAY ORGANIC SILT
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50	INORGANIC	PI plots on or above "A" line	**CH**	FAT CLAY
			PI plots below "A" line	**MH**	ELASTIC SILT
		ORGANIC	$\frac{Liquid\ limit - oven\ dried}{Liquid\ limit - not\ dried} < 0.75$	**OH**	ORGANIC CLAY ORGANIC SILT
HIGHLY ORGANIC SOILS	PRIMARILY ORGANIC MATTER, DARK IN COLOR, AND ORGANIC ODOR			**PT**	PEAT

PLASTICITY CHART



D&S ENGINEERING LABS

BORING LOG

B1

PROJECT: Highland Shores Boulevard Pavement Improvements
LOCATION: Highland Village, Texas
CLIENT: City of Highland Village
GPS COORDINATES: N33.092667, W97.078572
PROJECT NUMBER: G22-2124
GROUND ELEVATION: Approx. 564 feet
START DATE: 6/9/2022 FINISH DATE: 6/9/2022
DRILL METHOD: Hollow Stem Flight Auger
LOGGED BY: Dalton Hubbard (D&S)
DRILLED BY: Markevian Smith (D&S)

Legend:
- S-Shelby Tube
- N-Standard Penetration
- T-Texas Cone Penetration
- C-Core
- B-Bag Sample
- ▽ - Water Encountered

Depth (ft)	Sample Type	Hand Pen. (tsf) or SPT or TCP	Graphic Log		REC (%) RQD (%)	MC (%)	Atterberg Limits LL (%)	Atterberg Limits PL (%)	Atterberg Limits PI	Passing #200 Sieve (%)	Total Suction (pF)	Clay (%)	Swell (%)	DUW (pcf)	Unconf. Compr. Str (ksf)
0	C			**CONCRETE;** 9.5 inches											
				0.8 ft											
				ASHPHALT; 4.75 inches											
				563.2 ft											
	S	4.5+		562.8 ft		21.1				95					
	S	4.5+		**FAT CLAY (CH);** very stiff; light brown, reddish brown, light gray, gray; few iron oxide stains; few to little ferrous nodules; frequent sandy laminations		17.7	52	25	27				2.0	111.1	
5	S	4.5+													
	S	4.5+				17.3									
	S	4.5+													
	S	4.5+				16.5									
10	S	4.5+													
15	S	4.5+		- with gypsum crystals and dark gray weathered shale layers		20.7									
				15.0 ft											
				549.0 ft											
				End of boring at 15.0'											
20				Notes: -dry during drilling -dry upon completion											
25															
30															
35															

D&S ENGINEERING LABS

BORING LOG

B2

PROJECT: Highland Shores Boulevard Pavement Improvements
LOCATION: Highland Village, Texas
CLIENT: City of Highland Village
GPS COORDINATES: N33.092068, W97.075292
PROJECT NUMBER: G22-2124
GROUND ELEVATION: Approx. 564 feet
START DATE: 6/8/2022 FINISH DATE: 6/8/2022
DRILL METHOD: Hollow Stem Flight Auger
LOGGED BY: Ismael Hernandez (D&S)
DRILLED BY: Markevian Smith (D&S)

Legend:
- S-Shelby Tube
- N-Standard Penetration
- T-Texas Cone Penetration
- C-Core
- B-Bag Sample
- ▽ - Water Encountered

Depth (ft)	Sample Type	Hand Pen. (tsf) or SPT or TCP	Graphic Log		REC (%) RQD (%)	MC (%)	Atterberg Limits LL (%)	Atterberg Limits PL (%)	Atterberg Limits PI	Passing #200 Sieve (%)	Total Suction (pF)	Clay (%)	Swell (%)	DUW (pcf)	Unconf. Compr. Str (ksf)
0	C			**CONCRETE;** 8.5 inches											
				BASE; 3 inches											
	S	4.5		**CLAYEY SAND (SC);** reddish brown, reddish tan; trace lignite; trace to few ferrous nodules and iron oxide stains; fine-grained											
	S	4.5				10.6									
5															
	S	4.5				8.5	29	15	14						
						12.5									
	B														
10															

D&S ENGINEERING LABS

BORING LOG

B3

PROJECT: Highland Shores Boulevard Pavement Improvements
LOCATION: Highland Village, Texas
CLIENT: City of Highland Village
GPS COORDINATES: N33.090960, W97.074155
PROJECT NUMBER: G22-2124
GROUND ELEVATION: Approx. 552 feet
START DATE: 6/9/2022 FINISH DATE: 6/9/2022
DRILL METHOD: Hollow Stem Flight Auger
LOGGED BY: Dalton Hubbard (D&S)
DRILLED BY: Markevian Smith (D&S)

Legend:
- S-Shelby Tube
- N-Standard Penetration
- T-Texas Cone Penetration
- C-Core
- B-Bag Sample
- ▽ - Water Encountered

Depth (ft)	Sample Type	Hand Pen. (tsf) or SPT or TCP	Graphic Log		REC (%) RQD (%)	MC (%)	Atterberg Limits LL (%)	Atterberg Limits PL (%)	Atterberg Limits PI	Passing #200 Sieve (%)	Total Suction (pF)	Clay (%)	Swell (%)	DUW (pcf)	Unconf. Compr. Str (ksf)
0	C			**CONCRETE;** 9 inches 0.8 ft											
	S	2.5		**LEAN TO FAT CLAY (CL-CH);** very stiff; brown, gray, reddish brown; few iron oxide stains; dark gray shale layers 551.3 ft		25.5	47	25	22				0.9	97.5	
	S	4.5+				20.3									
5	S	4.5+				28.2									
	S	4.5+													
	S	4.5+				21.2									
	S	4.5+													
10	S	4.5+				14.6									
	S	4.5+													
				14.0 ft											
15	B			**SHALE;** gray 538.0 ft 15.0 ft											
				End of boring at 15.0' 537.0 ft											
20				Notes: -dry during drilling -dry upon completion											
25															
30															
35															

D&S ENGINEERING LABS

BORING LOG

B4

PROJECT: Highland Shores Boulevard Pavement Improvements
LOCATION: Highland Village, Texas
CLIENT: City of Highland Village
GPS COORDINATES: N33.089728, W97.071114
PROJECT NUMBER: G22-2124
GROUND ELEVATION: Approx. 540 feet
START DATE: 6/8/2022 FINISH DATE: 6/8/2022
DRILL METHOD: Hollow Stem Flight Auger
LOGGED BY: Ismael Hernandez (D&S)
DRILLED BY: Markevian Smith (D&S)

Legend:
- S-Shelby Tube
- N-Standard Penetration
- T-Texas Cone Penetration
- C-Core
- B-Bag Sample
- ▽ - Water Encountered

Depth (ft)	Sample Type	Hand Pen. (tsf) or SPT or TCP	Graphic Log		REC (%) RQD (%)	MC (%)	Atterberg Limits LL (%)	Atterberg Limits PL (%)	Atterberg Limits PI	Passing #200 Sieve (%)	Total Suction (pF)	Clay (%)	Swell (%)	DUW (pcf)	Unconf. Compr. Str (ksf)
0	C			**CONCRETE;** 6.75 inches											
				0.6 ft / 539.4 ft											
	S	2.5		**SANDY LEAN CLAY (CL);** stiff to very stiff; gray, brown; trace silts seams and iron oxide stains; shaley		17.3	41	22	19						
						31.0									
	S	2.0				22.5									
5	S	2.0				21.1									
	S	4.5+				8.4									
	B			-Shelby tube push refusal encountered at 6 feet											
10	B					12.7									
15	B			-with gray weathered shale layers		11.0									
				15.0 ft / 525.0 ft											
				End of boring at 15.0'											
20				Notes: -dry during drilling -dry upon completion											
25															
30															
35															

D&S ENGINEERING LABS

BORING LOG

B5

PROJECT: Highland Shores Boulevard Pavement Improvements
LOCATION: Highland Village, Texas
CLIENT: City of Highland Village
GPS COORDINATES: N33.087641, W97.068017
PROJECT NUMBER: G22-2124
GROUND ELEVATION: Approx. 567 feet
START DATE: 6/8/2022 FINISH DATE: 6/8/2022
DRILL METHOD: Hollow Stem Flight Auger
LOGGED BY: Ismael Hernandez (D&S)
DRILLED BY: Markevian Smith (D&S)

Legend:
- ■ S-Shelby Tube
- ☒ N-Standard Penetration
- ▽ T-Texas Cone Penetration
- ◧ C-Core
- ◪ B-Bag Sample
- ▽ - Water Encountered

Depth (ft)	Sample Type	Hand Pen. (tsf) or SPT or TCP	Graphic Log		REC (%) RQD (%)	MC (%)	Atterberg Limits LL (%)	Atterberg Limits PL (%)	Atterberg Limits PI	Passing #200 Sieve (%)	Total Suction (pF)	Clay (%)	Swell (%)	DUW (pcf)	Unconf. Compr. Str (ksf)
0	C			**CONCRETE;** 6.25 inches											
	S	4.5+		**LEAN CLAY WITH SAND (CL);** very stiff; reddish brown, gray, reddish tan; little to some iron oxide stains; little to some ferrous and sandy laminations; trace cemented sand; with sand		20.3				73					
	S	4.5+													
	S	4.5+				8.2	28	17	11				0.7	106.0	
5	S	4.5+													
	S	4.5+				14.7									
	S	4.5+													
	S	4.5+				13.6									
	S	4.5+				12.6									
10	B			**SHALE;** highly to completely weathered; gray											
	T	50=0.5", 50=0.5"													
				End of boring at 10.1'											
15															
20															
25															
30															
35															

0.5 ft
566.5 ft
9.0 ft
558.0 ft
10.1 ft
556.9 ft

Notes:
-dry during drilling
-dry upon completion

D&S ENGINEERING LABS

BORING LOG

B6

PROJECT: Highland Shores Boulevard Pavement Improvements
LOCATION: Highland Village, Texas
CLIENT: City of Highland Village
GPS COORDINATES: N33.085117, W97.065410
PROJECT NUMBER: G22-2124
GROUND ELEVATION: Approx. 590 feet
START DATE: 6/8/2022 FINISH DATE: 6/8/2022
DRILL METHOD: Hollow Stem Flight Auger
LOGGED BY: Ismael Hernandez (D&S)
DRILLED BY: Markevian Smith (D&S)

Legend:
- S-Shelby Tube
- N-Standard Penetration
- T-Texas Cone Penetration
- C-Core
- B-Bag Sample
- ▽ - Water Encountered

Depth (ft)	Sample Type	Hand Pen. (tsf) or SPT or TCP	Graphic Log		REC (%) RQD (%)	MC (%)	Atterberg Limits LL (%)	Atterberg Limits PL (%)	Atterberg Limits PI	Passing #200 Sieve (%)	Total Suction (pF)	Clay (%)	Swell (%)	DUW (pcf)	Unconf. Compr. Str (ksf)
0	C			**CONCRETE;** 6 inches											
				0.5 ft / 589.5 ft											
	S	0.5		**LEAN CLAY(CL);** medium stiff to very stiff; dark gray; reddish tan; few to little iron oxide stains; with sand		6.5									
	S	4.5													
5	S	4.5				14.5	27	15	12						
	S	3.5													
				6.0 ft											
	S	4.5		**CLAYEY SAND (SC);** reddish brown, gray, dark brown; fine grained -Shelby tube push refusal encountered at 7 feet 584.0 ft		10.3									
						15.8									
10	B														
	B														
15	S	1.0		15.0 ft											
				End of boring at 15.0' 575.0 ft											
				Notes: -dry during drilling -dry upon completion											
20															
25															
30															
35															

D&S ENGINEERING LABS

BORING LOG

B7

PROJECT: Highland Shores Boulevard Pavement Improvements
LOCATION: Highland Village, Texas
CLIENT: City of Highland Village
GPS COORDINATES: N33.084233, W97.063441
PROJECT NUMBER: G22-2124
GROUND ELEVATION: Approx. 560 feet
START DATE: 6/8/2022 FINISH DATE: 6/8/2022
DRILL METHOD: Hollow Stem Flight Auger
LOGGED BY: Ismael Hernandez (D&S)
DRILLED BY: Markevian Smith (D&S)

Legend:
■ S-Shelby Tube
☒ N-Standard Penetration
▽ T-Texas Cone Penetration
◧ C-Core
◪ B-Bag Sample
▽ - Water Encountered

Depth (ft)	Sample Type	Hand Pen. (tsf) or SPT or TCP	Graphic Log	REC (%) RQD (%)	MC (%)	Atterberg Limits LL (%)	Atterberg Limits PL (%)	Atterberg Limits PI	Passing #200 Sieve (%)	Total Suction (pF)	Clay (%)	Swell (%)	DUW (pcf)	Unconf. Compr. Str (ksf)
0	C				10.4									
	S	4.5+												
	S	4.5+			13.5	33	18	15				3.9	114.4	
	S	4.5+												
5	S	4.5+			12.4									
	S	4.5+												
	S	4.5+			8.3									
	B													
10														
15	B													

