Middle Earth Geo Testing, Inc.

www.middleearthgeo.com

Project: **Example CPT report**

Location: **Hayward CA**

CPT: SDF(196)

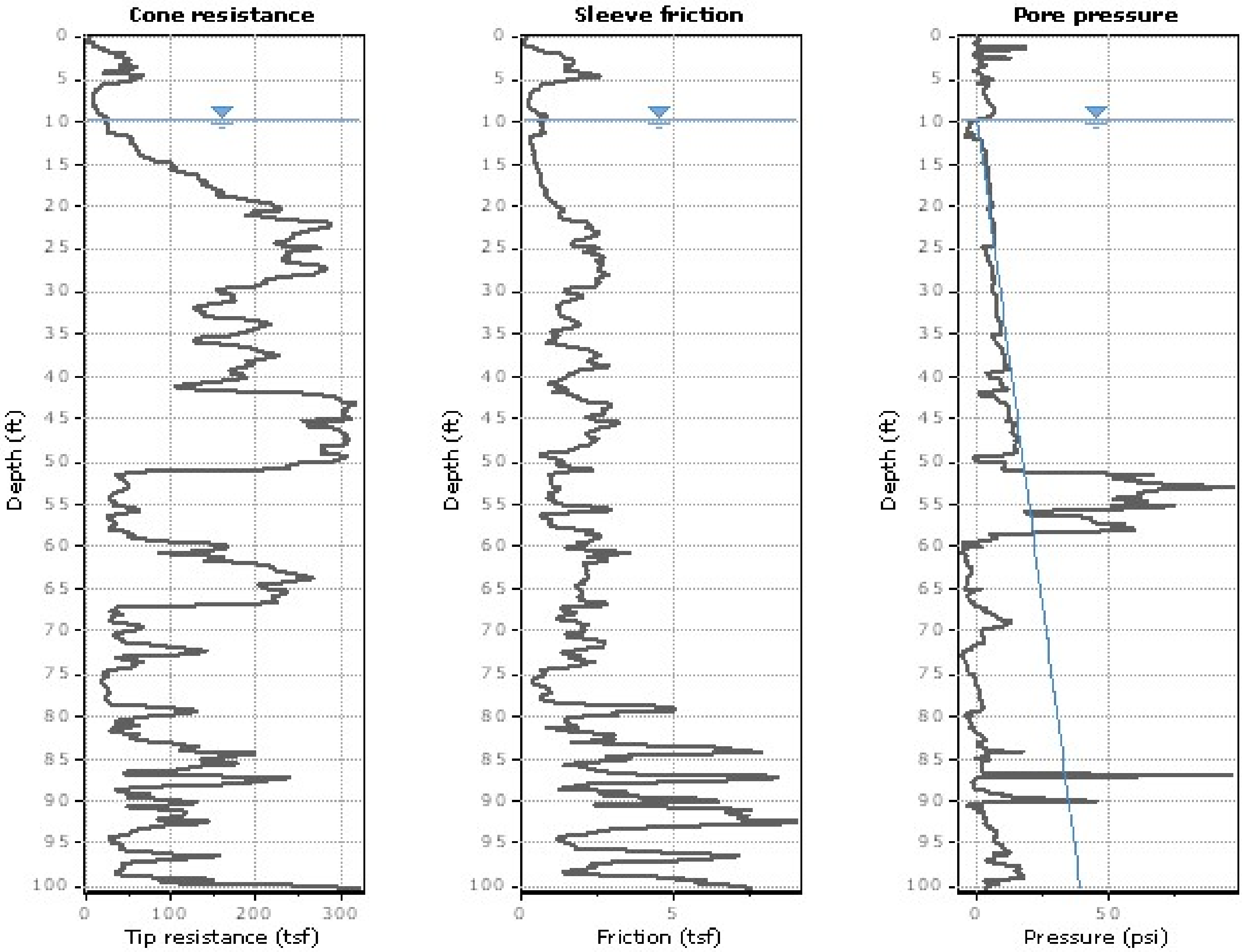
Total depth: 100.23 ft, Date: 7/17/2023

Surface Elevation: 108.00 ft

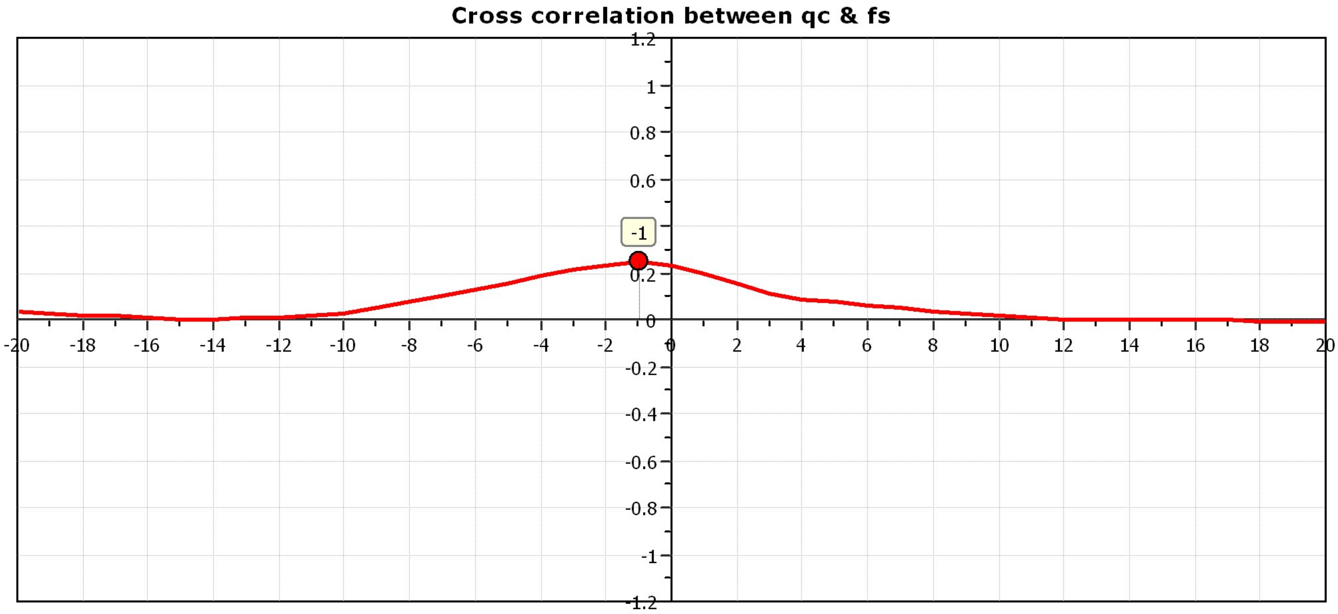
Coords: X:0.00, Y:0.00

Cone Type: 15cm²

Cone Operator: BH-JM



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



Middle Earth Geo Testing, Inc.

www.middleearthgeo.com

CPT: SDF(196)

