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Offices Covering all USA

Mn/DOT Foundations Unit

CPT Uses In The Design Of Foundations **August....., 2008**

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Assistant Geotechnical Engineer



Presentation Overview

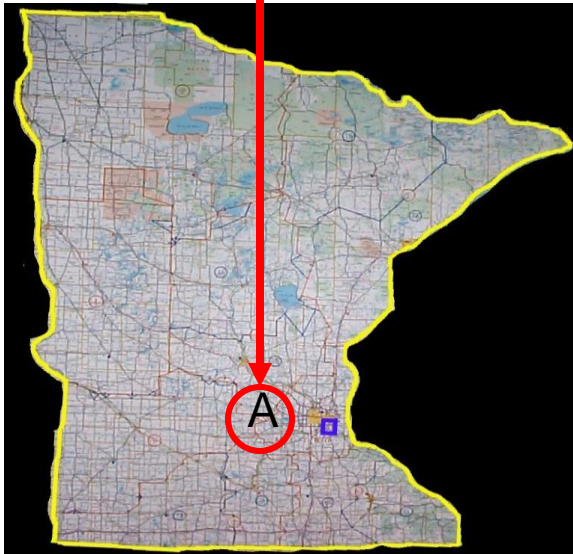
- Background
- Case Study
- Plan presentation
- CPT logs
- Spread sheet used/Calculation
- Pile Capacity Graph Comparison

Background

- Two Methods used for comparison
 1. Using N_{60} -Interpreted from CPT
Using DRIVEN program
 2. Using Cone Tip Stress (q_c) & Sleeve Friction (f_s)
Using Louisiana Pile Design method

Case Study 3: Pile Footing Design using CPT Soundings

- Location: Garvin Brook, MN
- Three-span bridge with a 45 inch Prestressed Concrete Beams
- Investigation: 2 CPT Soundings taken
- SP 8506-71 (BR# 85009)



