MILLER PACIFIC ENGINEERING GROUP

November 10, 2017
File: 1911.037altr.doc

Alameda Unified School District
2060 Challenger Drive
Alameda, California 94501

Attention: Chad Pimentel, Legal Counsel for AUSD

Re: Geotechnical Engineering Investigation
Evaluation of Liquefaction Risk and Liquefaction Induced Settlement Potential
Lincoln Middle School Campus
1250 Fernside Boulevard
Alameda, California

Introduction

This letter summarizes our geotechnical investigation of the Lincoln Middle School Campus located at 1250 Fernside Boulevard in Alameda, California. The approximate site location is presented on Figure 1, Site Location Map. The purpose of our geotechnical investigation is to evaluate the site soil and groundwater conditions and to assess the liquefaction risk and liquefaction induced settlement and lateral spreading potential across the school campus. Our scope includes exploring the subsurface conditions with six Cone Penetration Tests (CPTs), evaluating soil and laboratory data collected by Kaldveer Associates in 1990, including six boring logs (attached in Appendix B), conducting engineering analyses to evaluate the liquefaction risk and liquefaction induced settlement and lateral spreading potential, and presentation of our geotechnical conclusions in this letter report.

Site Description

The Lincoln Middle School campus is located on the southeasterly side of Fernside Boulevard, adjacent to San Leandro Bay, as shown on the Site Location Map, Figure 1. The existing campus consists of numerous permanent and portable buildings, paved driveways, parking areas, and play areas, and landscaping improvements, as shown on the Site Plan, Figure 2. The ground surface at the project site and the surrounding area is characterized by nearly level to gently sloping terrain. The margin of San Leandro Bay, located southeast of the campus, is at an elevation of approximately 12 to 15 feet lower than the main campus area.

Regional Geology

The site is located within the Coast Range Geomorphic Province of California. The regional bedrock geology consists of complexly folded, faulted, sheared, and altered sedimentary, igneous, and metamorphic rock of the Franciscan Complex. Bedrock is characterized by a diverse assemblage of greenstone, sandstone, shale, chert, and melange, with lesser amounts of conglomerate, calc-silicate rock, schist and other metamorphic rocks.

The regional topography is characterized by northwest-southeast trending mountain ridges and intervening valleys that were formed by movement between the North American and the Pacific

Plates. Continued deformation and erosion during the late Tertiary and Quaternary Age (the last several million years) formed the prominent coastal ridges and the inland depression that is now the San Francisco Bay. The more recent seismic activity within the Coast Range Geomorphic Province is concentrated along the San Andreas Fault zone, a complex group of generally north to northwest trending faults.

Geologic mapping[1] indicates the site is located in an area underlain by artificial fill, as shown on Figure 3. These artificial (manmade) fills were placed over soft clay (Bay Mud) and native sandy, silty, and clayey alluvial deposits.

Surface Conditions

The site is currently developed as a middle school campus. The attached Site Plan, Figure 2, shows the locations of existing buildings, driveways, and play areas. Most of the ground surface immediately around the existing buildings consists of asphalt paved surfaces.

Seismicity

The San Francisco Bay Region is located in a seismically active area and the proposed improvements will therefore experience the effects of future earthquakes. Such earthquakes could occur on any of several active faults within the region. These faults are shown on the Active Fault Map, Figure 4.

Subsurface Exploration and Laboratory Testing

We explored the subsurface soil and groundwater conditions with six Cone Penetration Tests (CPTs) at the approximate locations shown on the Site Plan, Figure 2. The CPTs were conducted with truck-mounted equipment on April 22, 2017. The CPTs were extended to depths of 43 feet to 70 feet below the ground surface. A schematic of the CPT apparatus is provided on Figure A-1 and a CPT Soil Interpretation Chart is provided on Figure A-2. CPT logs are shown on Figures A-3 through A-8.

We reviewed geotechnical data for Lincoln Middle School included in a report prepared by Kaldveer Associates dated May 17, 1990. Six exploratory borings were drilled using rotary wash and continuous flight auger equipment as a part of the 1990 Kaldveer Associates study. The Kaldveer boring logs are included in the attached Appendix B.

Subsurface Conditions

The subsurface conditions are consistent with the mapped geology. Review of subsurface data collected from the CPTs and Kaldveer borings conducted at the site indicate that the campus is generally underlain by approximately six to fourteen feet of fill. The fill generally consists of loose to medium-dense silty to clayey sands interbedded with layers of soft to stiff silty clays. The fills are heterogeneous in material types and properties, with isolated layers of loose sands and soft clays. Based on the available subsurface data, it appears that any potentially liquefiable layers within the manmade fills would be isolated, and not continuous layers

[1] Graymer, R. W., "Geologic Map and Map Database of the Oakland Metropolitan Area, Alameda, Contra Costa, and San Francisco Counties, California", 2000, USGS, MF-2342 Version 1.0., Scale 1:50,000.

extending beneath large areas of the campus. Beneath the fill is a relatively thin layer of soft clay and organic material, interpreted as Bay Mud or similar marsh deposits, which extends to a depth of approximately twenty to twenty five feet beneath the ground surface. Beneath the soft clay, each CPT encountered predominantly medium-dense to dense silty sand, sandy silt, and sandy clay extending to a depth of 50 feet or more.

Groundwater was measured at approximately four to nine feet below the ground surface during our CPT investigation (2017) and eight to twelve feet at the time of the Kaldveer borings (1990). It is anticipated that the groundwater level beneath the site is influenced by tidal activity in the nearby San Francisco Bay.

Liquefaction Risk and Liquefaction Induced Settlement Potential

The project site lies within a California Seismic Hazard Zone of Required Investigation for Liquefaction, as mapped by CGS (2003).

Liquefaction refers to the sudden, temporary loss of soil shear strength during strong ground shaking. Liquefaction-related phenomena include liquefaction-induced settlement, flow failure, and lateral spreading. These phenomena can occur where there are saturated, loose, granular deposits. Recent advances in liquefaction studies indicate that liquefaction can occur in granular materials with a high fines content (35 to 50% clayey and silty materials that pass the #200 sieve) provided the fines exhibit a plasticity less than 7. Granular layers with a potential for liquefaction were observed during our subsurface exploration.

To evaluate soil liquefaction, the seismic energy from an earthquake is compared with the ability of the soil to resist pore pressure generation. The earthquake energy is termed the cyclic stress ratio (CSR) and is a function of the maximum credible earthquake peak ground acceleration (PGA) and depth. The soil resistance to liquefaction is based on the relative density, and the amount and plasticity of the fines (silts and clays). The relative density of cohesionless soil is correlated with Cone Penetration Test data measured in the field.

We analyzed the potential for liquefaction utilizing the CPT Liquefaction Assessment software program CLiq (2007, ver. 2.1.6.9), and the procedures outlined by Idriss and Boulanger (2014). The design seismic conditions consisted of a magnitude 7.3 earthquake producing a PGA of 0.64g, which corresponds to the PGA_M per ASCE 7-10 Section 11.8.3, and assuming groundwater at a depth of four feet below the ground surface. The results of our liquefaction analyses are presented on Figures 5 through 10, and indicate discontinuous granular soil layers observed between roughly 4 and 14 feet, and discontinuous lenses between roughly 20 and 30 feet and 39 to 65-feet below the ground surface classify as liquefiable during the design seismic event. Therefore, we judge the risk of liquefaction at the site is high.

Potential liquefaction of sandy layers between 4 and 14 feet and between roughly 20 to 30 feet below the ground surface may result in ground surface settlement of between roughly 1.5-inches to 3.0-inches, based on the liquefaction analyses discussed above, and as shown on Figures 5 through 10. Potential liquefaction induced differential ground surface settlement within a given building footprint area is estimated to be approximately one half of the total settlement (approximately 0.75 to 1.5-inches).

Based on procedures outlined by Idriss and Boulanger, 2014, the discontinuous and relatively thin layers of potentially liquefiable soil observed 39-feet to 65-feet below the ground surface in the CPT's may experience 0.5-inch to 1.0-inch of post-liquefaction settlement. However, because there is a significant non-liquefiable soil "cap" overlying these deeper potentially liquefiable soil layers, we utilized the procedures outlined by Youd and Garris (1995) to determine if post-liquefaction settlement will be manifested in the form of ground surface settlement. As shown on Figure 11, based on the relative thicknesses of the non-liquefiable "cap" and the liquefiable layers, post-liquefaction settlements are not expected to result in ground surface settlement from the potentially liquefiable layers located below a depth of 39-feet.

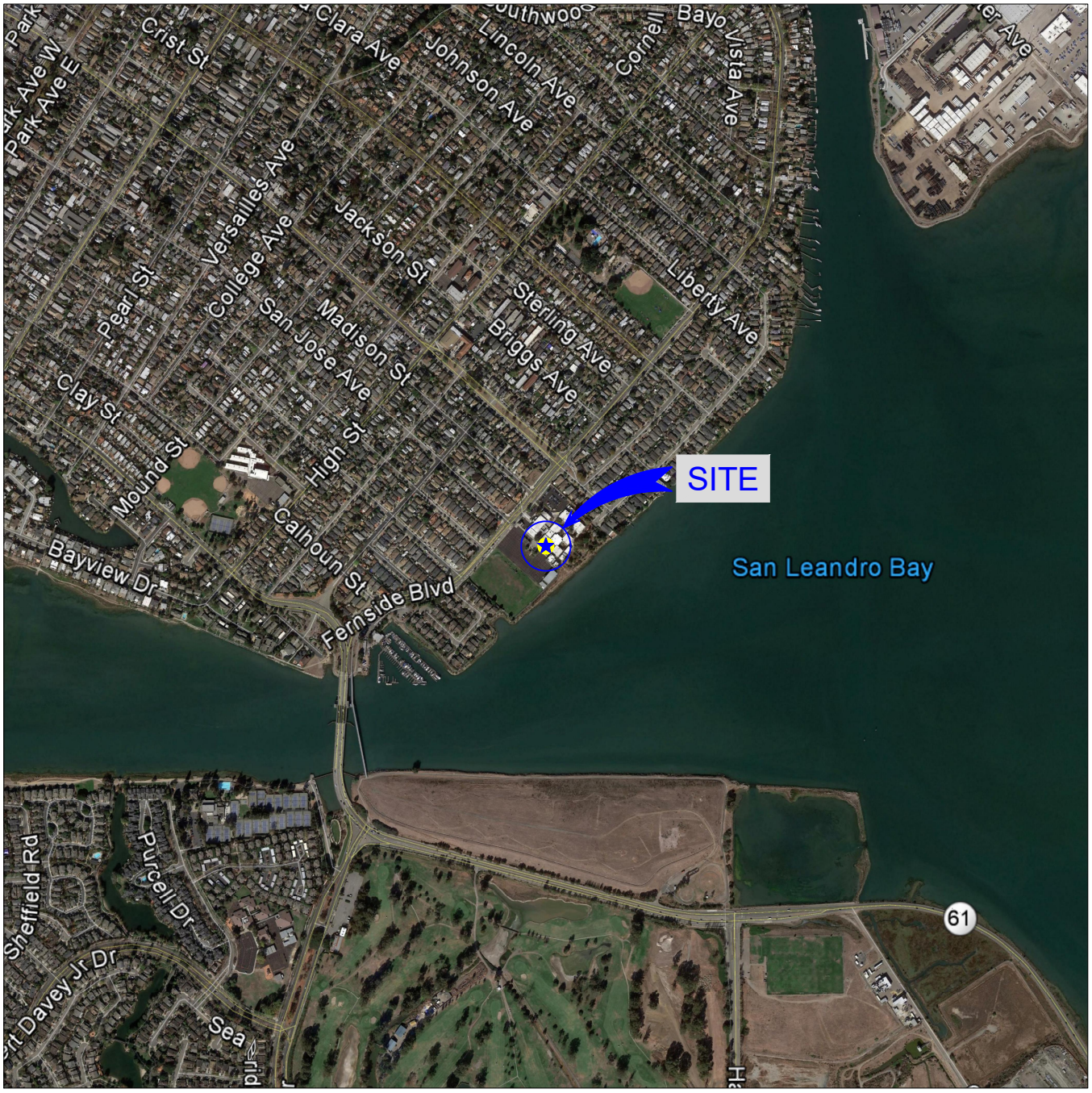
The risk of liquefaction induced lateral spreading is principally confined to liquefaction occurring in the upper roughly fifteen to twenty feet of soil, measured from the ground surface elevation in the main campus area. The data collected from CPT's and borings indicate that the upper twenty feet of soil consists either of a heterogeneous fill composed of discontinuous layers of silty sand, sandy silt, and silty clay, or soft clay (Bay Mud). Due to the apparent lack of continuous lenses of potentially liquefiable loose silty sand in the upper twenty feet of the soil profile, in our opinion the risk that liquefaction induced lateral spreading will impact the Lincoln Middle School Campus is relatively low.

If you have any questions, or if we can be of further assistance, please call us at your convenience.

Yours very truly,
MILLER PACIFIC ENGINEERING GROUP

Daniel S. Caldwell
Geotechnical Engineer #2006
(Expires 9/30/19)

Attachments: Figures 1 through 11, A-1 through A-8, Appendix B, Kaldveer Boring Logs 1-6



SITE: LATITUDE, 37.7525°
LONGITUDE, -122.2311°

SITE LOCATION

N.T.S.