Total depth: 100.23 ft, Date: 7/17/2023

Surface Elevation: 108.00 ft

Coords: X:0.00, Y:0.00

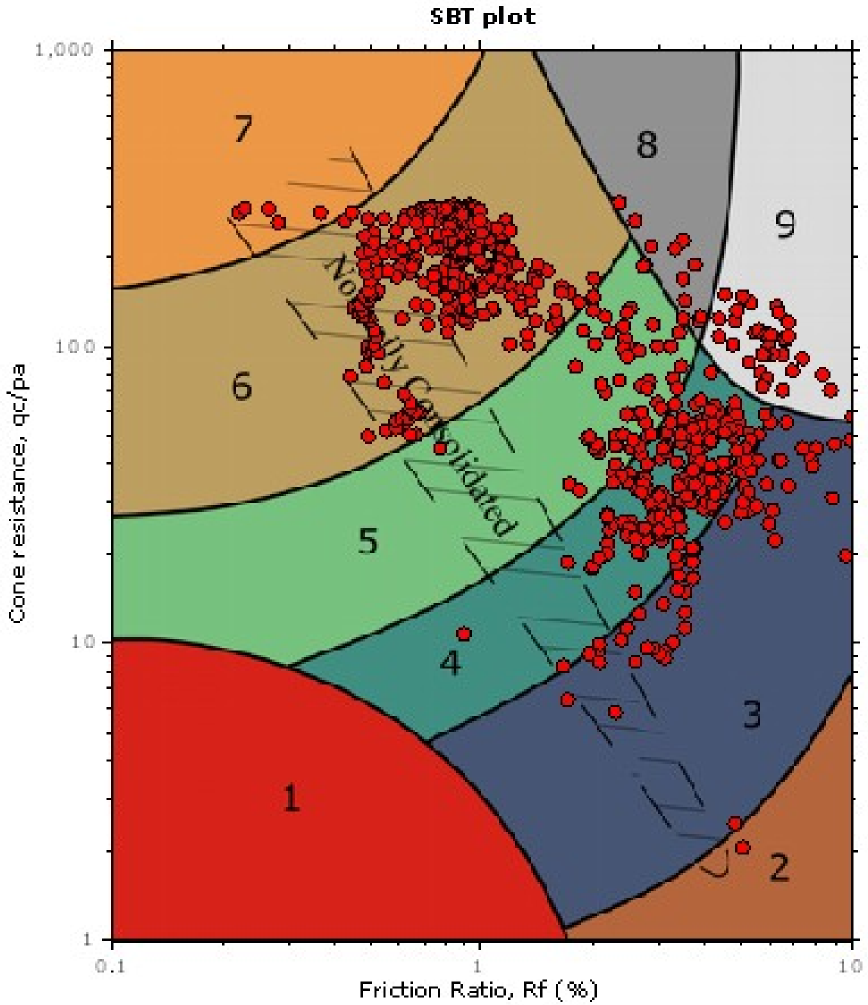
Cone Type: 15cm²

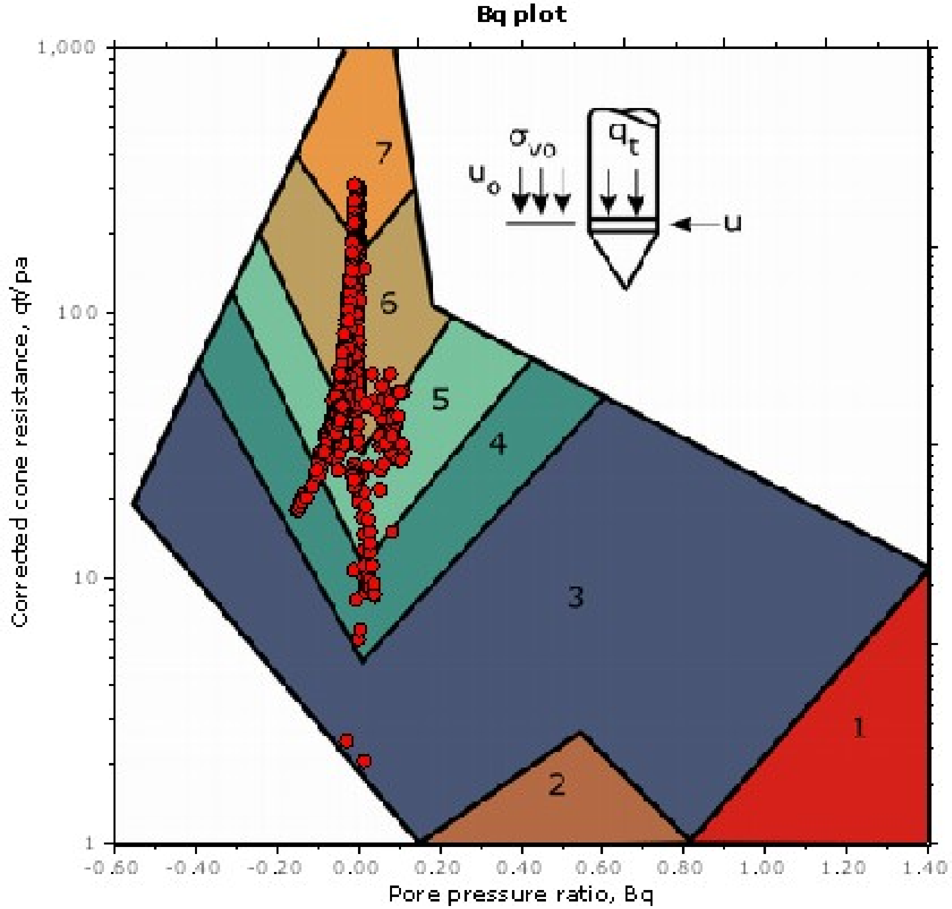
Cone Operator: BH-JM

Project: Example CPT report

Location: Hayward CA

SBT - Bq plots





SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravelly sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

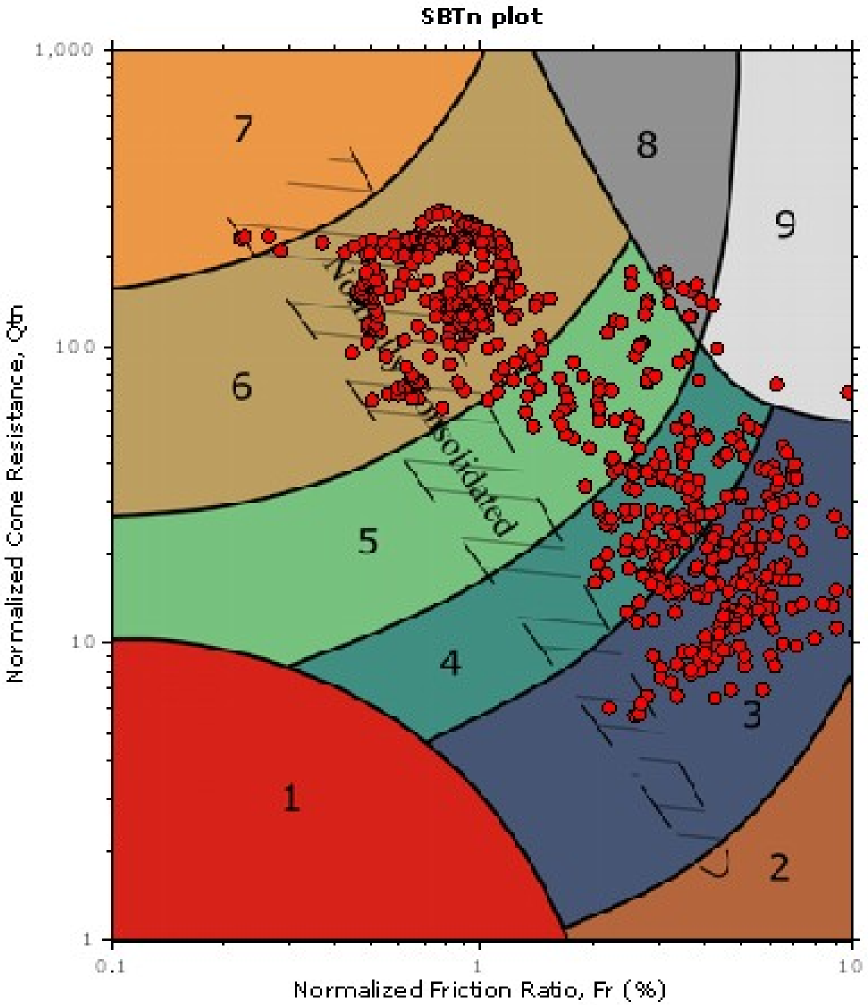
Middle Earth Geo Testing, Inc.