Close-Up Aerial View



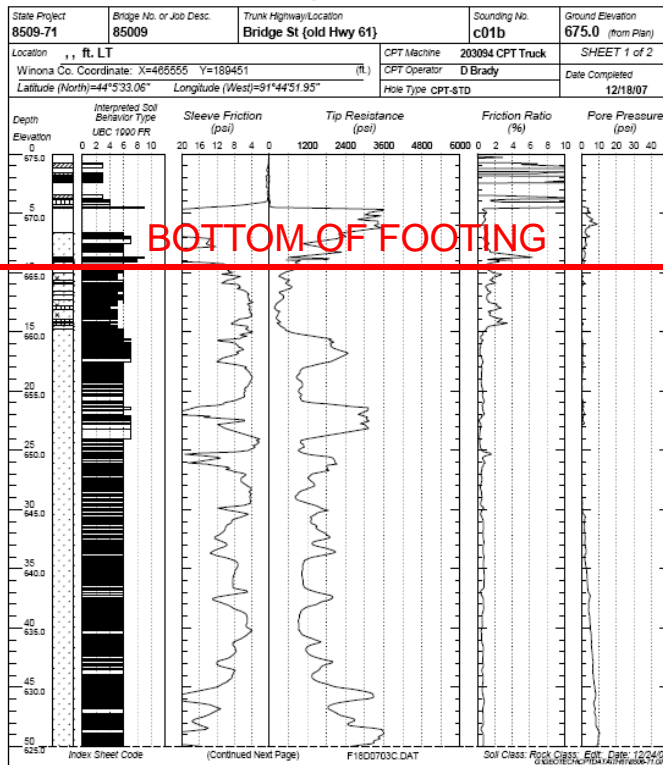
CPT Log with Tip Resistance

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER

U.S. Customary Units



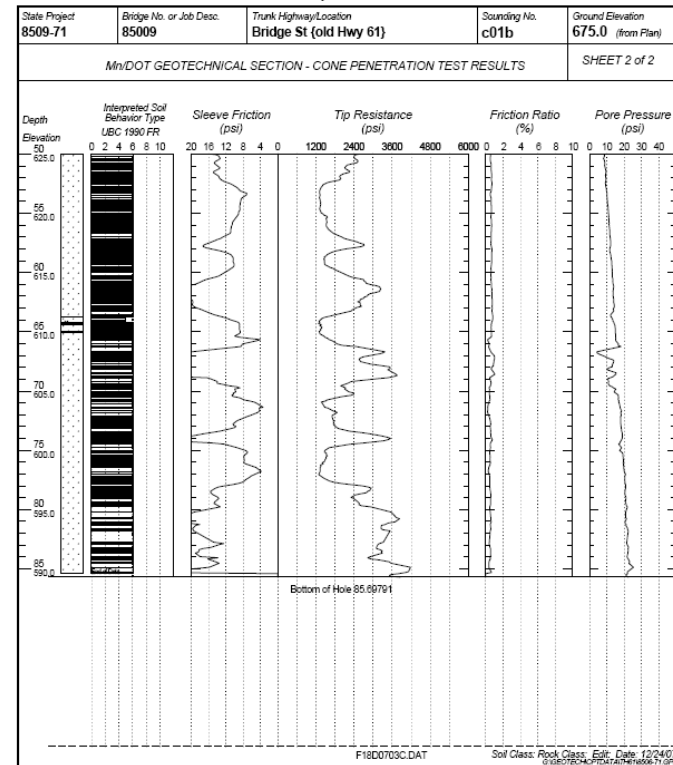
BOTTOM OF FOOTING

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER

U.S. Customary Units



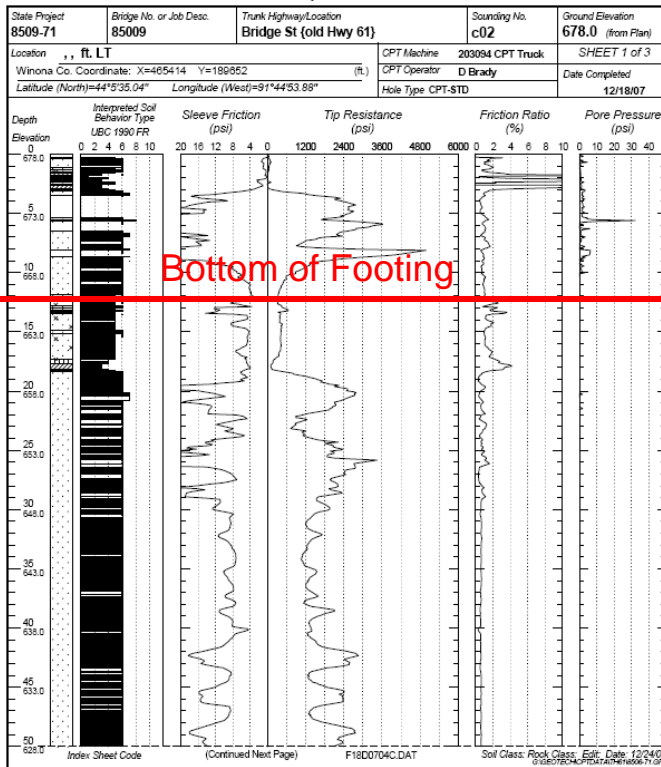
CPT Log with Tip Resistance

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER

U.S. Customary Units

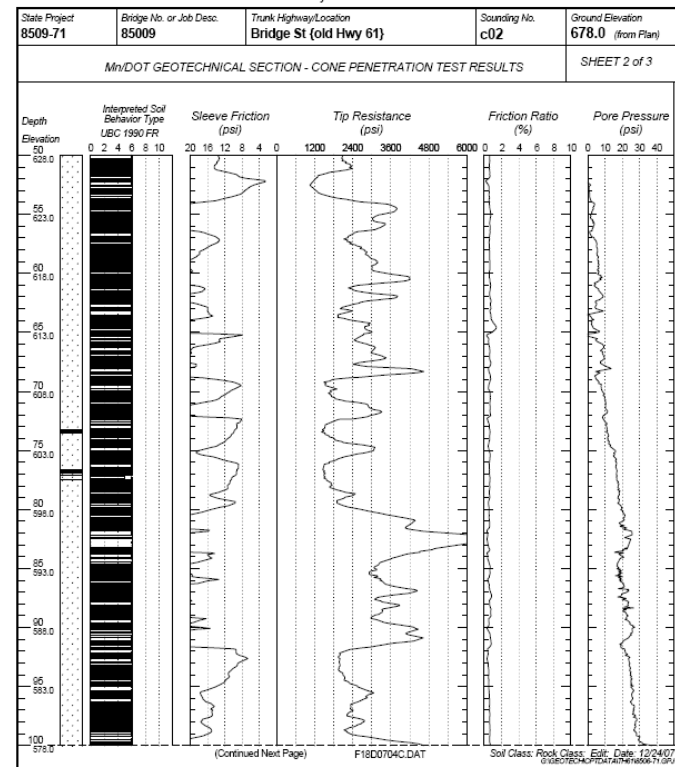


MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER

U.S. Customary Units



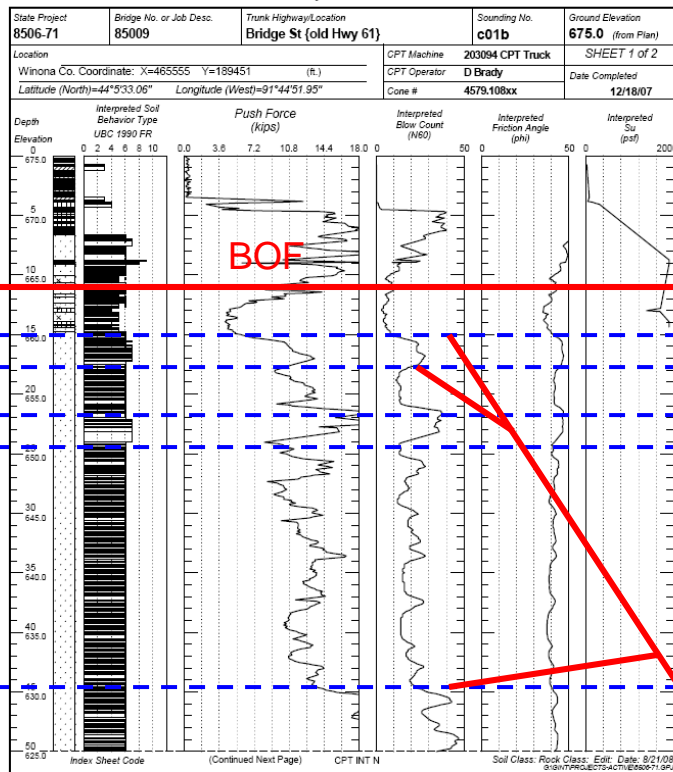