NORTH

REFERENCE: Google Earth, 2017

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SITE LOCATION MAP

Lincoln Middle School
1250 Fernside Boulevard
Alameda, California

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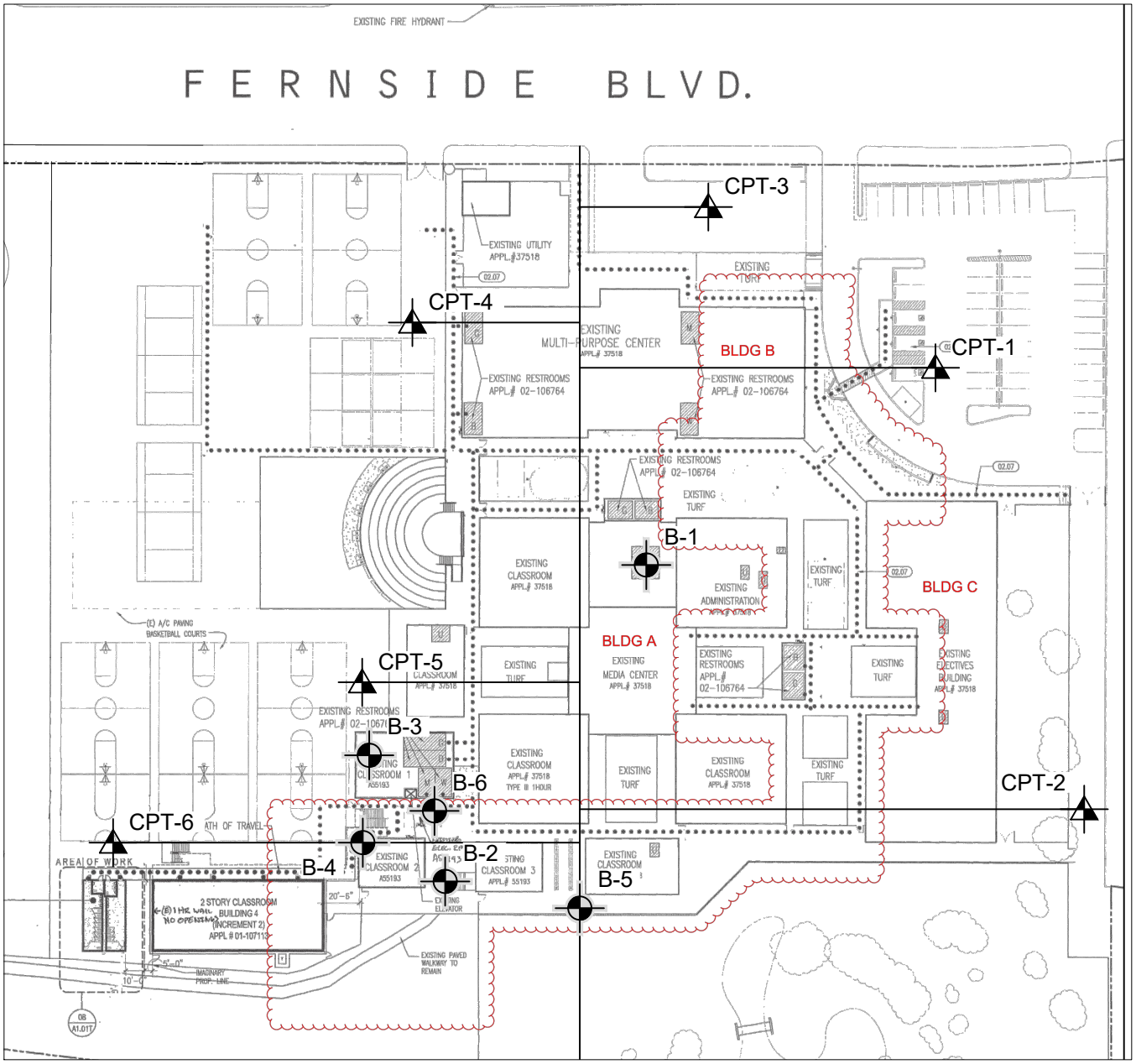
1
FIGURE



SITE PLAN

SCALE

0 50 100 200 FEET

NORTH

Approximate location of CPT completed by MPEG, 2017.

Approximate location of boring completed by Kaldveer Associates, 1990.

REFERENCE: Site Plan Provided by QKA

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SITE PLAN

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2
FIGURE

REGIONAL GEOLOGIC MAP

(NOT TO SCALE)

NORTH

LEGEND

af — ARTIFICIAL FILL (HOLOCENE)
Man made deposit of various materials and ages. Some are compacted and quite firm, but fills made before 1865 are nearly everywhere not compacted and consist simply of dumped materials.

Qds — DUNE SAND (HOLOCENE AND PLEISTOCENE)
Fine-grained, very well sorted, well-drained, eolian deposits.They occur mainly in large sheets, as well as many small hills, most displaying Barchan morphology.Dunes display as much as 30 m of erosional relief and are presently being buried by basin deposits (Qhb) and bay mud (Qhbm). They probably began accumulating after the last interglacial high stand of sea level began to recede about 71 ka, continued to form when sea level dropped to its Wisconsin minimum about 18 ka, and probably ceased to accumulate after sea level reached its present elevation (about 6 ka). Atwater (1982) recognized buried paleosols in the dunes, indicating periods of nondeposition

REFERENCE: Graymer, R.W. (2000), "Geologic Map of the Oakland Metropolitan Area, Alameda, Contra Costa, and San Francisco Counties, California", United States Geological Survey Miscellaneous Field Studies Map MF-2342, Version 1.0, Map Scale 1:50,000.

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REGIONAL GEOLOGIC MAP

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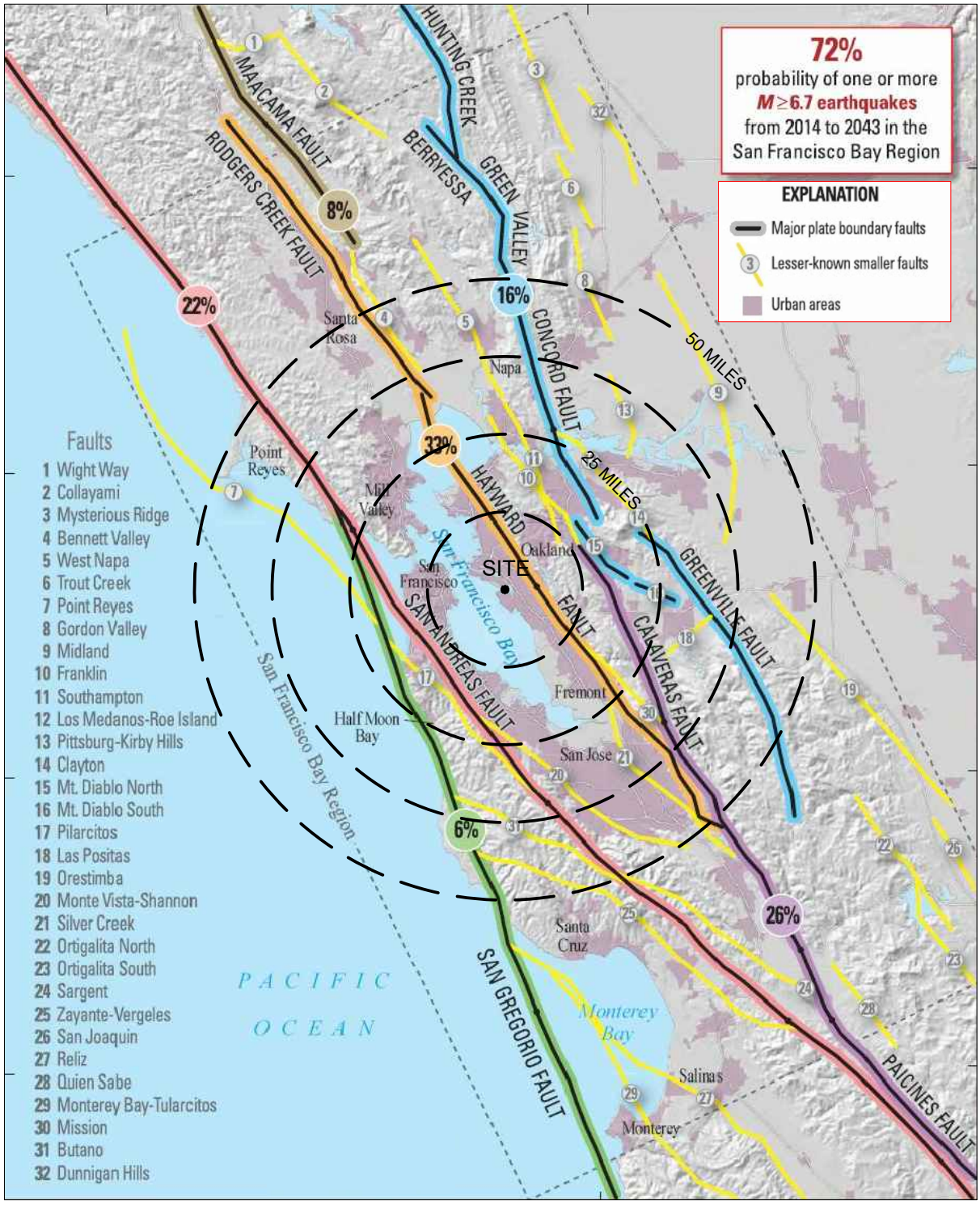
3
FIGURE



SITE COORDINATES
LAT. 37.7525°
LON. -122.2311°

SCALE
0 12.5 25 50 MILES

NORTH

DATA SOURCE:
1) U.S. Geological Survey, U.S. Department of the Interior, "Earthquake Outlook for the San Francisco Bay Region 2014-2043", Map of Known Active Faults in the San Francisco Bay Region, Fact Sheet 2016-3020, Revised August 2016 (ver. 1.1).

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ACTIVE FAULT MAP

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4
FIGURE

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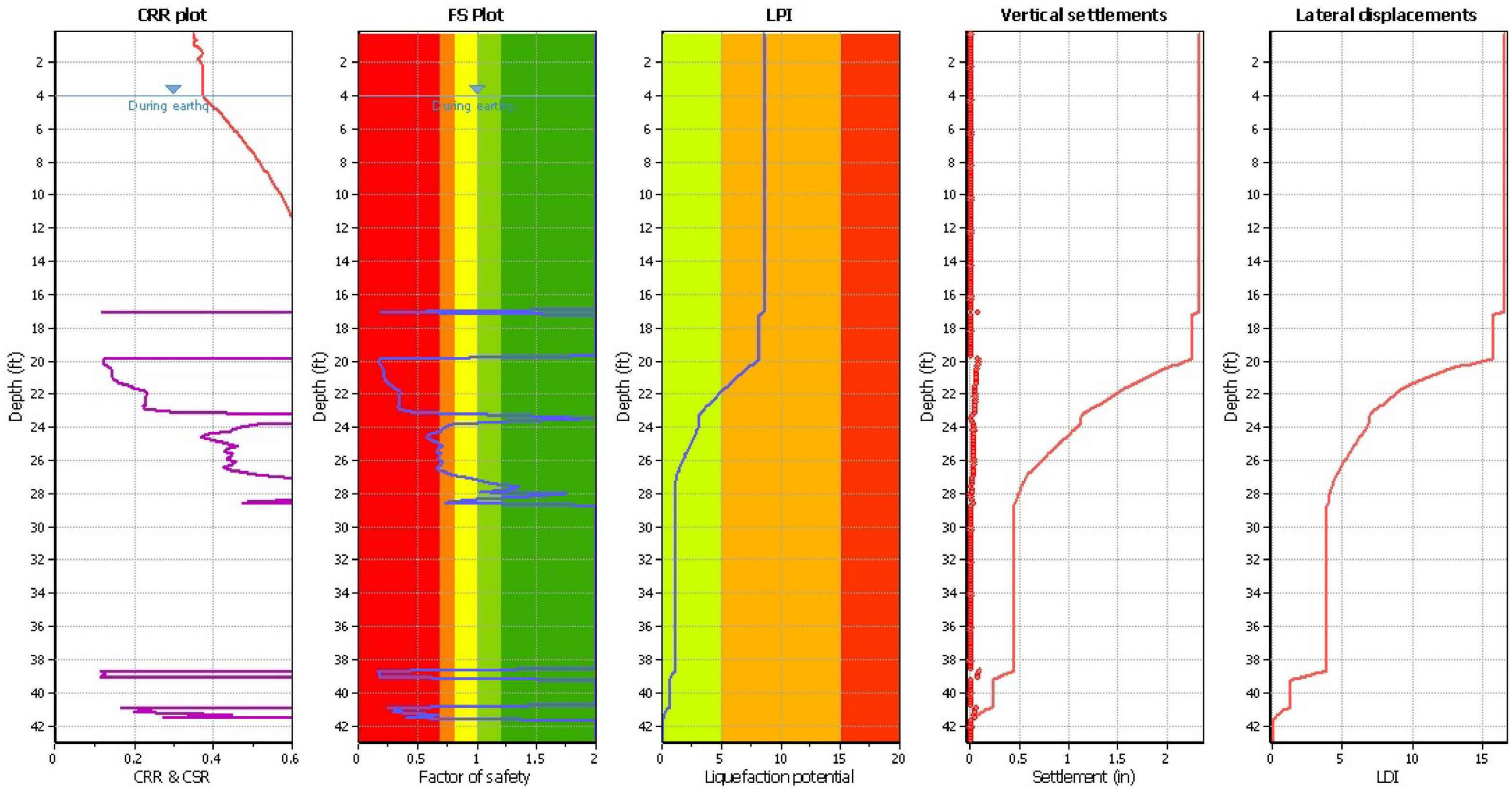
CPT name: CPT-01