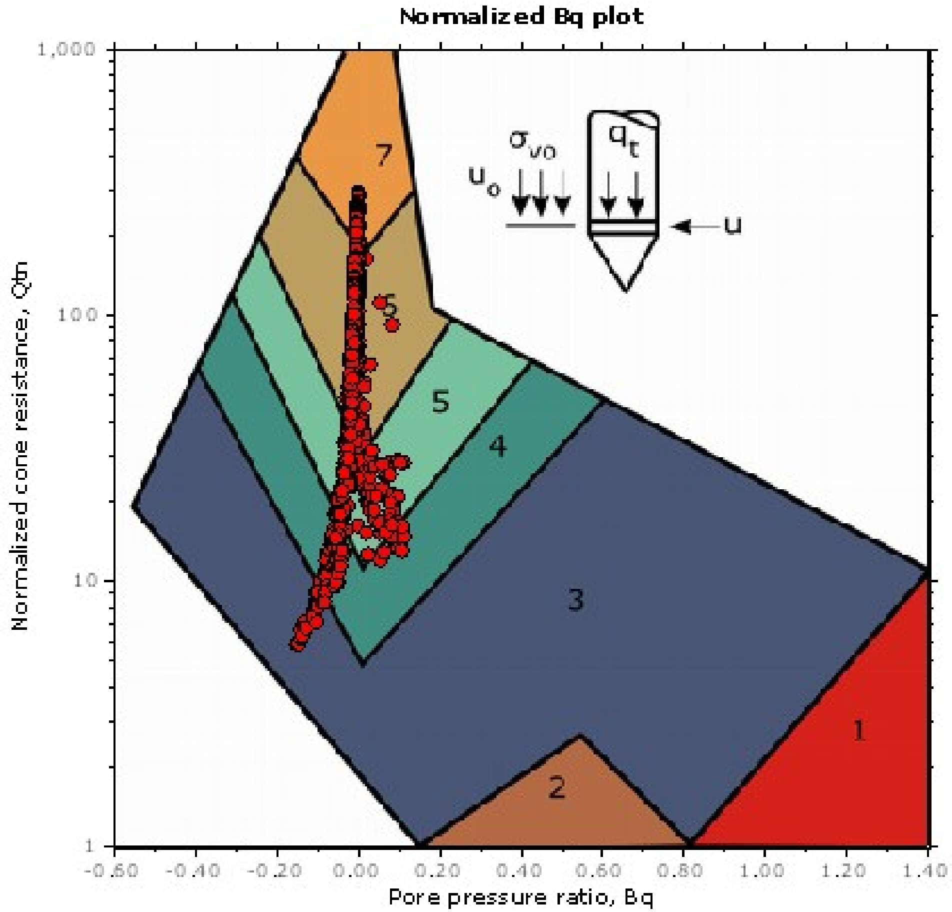
www.middleearthgeo.com

Project: Example CPT report
Location: Hayward CA

CPT: SDF(196)
Total depth: 100.23 ft, Date: 7/17/2023
Surface Elevation: 108.00 ft
Coords: X:0.00, Y:0.00
Cone Type: 15cm²
Cone Operator: BH-JM

SBT - Bq plots (normalized)





SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravelly sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

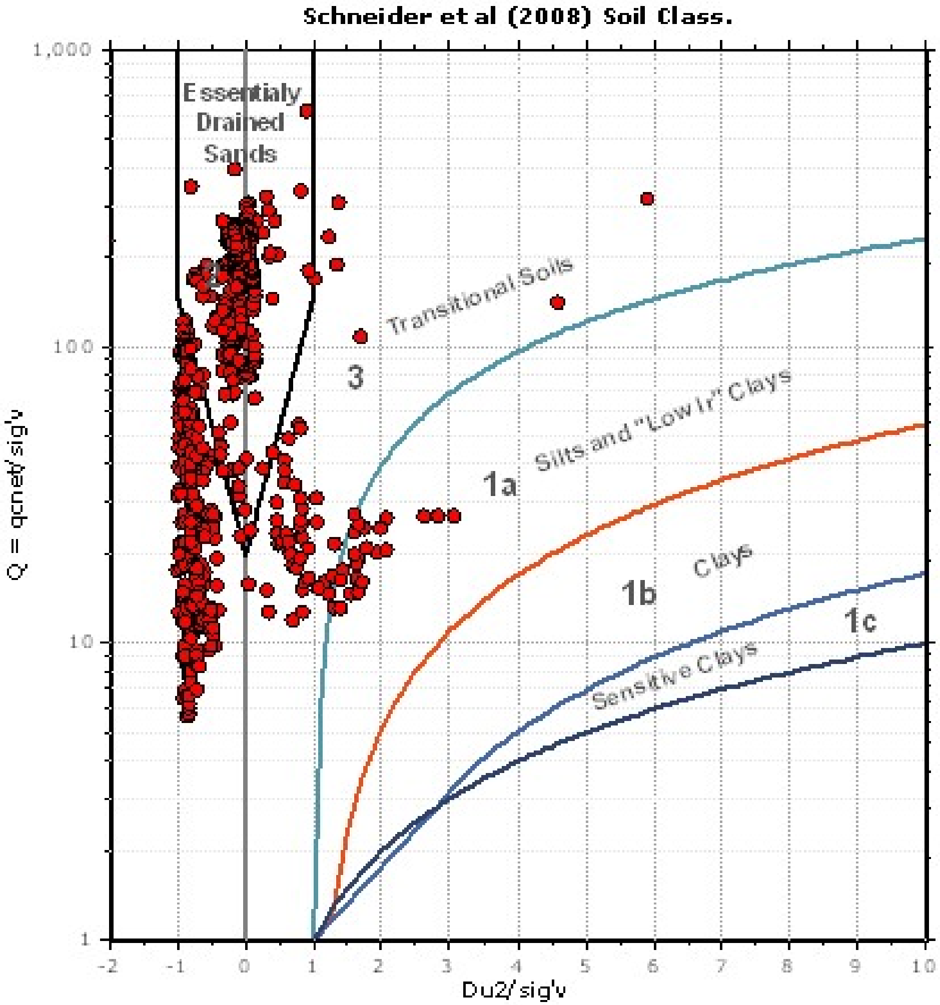
Middle Earth Geo Testing, Inc.

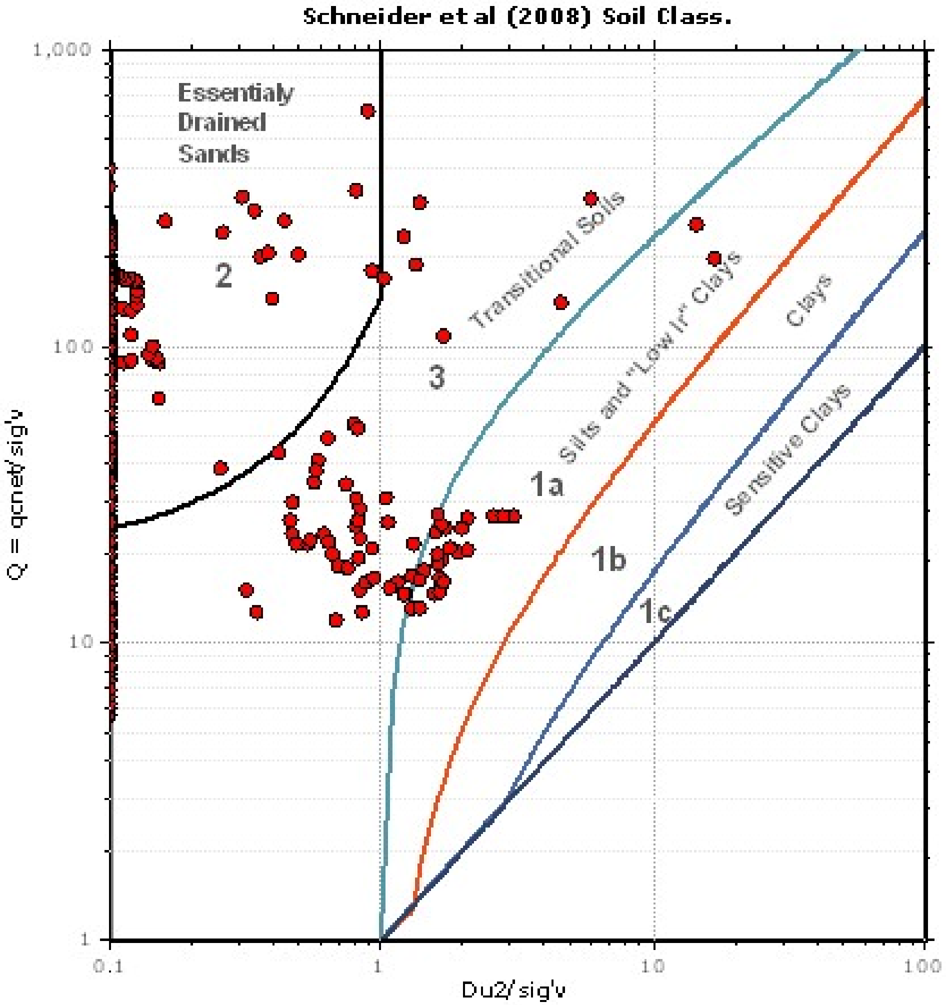
www.middleearthgeo.com

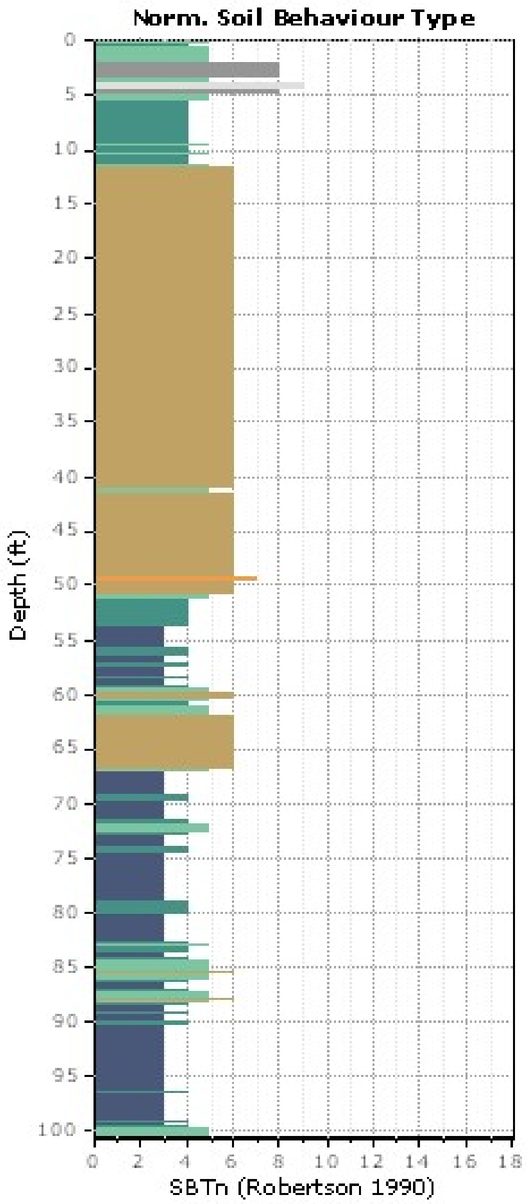
Project: Example CPT report
Location: Hayward CA