CONCRETE; 9 inches — 0.8 ft

CLAYEY SAND (SC); brown, reddish brown; trace silt seams — 559.3 ft

-Shelby tube push refusal encountered at 7 feet

15.0 ft

End of boring at 15.0' — 545.0 ft

Notes:
-dry during drilling
-dry upon completion

20
25
30
35

D&S ENGINEERING LABS

BORING LOG

B8

PROJECT: Highland Shores Boulevard Pavement Improvements
LOCATION: Highland Village, Texas
CLIENT: City of Highland Village
GPS COORDINATES: N33.084343, W97.059644
PROJECT NUMBER: G22-2124
GROUND ELEVATION: Approx. 550 feet
START DATE: 6/7/2022 FINISH DATE: 6/7/2022
DRILL METHOD: Hollow Stem Flight Auger
LOGGED BY: Ismael Hernandez (D&S)
DRILLED BY: Markevian Smith (D&S)

Legend:
- ■ S-Shelby Tube
- ☒ N-Standard Penetration
- ▽ T-Texas Cone Penetration
- ◧ C-Core
- ◪ B-Bag Sample
- ▽ - Water Encountered

Depth (ft)	Sample Type	Hand Pen. (tsf) or SPT or TCP	Graphic Log		REC (%) RQD (%)	MC (%)	Atterberg Limits LL (%)	Atterberg Limits PL (%)	Atterberg Limits PI	Passing #200 Sieve (%)	Total Suction (pF)	Clay (%)	Swell (%)	DUW (pcf)	Unconf. Compr. Str (ksf)
0	C			**ASPHALT;** 10.25 inches 0.9 ft											
	S	2.5		**SANDY LEAN CLAY (CL);** medium stiff to very stiff; brown, reddish brown, reddish tan; trace limestone fragments; few to little sand seams; frequent iron oxide laminations; shaley 549.2 ft		18.7									
	S	1.5													
	S	2.0				14.9	37	21	16						
5	S	3.0													
	S	1.0				16.6									
	S	4.5+													
	S	4.5+				15.1									
	S	4.5+													
10	S	3.5													
15	B	▽		-with dark gray weathered shale layers 15.0 ft		20.2									
				End of boring at 15.0' 535.0 ft											
20				Notes: -seepage at 15 feet during drilling -water at 15 feet upon completion											
25															
30															
35															

D&S ENGINEERING LABS

BORING LOG

B9

PROJECT: Highland Shores Boulevard Pavement Improvements
LOCATION: Highland Village, Texas
CLIENT: City of Highland Village
GPS COORDINATES: N33.085828, W97.056447
PROJECT NUMBER: G22-2124
GROUND ELEVATION: Approx. 568 feet
START DATE: 6/7/2022 FINISH DATE: 6/7/2022
DRILL METHOD: Hollow Stem Flight Auger
LOGGED BY: Dalton Hubbard (D&S)
DRILLED BY: Markevian Smith (D&S)

Legend:
- S-Shelby Tube
- N-Standard Penetration
- T-Texas Cone Penetration
- C-Core
- B-Bag Sample
- ▽ - Water Encountered

Depth (ft)	Sample Type	Hand Pen. (tsf) or SPT or TCP	Graphic Log	REC (%) RQD (%)	MC (%)	Atterberg Limits LL (%)	Atterberg Limits PL (%)	Atterberg Limits PI	Passing #200 Sieve (%)	Total Suction (pF)	Clay (%)	Swell (%)	DUW (pcf)	Unconf. Compr. Str (ksf)
0	C													
	S	3.0			20.9									
	S	2.5												
	S	2.0			16.9	30	17	13				0.1	113.3	
5	S	2.5												
	S	2.0			37.1									
	S	0.5												
	S	0.5			21.9									
	S	3.5												
10	S	4.5			21.4									
	S	4.5												
	S	4.5												
	S	4.5												
15	B													
20														
25														
30														
35														

ASPHALT; 9.5 inches — 0.8 ft

LEAN TO FAT CLAY (CL-CH); soft to very stiff; brown, dark brown, reddish brown, gray; trace to few iron oxide stains and cemented sand fragments; with gypsum crystals — 567.2 ft

-shaley below 10 feet

End of boring at 15.0' — 15.0 ft — 553.0 ft

Notes:
-seepage at 13 feet during drilling
-water at 15 feet upon completion

D&S ENGINEERING LABS

BORING LOG

B10

PROJECT: Highland Shores Boulevard Pavement Improvements
LOCATION: Highland Village, Texas
CLIENT: City of Highland Village
GPS COORDINATES: N33.085160, W97.054358
PROJECT NUMBER: G22-2124
GROUND ELEVATION: Approx. 594 feet
START DATE: 6/7/2022 FINISH DATE: 6/7/2022
DRILL METHOD: Hollow Stem Flight Auger
LOGGED BY: Ismael Hernandez (D&S)
DRILLED BY: Markevian Smith (D&S)

Legend:
- ■ S-Shelby Tube
- ☒ N-Standard Penetration
- ▽ T-Texas Cone Penetration
- ◧ C-Core
- ◪ B-Bag Sample
- ▽ - Water Encountered

Depth (ft)	Sample Type	Hand Pen. (tsf) or SPT or TCP	Graphic Log		REC (%) RQD (%)	MC (%)	Atterberg Limits LL (%)	Atterberg Limits PL (%)	Atterberg Limits PI	Passing #200 Sieve (%)	Total Suction (pF)	Clay (%)	Swell (%)	DUW (pcf)	Unconf. Compr. Str (ksf)
0	C			**ASPHALT;** 11 inches 0.9 ft											
	S	4.5		**CLAYEY SAND (SC);** brown, reddish brown; trace silt seams 593.1 ft		12.4				40					
	S	4.5													
	S	2.5				15.7	26	15	11						
5	S	0.5		5.0 ft											
	S	4.5		**SANDY LEAN CLAY(CL);** soft to very stiff; dark brown, reddish tan, brown 589.0 ft		18.9									
	S	0.5													
	S	4.0				20.0									
	S	3.0		9.0 ft											
10	S	0.5		**CLAYEY SAND (SC);** tan; reddish brown; trace silt seams 585.0 ft		23.4									
15	B			15.0 ft											
				End of boring at 15.0' 579.0 ft											
20				Notes: -dry during drilling -dry upon completion											
25															
30															
35															

D&S ENGINEERING LABS

SWELL TEST RESULTS

PROJECT: Highland Shores Boulevard Pavement Improvements CLIENT: City of Highland Village

PROJECT NUMBER: G22-2124 LOCATION: Highland Village, Texas

Boring Number	Depth feet	Initial Moisture Content, %	Applied Pressure, psf	Vertical Swell, %
B1	4-5	17.7	520	2.0
B3	1-2	25.5	130	0.9
B5	3-4	8.2	394	0.7
B7	2-3	13.5	259	3.9
B9	3-4	16.9	394	0.1

D&S ENGINEERING LABS

SOLUBLE SULFATE CONTENT RESULTS

TEX 145-E

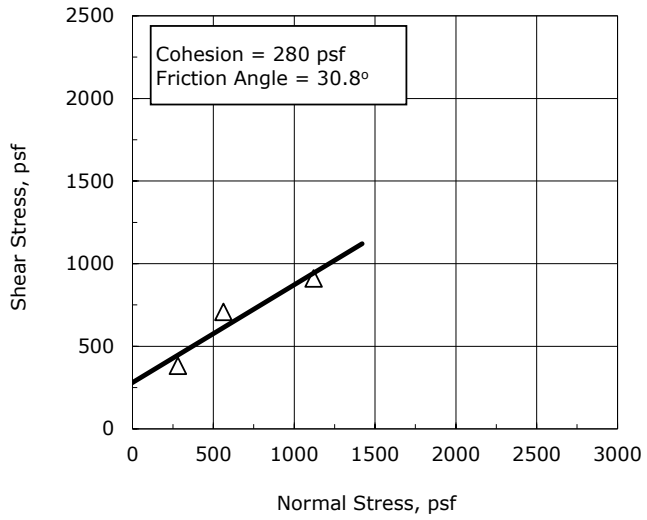
PROJECT: Highland Shores Boulevard Pavement Improvements PROJECT NUMBER: G22-2124

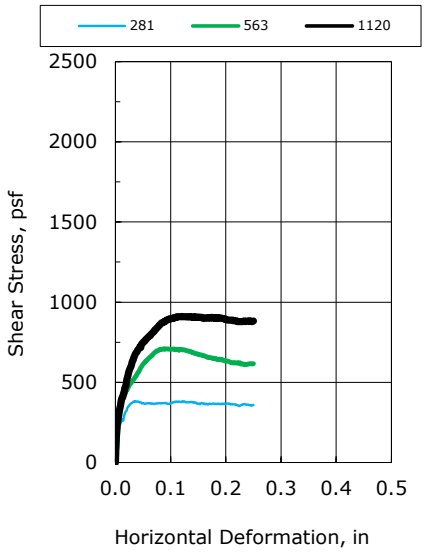
CLIENT: City of Highland Village LOCATION: Highland Village, Texas

Boring Number:	Depth (feet):	Soil Description	Soluble Sulfate Content (ppm)
B1	2-3	**FAT CLAY (CH);** very stiff; light brown, reddish brown, light gray, gray	540
B2	4-5	**CLAYEY SAND (SC);** reddish brown, reddish tan	1,300
B3	3-4	**LEAN TO FAT CLAY (CL-CH);** very stiff; brown, gray, reddish brown	3,293
B4	1-2	**SANDY LEAN CLAY (CL);** stiff to very stiff; gray, brown	373
B5	1-2	**LEAN CLAY (CL);** very stiff; reddish brown, gray; reddish tan	100
B6	1-2	**LEAN CLAY(CL);** medium stiff to very stiff; dark gray; reddish tan	1,724
B7	1-2	**CLAYEY SAND (SC);** brown, reddish brown	109
B8	1-2	**SANDY LEAN CLAY (CL);** brown, reddish brown, reddish tan	102
B9	1-2	**LEAN TO FAT CLAY (CL-CH);** brown, dark brown, reddish brown, gray	111
B10	1-2	**CLAYEY SAND (SC);** brown, reddish brown	100

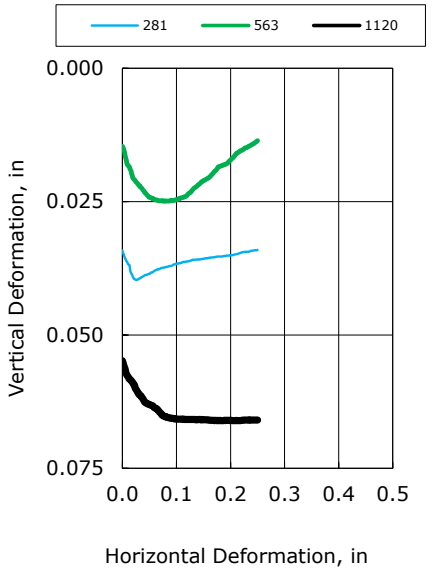
Client:	D&S Engineering Labs
Project Name:	Highland Shores Blvd Pave Improve
Project Location:	Highland Village, TX
GTX #:	313712
Test Date:	06/28/22
Tested By:	md
Checked By:	njh
Boring ID:	B8
Sample ID:	B8
Depth, ft:	4-5
Visual Description:	Moist, mottled brown, red and yellow clay with sand

Direct Shear Test of Soils Under Consolidated Drained Conditions by ASTM D3080





Test No.:	DS-1-1	DS-1-2	DS-1-3
Initial Diameter, in:	2.5	2.5	2.5
Initial Height, in:	1.0	1.0	1.0
Initial Mass, grams:	151.2	152.2	153.5
Initial Dry Density, pcf:	102.2	102.1	104.0
Initial Moisture Content, %:	14.8	15.7	14.6
Initial Bulk Density, pcf:	117.3	118.1	119.2
Initial Degree of Saturation:	61.6	65.0	63.5
Initial Void Ratio:	0.65	0.65	0.62
Final Dry Density, pcf:	105.8	103.5	111.3
Final Moisture Content, %:	22.0	23.2	21.6
Final Bulk Density, pcf:	129.1	127.5	135.3
Normal Stress, psf:	281	563	1120
Maximum Shear Stress, psf:	383	709	911
Shear Rate, in/min:	0.0004	0.0004	0.0004



Sample Type:	core
Estimated Specific Gravity:	2.70
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
% Passing #200 sieve:	---
Soil Classification:	---
Group Symbol:	---

Notes:

Moisture content obtained before shear from sample trimmings

Moisture Content determined by ASTM D2216

Cut, trimmed and placed into apparatus at the as-received density and moisture content

Values for cohesion and friction angle determined from best-fit straight line to the data for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site-specific conditions.

"---" indicates testing required to determine these values was not requested.