Liquefaction analysis overall plot



Input parameters and analysis data

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Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.00 ft	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

CLiq v.2.1.6.9 - CPT Liquefaction Assessment Software - Report created on: 11/8/2017, 2:05:13 PM
Project file: H:\Jobs\1900-1999\1911.037 Lincoln MS Liquefaction Eval\Analyses\1911.037.clq

5

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CPT-1 LIQUEFACTION ANALYSIS

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FIGURE

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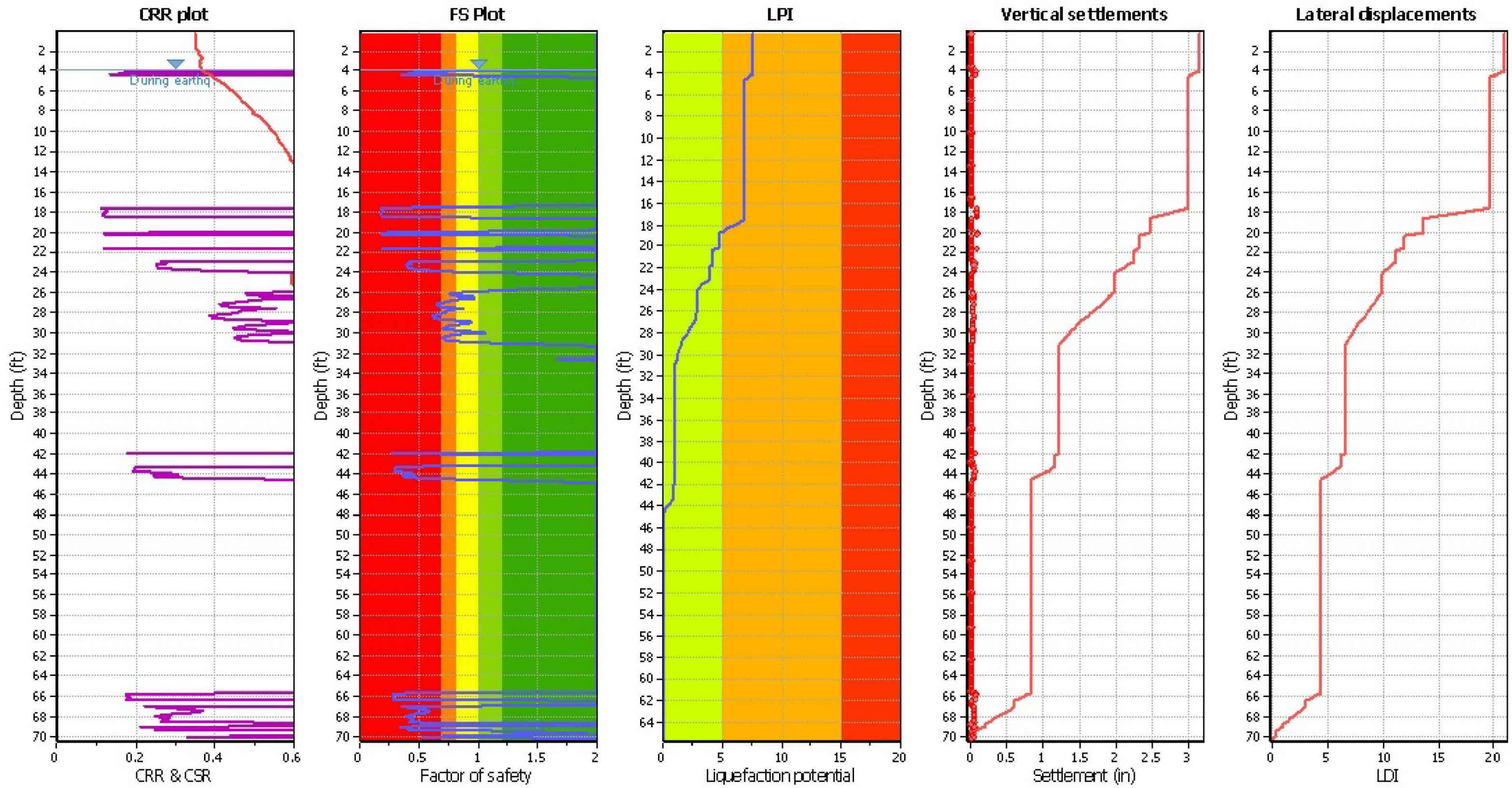
Liquefaction analysis overall plot



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Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	9.10 ft	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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CPT-2 LIQUEFACTION ANALYSIS

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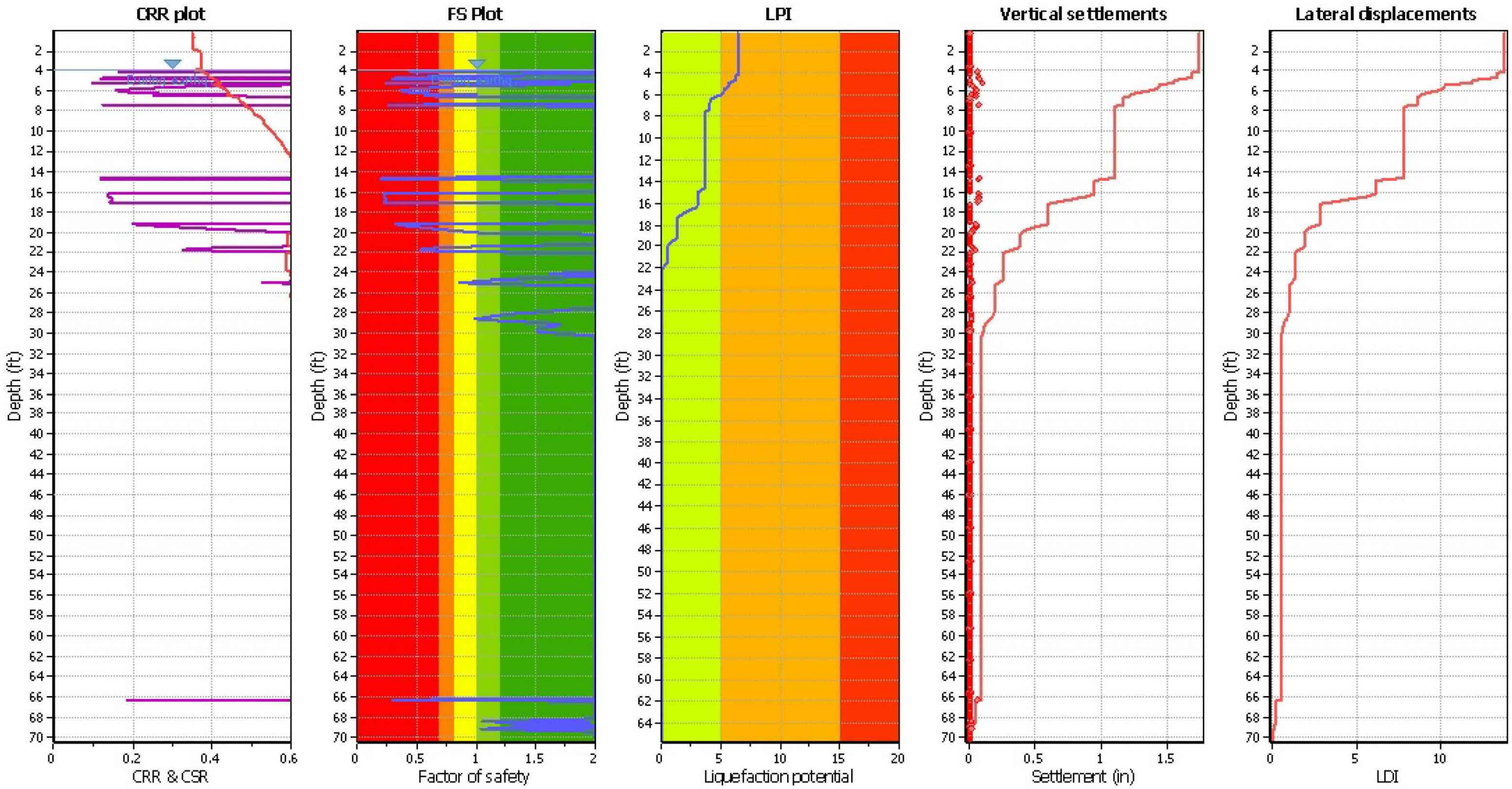
FIGURE 6

CPT name: CPT-03

Liquefaction analysis overall plot



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Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	7.90 ft	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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CPT-3 LIQUEFACTION ANALYSIS

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FIGURE 7

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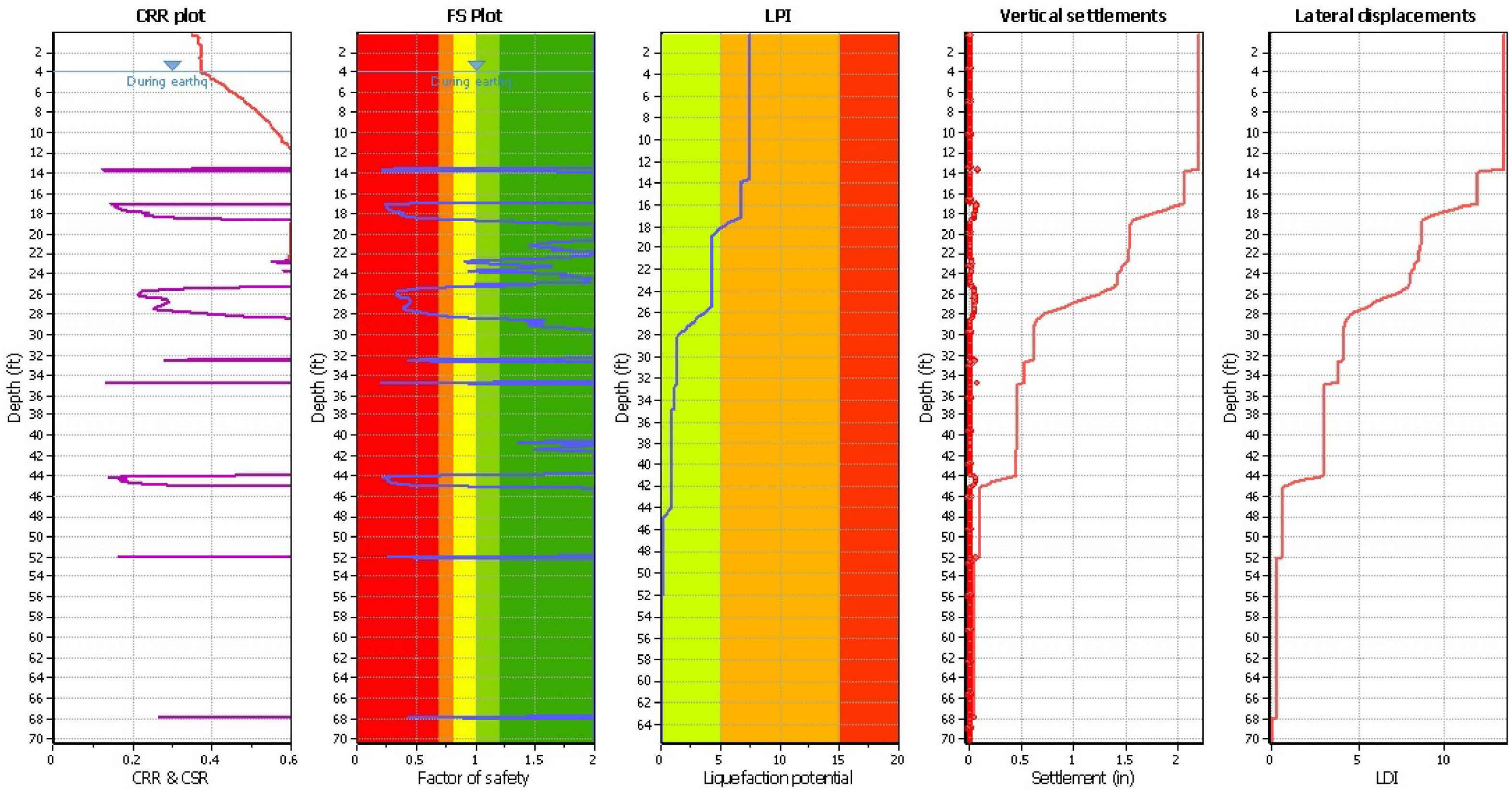
Liquefaction analysis overall plot



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Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
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F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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CPT-4 LIQUEFACTION ANALYSIS