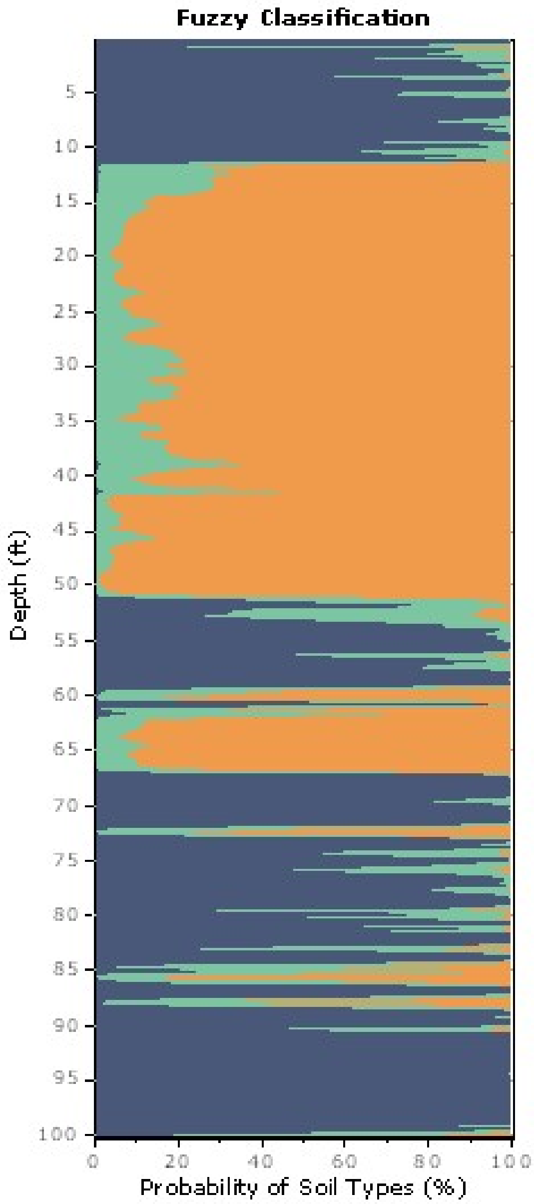
CPT: SDF(196)
Total depth: 100.23 ft, Date: 7/17/2023
Surface Elevation: 108.00 ft
Coords: X:0.00, Y:0.00
Cone Type: 15cm²
Cone Operator: BH-JM

Bq plots (Schneider)






Norm. Soil Behaviour Type
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
0 2 4 6 8 10 12 14 16 18
SBTn (Robertson 1990)


Fuzzy Classification
Depth (ft)
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
0 20 40 60 80 100
Probability of Soil Types (%)

Middle Earth Geo Testing, Inc.

www.middleearthgeo.com

Project: **Example CPT report**

Location: **Hayward CA**

CPT: SDF(196)