CPT Log with N_{60} Interpreted

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 69569

U.S. Customary Units

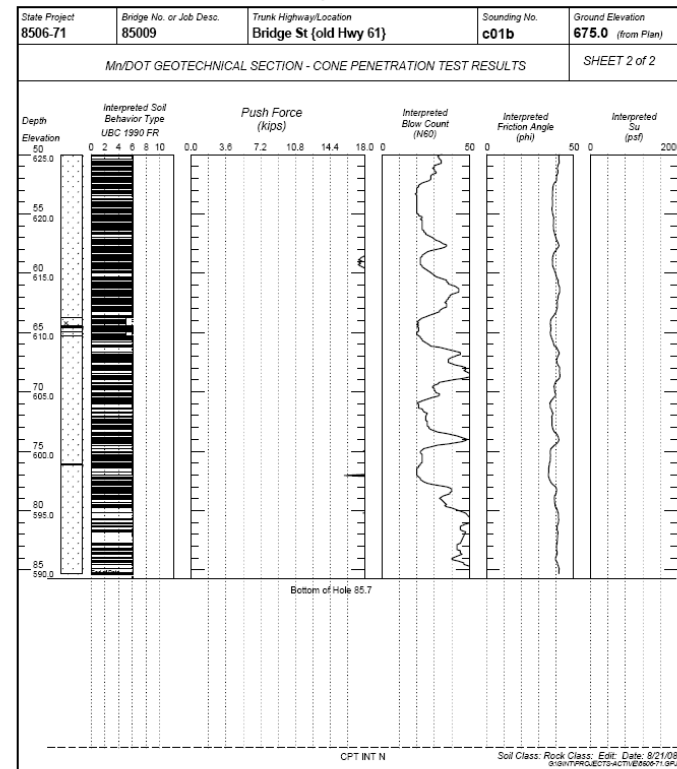


MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 69569

U.S. Customary Units



Try to have Soil Layers with similar N_{60} together

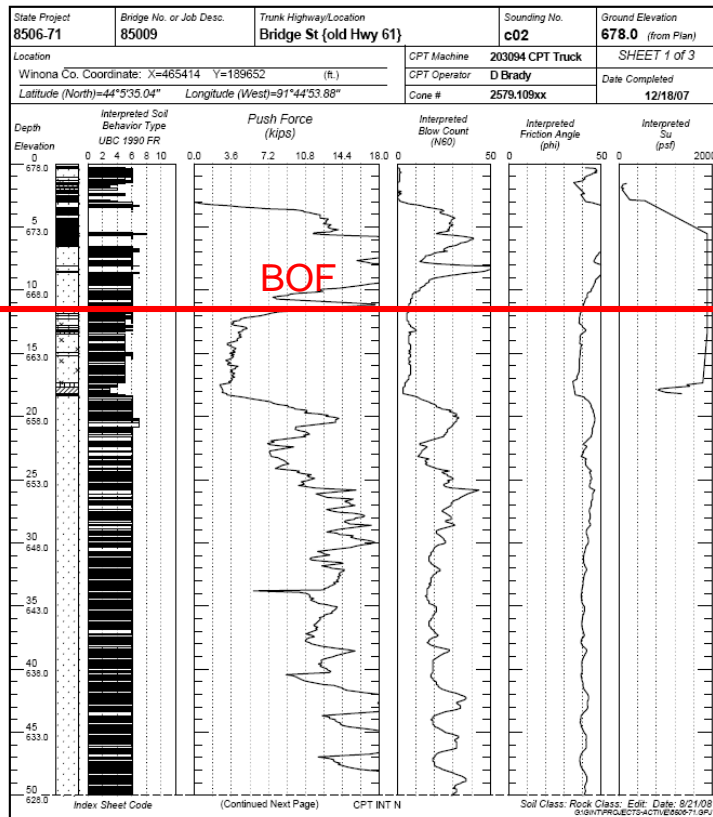
CPT with N_{60} Interpreted

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 69570

U.S. Customary Units

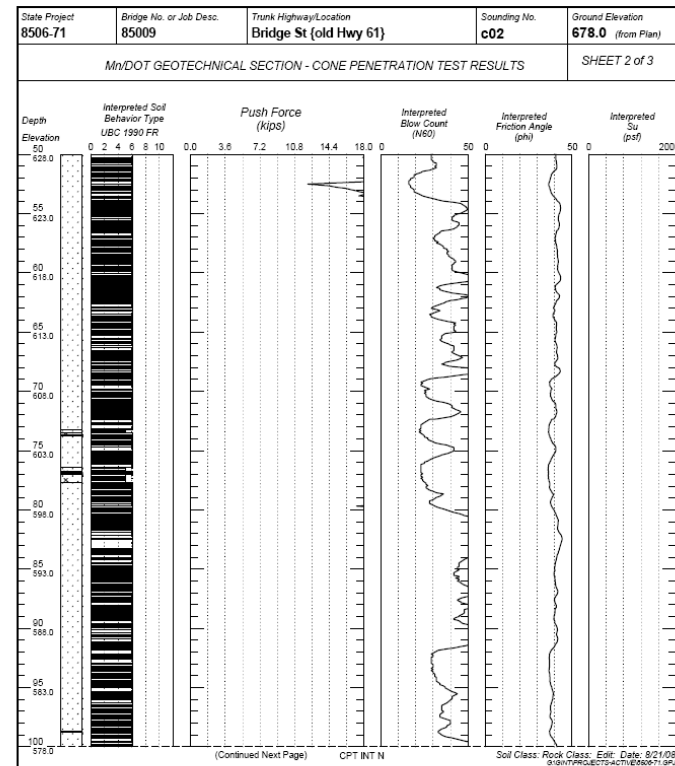


MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

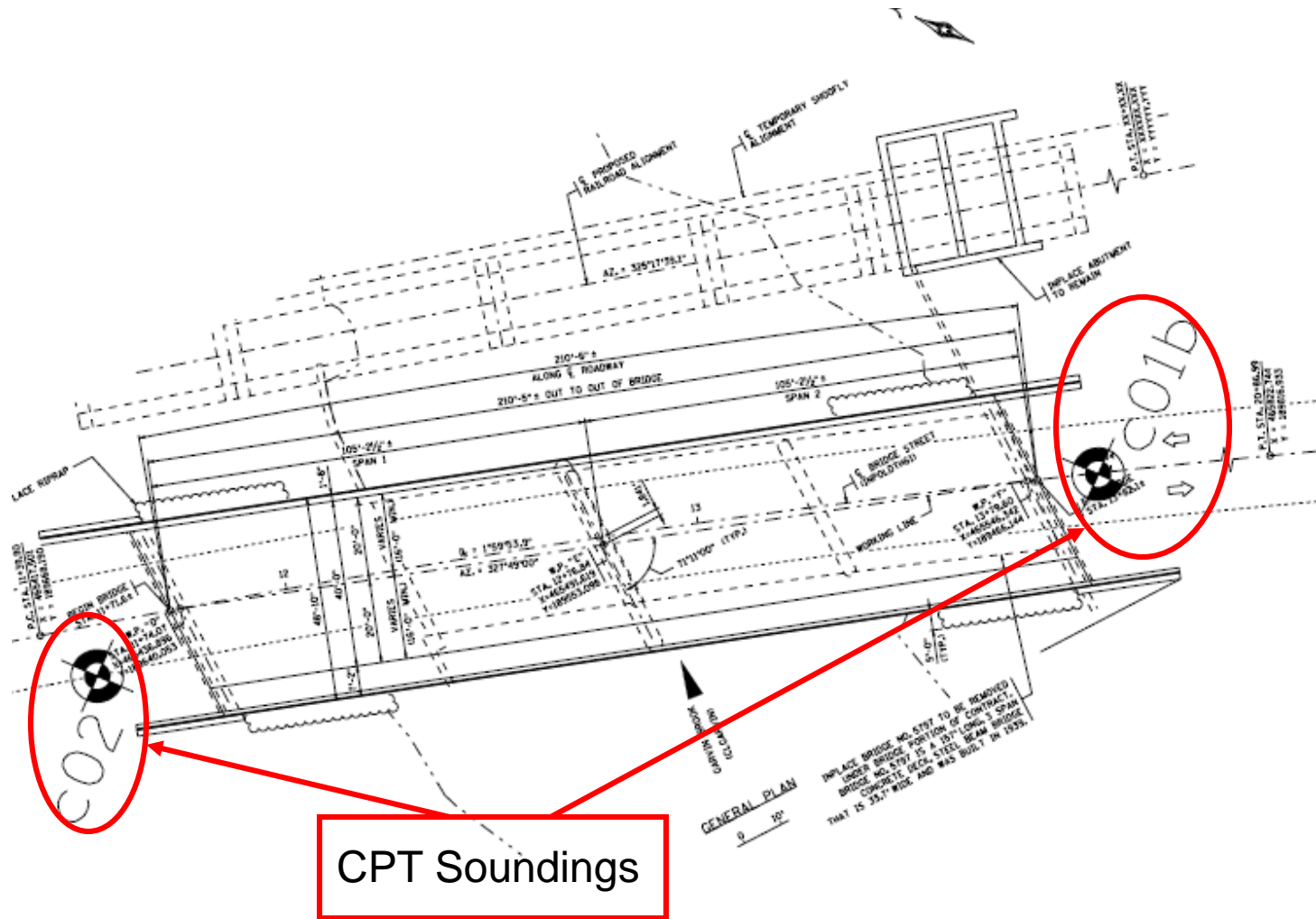
CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 69570