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FIGURE

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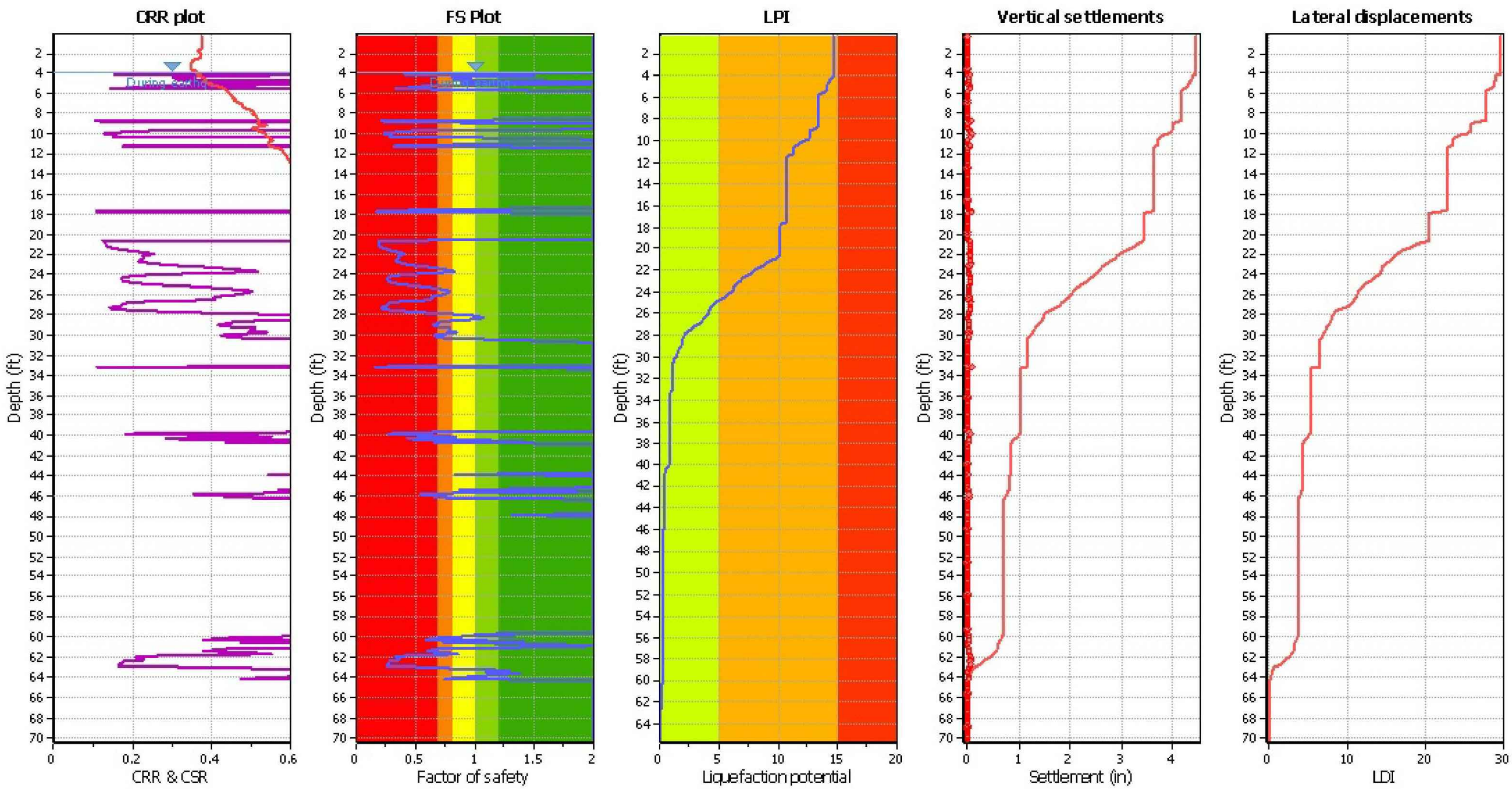
CPT name: CPT-05

Liquefaction analysis overall plot



Input parameters and analysis data

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Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	8.10 ft	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme
- Almost certain it will liquefy
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- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme
- Very high risk
- High risk
- Low risk

CLiq v.2.1.6.9 - CPT Liquefaction Assessment Software - Report created on: 11/8/2017, 2:05:17 PM
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CPT-5 LIQUEFACTION ANALYSIS

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FIGURE

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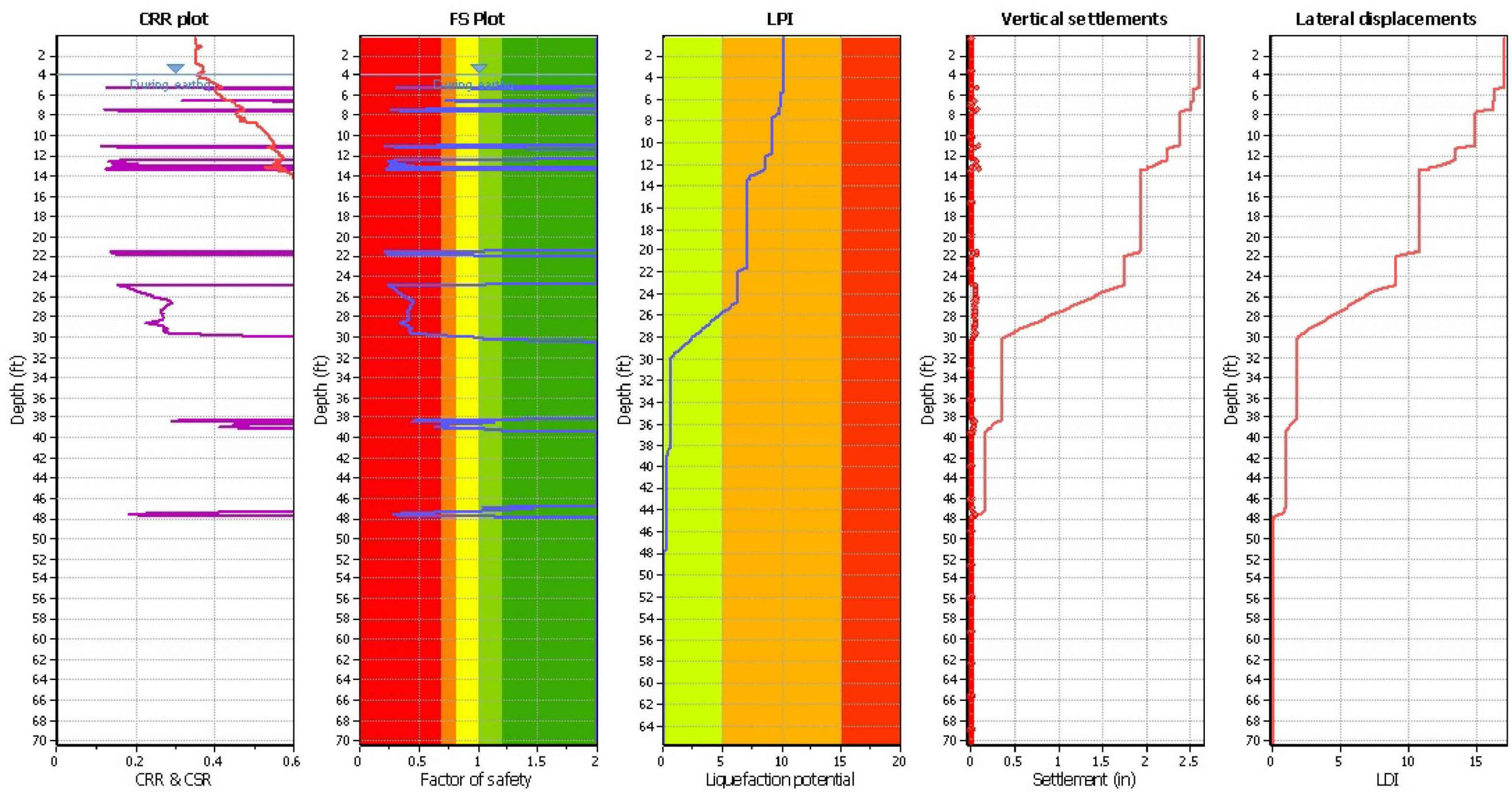
CPT name: CPT-06

Liquefaction analysis overall plot



Input parameters and analysis data

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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.10 ft	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
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LPI color scheme

- Very high risk
- High risk
- Low risk

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CPT-6 LIQUEFACTION ANALYSIS

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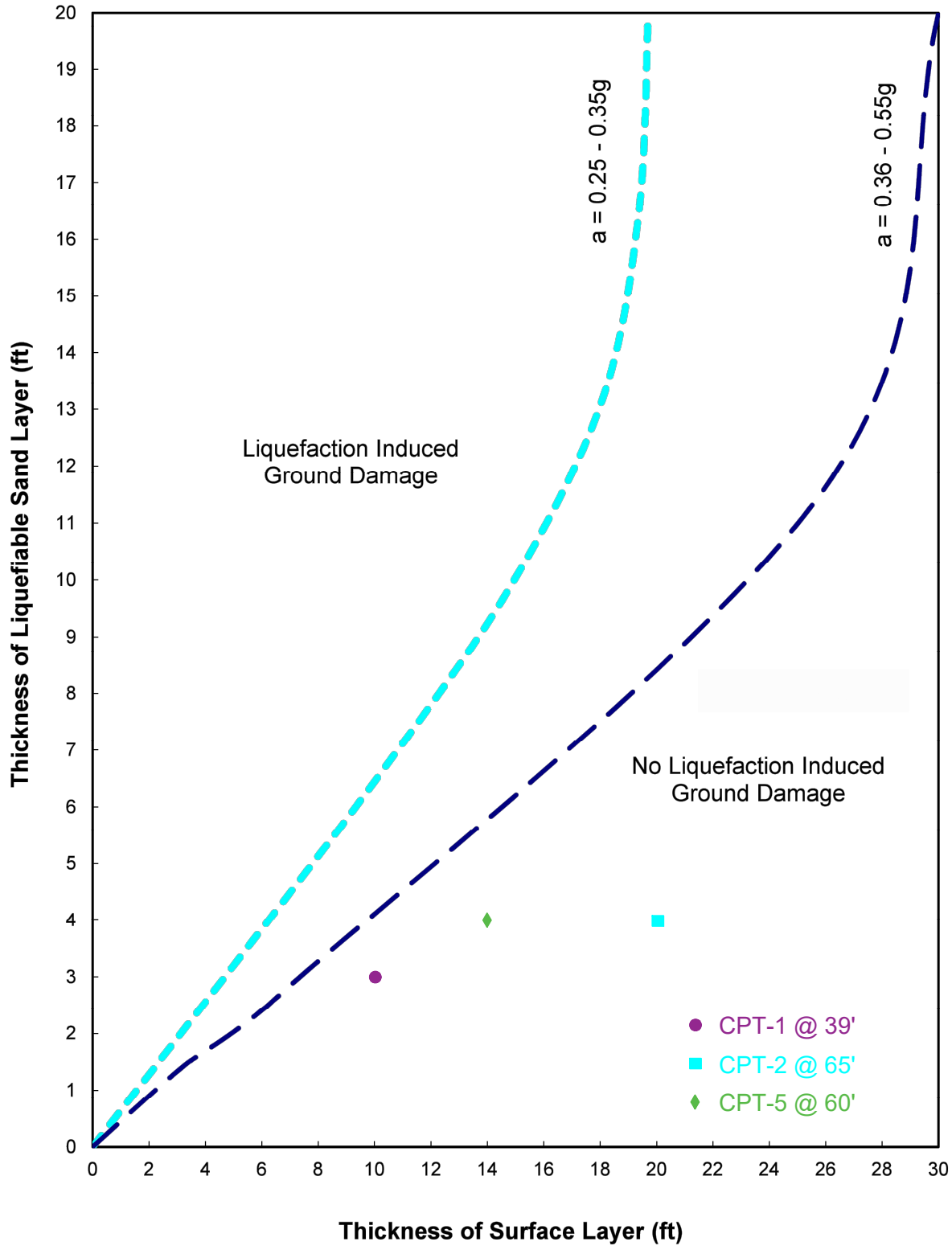
10
FIGURE

Liquefaction-Induced Ground-Surface Distribution
(Youd and Garris, 1995)



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LIQUEFACTION ANALYSIS - SURFACE EFFECTS