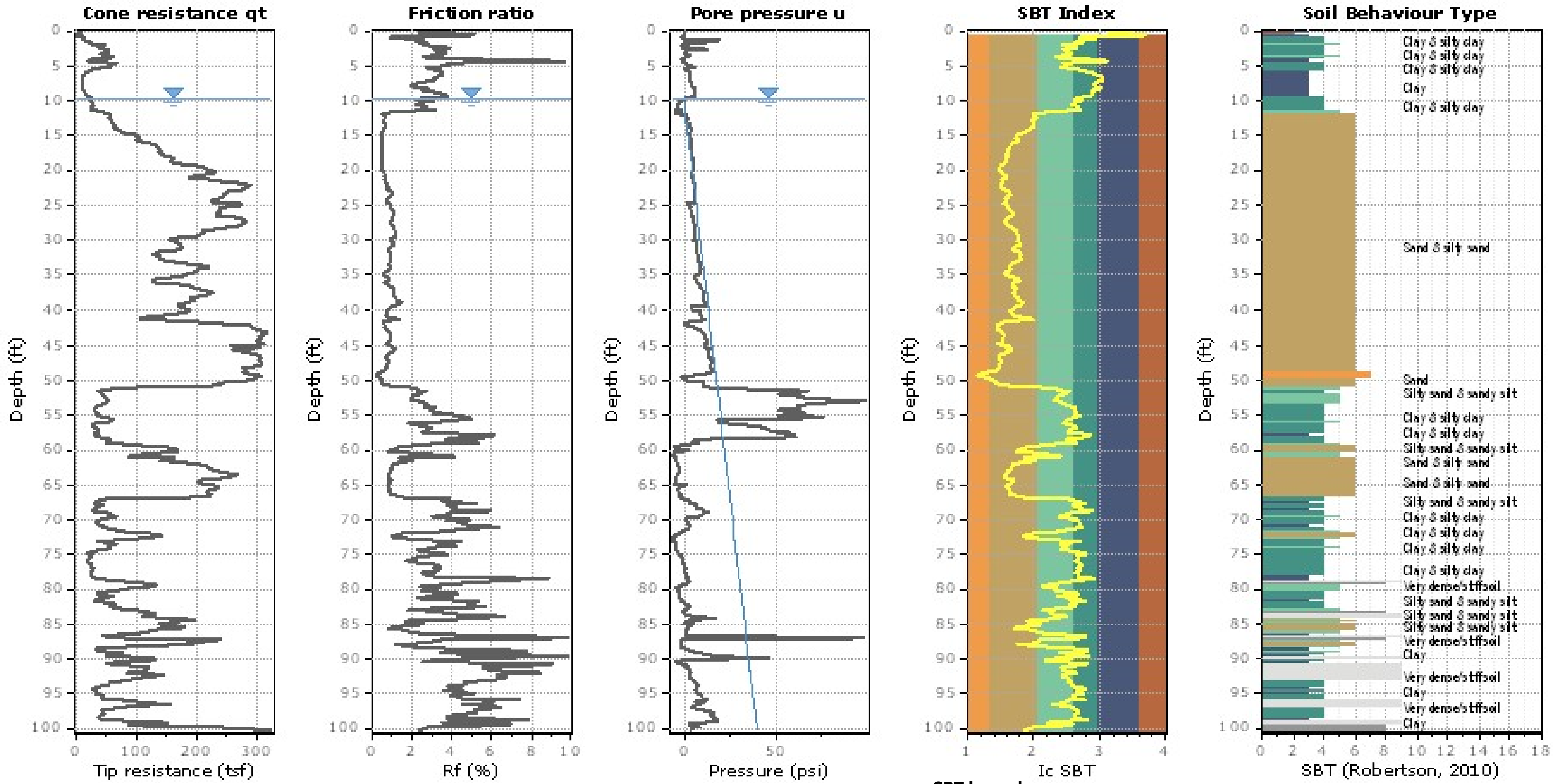
Total depth: 100.23 ft, Date: 7/17/2023

Surface Elevation: 108.00 ft

Coords: X:0.00, Y:0.00

Cone Type: 15cm²

Cone Operator: BH-JM



SBT legend

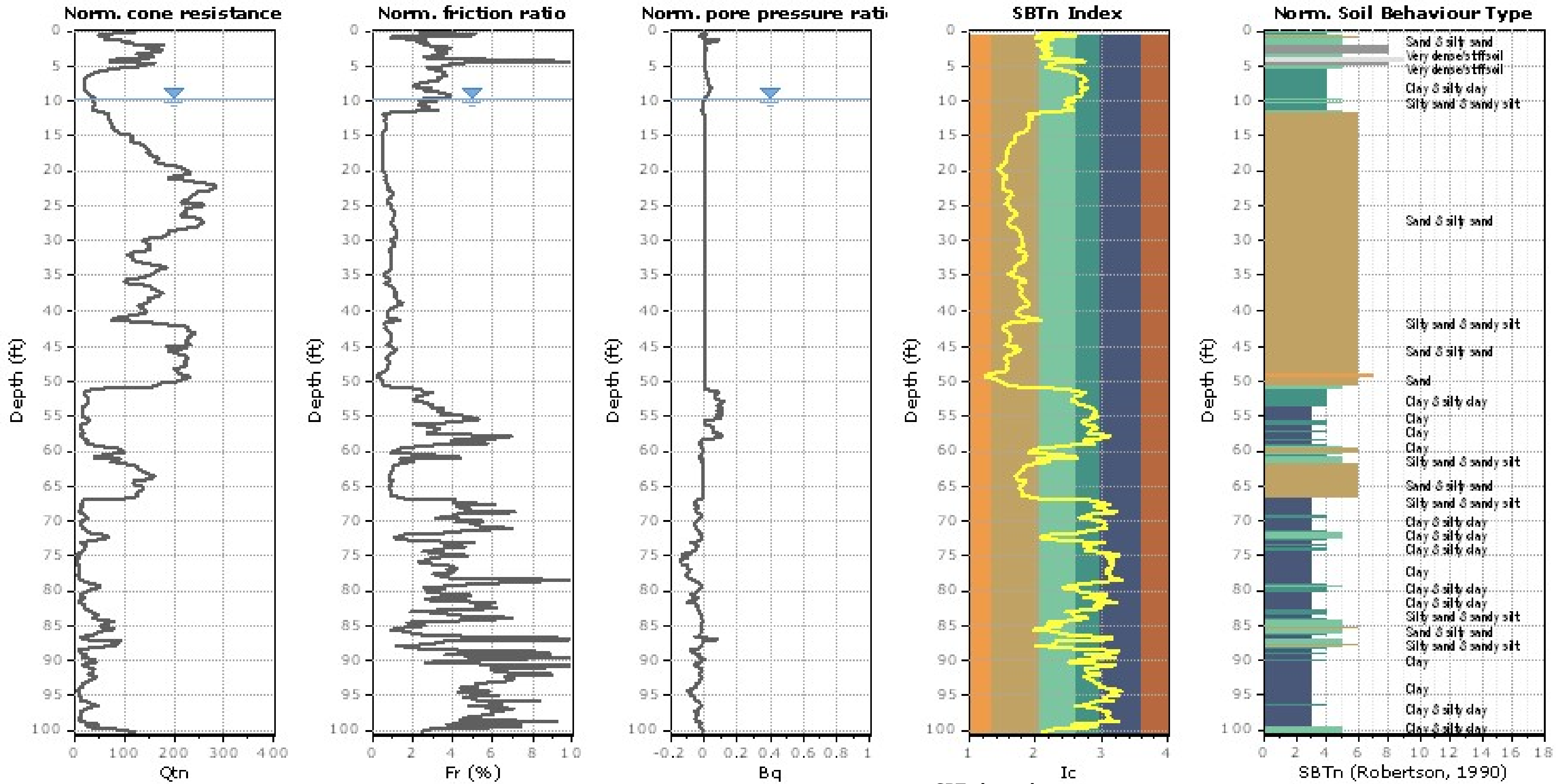
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Middle Earth Geo Testing, Inc.

www.middleearthgeo.com

Project: **Example CPT report**
Location: **Hayward CA**

CPT: SDF(196)
Total depth: 100.23 ft, Date: 7/17/2023
Surface Elevation: 108.00 ft
Coords: X:0.00, Y:0.00
Cone Type: 15cm²
Cone Operator: BH-JM



SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

Middle Earth Geo Testing, Inc.

www.middleearthgeo.com

Project: **Example CPT report**

Location: **Hayward CA**

CPT: SDF(196)

