MILLER PACIFIC ENGINEERING GROUP

August 4, 2017
File: 1911.035altr.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
Earhart Elementary School Campus
400 Packet Landing Road
Alameda, California

Introduction

This letter summarizes our geotechnical investigation of the Earhart Elementary School campus located at 400 Packet Landing Road 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 potential across the school campus. Our scope includes exploring the subsurface conditions with six Cone Penetration Tests (CPTs), conducting engineering analyses to evaluate the liquefaction risk and liquefaction induced settlement potential, and presentation of our geotechnical conclusions in this letter report.

Site Description

The Earhart Elementary School campus is located on the easterly side of Packet Landing Road, and is bordered on the east by Island Drive and on the south by Robert Davey Jr. Drive, as shown on the Site Location Map, Figure 1. The existing campus consists of numerous permanent and portable buildings, paved driveways and parking areas, paved and grass 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 slightly sloping terrain.

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 sands, as shown on Figure 3. These artificial (manmade) fills were placed over older dune sands and soft clay (Bay Mud).

Surface Conditions

The site is currently developed as an elementary 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

Miller Pacific Engineering Group 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 10, 2017. The CPTs were extended to depths of about 80 feet to 100 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.

Subsurface Conditions

The subsurface conditions are consistent with the mapped geology. Review of subsurface data collected from the CPTs conducted at the site indicate that the campus is generally underlain by approximately 15 to 20 feet of loose to medium-dense sandy fill, over soft clay (Bay Mud). The soft clay (Bay Mud) extends to a depth of about 50 to 60 feet below the ground surface. Beneath the soft clay, each CPT encountered predominantly medium-dense to dense silty sand and sandy silt extending to a depth of 100 feet or more.

Groundwater was measured at approximately five to twelve feet below the ground surface during our CPT investigations. It is anticipated that the groundwater level beneath the site is influenced by tidal activity in the nearby San Francisco Bay.

Given the low site elevations and proximity to San Francisco Bay, the highest historic groundwater elevation is assumed to coincide with the ground surface.

[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.

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.

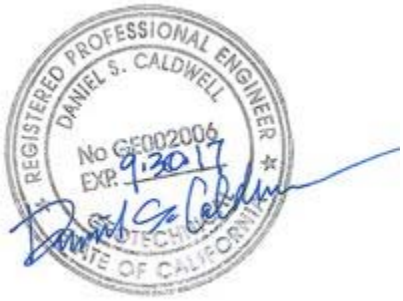
We analyzed the potential for liquefaction utilizing the CPT Liquefaction Assessment software program CLiq (2007, ver. 2.1.6.9), and the procedures outlined by Idriss and Boulanger (2014). The design seismic conditions consisted of a magnitude 7.3 earthquake producing a PGA of 0.54g, which corresponds to the PGA_M per ASCE 7-10 Section 11.8.3, and assuming groundwater at the ground surface. The results of our liquefaction analyses are presented on Figures 5 through 10, and indicate granular soil layers observed between roughly one and sixteen feet, and discontinuous lenses between roughly 59 and 90 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 one and sixteen feet below the ground surface may result in ground surface settlement of between roughly 1.0-inch to 2.5-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 0.5 to 1.5-inches).

Based on procedures outlined by Idriss and Boulanger, 2014, the discontinuous and relatively thin layers of potentially liquefiable soil observed 59-feet to 90-feet below the ground surface in the CPT's may experience 1.0-inch to 3.5-inches 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 59-feet.