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817.529.8464

Proctor Report

Report No: 1

Client: City of Highland Village

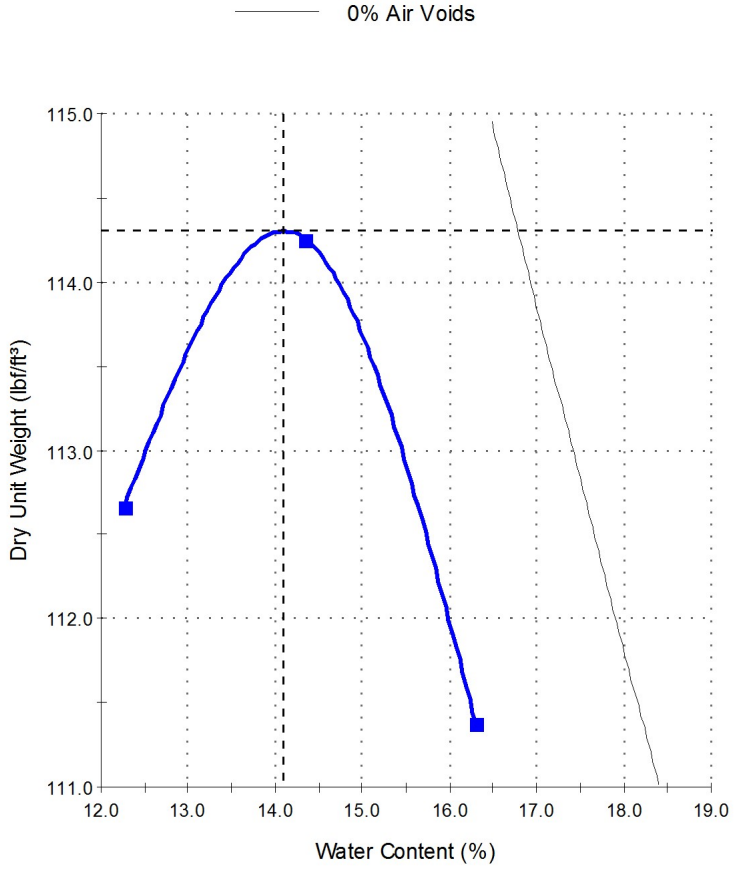
Project: Highland Shores Blvd Pavement Improvements
Highland Village, Texas

Submitted By: Ismael Hernandez
Date of Issue: 7/12/2022

Sample Details

Sample ID: 1
Lab Sample ID: 1
Date Sampled: 7/12/2022
Sampled By: Ismael Hernandez
Location: Highland Village, TX

Dry Unit Weight - Water Content Relationship



Test Results

ASTM D 698

Maximum Dry Unit Weight (lbf/ft³):	**114.3**
Optimum Water Content (%):	**14.1**
Method:	A
Preparation Method:	Dry
Specific Gravity (Fines):	2.65
Tested By:	John Nix
Date Tested:	7/11/2022
Visual Description:	Light Brown Sandy Clay Boring Material Mix

Comments

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Cement Series Proctor Report

Report No: 1

Client: City of Highland Village

Project: Highland Shores Blvd Pavement Improvements
Highland Village, Texas

Submitted By: Ismael Hernandez
Date of Issue: 7/12/2022

Sample Details

Sample ID: 1
Date Cored: 6/9/2022
Location: Highland Village, Texas
Sample Location: Highland Shores Boulevard
Date Cast: 7/6/2022
Date Received: 6/9/2022

Soil Cylinder Compressive Testing — ASTM D698

Cement Percent	3%	4%	5%
Date Tested	7/11/2022	7/11/2022	7/11/2022
Time Tested	2pm	2pm	2pm
Age (Days)	5	5	5
Diameter (in)	4.00	4.00	4.00
Capped Length (in)	4.60	4.60	4.60
L/D	1.15	1.15	1.15
Correction Factor	Not applied	Not applied	Not applied
Area (in²)	12.57	12.63	12.57
Density (lb/ft³)	109.7	110.8	110.9
Molded Moisture Verification	17.0	18.3	16.3
Maximum Load (lbf)	989	1341	1511
Fracture Type/Remarks	N C	N C	N C
Compressive Strength (psi)	80	110	120

Average Compressive Strength (psi): 103 psi

Notes	Remarks

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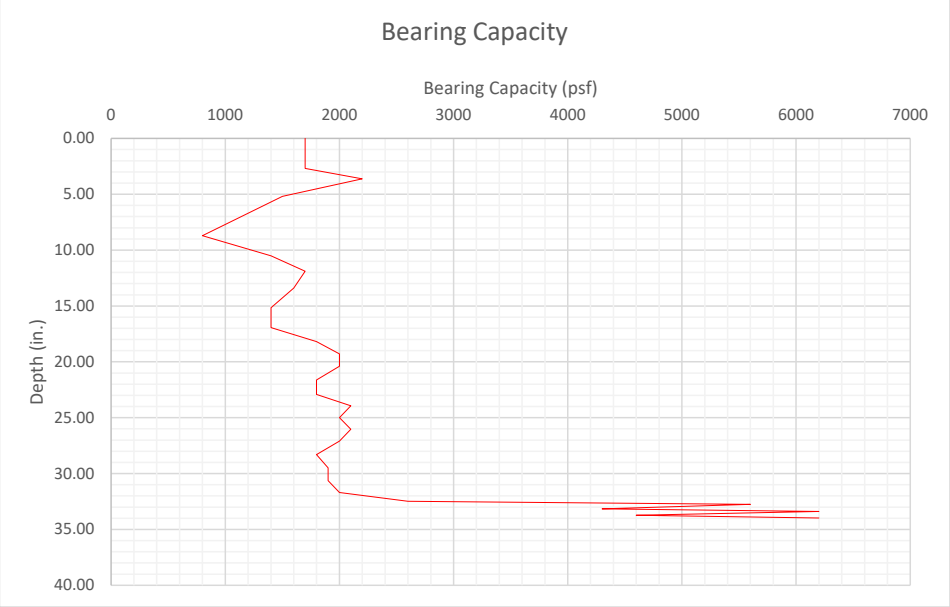
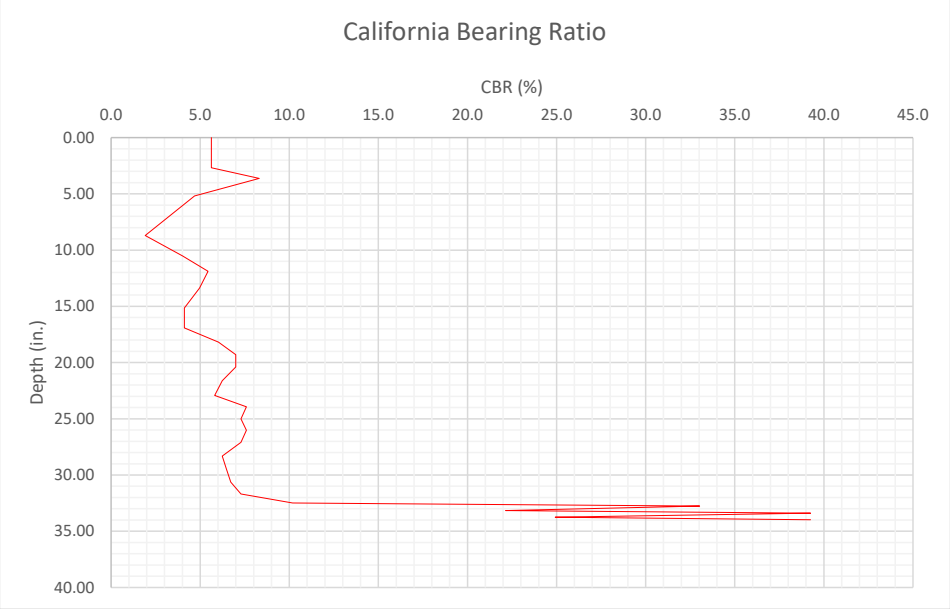
DYNAMIC CONE PENETROMETER TEST RESULTS

Project Name: Highland Shores Boulevard Pavement Improvements
Project Number: G22-2124
Report Number: 1
Test Location: B1
Starting Depth: 0 in

Service Date: 6/9/2022
Report Date: 7/11/2022
Hammer Weight: 17.6 lbs.
Soil Type: Other

Blow Number	Depth (in)	CBR (%)	Bearing (psf)
0	0.00	5.6	1700
1	1.34	5.6	1700
2	2.68	5.6	1700
3	3.62	8.3	2200
4	5.20	4.7	1500
5	8.70	1.9	800
6	10.51	4.0	1400
7	11.89	5.4	1700
8	13.39	5.0	1600
9	15.16	4.1	1400
10	16.93	4.1	1400
11	18.19	6.0	1800
12	19.29	7.0	2000
13	20.39	7.0	2000
14	21.61	6.2	1800
15	22.91	5.8	1800
16	23.94	7.6	2100
17	25.00	7.3	2000
18	26.02	7.6	2100
19	27.09	7.3	2000
20	28.31	6.2	1800
21	29.49	6.5	1900
22	30.63	6.7	1900
23	31.69	7.3	2000
24	32.48	10.2	2600
25	32.76	33.0	5600
26	33.15	22.2	4300
27	33.39	39.3	6200
28	33.74	24.9	4600
29	33.98	39.3	6200





CBR(OTHER) = 292 / (inPerBlow * 25.4)^1.12 [ASTM D6951-09]
CBR(CL) = 1 / (0.432283 * inPerBlow)^2 CBR<10 [ASTM D6951-09]
CBR(CH) = 1 / (0.072923 * inPerBlow) [ASTM D6951-09]
Bearing (psf) = 3.794 * CBR^0.664 * 144 [Porland Cement Assoc. 1955]

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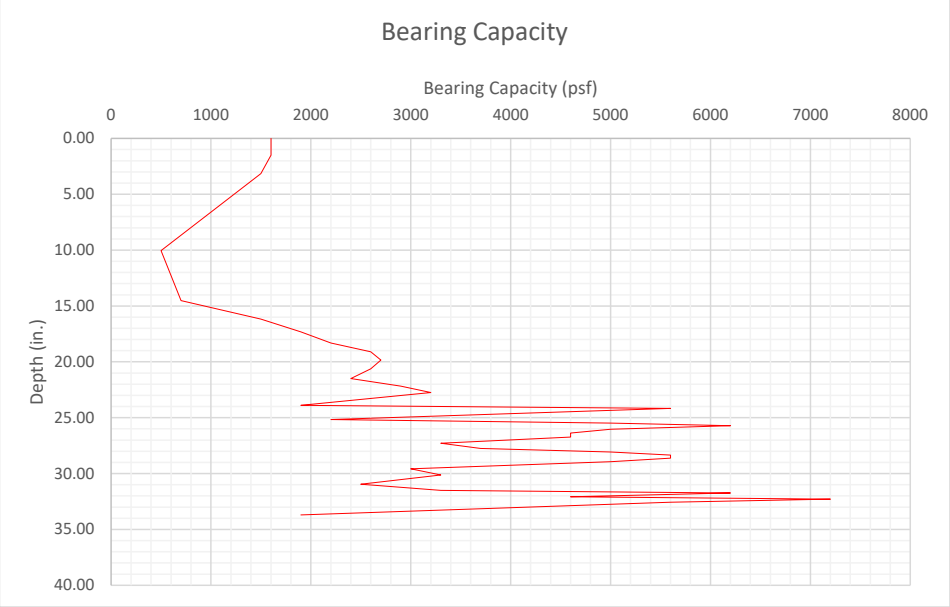
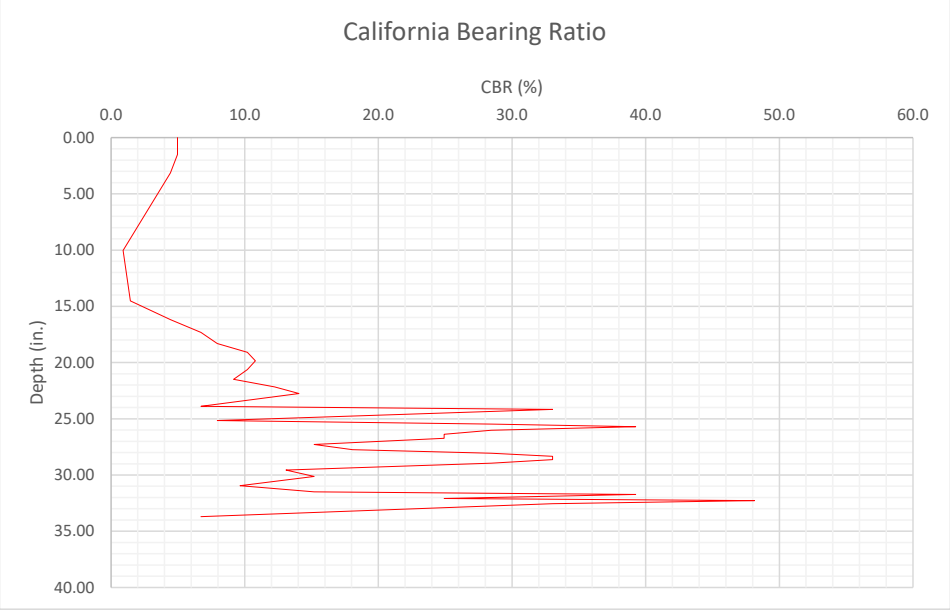
DYNAMIC CONE PENETROMETER TEST RESULTS