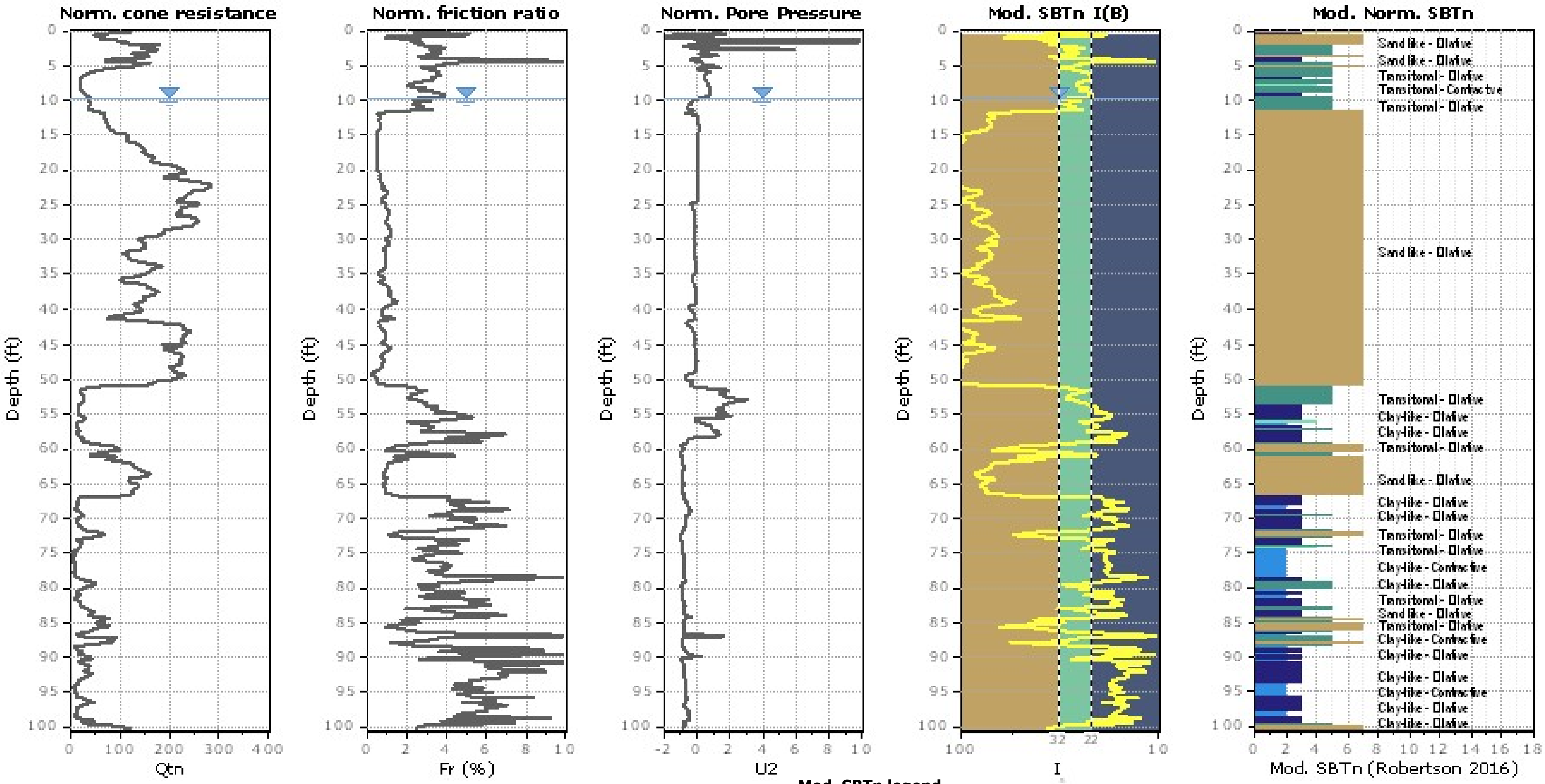
Total depth: 100.23 ft, Date: 7/17/2023

Surface Elevation: 108.00 ft

Coords: X:0.00, Y:0.00

Cone Type: 15cm²

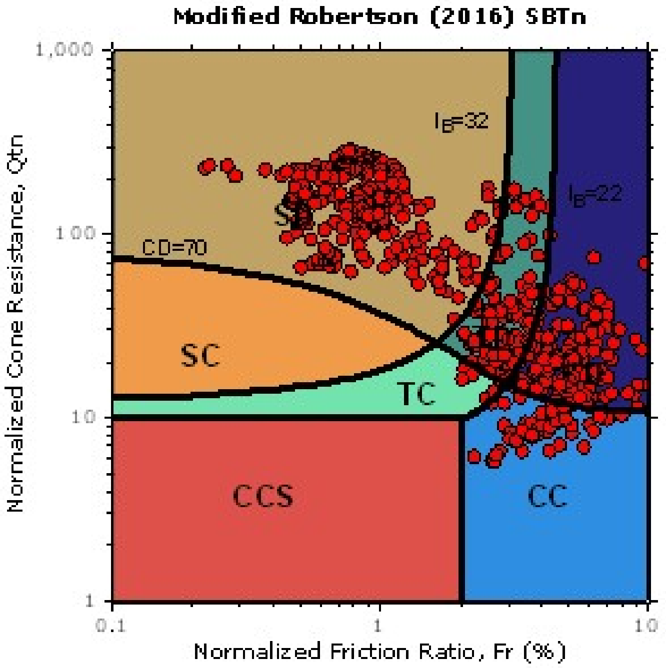
Cone Operator: BH-JM

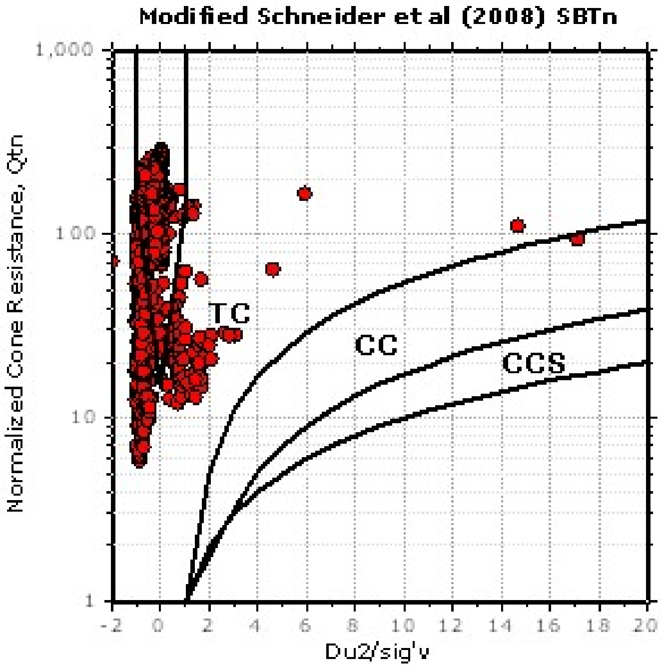


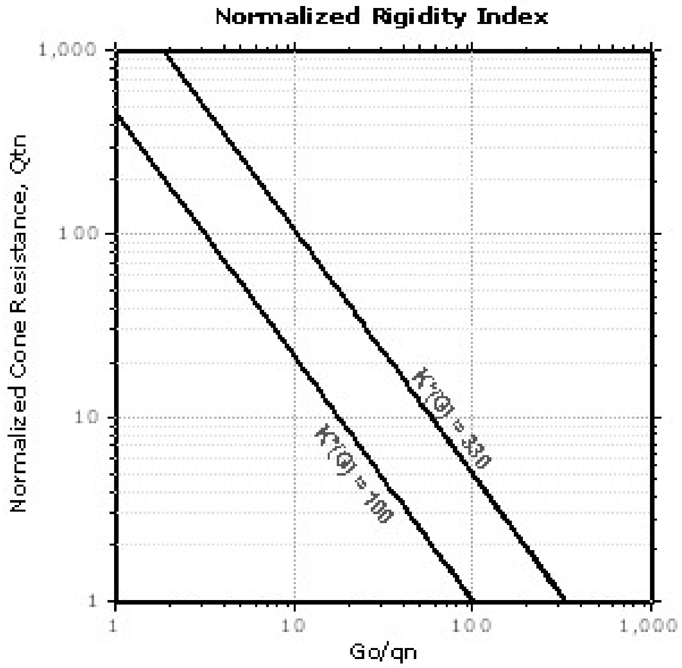
Mod. SBTn legend

1. CCS: ClayLike - Contractive, Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-Like: Dilative
4. TC: Transitional - Contractive
5. TD: Transitional - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

Middle Earth Geo Testing, Inc.

www.middleearthgeo.com

Project: **Example CPT report**

Location: **Hayward CA**

CPT: SDF(196)

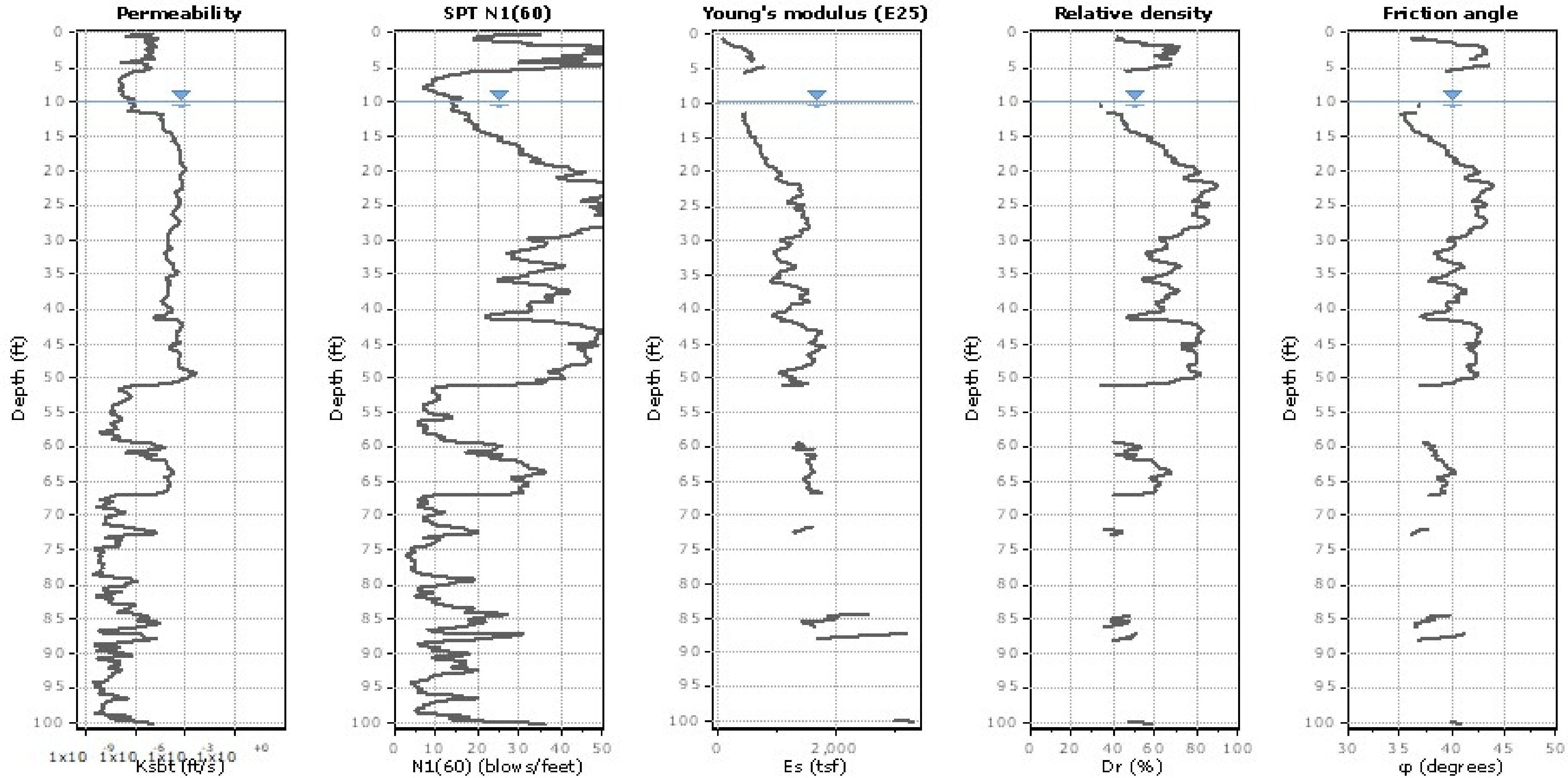
Total depth: 100.23 ft, Date: 7/17/2023

Surface Elevation: 108.00 ft

Coords: X:0.00, Y:0.00

Cone Type: 15cm²

Cone Operator: BH-JM



Calculation parameters

Permeability: Based on SBT_n

SPT N_{60}: Based on I_c and q_t

Young's modulus: Based on variable alpha using I_c (Robertson, 2009)

Relative density constant, C_{Dr}: 350.0

Phi: Based on Kulhawy & Mayne (1990)