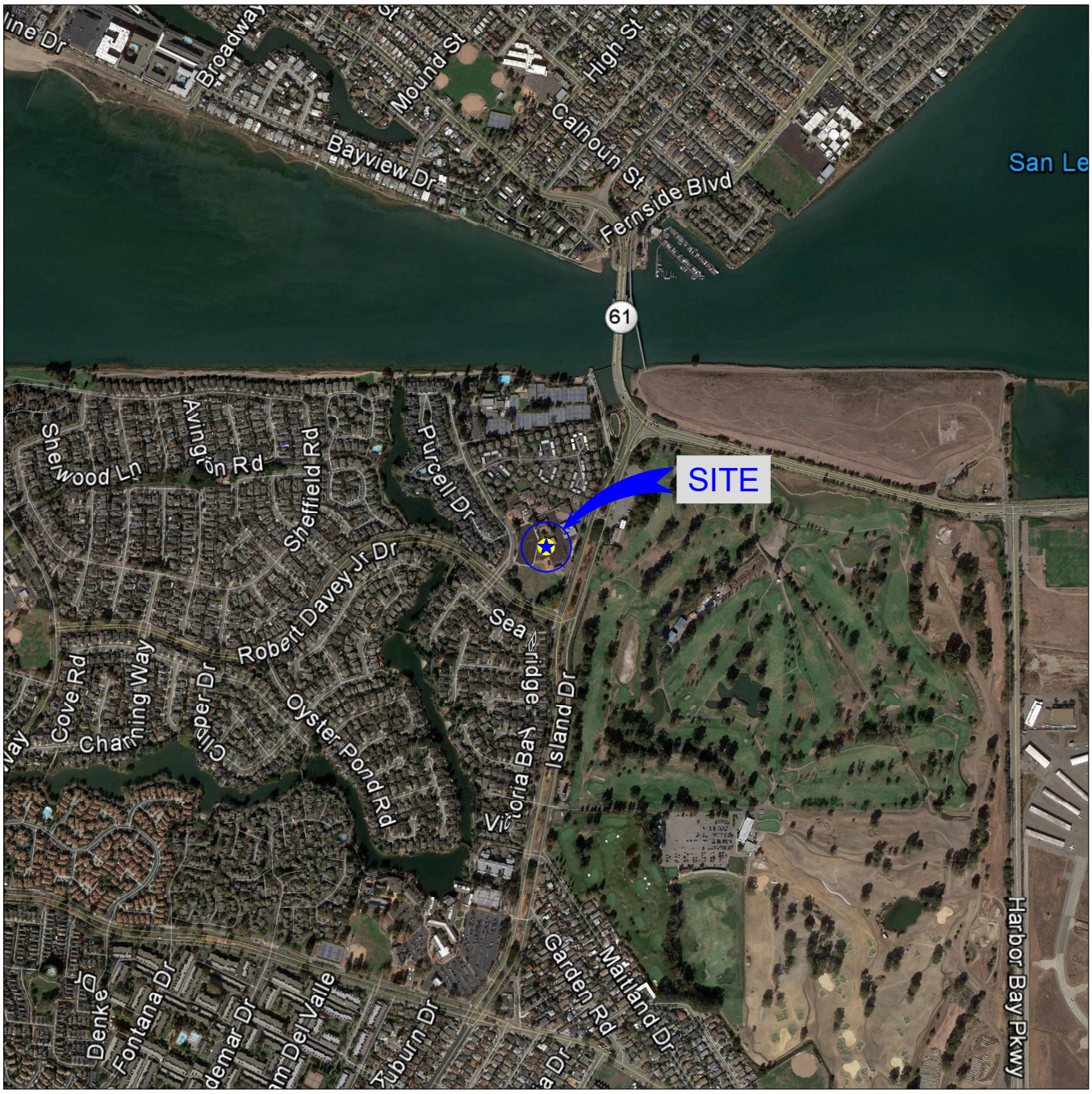
If you have any questions, or if we can be of further assistance, please call us at your convenience.

Yours very truly,
MILLER PACIFIC ENGINEERING GROUP



Daniel S. Caldwell
Geotechnical Engineer #2006
(Expires 9/30/17)

Attachments: Figures 1 through 11, A-1 through A-8



SITE: LATITUDE, 37.7451°
LONGITUDE, -122.2379°

SITE LOCATION

N.T.S.