Project Name: Highland Shores Boulevard Pavement Improvements
Project Number: G22-2124
Report Number: 1
Test Location: B2
Starting Depth: 0 in

Service Date: 6/8/2022
Report Date: 7/11/2022
Hammer Weight: 17.6 lbs.
Soil Type: Other

Blow Number	Depth (in)	CBR (%)	Bearing (psf)
0	0.00	5.0	1600
1	1.50	5.0	1600
2	3.15	4.4	1500
3	10.04	0.9	500
4	14.53	1.5	700
5	16.18	4.4	1500
6	17.32	6.7	1900
7	18.31	7.9	2200
8	19.09	10.2	2600
9	19.84	10.8	2700
10	20.63	10.2	2600
11	21.50	9.2	2400
12	22.17	12.2	2900
13	22.76	14.1	3200
14	23.90	6.7	1900
15	24.17	33.0	5600
16	25.16	7.9	2200
17	25.47	28.4	5000
18	25.71	39.3	6200
19	26.02	28.4	5000
20	26.38	24.9	4600
21	26.73	24.9	4600
22	27.28	15.2	3300
23	27.76	18.1	3700
24	28.07	28.4	5000
25	28.35	33.0	5600
26	28.62	33.0	5600
27	28.94	28.4	5000
28	29.57	13.1	3000
29	30.12	15.2	3300
30	30.94	9.6	2500
31	31.50	15.2	3300
32	31.73	39.3	6200
33	32.09	24.9	4600
34	32.28	48.1	7200
35	32.56	33.0	5600
36	33.70	6.7	1900





CBR(OTHER) = 292 / (inPerBlow * 25.4)^1.12 [ASTM D6951-09]
CBR(CL) = 1 / (0.432283 * inPerBlow)^2 CBR<10 [ASTM D6951-09]
CBR(CH) = 1 / (0.072923 * inPerBlow) [ASTM D6951-09]
Bearing (psf) = 3.794 * CBR^0.664 * 144 [Porland Cement Assoc. 1955]

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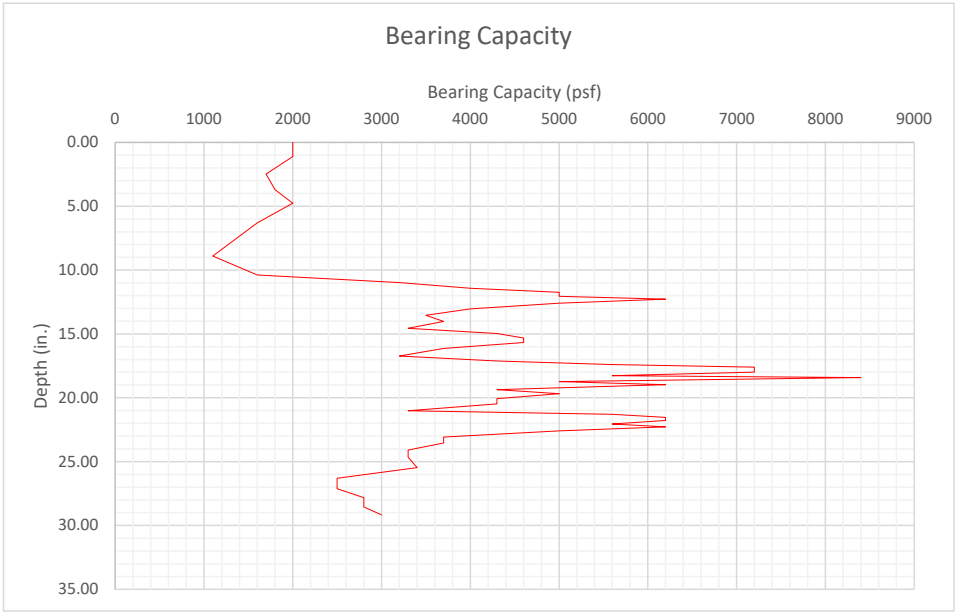
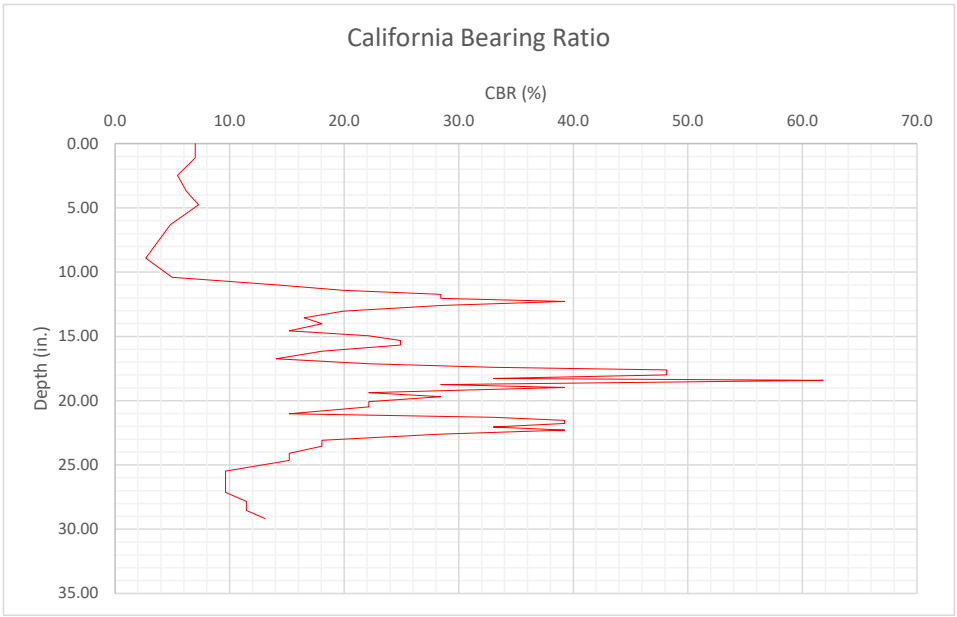
DYNAMIC CONE PENETROMETER TEST RESULTS

Project Name: Highland Shores Boulevard Pavement Improvements
Project Number: G22-2124
Report Number: 1
Test Location: B4
Starting Depth: 0 in

Service Date: 6/9/2022
Report Date: 7/11/2022
Hammer Weight: 17.6 lbs.
Soil Type: Other

Blow Number	Depth (in)	CBR (%)	Bearing (psf)
0	0.00	7.0	2000
1	1.10	7.0	2000
2	2.48	5.4	1700
3	3.70	6.2	1800
4	4.76	7.3	2000
5	6.30	4.8	1600
6	8.90	2.7	1100
7	10.39	5.0	1600
8	10.98	14.1	3200
9	11.42	19.9	4000
10	11.73	28.4	5000
11	12.05	28.4	5000
12	12.28	39.3	6200
13	12.60	28.4	5000
14	13.03	19.9	4000
15	13.54	16.5	3500
16	14.02	18.1	3700
17	14.57	15.2	3300
18	14.96	22.2	4300
19	15.31	24.9	4600
20	15.67	24.9	4600
21	16.14	18.1	3700
22	16.73	14.1	3200
23	17.13	22.2	4300
24	17.40	33.0	5600
25	17.60	48.1	7200
26	17.80	48.1	7200
27	17.99	48.1	7200
28	18.27	33.0	5600
29	18.43	61.8	8400
30	18.74	28.4	5000
31	18.98	39.3	6200
32	19.37	22.2	4300
33	19.69	28.4	5000
34	20.08	22.2	4300
35	20.47	22.2	4300
36	21.02	15.2	3300
37	21.30	33.0	5600
38	21.54	39.3	6200
39	21.77	39.3	6200
40	22.05	33.0	5600
41	22.28	39.3	6200
42	22.60	28.4	5000
43	23.07	18.1	3700
44	23.54	18.1	3700
45	24.09	15.2	3300
46	24.65	15.2	3300





CBR(OTHER) = 292 / (inPerBlow * 25.4)^1.12 [ASTM D6951-09]
CBR(CL) = 1 / (0.432283 * inPerBlow)^2 CBR<10 [ASTM D6951-09]
CBR(CH) = 1 / (0.072923 * inPerBlow) [ASTM D6951-09]
Bearing (psf) = 3.794 * CBR^0.664 * 144 [Porland Cement Assoc. 1955]

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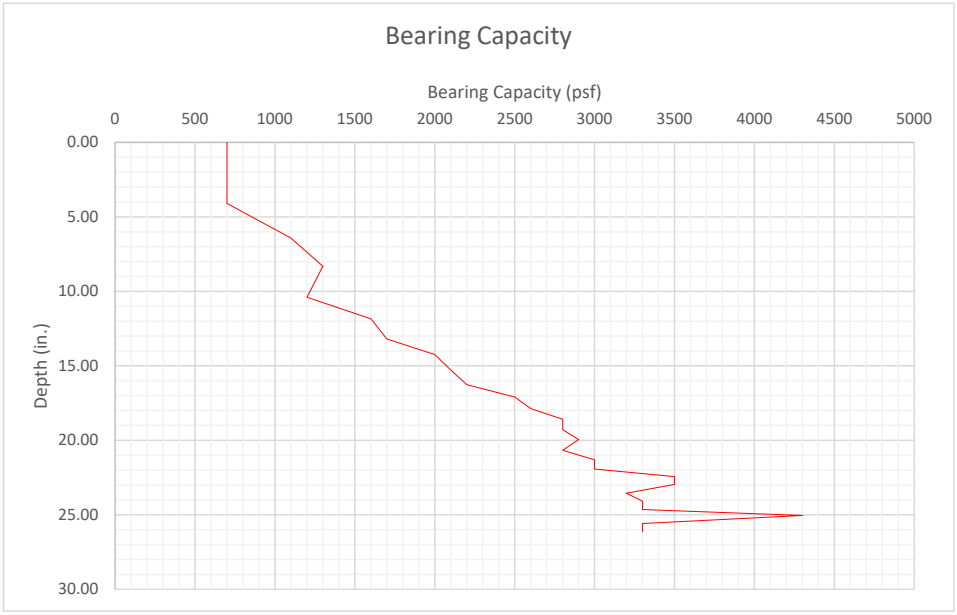
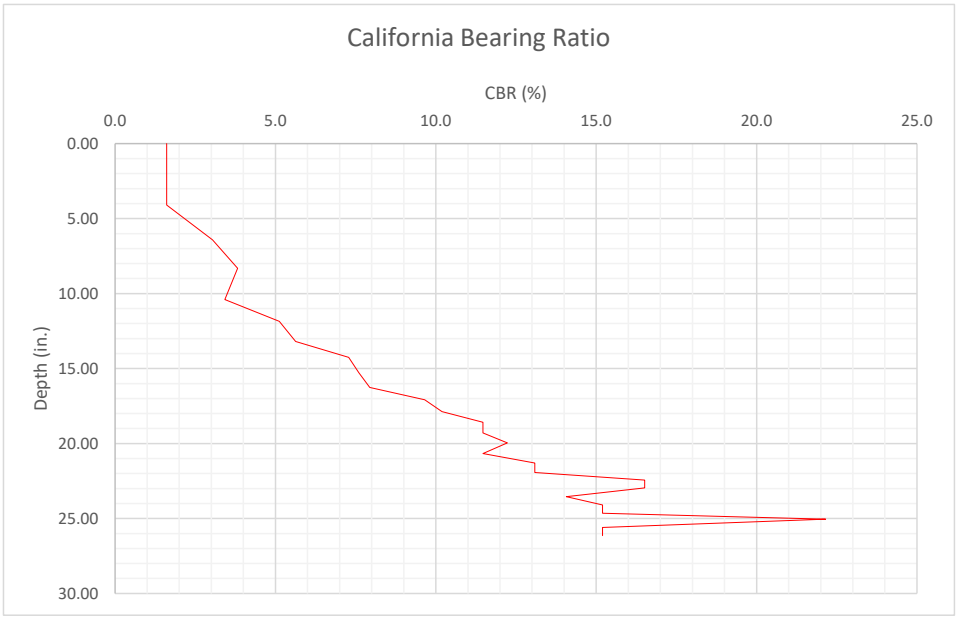
DYNAMIC CONE PENETROMETER TEST RESULTS

Project Name: Highland Shores Boulevard Pavement Improvements
Project Number: G22-2124
Report Number: 1
Test Location: B4
Starting Depth: 0 in