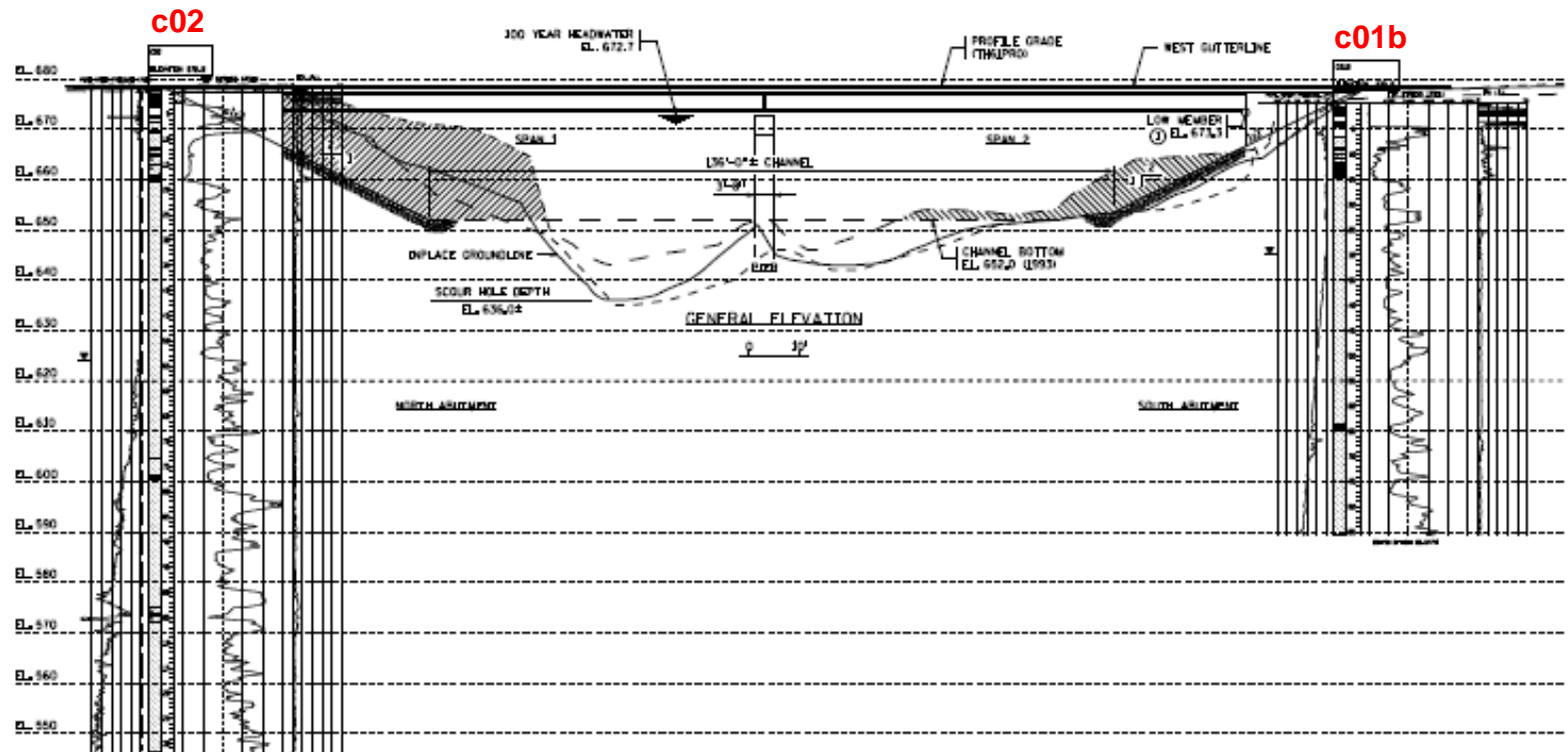
U.S. Customary Units



CPT Plot on Bridge Plan



Bridge Profile with CPT Soundings



Driven Program Used for Pile Capacity Calculation

Driven - C:\DRIVEN\SP85B12.DVN

File Project Output Driveability Help

Soil Profile

Soil Layer Profile

Soil Layer #2

Layer General Data

Depth to bottom of layer 9.000 ft

Total unit weight of soil 120.000 pcf

Driving strength loss 20.000 %

Layer Soil Type

☐ Cohesive ☒ Cohesionless

Internal Friction Angle Skin Friction 37.30 degrees

☒ Use SPT 'N' Values Edit

Internal Friction Angle End Bearing 37.30 degrees

☒ Use SPT 'N' Values Edit

Pile Type Pipe Pile - Closed End Edit

OK Cancel

Split Layer Delete Layer Calculator Help

The screenshot shows the 'Driven' software interface. The 'Soil Profile' window is active, displaying a vertical soil layer profile on the left with depth markers from 0.0 ft to 85.0 ft. The 'Soil Layer #2' panel on the right contains input fields for 'Layer General Data' and 'Layer Soil Type'. The 'Internal Friction Angle Skin Friction' field is set to 37.30 degrees and is circled in red. A red arrow points from a text box on the right to this field. The text box contains the text 'N_avg Interpreted Value from CPT'. Other fields include 'Depth to bottom of layer' (9.000 ft), 'Total unit weight of soil' (120.000 pcf), 'Driving strength loss' (20.000 %), 'Internal Friction Angle End Bearing' (37.30 degrees), and 'Pile Type' (Pipe Pile - Closed End). Buttons for 'OK', 'Cancel', 'Split Layer', 'Delete Layer', 'Calculator', and 'Help' are at the bottom.

N_{avg} Interpreted
Value from CPT

Driven Output

Substructure: **Boring c01b (South Abutment)** Project: **Bridge st(old TH61)**
 Pile Type: **12.0" Pipe Pile** Location: **Bridge**
 Bottom of Footing Elevation, ft: **666.0**
 Boring Elevation, ft: **675.0**

Driven results from "Tabular Output"

Data from Driven

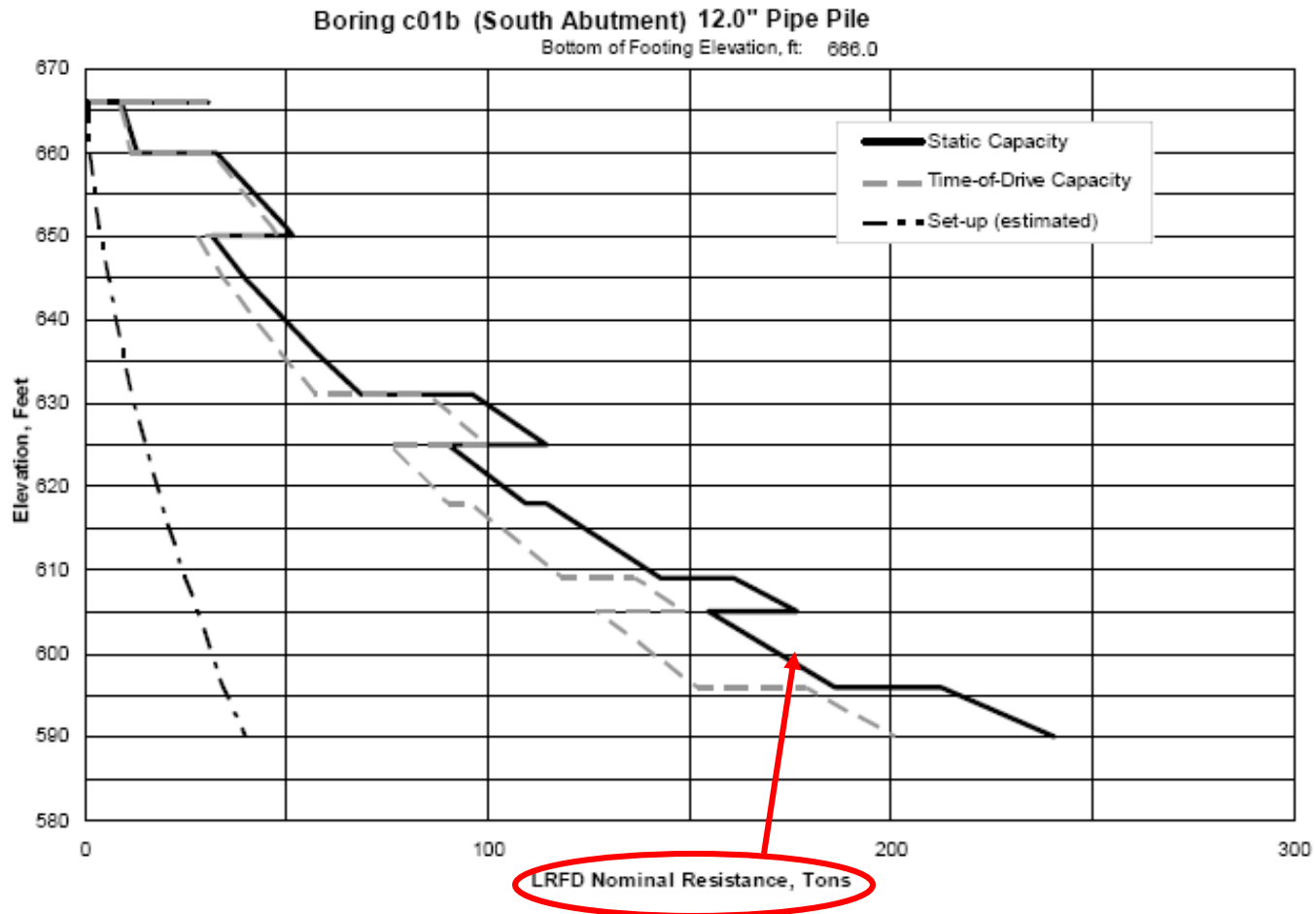
Static data taken from "Depth" and either "Restrike" or
 "Ultimate" column ToD (Time-of-
 Drive) data taken from "Driving" column