NORTH

REFERENCE: Google Earth, 2017

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SITE LOCATION MAP

Earhart Elementary School
400 Packet Landing Road
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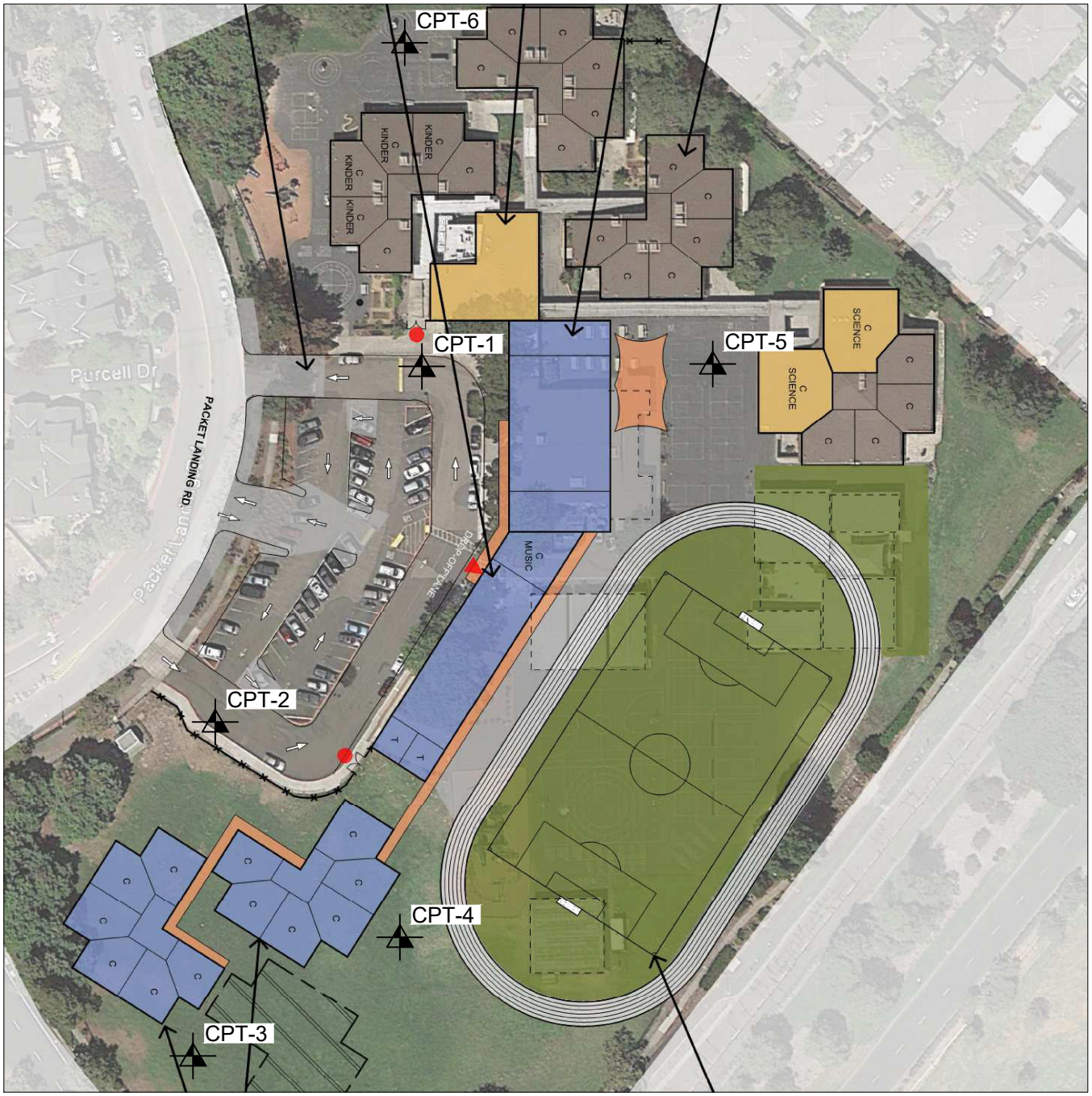
1
FIGURE