Service Date: 6/8/2022
Report Date: 7/11/2022
Hammer Weight: 17.6 lbs.
Soil Type: Other

Blow Number	Depth (in)	CBR (%)	Bearing (psf)
0	0.00	1.6	700
1	4.09	1.6	700
2	6.42	3.0	1100
3	8.31	3.8	1300
4	10.39	3.4	1200
5	11.85	5.1	1600
6	13.19	5.6	1700
7	14.25	7.3	2000
8	15.28	7.6	2100
9	16.26	7.9	2200
10	17.09	9.6	2500
11	17.87	10.2	2600
12	18.58	11.5	2800
13	19.29	11.5	2800
14	19.96	12.2	2900
15	20.67	11.5	2800
16	21.30	13.1	3000
17	21.93	13.1	3000
18	22.44	16.5	3500
19	22.95	16.5	3500
20	23.54	14.1	3200
21	24.09	15.2	3300
22	24.65	15.2	3300
23	25.04	22.2	4300
24	25.59	15.2	3300
25	26.14	15.2	3300





CBR(OTHER) = 292 / (inPerBlow * 25.4)^1.12 [ASTM D6951-09]
CBR(CL) = 1 / (0.432283 * inPerBlow)^2 CBR<10 [ASTM D6951-09]
CBR(CH) = 1 / (0.072923 * inPerBlow) [ASTM D6951-09]
Bearing (psf) = 3.794 * CBR^0.664 * 144 [Porland Cement Assoc. 1955]

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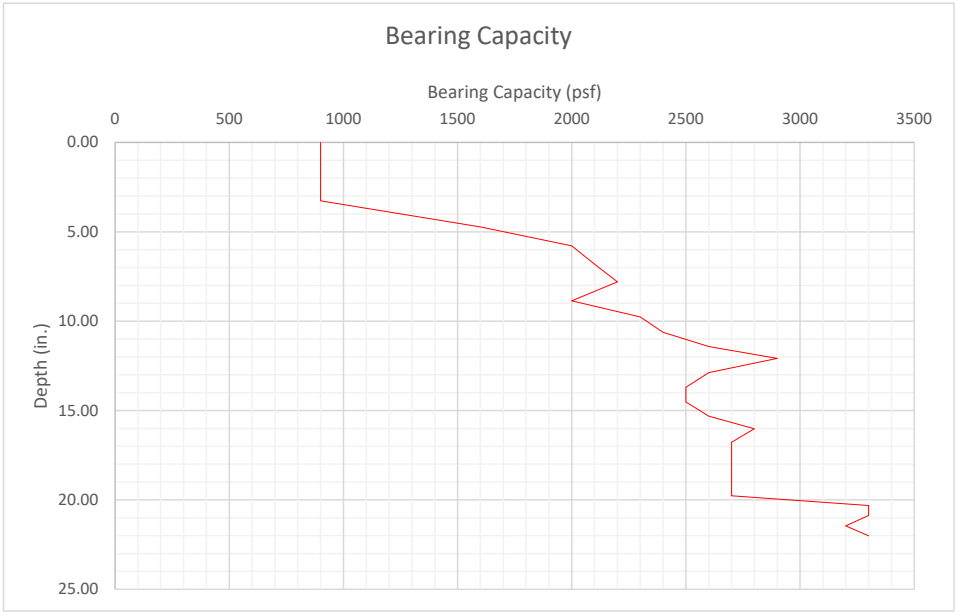
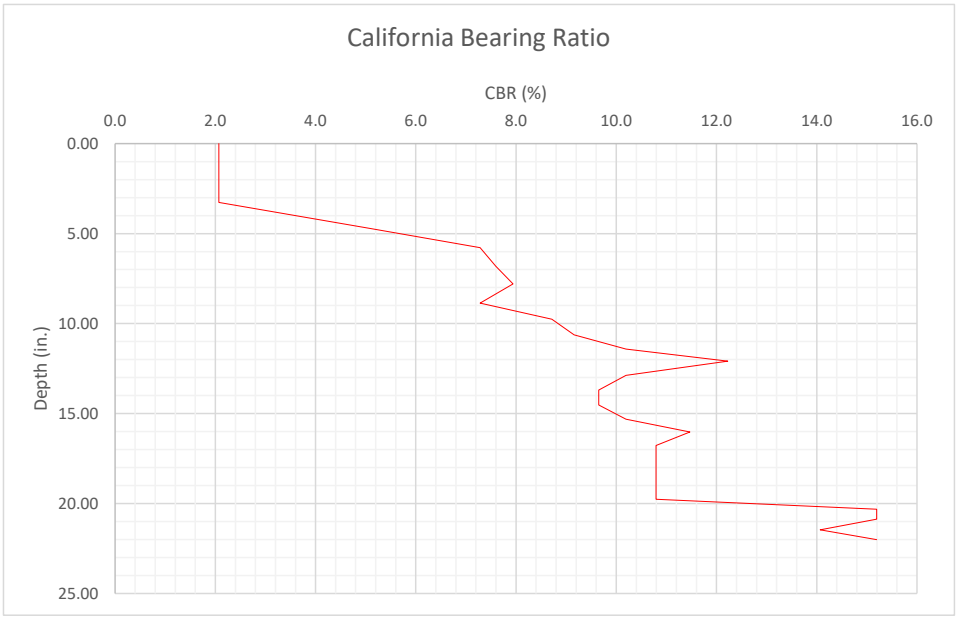
DYNAMIC CONE PENETROMETER TEST RESULTS

Project Name: Highland Shores Boulevard Pavement Improvements
Project Number: G22-2124
Report Number: 1
Test Location: B5
Starting Depth: 0 in

Service Date: 6/8/2022
Report Date: 7/11/2022
Hammer Weight: 17.6 lbs.
Soil Type: Other

Blow Number	Depth (in)	CBR (%)	Bearing (psf)
0	0.00	2.1	900
1	3.27	2.1	900
2	4.72	5.1	1600
3	5.79	7.3	2000
4	6.81	7.6	2100
5	7.80	7.9	2200
6	8.86	7.3	2000
7	9.76	8.7	2300
8	10.63	9.2	2400
9	11.42	10.2	2600
10	12.09	12.2	2900
11	12.87	10.2	2600
12	13.70	9.6	2500
13	14.53	9.6	2500
14	15.31	10.2	2600
15	16.02	11.5	2800
16	16.77	10.8	2700
17	17.52	10.8	2700
18	18.27	10.8	2700
19	19.02	10.8	2700
20	19.76	10.8	2700
21	20.31	15.2	3300
22	20.87	15.2	3300
23	21.46	14.1	3200
24	22.01	15.2	3300





CBR(OTHER) = 292 / (inPerBlow * 25.4)^1.12 [ASTM D6951-09]
CBR(CL) = 1 / (0.432283 * inPerBlow)^2 CBR<10 [ASTM D6951-09]
CBR(CH) = 1 / (0.072923 * inPerBlow) [ASTM D6951-09]
Bearing (psf) = 3.794 * CBR^0.664 * 144 [Porland Cement Assoc. 1955]

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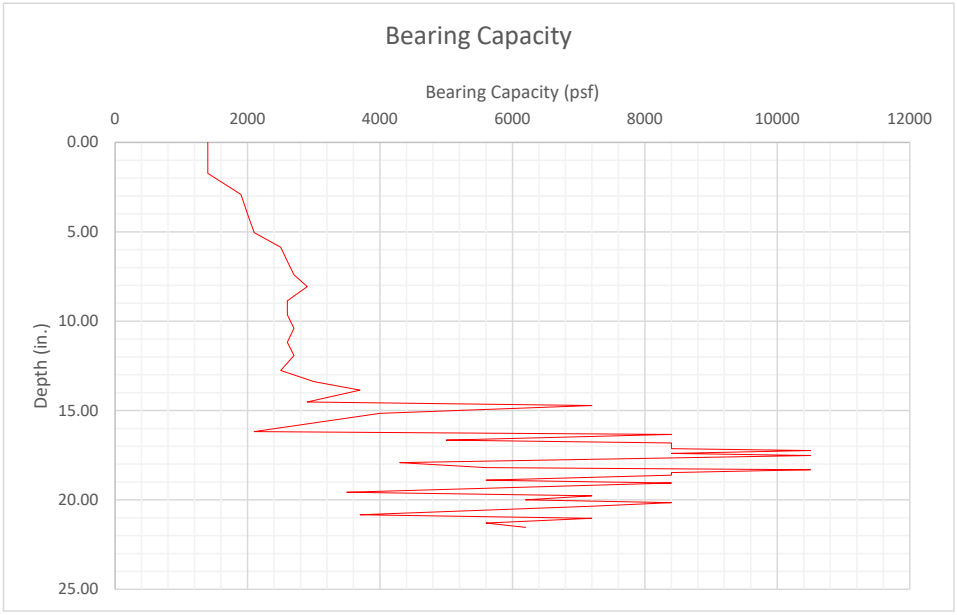
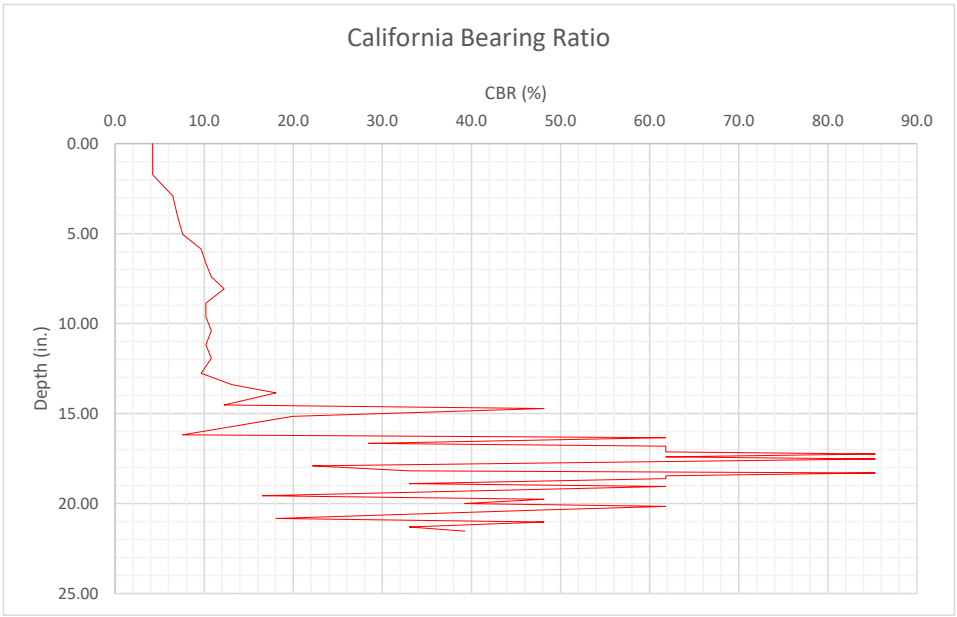
DYNAMIC CONE PENETROMETER TEST RESULTS

Project Name: Highland Shores Boulevard Pavement Improvements
Project Number: G22-2124
Report Number: 1
Test Location: B6
Starting Depth: 0 in

Service Date: 6/8/2022
Report Date: 7/11/2022
Hammer Weight: 17.6 lbs.
Soil Type: Other

Blow Number	Depth (in)	CBR (%)	Bearing (psf)
0	0.00	4.2	1400
1	1.73	4.2	1400
2	2.91	6.5	1900
3	4.02	7.0	2000
4	5.04	7.6	2100
5	5.87	9.6	2500
6	6.65	10.2	2600
7	7.40	10.8	2700
8	8.07	12.2	2900
9	8.86	10.2	2600
10	9.65	10.2	2600
11	10.39	10.8	2700
12	11.18	10.2	2600
13	11.93	10.8	2700
14	12.76	9.6	2500
15	13.39	13.1	3000
16	13.86	18.1	3700
17	14.53	12.2	2900
18	14.72	48.1	7200
19	15.16	19.9	4000
20	16.18	7.6	2100
21	16.34	61.8	8400
22	16.65	28.4	5000
23	16.81	61.8	8400
24	16.97	61.8	8400
25	17.13	61.8	8400
26	17.24	85.3	10500
27	17.40	61.8	8400
28	17.52	85.3	10500
29	17.91	22.2	4300
30	18.19	33.0	5600
31	18.31	85.3	10500
32	18.46	61.8	8400
33	18.62	61.8	8400
34	18.90	33.0	5600
35	19.06	61.8	8400
36	19.57	16.5	3500
37	19.76	48.1	7200
38	20.00	39.3	6200
39	20.16	61.8	8400
40	20.35	48.1	7200
41	20.83	18.1	3700
42	21.02	48.1	7200
43	21.30	33.0	5600
44	21.54	39.3	6200