Depth, ft	Static Skin Friction, kips	End Bearing, kips	ToD Skin Friction, kips	Total Static Capacity, kips	Total ToD Capacity, kips	Elev, ft	Set-up, Kips	Total Static Capacity, Tons	Total ToD Capacity, Tons	Set-up, tons
0.01	0	0	0	0.00	0.00	666.00	0.00	0.00	0.00	0.00
3.99	0	0	0	0.00	0.00	666.00	0.00	0.00	0.00	0.00
4.01	0	0	0	0.00	0.00	666.00	0.00	0.00	0.00	0.00
4.99	0	0	0	0.00	0.00	666.00	0.00	0.00	0.00	0.00
5	0	29.82	0	29.82	29.82	666.00	0.00	14.91	14.91	0.00
8.99	6	55.31	4.8	61.31	60.11	666.00	1.20	30.66	30.06	0.60
9.01	6.03	12.32	4.82	18.35	17.14	665.99	1.21	9.18	8.57	0.61
14.99	13.46	12.32	10.77	25.78	23.09	660.01	2.69	12.89	11.55	1.35
15.01	13.5	51.92	10.8	65.42	62.72	659.99	2.70	32.71	31.36	1.35
24.01	37.09	63.18	29.68	100.27	92.86	650.99	7.41	50.14	46.43	3.71
24.99	40.34	63.18	32.27	103.52	95.45	650.01	8.07	51.76	47.73	4.04
25.01	40.4	22.46	32.32	62.86	54.78	649.99	8.08	31.43	27.39	4.04
29.99	57.13	22.46	45.71	79.59	68.17	645.01	11.42	39.80	34.09	5.71
30.01	57.21	22.46	45.77	79.67	68.23	644.99	11.44	39.84	34.12	5.72
39.01	92.68	22.46	74.15	115.14	96.61	635.99	18.53	57.57	48.31	9.27
43.99	114.4	22.46	91.52	136.86	113.98	631.01	22.88	68.43	56.99	11.44
44.01	114.5	77.81	91.6	192.31	169.41	630.99	22.90	96.16	84.71	11.45
49.99	151.51	77.81	121.21	229.32	199.02	625.01	30.30	114.66	99.51	15.15
50.01	151.63	29.05	121.3	180.68	150.35	624.99	30.33	90.34	75.18	15.17
56.99	189.47	29.05	151.58	218.52	180.63	618.01	37.89	109.26	90.32	18.95
57.01	189.59	39.42	151.67	229.01	191.09	617.99	37.92	114.51	95.55	18.96
65.99	246.57	39.42	197.26	285.99	236.68	609.01	49.31	143.00	118.34	24.66
66.01	246.72	75.46	197.37	322.18	272.83	608.99	49.35	161.09	136.42	24.68
69.99	277.91	75.46	222.33	353.37	297.79	605.01	55.58	176.69	148.90	27.79
70.01	278.06	31.45	222.44	309.51	253.89	604.99	55.62	154.76	126.95	27.81
78.99	340.76	31.45	272.61	372.21	304.06	596.01	68.15	186.11	152.03	34.08
79.01	340.93	84.51	272.74	425.44	357.25	595.99	68.19	212.72	178.63	34.10
84.99	396.7	84.51	317.36	481.21	401.87	590.01	79.34	240.61	200.94	39.67

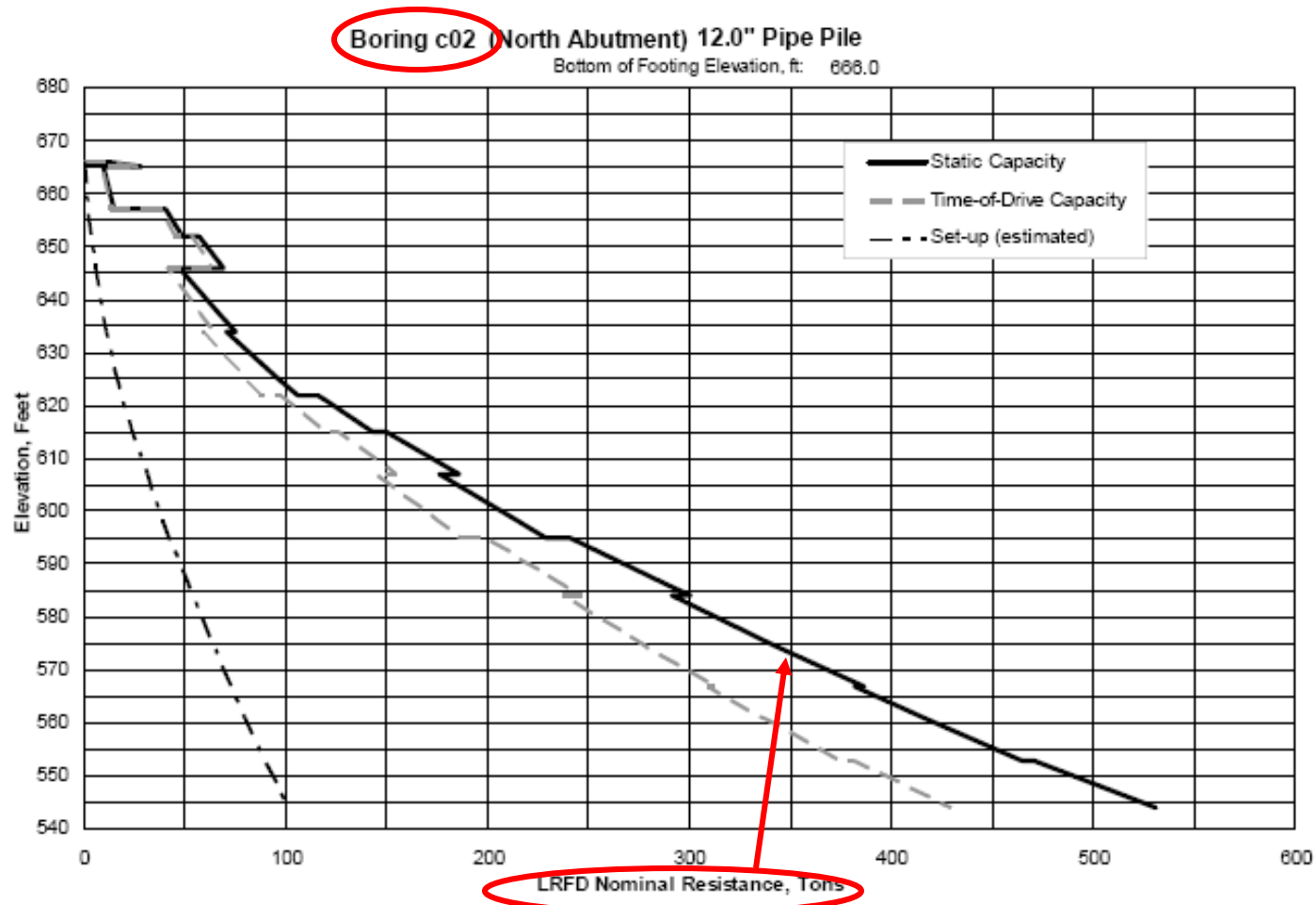
Output from Driven

Data used for Pile Capacity Graph

Pile Capacity Graph Using DRIVEN



Pile Capacity Graph Using Driven



Sample Input Data using LTRC program

Depth	qc User Units	fs User Units
0	0	0
0.18968	4.17816	0
0.26015	1.692	0
0.31888	1.10016	0.0346464
0.37674	3.94056	0.068364
0.44721	5.12424	0.0828792
0.52682	6.5448	0.0848376
0.60513		0.1018584
0.68169	8.67528	0.0868608
0.75869	5.83488	0.0646056
0.83352	5.598	0.0562536
0.90921	4.5324	0.06714
0.98578	3.82248	0.0617904
1.0941	3.34872	0.0708552
1.18328	3.94056	0.0708624
1.26507	3.34872	0.052596
1.34163	3.58632	0.0267048
1.4169	2.52072	0.0191016
1.49259	1.692	0.0198288
1.56785	1.33776	0.0242856
1.64268	0.74592	0.0246888
1.71793	0.74592	0.0277848
1.79667	0.27216	0.0452664
1.87803	0.39024	0.0015624
1.96025	0.864	0.0074016
2.04116	0.62712	0.0237024
2.12208	0.62712	0.072036
2.20212	0.27216	0.17928