User defined estimation data

Middle Earth Geo Testing, Inc.

www.middleearthgeo.com

CPT: SDF(196)

Total depth: 100.23 ft, Date: 7/17/2023

Surface Elevation: 108.00 ft

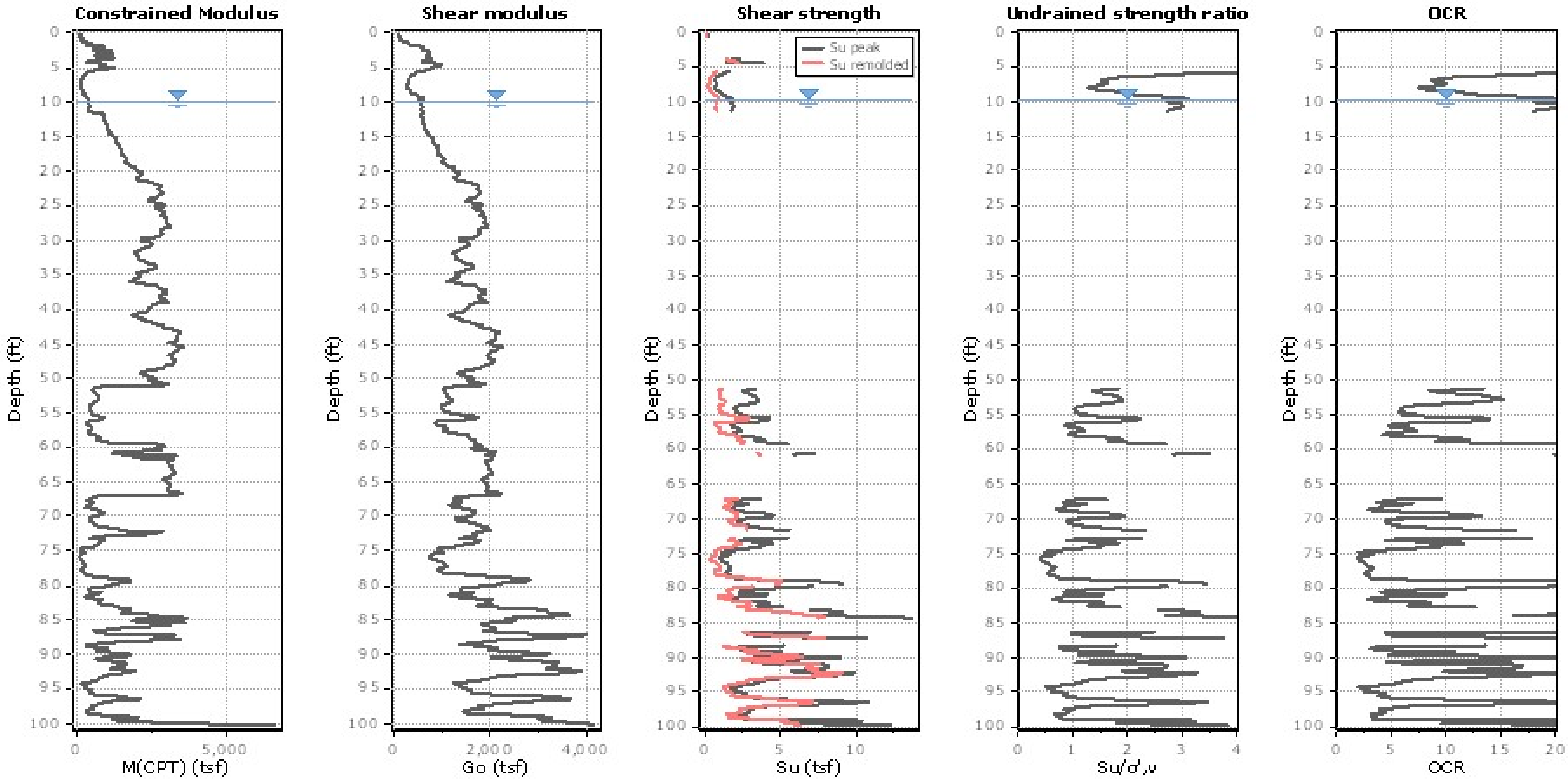
Coords: X:0.00, Y:0.00

Cone Type: 15cm²

Cone Operator: BH-JM

Project: **Example CPT report**

Location: **Hayward CA**



Calculation parameters

Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)

Go: Based on variable alpha using I_c (Robertson, 2009)

Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: Auto

User defined estimation data

Flat Dilatometer Test data

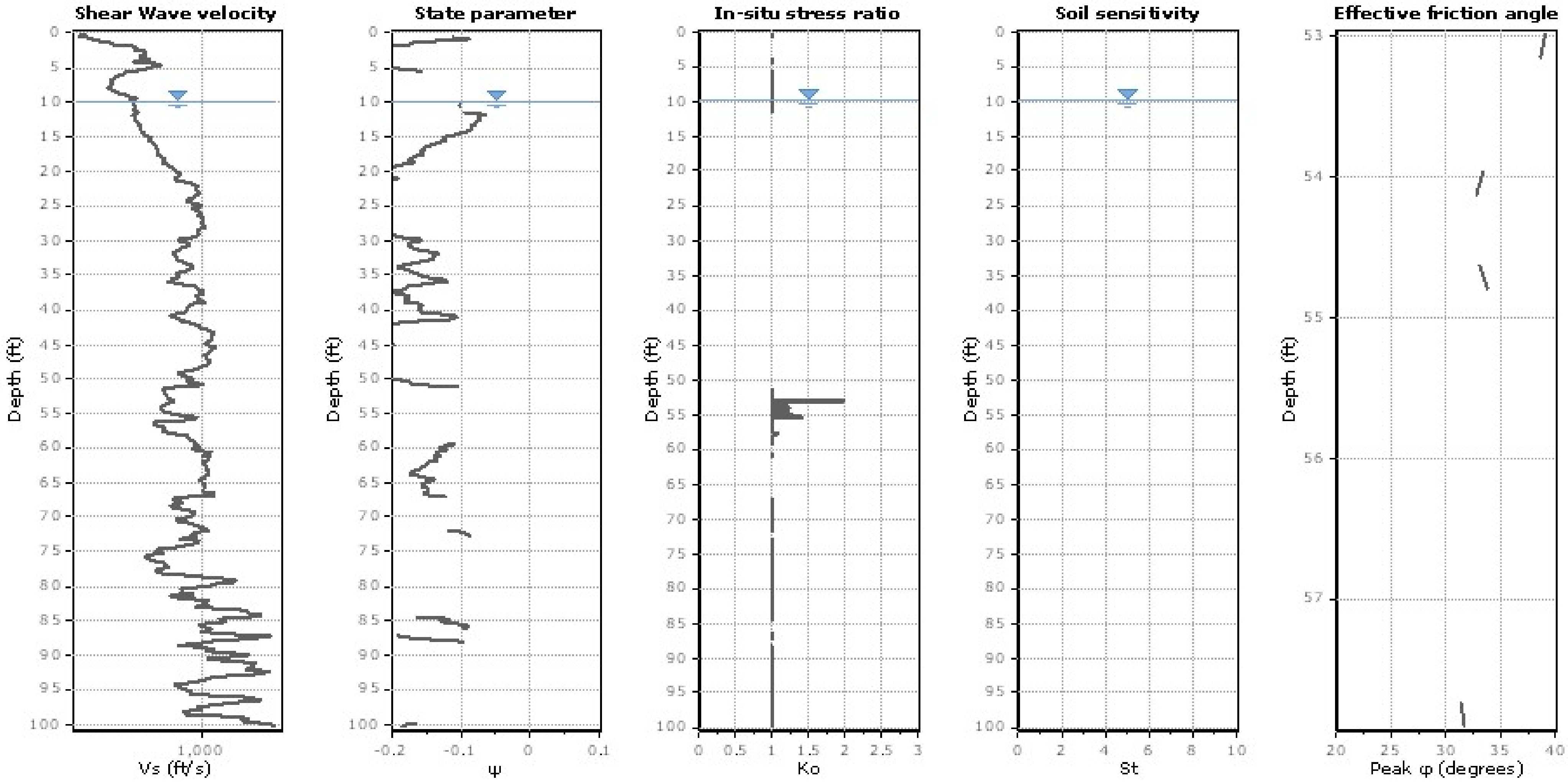
![Middle Earth Geo Testing Inc. logo]

Middle Earth Geo Testing, Inc.

www.middleearthgeo.com

CPT: SDF(196)
Total depth: 100.23 ft, Date: 7/17/2023
Surface Elevation: 108.00 ft
Coords: X:0.00, Y:0.00
Cone Type: 15cm²
Cone Operator: BH-JM