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CBR(CL) = 1 / (0.432283 * inPerBlow)^2 CBR<10 [ASTM D6951-09]
CBR(CH) = 1 / (0.072923 * inPerBlow) [ASTM D6951-09]
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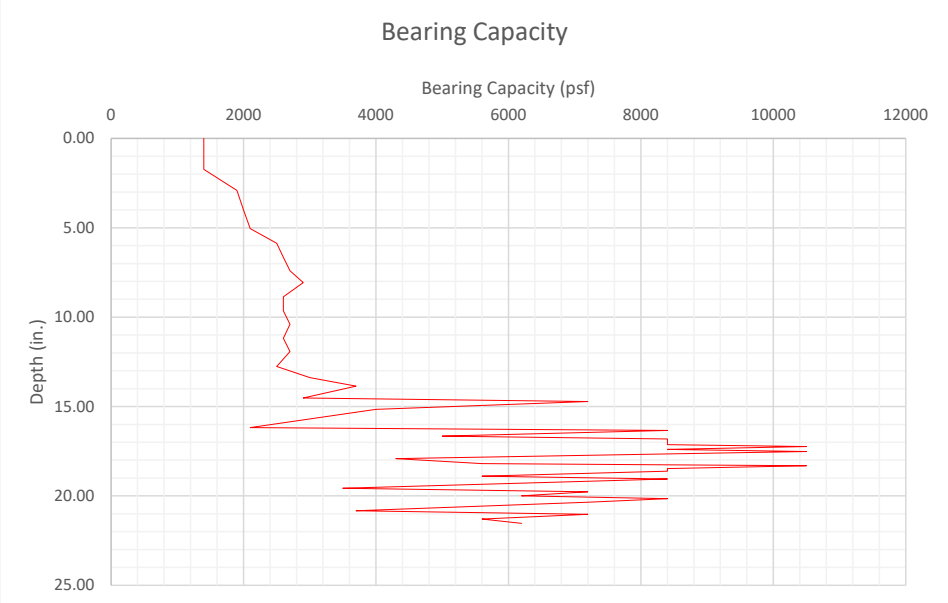
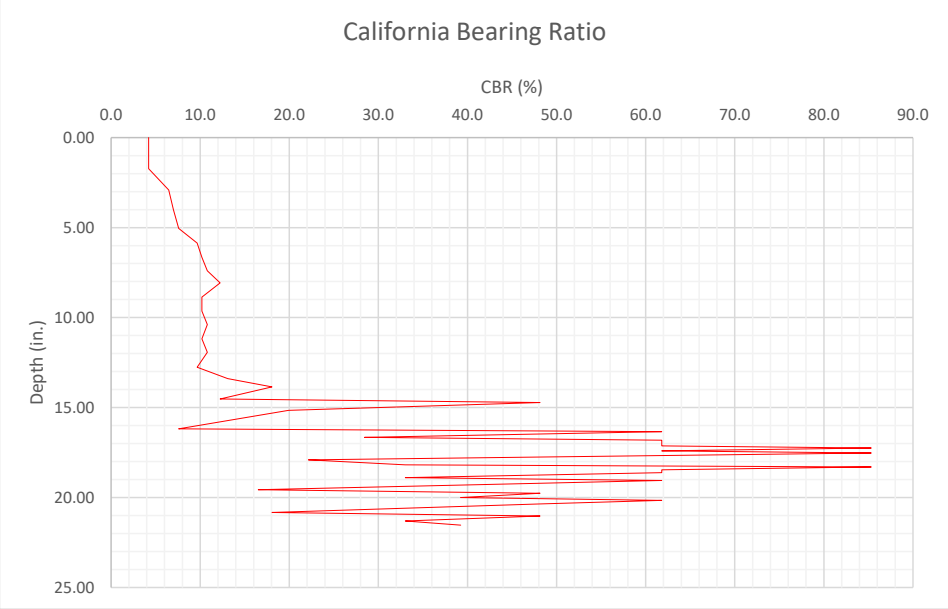
DYNAMIC CONE PENETROMETER TEST RESULTS

Project Name: Highland Shores Boulevard Pavement Improvements
Project Number: G22-2124
Report Number: 1
Test Location: B7
Starting Depth: 0 in

Service Date: 6/8/2022
Report Date: 7/11/2022
Hammer Weight: 17.6 lbs.
Soil Type: Other

Blow Number	Depth (in)	CBR (%)	Bearing (psf)
0	0.00	4.2	1400
1	1.73	4.2	1400
2	2.91	6.5	1900
3	4.02	7.0	2000
4	5.04	7.6	2100
5	5.87	9.6	2500
6	6.65	10.2	2600
7	7.40	10.8	2700
8	8.07	12.2	2900
9	8.86	10.2	2600
10	9.65	10.2	2600
11	10.39	10.8	2700
12	11.18	10.2	2600
13	11.93	10.8	2700
14	12.76	9.6	2500
15	13.39	13.1	3000
16	13.86	18.1	3700
17	14.53	12.2	2900
18	14.72	48.1	7200
19	15.16	19.9	4000
20	16.18	7.6	2100
21	16.34	61.8	8400
22	16.65	28.4	5000
23	16.81	61.8	8400
24	16.97	61.8	8400
25	17.13	61.8	8400
26	17.24	85.3	10500
27	17.40	61.8	8400
28	17.52	85.3	10500
29	17.91	22.2	4300
30	18.19	33.0	5600
31	18.31	85.3	10500
32	18.46	61.8	8400
33	18.62	61.8	8400
34	18.90	33.0	5600
35	19.06	61.8	8400
36	19.57	16.5	3500
37	19.76	48.1	7200
38	20.00	39.3	6200
39	20.16	61.8	8400
40	20.35	48.1	7200
41	20.83	18.1	3700
42	21.02	48.1	7200
43	21.30	33.0	5600
44	21.54	39.3	6200





CBR(OTHER) = 292 / (inPerBlow * 25.4)^1.12 [ASTM D6951-09]
CBR(CL) = 1 / (0.432283 * inPerBlow)^2 CBR<10 [ASTM D6951-09]
CBR(CH) = 1 / (0.072923 * inPerBlow) [ASTM D6951-09]
Bearing (psf) = 3.794 * CBR^0.664 * 144 [Porland Cement Assoc. 1955]

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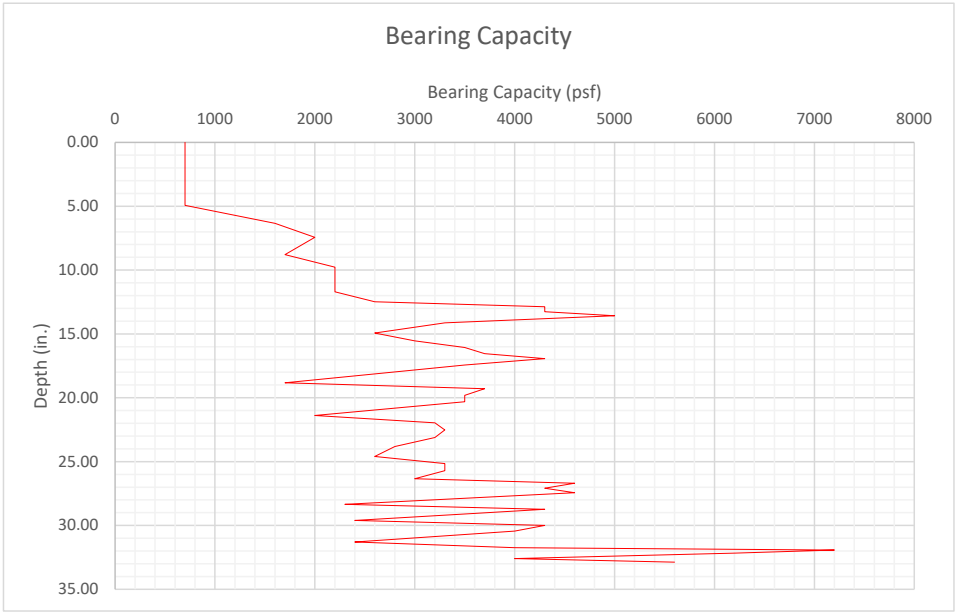
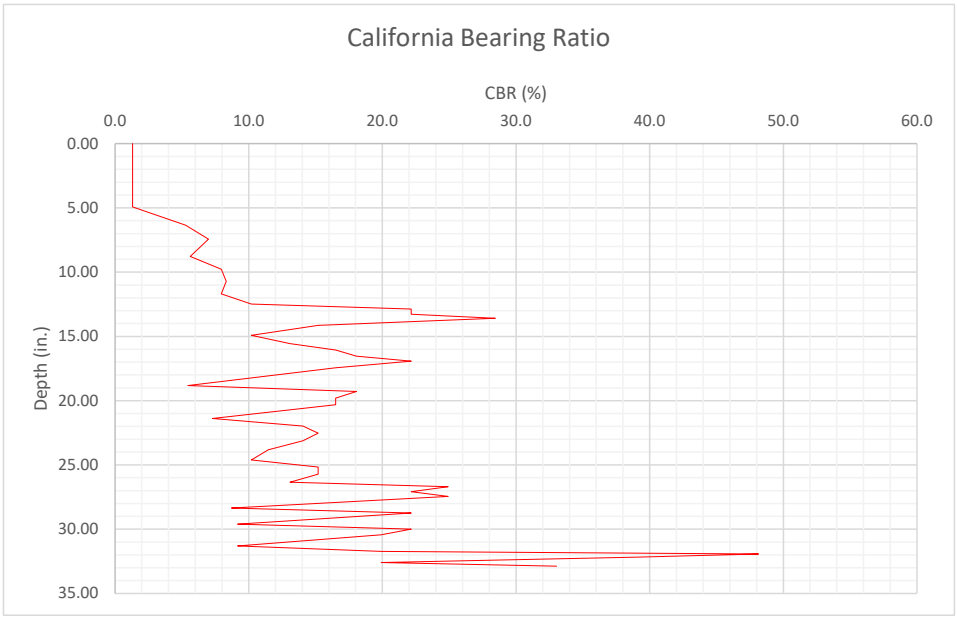
DYNAMIC CONE PENETROMETER TEST RESULTS

Project Name: Highland Shores Boulevard Pavement Improvements
Project Number: G22-2124
Report Number: 1
Test Location: B8
Starting Depth: 0 in

Service Date: 6/7/2022
Report Date: 7/11/2022
Hammer Weight: 17.6 lbs.
Soil Type: Other

Blow Number	Depth (in)	CBR (%)	Bearing (psf)
0	0.00	1.3	700
1	4.92	1.3	700
2	6.34	5.3	1600
3	7.44	7.0	2000
4	8.78	5.6	1700
5	9.76	7.9	2200
6	10.71	8.3	2200
7	11.69	7.9	2200
8	12.48	10.2	2600
9	12.87	22.2	4300
10	13.27	22.2	4300
11	13.58	28.4	5000
12	14.13	15.2	3300
13	14.92	10.2	2600
14	15.55	13.1	3000
15	16.06	16.5	3500
16	16.54	18.1	3700
17	16.93	22.2	4300
18	17.44	16.5	3500
19	18.82	5.4	1700
20	19.29	18.1	3700
21	19.80	16.5	3500
22	20.31	16.5	3500
23	21.38	7.3	2000
24	21.97	14.1	3200
25	22.52	15.2	3300
26	23.11	14.1	3200
27	23.82	11.5	2800
28	24.61	10.2	2600
29	25.16	15.2	3300
30	25.71	15.2	3300
31	26.34	13.1	3000
32	26.69	24.9	4600
33	27.09	22.2	4300
34	27.44	24.9	4600
35	28.35	8.7	2300
36	28.74	22.2	4300
37	29.61	9.2	2400
38	30.00	22.2	4300
39	30.43	19.9	4000
40	31.30	9.2	2400
41	31.73	19.9	4000
42	31.93	48.1	7200
43	32.17	39.3	6200
44	32.60	19.9	4000
45	32.87	33.0	5600





CBR(OTHER) = 292 / (inPerBlow * 25.4)^1.12 [ASTM D6951-09]
CBR(CL) = 1 / (0.432283 * inPerBlow)^2 CBR<10 [ASTM D6951-09]
CBR(CH) = 1 / (0.072923 * inPerBlow) [ASTM D6951-09]
Bearing (psf) = 3.794 * CBR^0.664 * 144 [Porland Cement Assoc. 1955]