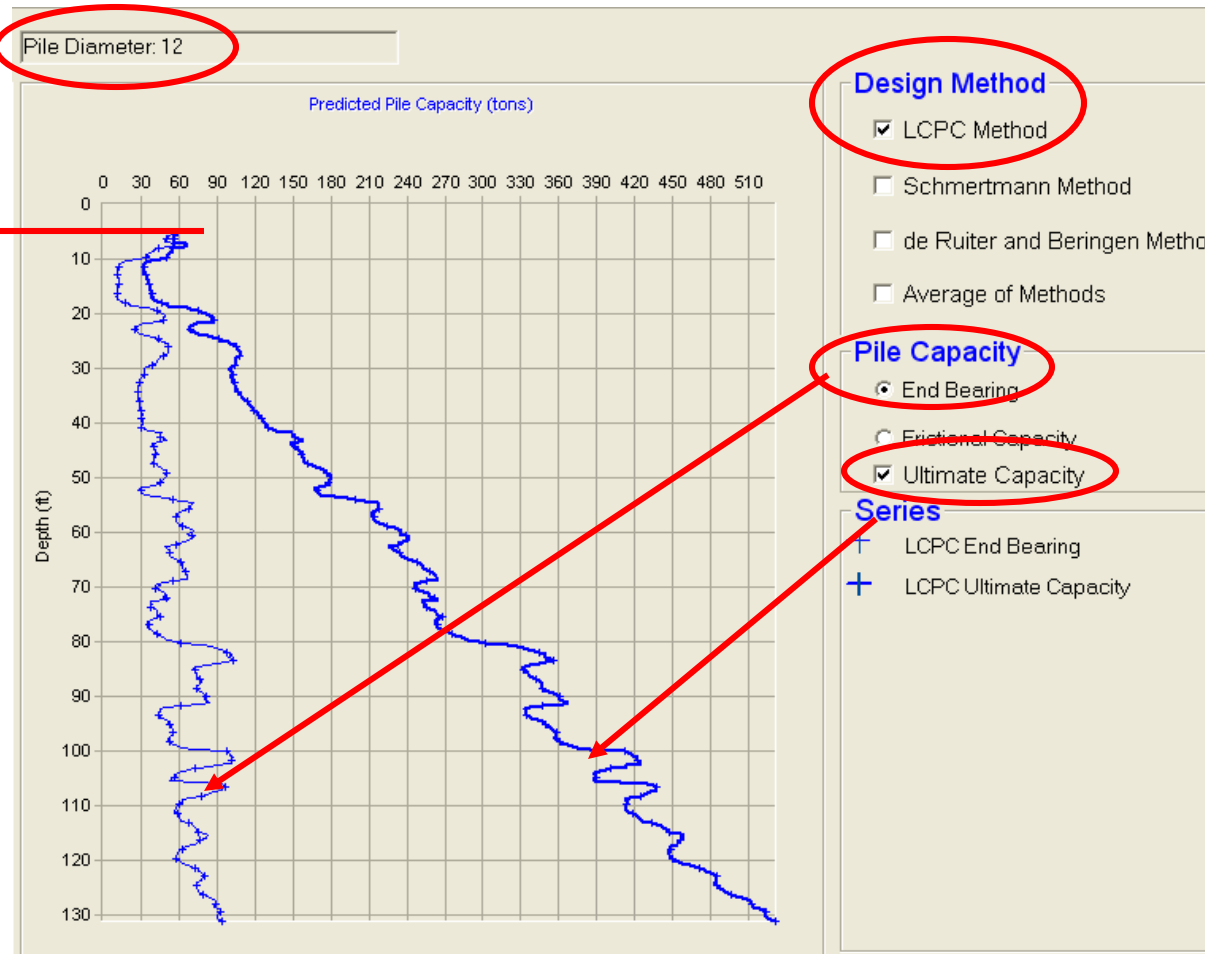
(ft)

Tip Stress (TSF)

Sleeve Friction (TSF)

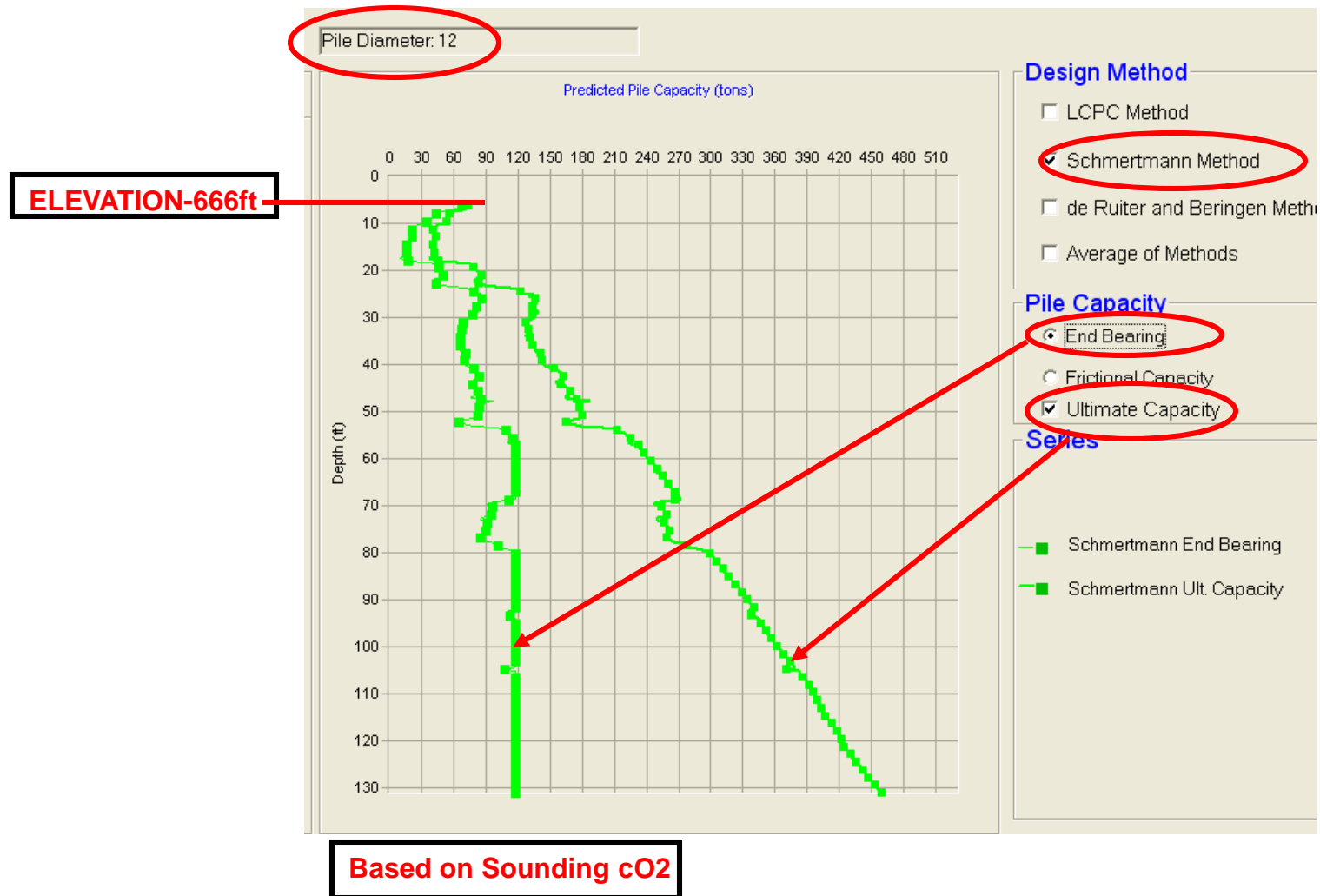
Based on Sounding cO2 (gINT Output)