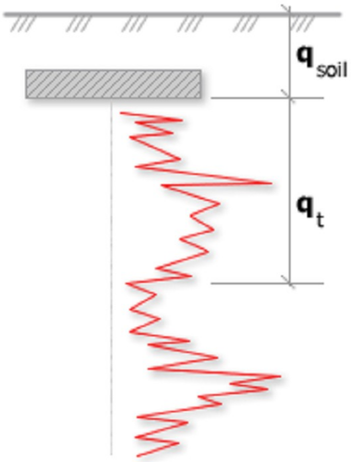
Project: **Example CPT report**
Location: **Hayward CA**



Calculation parameters

Soil Sensitivity factor, N_S: 350.00

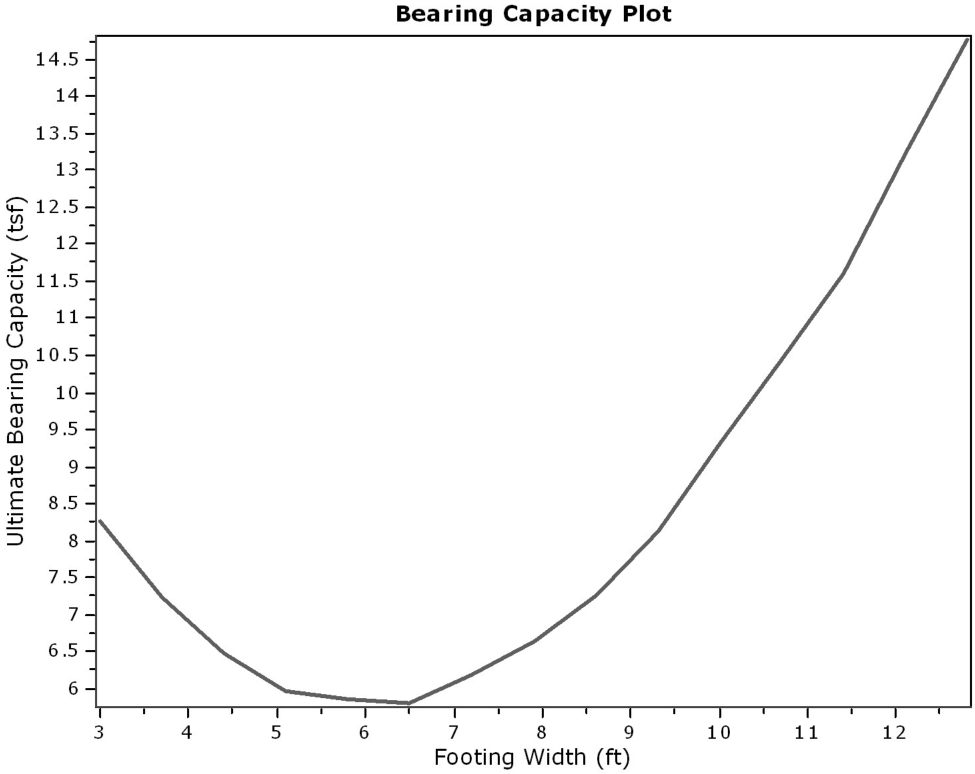
User defined estimation data



Bearing Capacity calculation is perfromed based on the formula:

$$Q_{ult} = R_k \times q_t + q_{soil}$$

where:
R_k: Bearing capacity factor
q_t: Average corrected cone resistance over calculation depth
q_{soil}: Pressure applied by soil above footing



:: Tabular results ::

No	B (ft)	Start Depth (ft)	End Depth (ft)	Ave. q_t (tsf)	R_k	Soil Press. (tsf)	Ult. bearing cap. (tsf)
1	3.00	1.60	6.10	40.80	0.20	0.10	8.26
2	3.70	1.60	7.15	35.65	0.20	0.10	7.23
3	4.40	1.60	8.20	31.88	0.20	0.10	6.47
4	5.10	1.60	9.25	29.36	0.20	0.10	5.97
5	5.80	1.60	10.30	28.80	0.20	0.10	5.86
6	6.50	1.60	11.35	28.51	0.20	0.10	5.80
7	7.20	1.60	12.40	30.46	0.20	0.10	6.19
8	7.90	1.60	13.45	32.76	0.20	0.10	6.65
9	8.60	1.60	14.50	35.84	0.20	0.10	7.26
10	9.30	1.60	15.55	40.15	0.20	0.10	8.13
11	10.00	1.60	16.60	46.09	0.20	0.10	9.31
12	10.70	1.60	17.65	51.68	0.20	0.10	10.43
13	11.40	1.60	18.70	57.57	0.20	0.10	11.61
14	12.10	1.60	19.75	65.64	0.20	0.10	13.22
15	12.80	1.60	20.80	73.36	0.20	0.10	14.77

Presented below is a list of formulas used for the estimation of various soil properties. The formulas are presented in SI unit system and assume that all components are expressed in the same units.

:: Unit Weight, g (kN/m³) ::

$$g = g_w \cdot \left(0.27 \cdot \log(R_f) + 0.36 \cdot \log(\frac{q_t}{p_a}) + 1.236\right)$$

where g_w = water unit weight

:: Permeability, k (m/s) ::

$I_c < 3.27$ and $I_c > 1.00$ then $k = 10^{0.952-3.04 \cdot I_c}$

$I_c \leq 4.00$ and $I_c > 3.27$ then $k = 10^{-4.52-1.37 \cdot I_c}$

:: N_{SPT} (blows per 30 cm) ::

$$N_{60} = \left(\frac{q_c}{P_a}\right) \cdot \frac{1}{10^{1.1268-0.2817 \cdot I_c}}$$

$$N_{1(60)} = Q_{tn} \cdot \frac{1}{10^{1.1268-0.2817 \cdot I_c}}$$

:: Young's Modulus, Es (MPa) ::

$$(q_t - \sigma_v) \cdot 0.015 \cdot 10^{0.55 \cdot I_c + 1.68}$$

(applicable only to $I_c < I_{c\_cutoff}$)

:: Relative Density, Dr (%) ::

$$100 \cdot \sqrt{\frac{Q_{tn}}{k_{DR}}}$$

(applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

:: State Parameter, ψ ::

$$\psi = 0.56 - 0.33 \cdot \log(Q_{tn,cs})$$

:: Drained Friction Angle, φ (°) ::

[illegible]

(applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

:: 1-D constrained modulus, M (MPa) ::

If $I_c > 2.20$
$\alpha = 14$ for $Q_{tn} > 14$
$\alpha = Q_{tn}$ for $Q_{tn} \leq 14$
$M_{CPT} = \alpha \cdot (q_t - \sigma_v)$

If $I_c \geq 2.20$
[illegible]

:: Small strain shear Modulus, Go (MPa) ::

$$G_0 = (q_t - \sigma_v) \cdot 0.0188 \cdot 10^{0.55 \cdot I_c + 1.68}$$

:: Shear Wave Velocity, Vs (m/s) ::

$$V_s = \left(\frac{G_0}{\rho}\right)^{0.50}$$

:: Undrained peak shear strength, Su (kPa) ::

$N_{kt} = 10.50 + 7 \cdot \log(F_r)$ or user defined

$$S_u = \frac{(q_t - \sigma_v)}{N_{kt}}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Remolded undrained shear strength, Su(rem) (kPa) ::

$S_{u(rem)} = f_s$ (applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Overconsolidation Ratio, OCR ::

$$k_{OCR} = \left[\frac{Q_{tn}^{0.20}}{0.25 \cdot (10.50 \cdot + 7 \cdot \log(F_r))}\right]^{1.25}$$ or user defined

$$OCR = k_{OCR} \cdot Q_{tn}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: In situ Stress Ratio, Ko ::

$$K_O = (1 - \sin\varphi') \cdot OCR^{\sin\varphi'}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Soil Sensitivity, S_t ::

$$S_t = \frac{N_S}{F_r}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Peak Friction Angle, φ' (°) ::

$$\varphi' = 29.5° \cdot B_q^{0.121} \cdot (0.256 + 0.336 \cdot B_q + \log Q_t)$$

(applicable for $0.10 < B_q < 1.00$)

References

• Robertson, P.K., Cabal K.L., Guide to Cone Penetration Testing for Geotechnical Engineering, Gregg Drilling & Testing, Inc., 5th Edition, November 2012

• Robertson, P.K., Interpretation of Cone Penetration Tests - a unified approach., Can. Geotech. J. 46(11): 1337–1355 (2009)