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11
FIGURE

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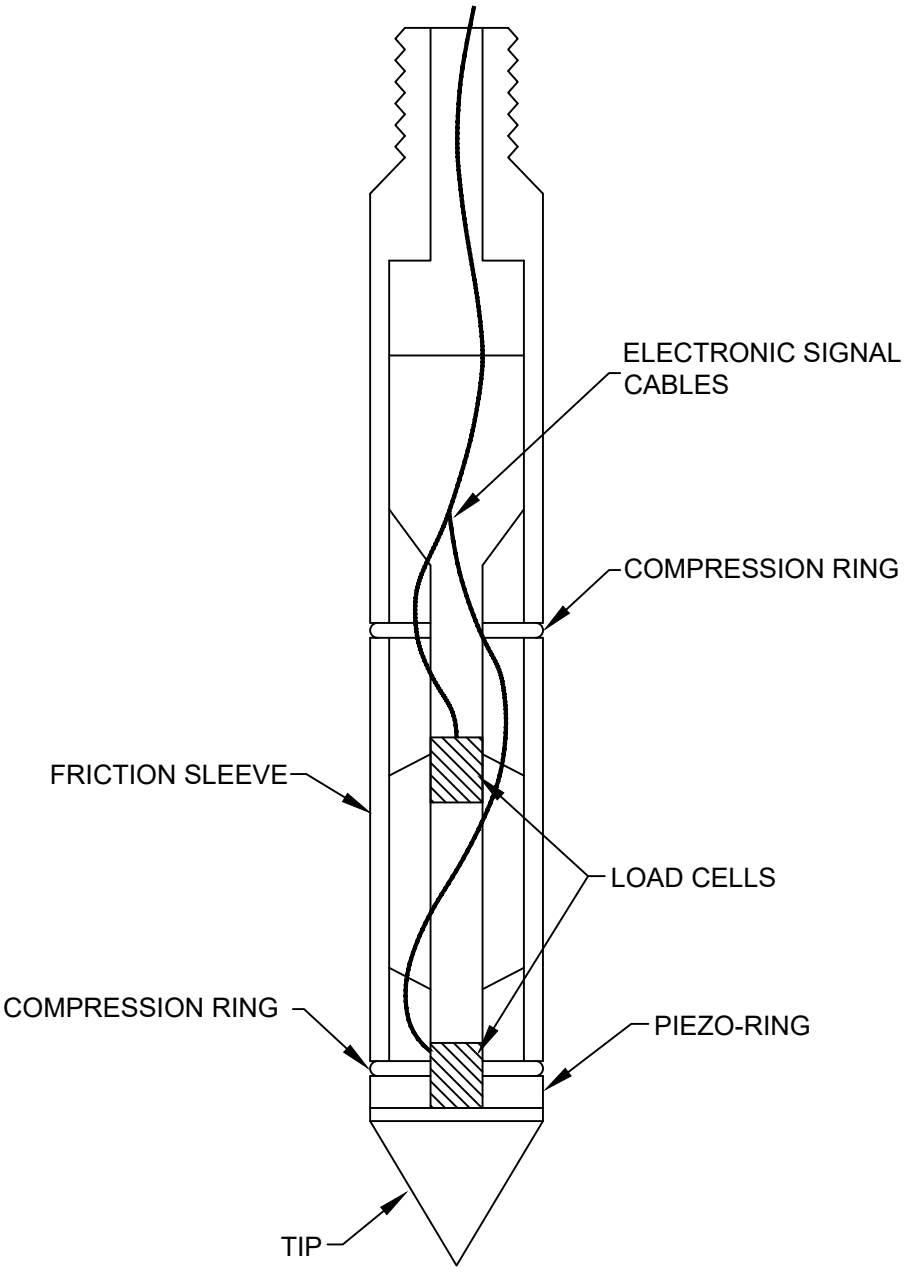
APPENDIX A



CONE PENETROMETER

(NO SCALE)

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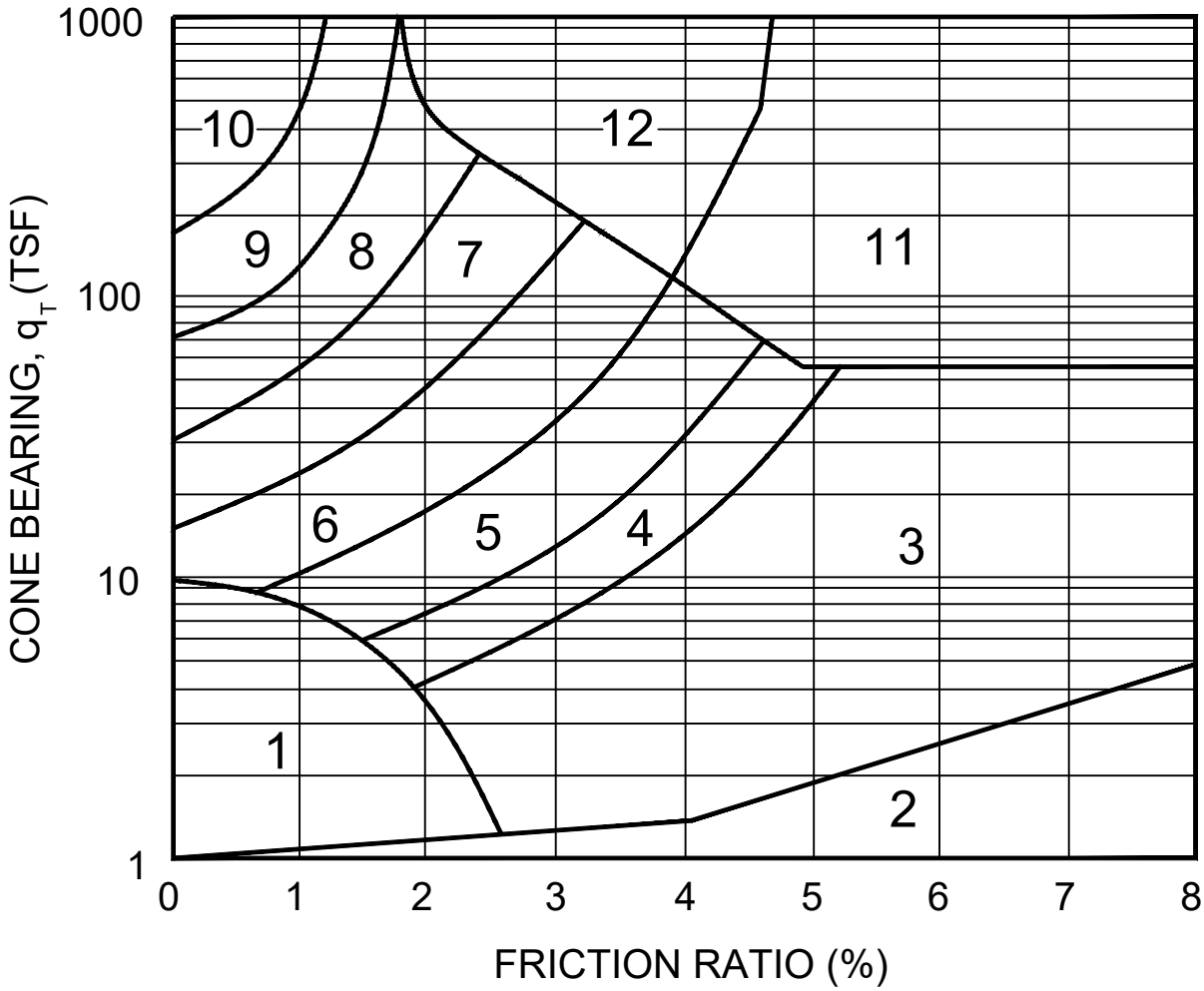
1250 Fernside Boulevard
Alameda, California

Project No. 1911.037 Date: 4/7/17

Drawn MMT
Checked

A-1
FIGURE



Zone:	Qc/N	Soil Behavior Type:
1)	2	Sensitive Fine Grained
2)	1	Organic Material
3)	1	Clay
4)	1.5	Silty Clay to Clay
5)	2	Clayey Silt to Silty Clay
6)	2.5	Sandy Silt to Clayey Silt
7)	3	Silty Sand to Sandy Silt
8)	4	Sand to Silty Sand
9)	5	Sand
10)	6	Gravelly Sand to Sand
11)	1	Very Stiff Fine Grained (*)
12)	2	Sand to Clayey Sand (*)

(*) Overconsolidated or Cemented

Reference: Robertson, P.K. (1986), "In-Situ Testing and Its Application to Geotechnical Engineering," Canadian Geotechnical Journal, Vol. 23; No. 23; No. 4, pp. 573-594

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CPT SOIL INTERPRETATION CHART

Lincoln Middle School
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Project No. 1911.037 Date: 4/7/17

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A-2
FIGURE

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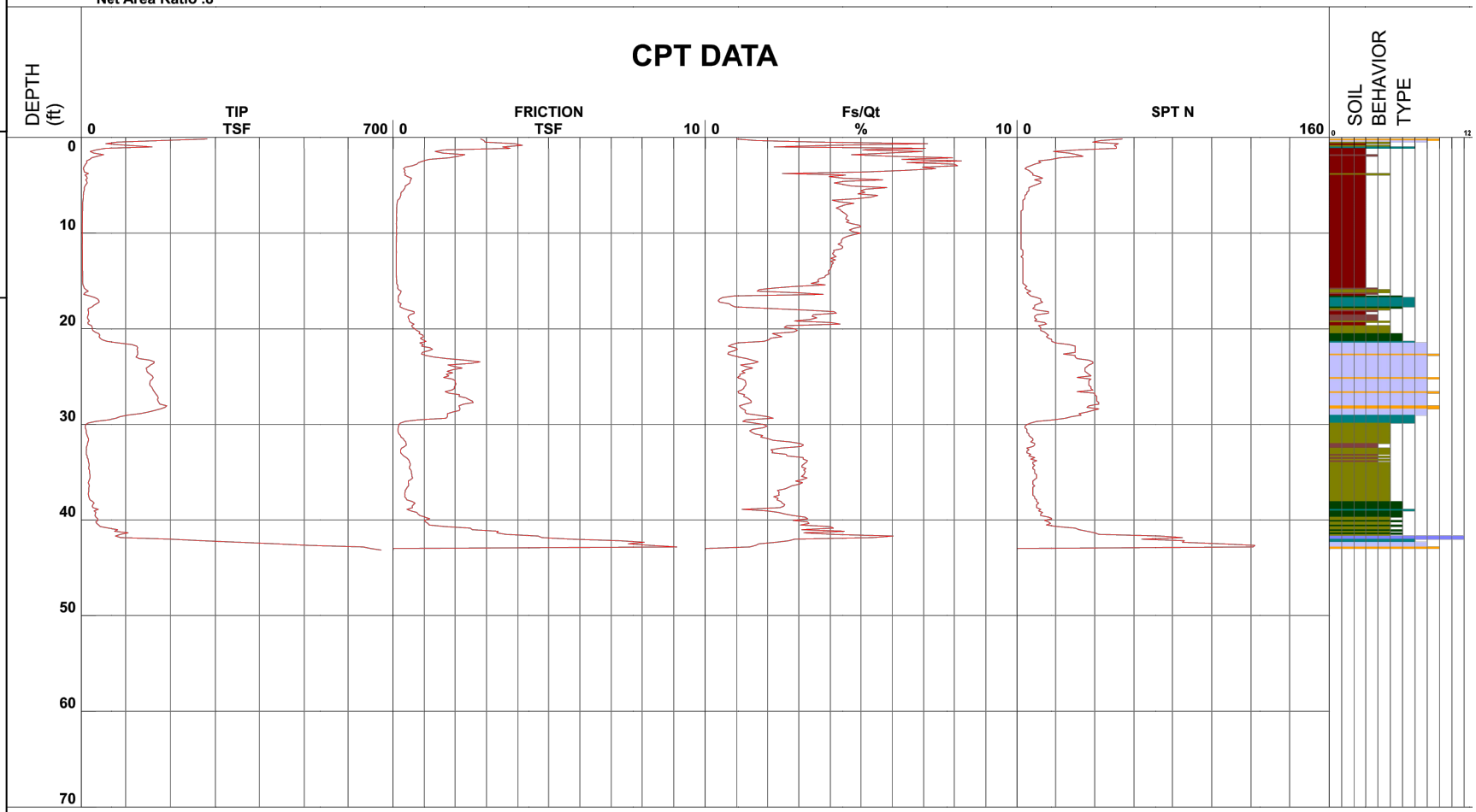
Miller Pacific Engineering

Project	Lincoln Middle School	Operator	RB KK	Filename	SDF(053).cpt
Job Number	1911.037	Cone Number	DDG1379	GPS	
Hole Number	CPT-01	Date and Time	4/22/2017 2:02:04 PM	Maximum Depth	43.14 ft
EST GW Depth During Test		8.00 ft			

Net Area Ratio .8

CPT DATA



1 - sensitive fine grained
2 - organic material
3 - clay
4 - silty clay to clay
5 - clayey silt to silty clay
6 - sandy silt to clayey silt
7 - silty sand to sandy silt
8 - sand to silty sand
9 - sand
10 - gravelly sand to sand
11 - very stiff fine grained (*)
12 - sand to clayey sand (*)