Pile Capacity Graph using LTRC Program

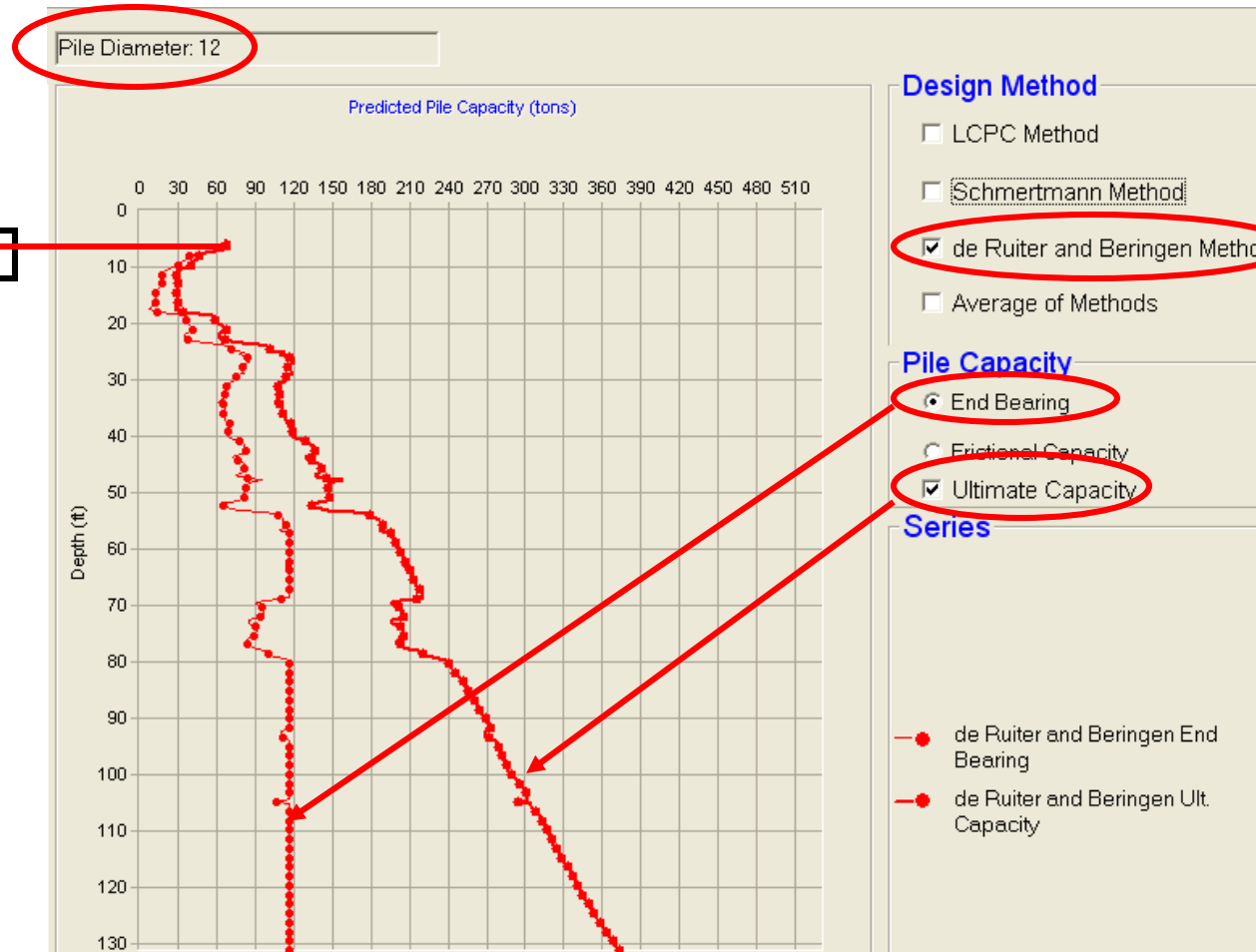


Based on Sounding cO2

Pile Capacity Graph Using LTRC Program



Pile Capacity Graph Using LTRC Program

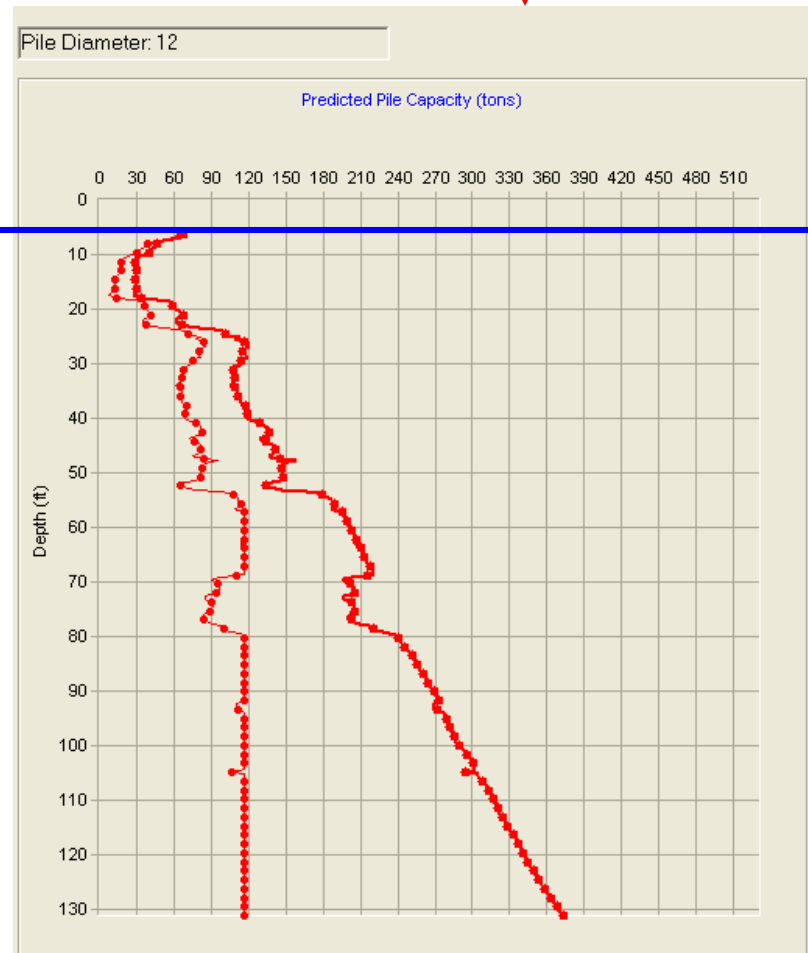
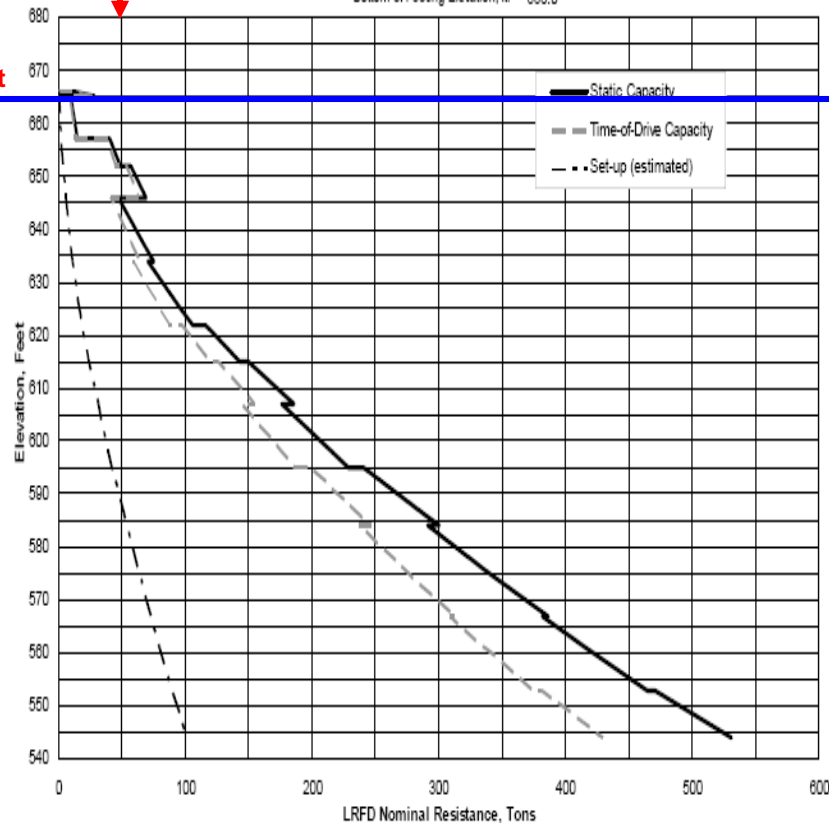