SITE PLAN

SCALE

0 50 100 200 FEET

NORTH

Approximate CPT location completed by MPEG, 2017

REFERENCE: Site Plan Provided by QKA

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SITE PLAN

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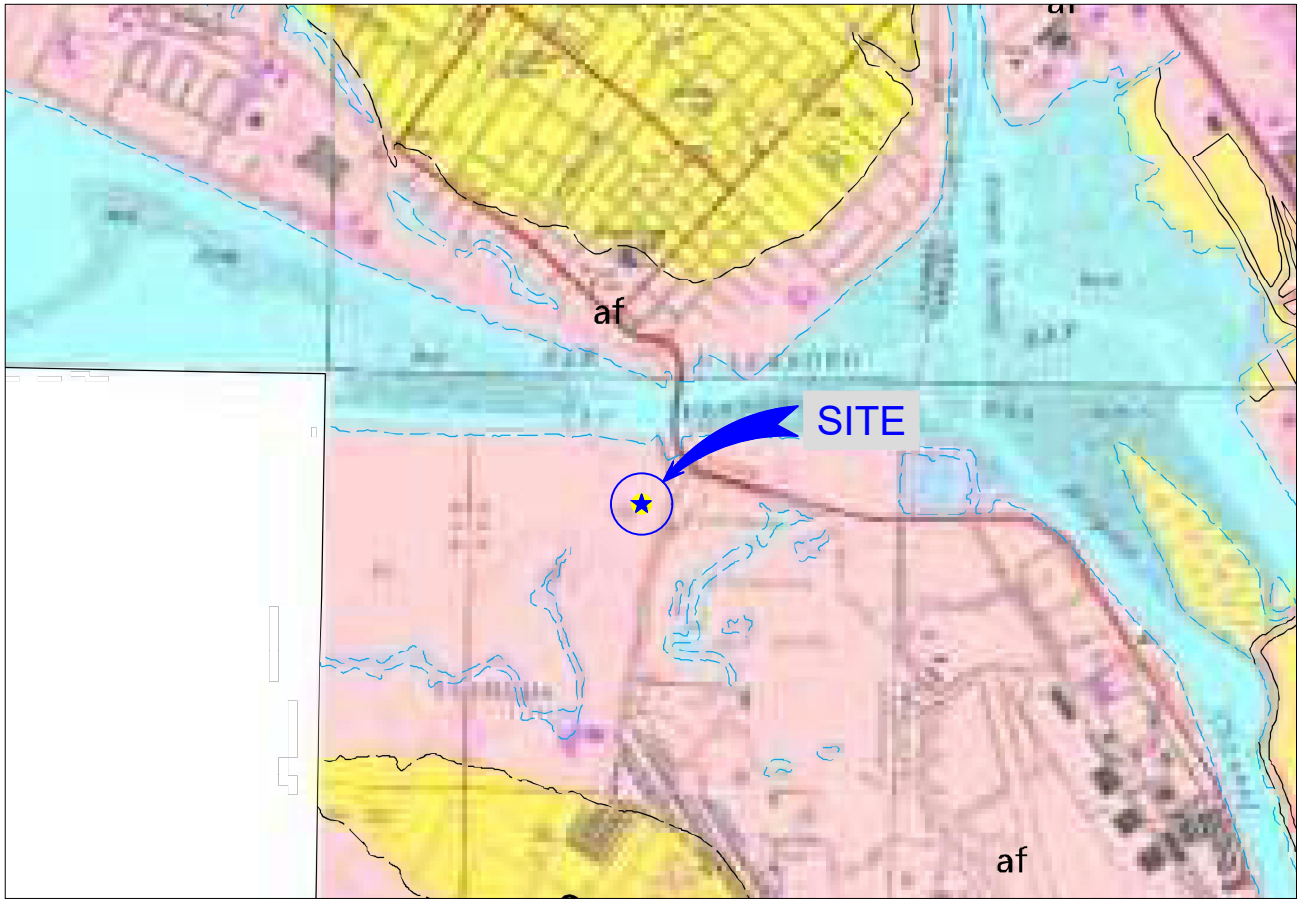
2
FIGURE