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

Lincoln Middle School
1250 Fernside Boulevard
Alameda, California

Project No. 1911.037
Date: 4/7/17

Drawn MMT
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CPT-1 PLOT

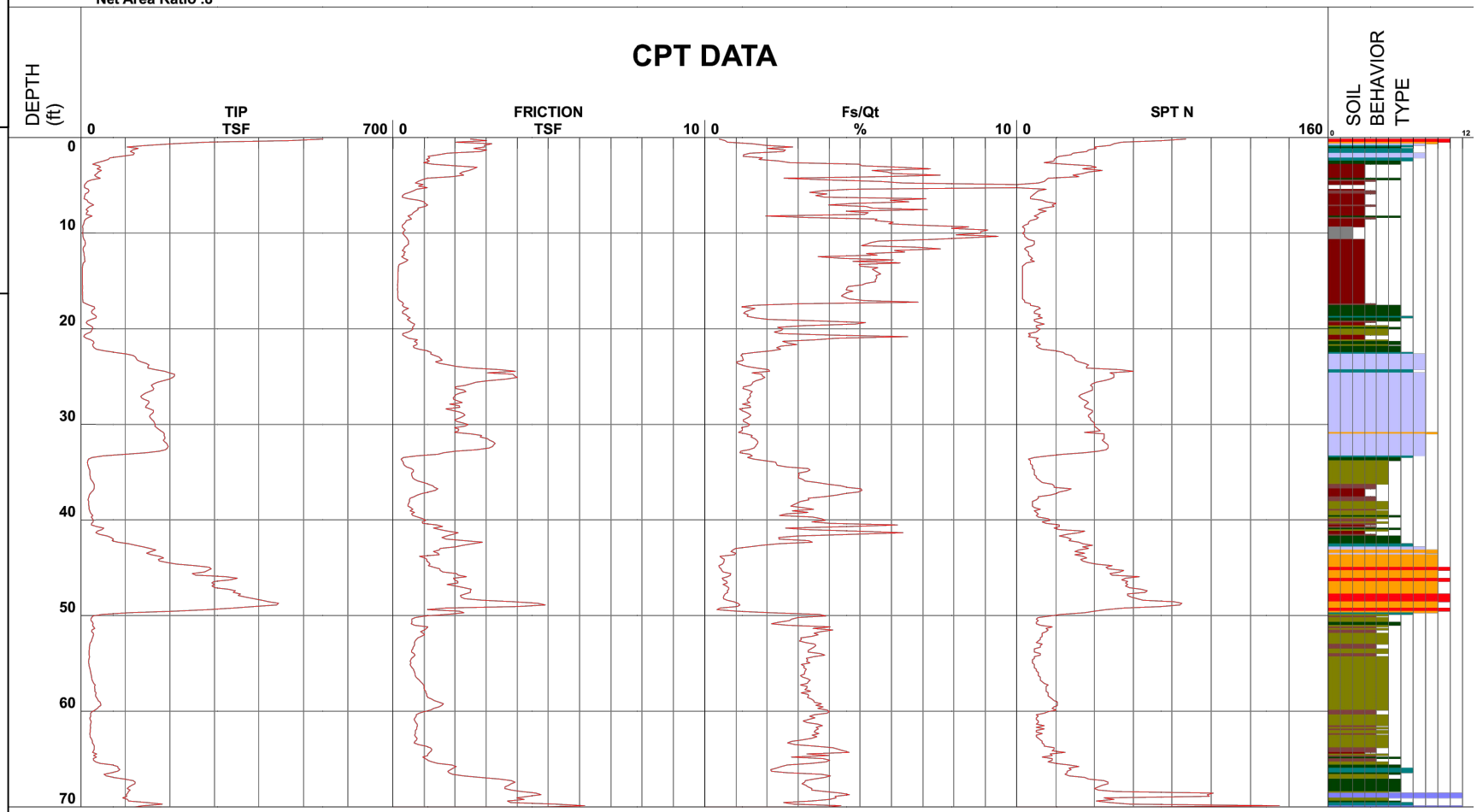
FIGURE A-3

Miller Pacific Engineering

Project	Lincoln Middle School	Operator	RB KK	Filename	SDF(054).cpt
Job Number	1911.037	Cone Number	DDG1379	GPS	
Hole Number	CPT-02	Date and Time	4/22/2017 3:02:53 PM	Maximum Depth	70.54 ft
EST GW Depth During Test		9.10 ft			

Net Area Ratio .8

CPT DATA



1 - sensitive fine grained
2 - organic material
3 - clay
4 - silty clay to clay
5 - clayey silt to silty clay
6 - sandy silt to clayey silt
7 - silty sand to sandy silt
8 - sand to silty sand
9 - sand
10 - gravelly sand to sand
11 - very stiff fine grained (*)
12 - sand to clayey sand (*)

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

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Lincoln Middle School
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Project No. 1911.037
Date: 4/7/17

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CPT-2 PLOT

FIGURE A-4

FILENAME: 1911.037 CPT.dwg

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Project No. 1911.037

Date: 4/7/17

Drawn MMT
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CPT-3 PLOT

FIGURE A-5

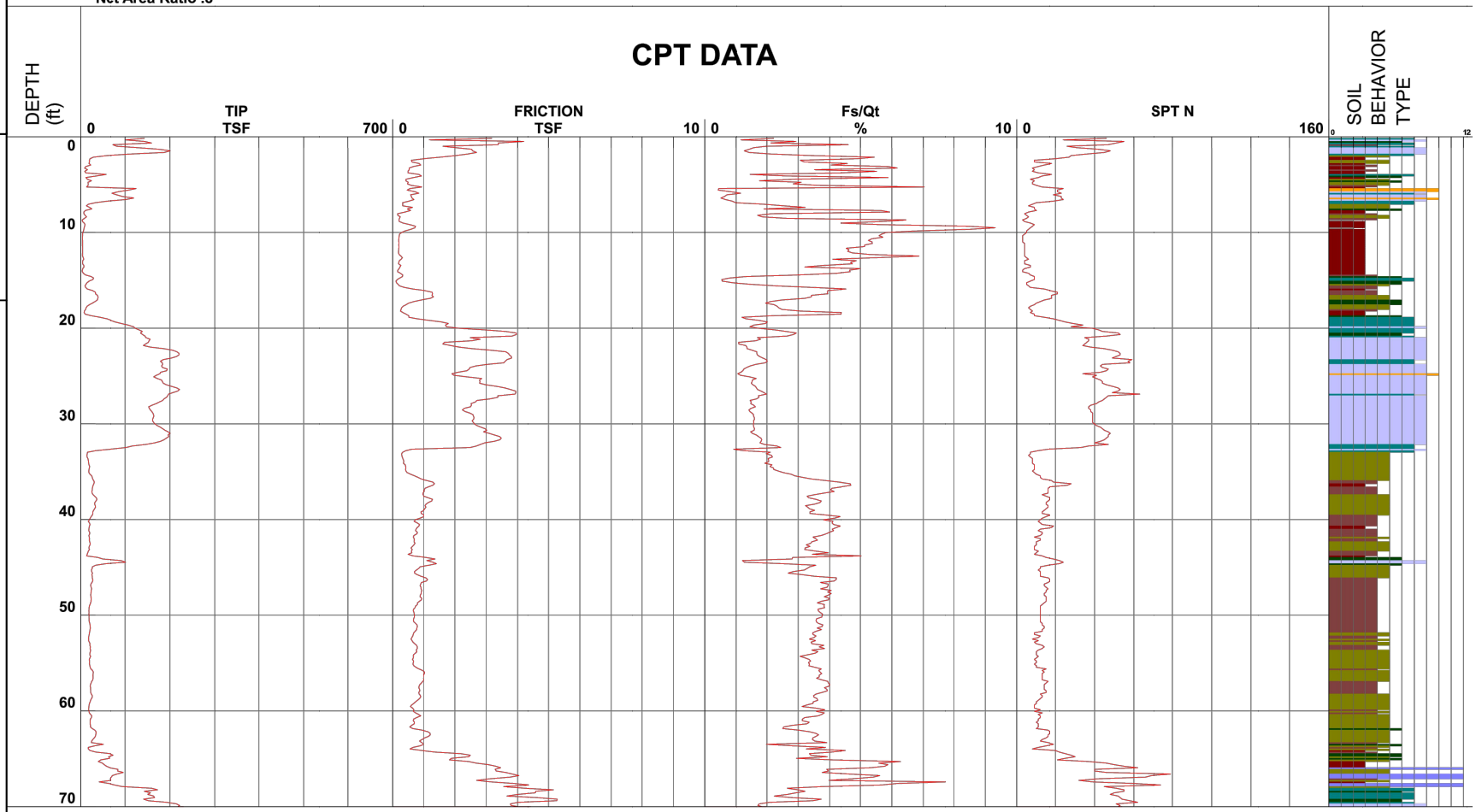
Miller Pacific Engineering

Middle Earth GEO TESTING INC.

Project	Lincoln Middle School	Operator	RB KK	Filename	SDF(055).cpt
Job Number	1911.037	Cone Number	DDG1379	GPS	
Hole Number	CPT-03	Date and Time	4/22/2017 3:53:50 PM	Maximum Depth	70.54 ft
EST GW Depth During Test		7.90 ft			

Net Area Ratio .8

CPT DATA



1 - sensitive fine grained
2 - organic material
3 - clay
4 - silty clay to clay
5 - clayey silt to silty clay
6 - sandy silt to clayey silt
7 - silty sand to sandy silt
8 - sand to silty sand
9 - sand
10 - gravelly sand to sand
11 - very stiff fine grained (*)
12 - sand to clayey sand (*)

Cone Size 10cm squared

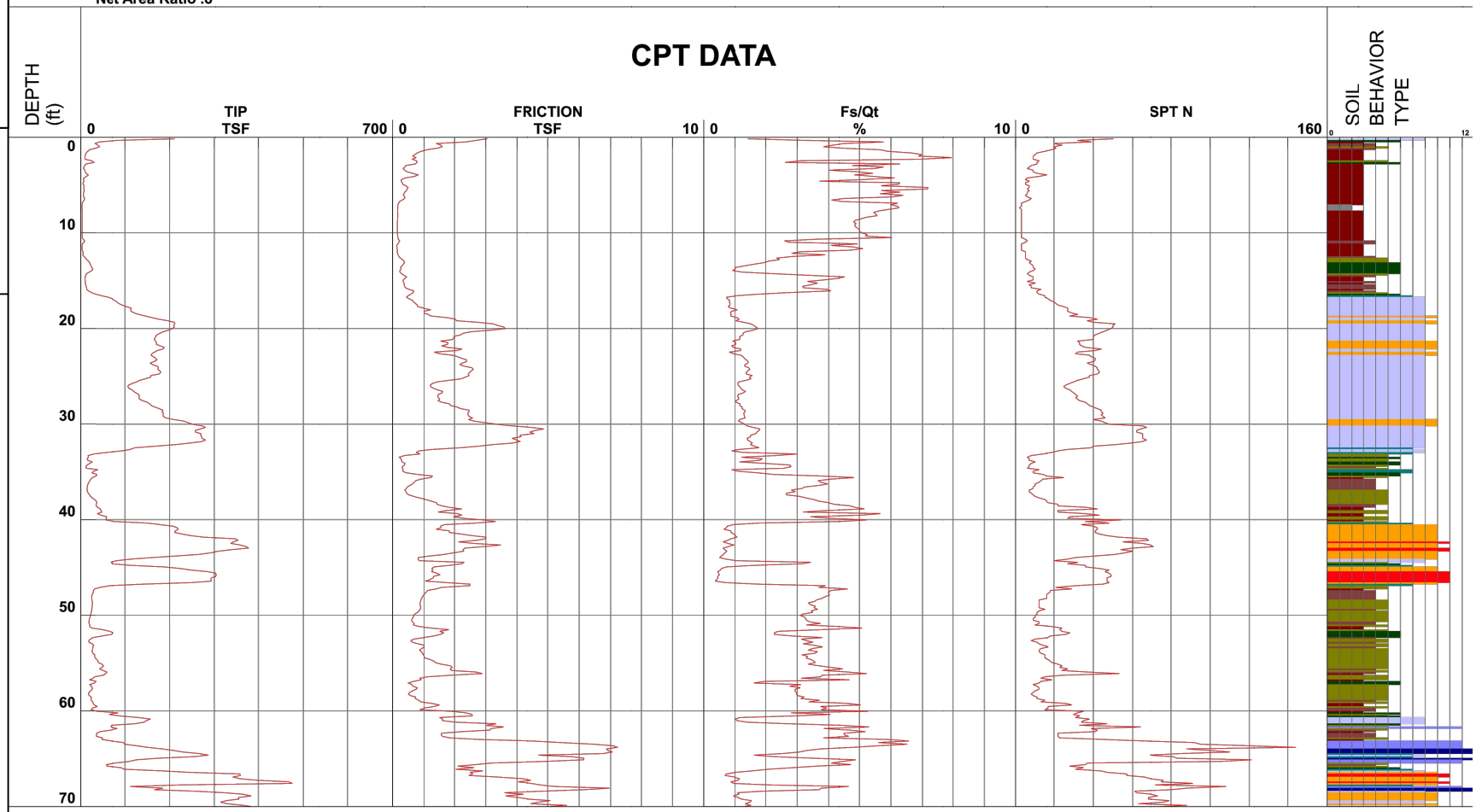
S*Soil behavior type and SPT based on data from UBC-1983

Miller Pacific Engineering

Project	Lincoln Middle School	Operator	RB KK	Filename	SDF(051).cpt
Job Number	1911.037	Cone Number	DDG1379	GPS	
Hole Number	CPT-04	Date and Time	4/22/2017 11:23:49 AM	Maximum Depth	70.54 ft
EST GW Depth During Test		4.70 ft			

Net Area Ratio .8

CPT DATA



1 - sensitive fine grained
2 - organic material
3 - clay
4 - silty clay to clay
5 - clayey silt to silty clay
6 - sandy silt to clayey silt
7 - silty sand to sandy silt
8 - sand to silty sand
9 - sand
10 - gravelly sand to sand
11 - very stiff fine grained (*)
12 - sand to clayey sand (*)

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

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FILENAME: 1911.037 CPT.dwg

Lincoln Middle School
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Project No. 1911.037
Date: 4/7/17