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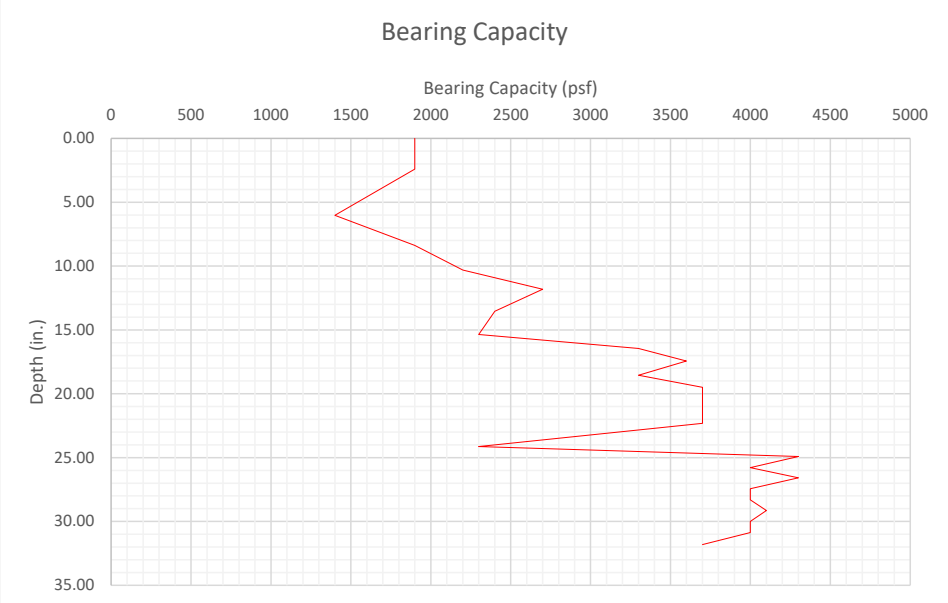
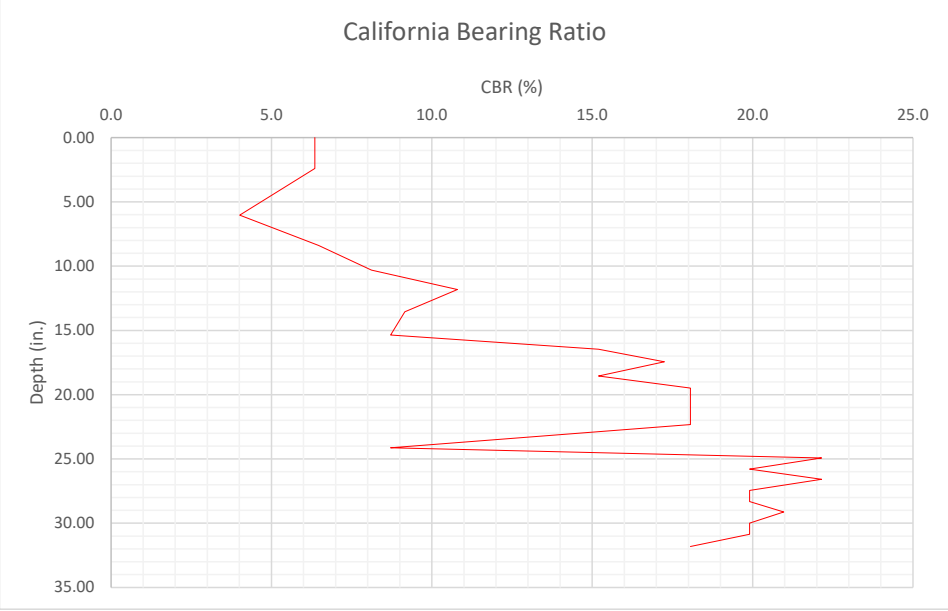
DYNAMIC CONE PENETROMETER TEST RESULTS

Project Name: Highland Shores Boulevard Pavement Improvements
Project Number: G22-2124
Report Number: 1
Test Location: B9
Starting Depth: 0 in

Service Date: 6/7/2022
Report Date: 7/11/2022
Hammer Weight: 17.6 lbs.
Soil Type: Other

Blow Number	Depth (in)	CBR (%)	Bearing (psf)
0	0.00	6.4	1900
2	2.40	6.4	1900
4	6.02	4.0	1400
6	8.39	6.5	1900
8	10.31	8.1	2200
10	11.81	10.8	2700
12	13.54	9.2	2400
14	15.35	8.7	2300
16	16.46	15.2	3300
18	17.44	17.3	3600
20	18.54	15.2	3300
22	19.49	18.1	3700
24	20.43	18.1	3700
26	21.38	18.1	3700
28	22.32	18.1	3700
30	24.13	8.7	2300
32	24.92	22.2	4300
34	25.79	19.9	4000
36	26.57	22.2	4300
38	27.44	19.9	4000
40	28.31	19.9	4000
42	29.13	21.0	4100
44	30.00	19.9	4000
46	30.87	19.9	4000
48	31.81	18.1	3700





CBR(OTHER) = 292 / (inPerBlow * 25.4)^1.12 [ASTM D6951-09]
CBR(CL) = 1 / (0.432283 * inPerBlow)^2 CBR<10 [ASTM D6951-09]
CBR(CH) = 1 / (0.072923 * inPerBlow) [ASTM D6951-09]
Bearing (psf) = 3.794 * CBR^0.664 * 144 [Porland Cement Assoc. 1955]

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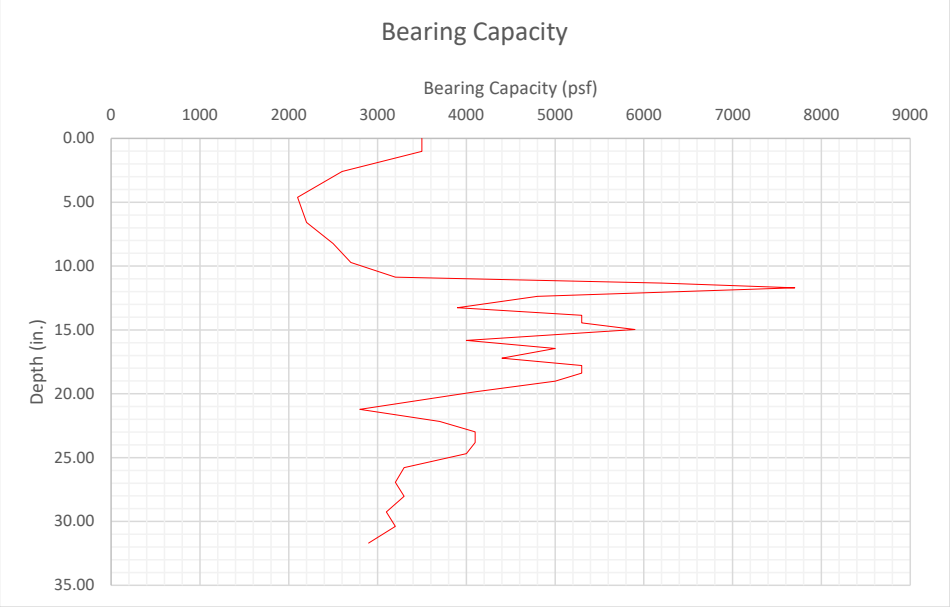
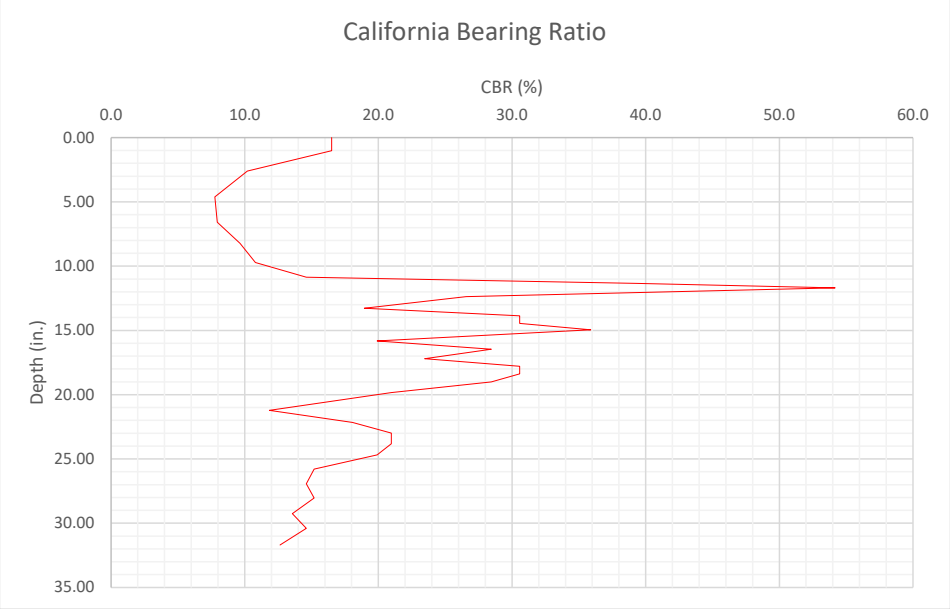
DYNAMIC CONE PENETROMETER TEST RESULTS

Project Name: Highland Shores Boulevard Pavement Improvements
Project Number: G22-2124
Report Number: 1
Test Location: B10
Starting Depth: 0 in

Service Date: 6/7/2022
Report Date: 7/11/2022
Hammer Weight: 17.6 lbs.
Soil Type: Other

Blow Number	Depth (in)	CBR (%)	Bearing (psf)
0	0.00	16.5	3500
2	1.02	16.5	3500
4	2.60	10.2	2600
6	4.61	7.8	2100
8	6.57	7.9	2200
10	8.23	9.6	2500
12	9.72	10.8	2700
14	10.87	14.6	3200
16	11.34	39.3	6200
18	11.69	54.2	7700
20	12.36	26.6	4800
22	13.27	18.9	3900
24	13.86	30.6	5300
26	14.45	30.6	5300
28	14.96	35.9	5900
30	15.83	19.9	4000
32	16.46	28.4	5000
34	17.20	23.5	4400
36	17.80	30.6	5300
38	18.39	30.6	5300
40	19.02	28.4	5000
42	19.84	21.0	4100
44	21.22	11.8	2800
46	22.17	18.1	3700
48	22.99	21.0	4100
50	23.82	21.0	4100
52	24.69	19.9	4000
54	25.79	15.2	3300
56	26.93	14.6	3200
58	28.03	15.2	3300
60	29.25	13.6	3100
62	30.39	14.6	3200
64	31.69	12.6	2900





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CBR(CL) = 1 / (0.432283 * inPerBlow)^2 CBR<10 [ASTM D6951-09]
CBR(CH) = 1 / (0.072923 * inPerBlow) [ASTM D6951-09]
Bearing (psf) = 3.794 * CBR^0.664 * 144 [Porland Cement Assoc. 1955]

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B1

B2

B3

Boring	Description
B1	Concrete 9.5 inches, Asphalt 4.75 inches
B2	Concrete 8.5 inches
B3	Concrete 8.5 inches

D&S ENGINEERING LABS

PAVEMENT CORES

HIGHLAND SHORES BOULEVARD

Highland Village

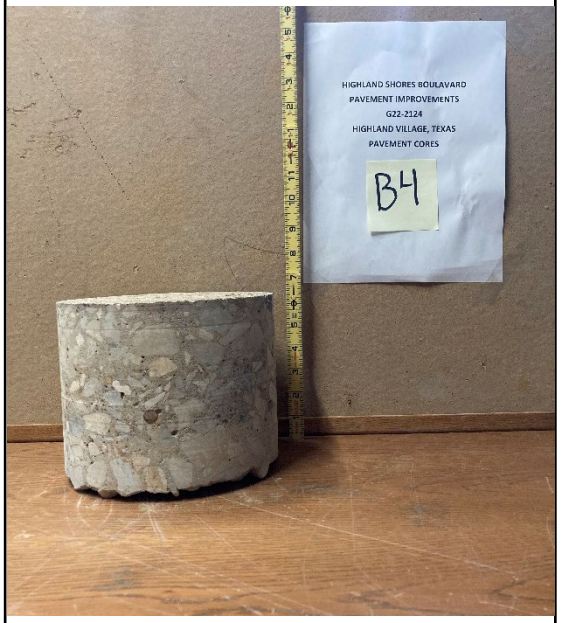
TEXAS

SHEET NO.