Comparison of Driven & LTRC Program

de Ruiter & Beringen Design Method

DRIVEN

Boring c02 (North Abutment) 12.0" Pipe Pile
Bottom of Footing Elevation, ft: 666.0



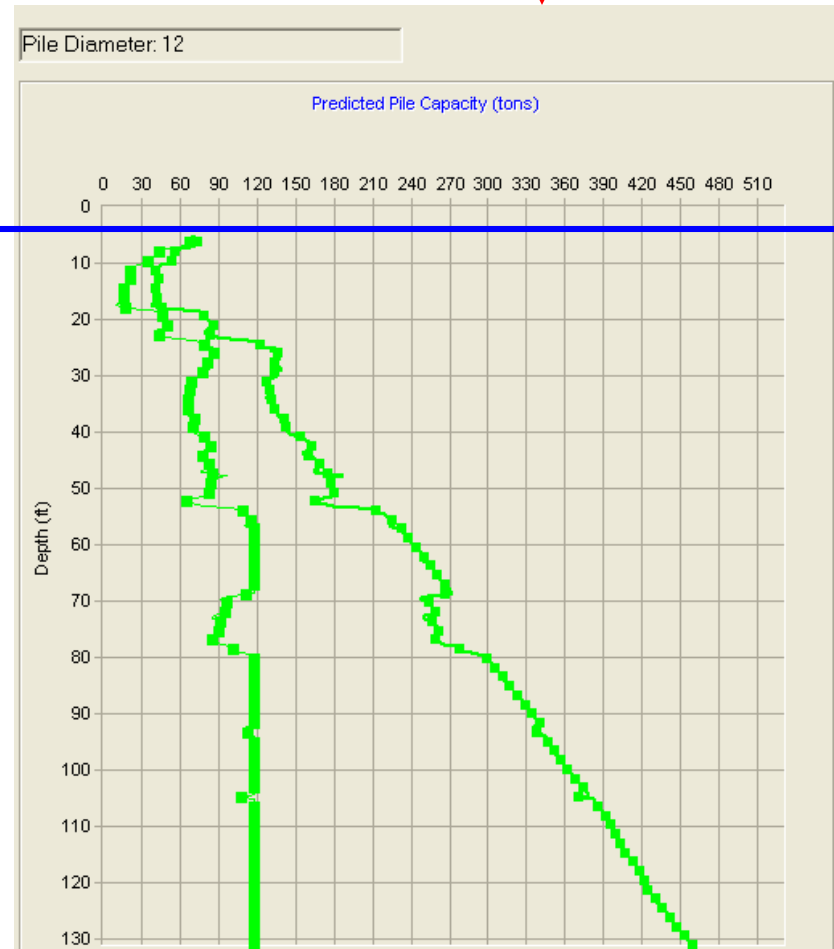
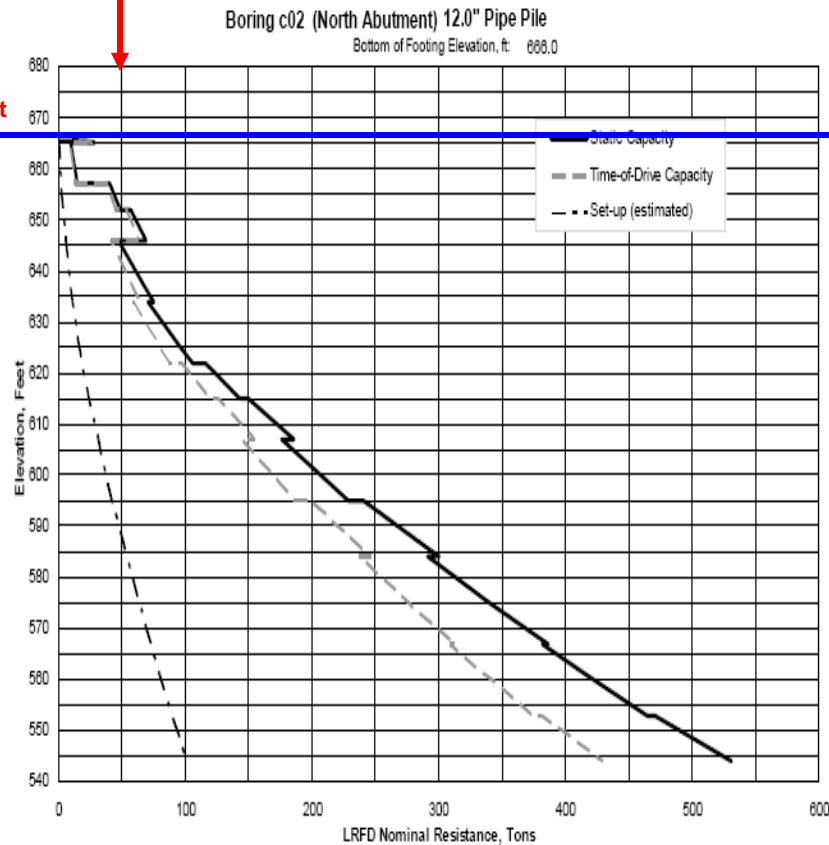
Comparison of Driven & LTRC Program

DRIVEN

Schmertmann Method



ELE - 666ft



Comparison of Driven & LTRC Program

DRIVEN

LCPC Method



Boring c02 (North Abutment) 12.0" Pipe Pile
Bottom of Footing Elevation, ft: 666.0