Drawn MMT
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CPT-4 PLOT

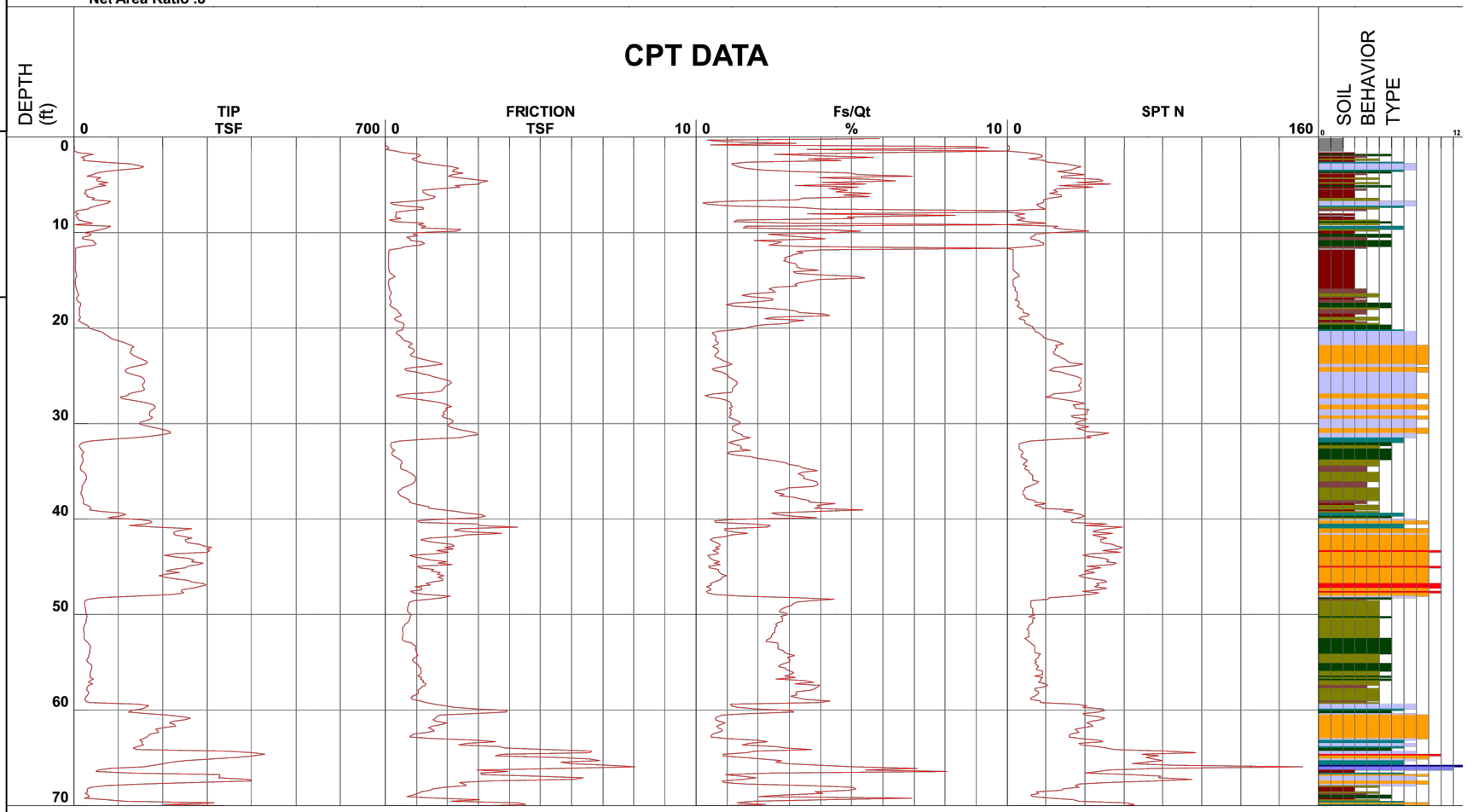
FIGURE A-6

Miller Pacific Engineering

Project	Lincoln Middle School	Operator	RB KK	Filename	SDF(050).cpt
Job Number	1911.037	Cone Number	DDG1379	GPS	
Hole Number	CPT-05	Date and Time	4/22/2017 10:26:42 AM	Maximum Depth	70.54 ft
EST GW Depth During Test		8.10 ft			

Net Area Ratio .8

CPT DATA



1 - sensitive fine grained
2 - organic material
3 - clay
4 - silty clay to clay
5 - clayey silt to silty clay
6 - sandy silt to clayey silt
7 - silty sand to sandy silt
8 - sand to silty sand
9 - sand
10 - gravelly sand to sand
11 - very stiff fine grained (*)
12 - sand to clayey sand (*)

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

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Alameda, California

Project No. 1911.037
Date: 4/7/17

Drawn MMT
Checked

CPT-5 PLOT

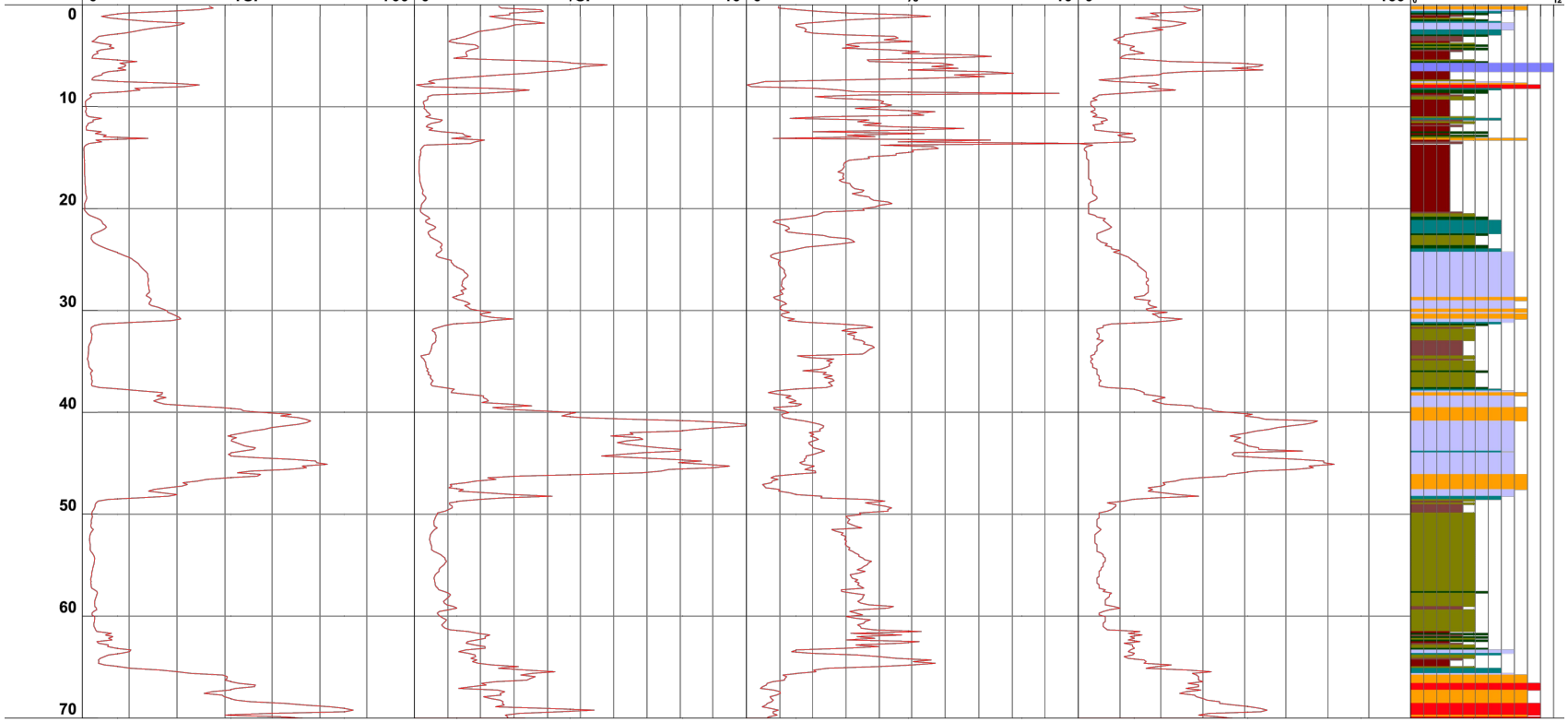
FIGURE A-7

Miller Pacific Engineering

Project	Lincoln Middle School	Operator	RB KK	Filename	SDF(052).cpt
Job Number	1911.037	Cone Number	DDG1379	GPS	
Hole Number	CPT-06	Date and Time	4/22/2017 12:35:22 PM	Maximum Depth	70.54 ft
EST GW Depth During Test		4.10 ft			

Net Area Ratio .8

CPT DATA



1 - sensitive fine grained
2 - organic material
3 - clay
4 - silty clay to clay
5 - clayey silt to silty clay
6 - sandy silt to clayey silt
7 - silty sand to sandy silt
8 - sand to silty sand
9 - sand
10 - gravelly sand to sand
11 - very stiff fine grained (*)
12 - sand to clayey sand (*)

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

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FILENAME: 1911.037 CPT.dwg

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Project No. 1911.037
Date: 4/7/17

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CPT-6 PLOT

FIGURE A-8

MILLER PACIFIC
ENGINEERING GROUP

APPENDIX B

PRIMARY DIVISIONS			GROUP SYMBOL	SECONDARY DIVISIONS
COARSE GRAINED SOILS — MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVELS — MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO 4 SIEVE	CLEAN GRAVELS (LESS THAN 5% FINES)	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GRAVEL WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines
			GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines
	SANDS — MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO 4 SIEVE	CLEAN SANDS (LESS THAN 5% FINES)	SW	Well graded sands, gravelly sands, little or no fines
			SP	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures, non-plastic fines
			SC	Clayey sands, sand-clay mixtures, plastic fines
FINE GRAINED SOILS — MORE THAN HALF OF MATERIAL IS SMALLER THAN NO 200 SIEVE SIZE	SILTS AND CLAYS — LIQUID LIMIT IS LESS THAN 50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS — LIQUID LIMIT IS GREATER THAN 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils

DEFINITION OF TERMS

	U.S. STANDARD SERIES SIEVE				CLEAR SQUARE SIEVE OPENINGS			
	200	40	10	4	3/4"	3"	12"	
SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS	
	FINE	MEDIUM	COARSE	FINE	COARSE			

GRAIN SIZES

SANDS AND GRAVELS	BLOWS/FOOT†
VERY LOOSE	0 - 4
LOOSE	4 - 10
MEDIUM DENSE	10 - 30
DENSE	30 - 50
VERY DENSE	OVER 50

RELATIVE DENSITY

SILTS AND CLAYS	STRENGTH‡	BLOWS/FOOT†
VERY SOFT	0 - 1/4	0 - 2
SOFT	1/4 - 1/2	2 - 4
FIRM	1/2 - 1	4 - 8
STIFF	1 - 2	8 - 16
VERY STIFF	2 - 4	16 - 32
HARD	OVER 4	OVER 32

CONSISTENCY

†Number of blows of 140 pound hammer falling 30 inches to drive a 2 inch O.D. (1-3/8 inch I.D.) split spoon (ASTM D-1586).

‡Unconfined compressive strength in tons/sq. ft. as determined by laboratory testing or approximated by the standard penetration test (ASTM D-1586), pocket penetrometer, torvane, or visual observation.

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KEY TO EXPLORATORY BORING LOGS
Unified Soil Classification System (ASTM D-2487)

ADDITIONS TO LINCOLN MIDDLE SCHOOL
Alameda, California

PROJECT NO.	DATE	Figure
K1191-13	May 1990	A-1

DRILL RIG Continuous Flight Auger	SURFACE ELEVATION —	LOGGED BY MD
DEPTH TO GROUNDWATER Not Established	BORING DIAMETER 4¼ Inches	DATE DRILLED 4/17/90

DESCRIPTION AND CLASSIFICATION				DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT.)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)
DESCRIPTION AND REMARKS	COLOR	CONSIST.	SOIL TYPE						
CLAY, sandy (fine- to medium-grained) some silt	mottled brown grey orange	stiff	CL-SC	1		23*			
				2		24*	14	109	2.7
(grading with gravel, fine- to medium-grained)				3		25*			
				4					
				5					
				6					
SAND, silty, some clay	brown tan	medium dense	SM	7					
				8		24*			
(FILL)				9					
				10					
				11					
				12					
CLAY, silty (Bay Mud)	blue grey	firm	CL CH	13		10*	73	56	0.5
Notes: 1. The stratification lines represent the approximate boundaries between soil types and the transition may be gradual. 2. For an explanation of penetration resistance values marked with an asterisk (*) see first page, Appendix A.				14					
				15					
				16					
				17					
				18					
		stiff		19		16*			
Bottom of Boring = 19½ Feet				20					

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EXPLORATORY BORING LOG

ADDITIONS TO LINCOLN MIDDLE SCHOOL
Alameda, California

PROJECT NO.	DATE	BORING NO.
K1191-13	May 1990	1

DRILL RIG Rotary Wash	SURFACE ELEVATION —	LOGGED BY MD
DEPTH TO GROUNDWATER 11' (see note 3)	BORING DIAMETER 3½ Inches	DATE DRILLED 4/19/90

DESCRIPTION AND REMARKS	COLOR	CONSIST.	SOIL TYPE	DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT.)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)
SAND (fine- to coarse-grained), some silt and clay	black brown	medium dense	SM SC	1		12			
(grading interbedded lenses of clayey silt and silty clay)	mottled black brown orange grey			2					
				3		14	12		
				4		13			
				5					
				6					
				7					
				8					
(grading clay lens, some gravel, fine-grained)		firm	CL	9		5	18		
		loose- very loose		10					
Passing #200 Sieve = 25%				11		4	▽		
				12					
				13					
(FILL)				14		4			
CLAY, silty (Bay Mud)	blue grey	soft	CL-CH	15					
(grading interbedded lenses of sand)				16					
				17					
		very soft		18		3*	91		
				19					
				20					