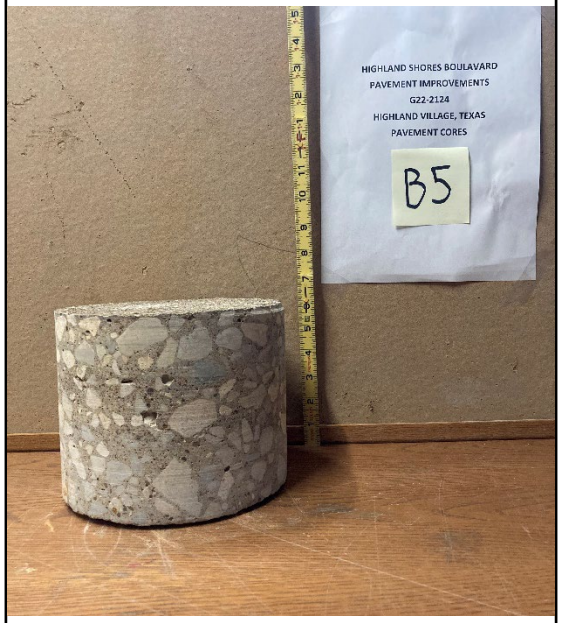
PV1

DATE DRILLED

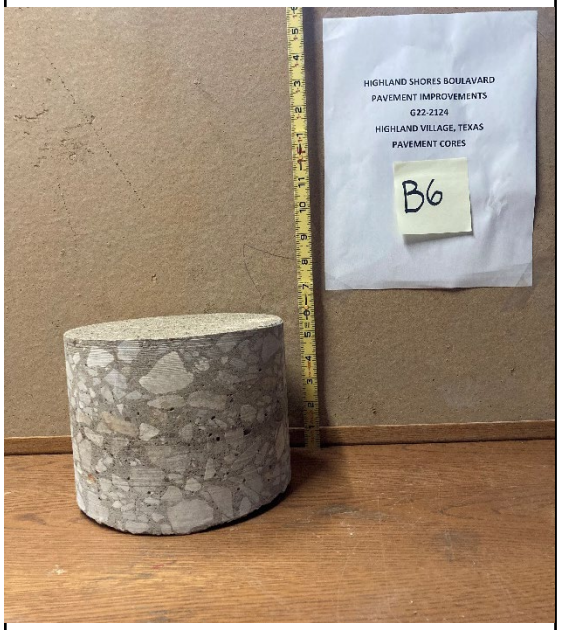
June 7 - 9, 2022



B4



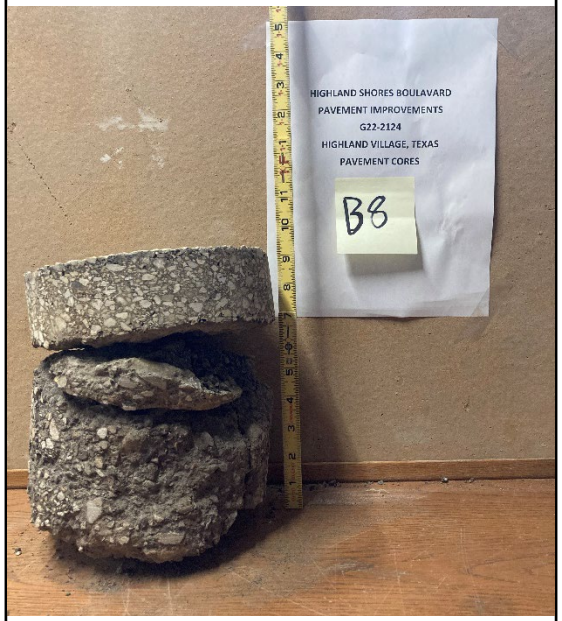
B5



B6

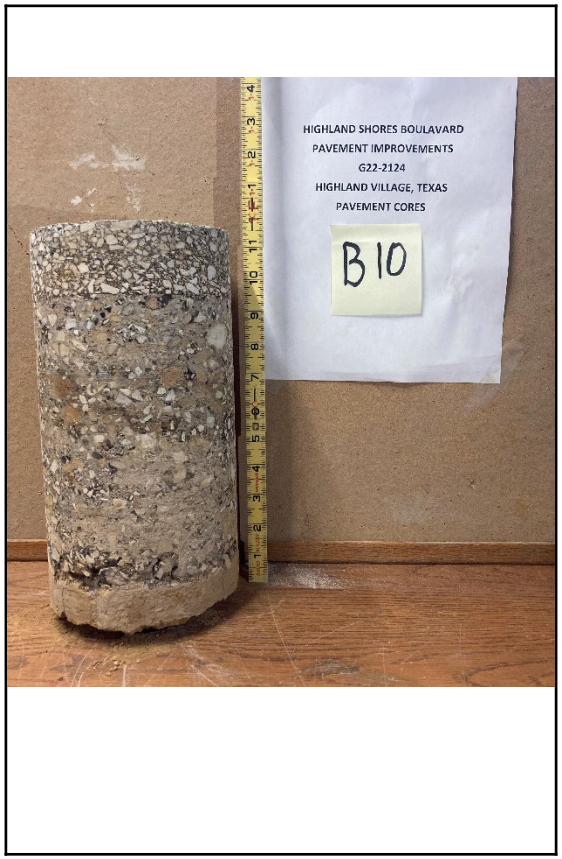
Boring	Description
B4	Concrete 6.75 inches
B5	Concrete 6.25 inches
B6	Concrete 6.0 inches

PICTURE NOT TAKEN CORE DAMAGED IN FIELD



B7 B8 B9

Boring	Description
B7	Concrete 6.5 inches
B8	Asphalt 10.25 inches
B9	Asphalt 9.5 inches



B10

Boring	Description
B10	Asphalt 11.0 inches

APPENDIX B - GENERAL DESCRIPTION OF PROCEDURE

ANALYTICAL METHODS TO PREDICT MOVEMENT

CLASSIFICATION TESTS

Classification testing is perhaps the most basic, yet fundamental tool available for predicting potential movements of clay soils. Classification testing typically consists of moisture content, Atterberg Limits, and Grain-size distribution determinations. From these results a general assessment of a soil's propensity for volume change with changes in soil moisture content can be made.

Moisture Content

By studying the moisture content of the soils at varying depths and comparing them with the results of Atterberg Limits, one can estimate a rough order of magnitude of potential soil movement at various moisture contents, as well as movements with moisture changes. These tests are typically performed in accordance with ASTM D2216.

Atterberg Limits

Atterberg limits determine the liquid limit (LL), plastic limit (PL), and plasticity index (PI) of a soil. The liquid limit is the moisture content at which a soil begins to behave as a viscous fluid. The plastic limit is the moisture content at which a soil becomes workable like putty, and at which a clay soil begins to crumble when rolled into a thin thread (1/8" diameter). The PI is the numerical difference between the moisture constants at the liquid limit and the plastic limit. This test is typically performed in accordance with ASTM D4318.

Clay mineralogy and the particle size influence the Atterberg Limits values, with certain minerals (e.g., montmorillonite) and smaller particle sizes having higher PI values, and therefore higher movement potential.

A soil with a PI below about 15 to 18 is considered to be generally stable and should not experience significant movement with changes in moisture content. Soils with a PI above about 30 to 35 are considered to be highly active and may exhibit considerable movement with changes in moisture content.

Fat clays with very high liquid limits, weakly cemented sandy clays, or silty clays are examples of soils in which it can be difficult to predict movement from classification testing alone.

Grain-size Distribution

The simplest grain-size distribution test involves washing a soil specimen over the No. 200 mesh sieve with an opening size of 0.075 mm (ASTM D1140). This particle size has been defined by the engineering community as the demarcation between coarse-grained and fine-grained soils. Particles smaller than this size can be further distinguished between silt-size and clay-size particles by use of a Hydrometer test (ASTM D422). A more complete grain-size distribution test that uses sieves to relative amount of particles according is the Sieve Gradation Analysis of Soils

(ASTM D6913). Once the characteristics of the soil are determined through classification testing, a number of movement prediction techniques are available to predict the potential movement of the soils. Some of these are discussed in general below.

TEXAS DEPARTMENT OF TRANSPORTATION METHOD 124-E

The Texas Department of Transportation (TxDOT) has developed a generally simplistic method to predict movements for highways based on the plasticity index of the soil. The TxDOT method is empirical and is based on the Atterberg limits and moisture content of the subsurface soil. This method generally assumes three different initial moisture conditions: dry, “as-is”, and wet. Computation of each over an assumed depth of seasonal moisture variation (usually about 15 feet or less) provides an estimate of potential movement at each initial condition. This method requires a number of additional assumptions to develop a potential movement estimate. As such, the predicted movements generally possess large uncertainties when applied to the analysis of conditions under building slabs and foundations. In our opinion, estimates derived by this method should not be used alone in determination of potential movement.

SWELL TESTS

Swell tests can lead to more accurate site-specific predictions of potential vertical movement by measuring actual swell volumes at in situ initial moisture contents. One-dimensional swell tests are almost always performed for this measurement. Though swell is a three-dimensional process, the one-dimensional test provides greatly improved potential vertical movement estimates than other methods alone, particularly when the results are “weighted” with respect to depth, putting more emphasis on the swell characteristics closer to the surface and less on values at depth.

POTENTIAL VERTICAL MOVEMENT

A general index for movement is known as the Potential Vertical Rise (PVR). The actual term PVR refers to the TxDOT Method 124-E mentioned above. For the purpose of this report the term Potential Vertical Movement (PVM) will be used since PVM estimates are derived using multiple analytical techniques, not just TxDOT methods.

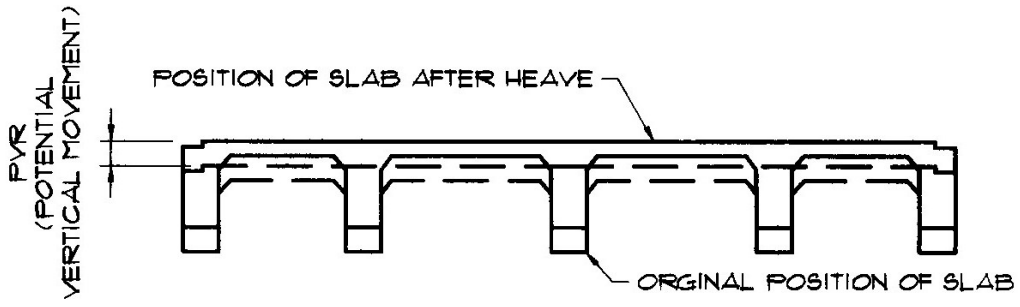
It should be noted that slabs and foundations constructed on clay or clayey soils may have at least some risk of potential vertical movement due to changes in soil moisture contents. To eliminate that risk, slabs and foundation elements may be designed as structural elements physically separated by some distance from the subgrade soils (usually 4 to 12 inches).

In some cases, a floor slab with movements as little as 1/4 of an inch may result in damage to interior walls, such as cracking in sheet rock or masonry walls, or separation of floor tiles. However, these cracks are often minor and most people consider them 'liveable'. In other cases, movement of one inch may cause significant damage, inconvenience, or even create a hazard (trip hazard or others).

Vertical movement of clay soils under slab on grade foundations due to soil moisture changes can result from a variety causes, including poor site grading and drainage, improperly prepared subgrade, trees, and large shrubbery located too close to structures, utility leaks or breaks, poor subgrade maintenance such as inadequate or excessive irrigation, or other causes. The potential for post-construction vertical movement can be minimized through adequate design, proper construction, and adherence to the recommendations contained herein for post-construction maintenance.

POTENTIAL VERTICAL MOVEMENT (PVM)

PVM is generally considered to be a measurement of the change in height of a foundation from the elevation it was originally placed. Experience and generally accepted practice suggests that if the PVM of a site is less than one inch, the associated differential movement will be minor and acceptable to most people.



POTENTIAL VERTICAL RISE

SETTLEMENT

Settlement is a measure of a downward movement due to consolidation of soil. This can occur from improperly placed fill (uncompacted or under-compacted), loose native soil, or from large amounts of unconfined sandy material. Properly compacted fill may settle approximately 1 percent of its depth, particularly when fill depths exceed 10 feet.

SPECIAL COMMENTARY ON CONCRETE AND EARTHWORK

RESTRAINT TO SHRINKAGE CRACKS

One of the characteristics of concrete is that during the curing process shrinkage occurs and if there are any restraints to prevent the concrete from shrinking, cracks can form. In a typical slab on grade or structurally suspended foundation there will be cracks due to interior beams and piers that restrict shrinkage. This restriction is called Restraint to Shrinkage (RTS). In post tensioned slabs, the post tensioning strands are slack when installed and must be stressed at a later time. The best procedure is to stress the cables approximately 30 percent within one to two days of placing the concrete. Then the cables are stressed fully when the concrete reaches greater strength, usually in 7 days. During this time before the cables are stressed fully, the concrete may crack more than conventionally reinforced slabs. When the cables are stressed, some of the cracks will pull together. These RTS cracks do not normally adversely affect the overall performance of the foundation. It should be noted that for exposed floors, especially those that will be painted, stained, or stamped, these cracks may be aesthetically unacceptable. Any tile which is applied directly to concrete or over a mortar bed over concrete has a high probability of minor cracks occurring in the tile due to RTS. It is recommended if tile is used to install expansion joints in appropriate locations to minimize these cracks.

UTILITY TRENCH EXCAVATION

Trench excavation for utilities should be sloped or braced in the interest of safety. Attention is drawn to OSHA Safety and Health Standards (29 CFR 1926/1910), Subpart P, regarding trench excavations greater than 5 feet in depth.

FIELD SUPERVISION AND DENSITY TESTING

Construction observation and testing by a field technician under the direction of a licensed geotechnical engineer should be provided. Some adjustments in the test frequencies may be required based upon the general fill types and soil conditions at the time of fill placement.

We recommend that all site and subgrade preparation, proofrolling, and pavement construction be monitored by a qualified engineering firm. D&S would be pleased to provide these services in support of this project. Density tests should be performed to verify proper compaction and moisture content of any earthwork. Inspection should be performed prior to and during concrete placement operations. D&S would be pleased to assist you on this project.

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