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EXPLORATORY BORING LOG

ADDITIONS TO LINCOLN MIDDLE SCHOOL
Alameda, California

PROJECT NO.	DATE	BORING NO.
K1191-13	May 1990	2

DRILL RIG	Rotary Wash	SURFACE ELEVATION	--	LOGGED BY	MD
DEPTH TO GROUNDWATER	11' (see note 3)	BORING DIAMETER	3½ Inches	DATE DRILLED	4/19/90

DESCRIPTION AND CLASSIFICATION				DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT.)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE
DESCRIPTION AND REMARKS	COLOR	CONSIST.	SOIL TYPE						
CLAY, silty (Bay Mud) (continued)	blue grey	soft	CL	21					
SAND (fine- to medium-grained), some silt	blue green	medium dense	SM	22					
				23					
				24					
				25		49*	18	111	0.6
				26					
				27					
				28					
				29					
				30					
CLAY, silty, some sand (fine-grained) with interbedded sand lenses	blue green	stiff	CL	31					
				32					
				33		9	21		
				34					
				35					
				36					
				37					
				38					
				39					
				40		15			

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EXPLORATORY BORING LOG

ADDITIONS TO LINCOLN MIDDLE SCHOOL
Alameda, California

PROJECT NO.	DATE	BORING NO.
K1191-13	May 1990	2

DRILL RIG	Rotary Wash	SURFACE ELEVATION	—	LOGGED BY	MD
DEPTH TO GROUNDWATER	11'(see note 3)	BORING DIAMETER	3½ Inches	DATE DRILLED	4/19/90

DESCRIPTION AND CLASSIFICATION				DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (TSF)
DESCRIPTION AND REMARKS	COLOR	CONSIST.	SOIL TYPE						
CLAY, silty, trace of sand (fine-grained) with interbedded sand lenses (continued)	blue grey	stiff	CL	41		15			
				42					
				43					
				44					
				45					
				46					
				47					
GRAVEL (fine- to coarse-grained), sandy (fine- to coarse-grained), some silt and clay	mottled brown grey orange	very dense	GC	48					
				49		62			
				50					
Bottom of Boring = 50 Feet				51					
				52					
				53					
				54					
				55					
				56					
				57					
				58					
				59					
				60					

Notes:
1. The stratification lines represent the approximate boundaries between soil types and the transition may be gradual.
2. For an explanation of penetration resistance values marked with an asterisk (*) see first page, Appendix A.
3. Ground water level was measured at 11 feet after drilling.

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EXPLORATORY BORING LOG

ADDITIONS TO LINCOLN MIDDLE SCHOOL
Alameda, California

PROJECT NO.	DATE	BORING NO.
K1191-13	May 1990	2

DRILL RIG Rotary Wash	SURFACE ELEVATION —	LOGGED BY MD
DEPTH TO GROUNDWATER Not Established	BORING DIAMETER 3½ Inches	DATE DRILLED 4/19/90

DESCRIPTION AND CLASSIFICATION				DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT.)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)
DESCRIPTION AND REMARKS	COLOR	CONSIST.	SOIL TYPE						
1½" AC over 5" Baserock									
SAND (fine- to coarse-grained), some silt and clay	mottled brown orange grey blue	medium dense	SM-SC	1		16			
(trace of gravel, fine-grained)				2					
				3		24			
				4					
(grading interbedded lenses of clay, gravelly, fine-grained, sandy, fine- to coarse-grained, silty)		soft-firm	CL	5					
				6		4	19		
CLAY, silty, sandy (fine-to-coarse-grained)	orange brown	firm	CL-SC	7					
				8					
				9		5			
				10					
				11					
Passing #200 Sieve = 88%			CL	12					
(FILL)				13		4			
CLAY, silty (Bay Mud)	blue grey	soft	CL	14					
				15					
				16					
				17					
				18		13			
				19					
				20					

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EXPLORATORY BORING LOG

ADDITIONS TO LINCOLN MIDDLE SCHOOL
Alameda, California

PROJECT NO.	DATE	BORING NO.
K1191-13	May 1990	3

DRILL RIG	Rotary Wash	SURFACE ELEVATION	—	LOGGED BY	MD
DEPTH TO GROUNDWATER	Not Established	BORING DIAMETER	3½ Inches	DATE DRILLED	4/19/90

DESCRIPTION AND CLASSIFICATION				DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT.)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)
DESCRIPTION AND REMARKS	COLOR	CONSIST.	SOIL TYPE						
CLAY, silty (Bay Mud) (continued)	blue grey	soft	CL	21					
SAND (fine-grained), some silt	blue green	loose	SM	22					
				23					
				24		7*			
				25					
				26					
				27					
		medium dense		28					
				29		22			
				30					
				31					
				32					
				33					
				34					
				35					
				36					
				37					
				38					
				39		23	19		
				40					

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EXPLORATORY BORING LOG

ADDITIONS TO LINCOLN MIDDLE SCHOOL
Alameda, California

PROJECT NO.	DATE	BORING NO.
K1191-13	May 1990	3

DRILL RIG Rotary Wash	SURFACE ELEVATION —	LOGGED BY MD
DEPTH TO GROUNDWATER Not Established	BORING DIAMETER 3½ Inches	DATE DRILLED 4/19/90

DESCRIPTION AND REMARKS	COLOR	CONSIST.	SOIL TYPE	DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT %	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)
SAND (fine-grained), some silt (continued)	blue green	medium dense	SM	41					
				42					
CLAY, silty, some sand (fine-grained)	blue grey green	hard	CL	43					
				44					
				45					
				46					
				47					
				48					
				49		34			
Bottom of Boring = 49½ Feet				50					
				51					
				52					
				53					
				54					
				55					
				56					
				57					
				58					
				59					
				60					

Notes:
1. The stratification lines represent the approximate boundaries between soil types and the transition may be gradual.
2. For an explanation of penetration resistance values marked with an asterisk (*) see first page, Appendix A.

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EXPLORATORY BORING LOG

ADDITIONS TO LINCOLN MIDDLE SCHOOL
Alameda, California

PROJECT NO.	DATE	BORING NO.
K1191-13	May 1990	3

DRILL RIG Continuous Flight Auger	SURFACE ELEVATION --	LOGGED BY MD
DEPTH TO GROUNDWATER 12½' (see note 3)	BORING DIAMETER 6 Inches	DATE DRILLED 4/25/90

DESCRIPTION AND REMARKS	COLOR	CONSIST.	SOIL TYPE	DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT.)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)
2" AC over 4" Baserock									
SAND (fine- to coarse-grained), some silt and gravel (fine-grained), occasional clay balls	mottled black brown orange	medium dense	SC-CL	1					
				2		26			
(grading interbedded lenses of clay, silty, with sand, fine- to medium-grained)				3		15	18		
				4					
				5		12			
				6					
				7					
				8					
(grading without clay, trace of silt) Passing #200 Sieve = 15%		loose	SM	9		6			
				10					
				11					
				12			▽		
				13					
(FILL)				14		6			
CLAY, silty (Bay Mud)	blue grey	firm	CL-CH	15					
Liquid Limit = 61%				16		6*			
Plasticity Index = 35%		soft		17					
Passing #200 Sieve = 99%				18					
(lens of sand)				19					
				20		19*			

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EXPLORATORY BORING LOG

ADDITIONS TO LINCOLN MIDDLE SCHOOL
Alameda, California

PROJECT NO.	DATE	BORING NO.
K1191-13	May 1990	4

DRILL RIG	Continuous Flight Auger	SURFACE ELEVATION	---	LOGGED BY	MD
DEPTH TO GROUNDWATER	12½'(see note 3)	BORING DIAMETER	6 Inches	DATE DRILLED	4/25/90

DESCRIPTION AND REMARKS	COLOR	CONSIST.	SOIL TYPE	DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT.)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)
CLAY, silty (Bay Mud) (continued)	blue grey	firm	CL-CH	21		19*			
SAND (fine-grained), some silt	blue green	medium dense	SM	22					
				23					
				24					
				25					
				26		14	22		
Bottom of Boring = 26½ Feet				27					
				28					
				29					
				30					
				31					
				32					
				33					
				34					
				35					
				36					
				37					
				38					
				39					
				40					

Notes:
1. The stratification lines represent the approximate boundaries between soil types and the transition may be gradual.
2. For an explanation of penetration resistance values marked with an asterisk (*) see first page, Appendix A.
3. Ground water level was measured at 12½ feet at time of drilling.

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EXPLORATORY BORING LOG

ADDITIONS TO LINCOLN MIDDLE SCHOOL
Alameda, California

PROJECT NO.	DATE	BORING NO.
K1191-13	May 1990	4

DRILL RIG Continuous Flight Auger	SURFACE ELEVATION --	LOGGED BY MD
DEPTH TO GROUNDWATER 8'(see note 3)	BORING DIAMETER 6 Inches	DATE DRILLED 4/25/90

DESCRIPTION AND REMARKS	COLOR	CONSIST.	SOIL TYPE	DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT.)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)
3" AC over 6" Baserock									
CLAY, silty, sandy (fine- to medium-grained)	dark brown	stiff	CL	1–2		13	17		
CLAY, silty, with sand (fine- to coarse-grained), trace of gravel (fine-grained)	tan brown mottled with orange	very stiff	CL	3–4		18			
				5–6		17			
				7–8			▽		
(grading sandy, fine- to coarse-grained, gravelly, fine-grained) Passing #200 Sieve = 54%		soft		9–10		3			
(FILL)				11–13					
CLAY, silty (Bay Mud)	blue grey	very soft	CL-CH	14–15		4*	87	49	0.3
				16–18					
SAND (fine-grained), some silt Passing #200 Sieve = 21%	blue green	very loose	SM	19–20		7*			

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EXPLORATORY BORING LOG

ADDITIONS TO LINCOLN MIDDLE SCHOOL
Alameda, California

PROJECT NO.	DATE	BORING NO.
K1191-13	May 1990	5

DRILL RIG Continuous Flight Auger	SURFACE ELEVATION —	LOGGED BY MD
DEPTH TO GROUNDWATER 8'(see note 3)	BORING DIAMETER 6 Inches	DATE DRILLED 4/25/90

DESCRIPTION AND REMARKS	COLOR	CONSIST.	SOIL TYPE	DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT.)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)
SAND (fine-grained), some silt and clay (continued)	blue green	very loose	SC	21 22 23 24		7*			
		medium dense		25		29			
Bottom of Boring = 25½ Feet				26 27 28 29 30 31 32 33 34 35 36 37 38 39 40					

Notes:
1. The stratification lines represent the approximate boundaries between soil types and the transition may be gradual.
2. For an explanation of penetration resistance values marked with an asterisk (*) see first page, Appendix A.
3. Ground water level was measured at 8 feet at time of drilling.

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EXPLORATORY BORING LOG

ADDITIONS TO LINCOLN MIDDLE SCHOOL
Alameda, California

PROJECT NO.	DATE	BORING NO.
K1191-13	May 1990	5

DRILL RIG Continuous Flight Auger	SURFACE ELEVATION —	LOGGED BY MD
DEPTH TO GROUNDWATER 10'(see note 3)	BORING DIAMETER 6 Inches	DATE DRILLED 4/25/90

DESCRIPTION AND REMARKS	COLOR	CONSIST.	SOIL TYPE	DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT.)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)
2" AC over 5" Baserock									
SAND (fine- to medium-grained), some silt	brown tan	loose	SM	1					
SAND (fine-grained), clayey, some silt	black	loose	SC	2		10			
				3					
SAND (fine- to coarse-grained), some clay, silt and gravel (fine-grained)	mottled black brown orange	loose	SC	4		10			
				5					
		medium dense		6		17			
				7					
				8					
	mottled grey green	loose		9					
				10		4	▽		
				11					
				12					
CLAY, silty (Bay Mud)	blue grey	very soft	CL-CH	13					
				14		3*			
				15					
				16					
				17					
SAND (fine-grained), some silt, trace of shells	blue black	very loose	SM	18					
				19		5*			
				20					

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EXPLORATORY BORING LOG

ADDITIONS TO LINCOLN MIDDLE SCHOOL
Alameda, California

PROJECT NO.	DATE	BORING NO.
K1191-13	May 1990	6

DRILL RIG Continuous Flight Auger	SURFACE ELEVATION --	LOGGED BY MD
DEPTH TO GROUNDWATER 10'(see note 3)	BORING DIAMETER 6 Inches	DATE DRILLED 4/25/90

DESCRIPTION AND CLASSIFICATION				DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT.)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)
DESCRIPTION AND REMARKS	COLOR	CONSIST.	SOIL TYPE						
SAND (fine-grained), some silt and clay, trace of shells (continued)	blue black	very loose	SC	21 22					
(grading no clay or shells)	blue green	medium dense	SM	23 24		22			
Bottom of Boring = 24½ Feet				25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40					

Notes:
1. The stratification lines represent the approximate boundaries between soil types and the transition may be gradual.
2. For an explanation of penetration resistance values marked with an asterisk (*) see first page, Appendix A.
3. Ground water level was measured at 10 feet at time of drilling.

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EXPLORATORY BORING LOG

ADDITIONS TO LINCOLN MIDDLE SCHOOL
Alameda, California

PROJECT NO.	DATE	BORING NO.
K1191-13	May 1990	6