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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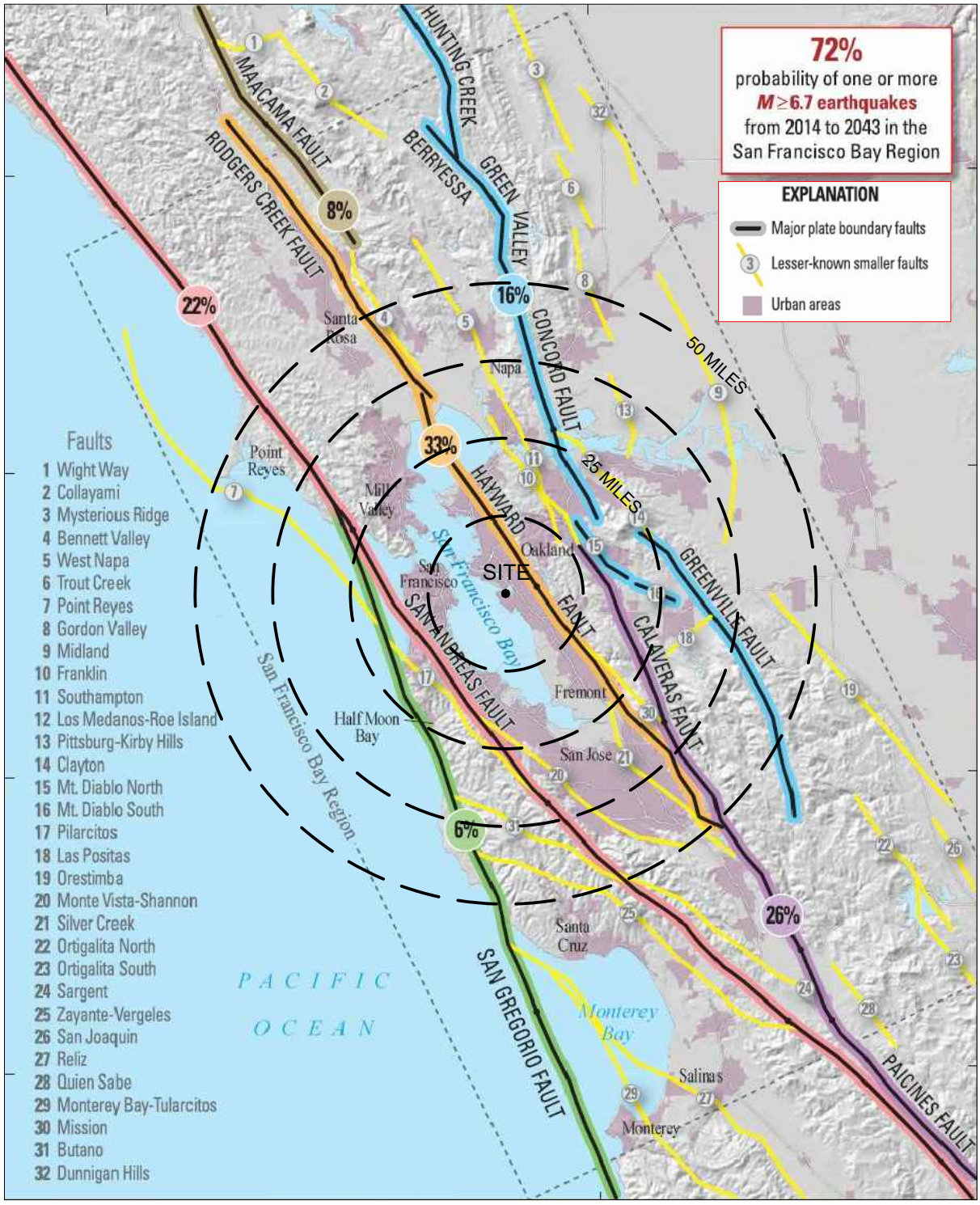
3
FIGURE



SITE COORDINATES
LAT. 37.7451°
LON. -122.2379°

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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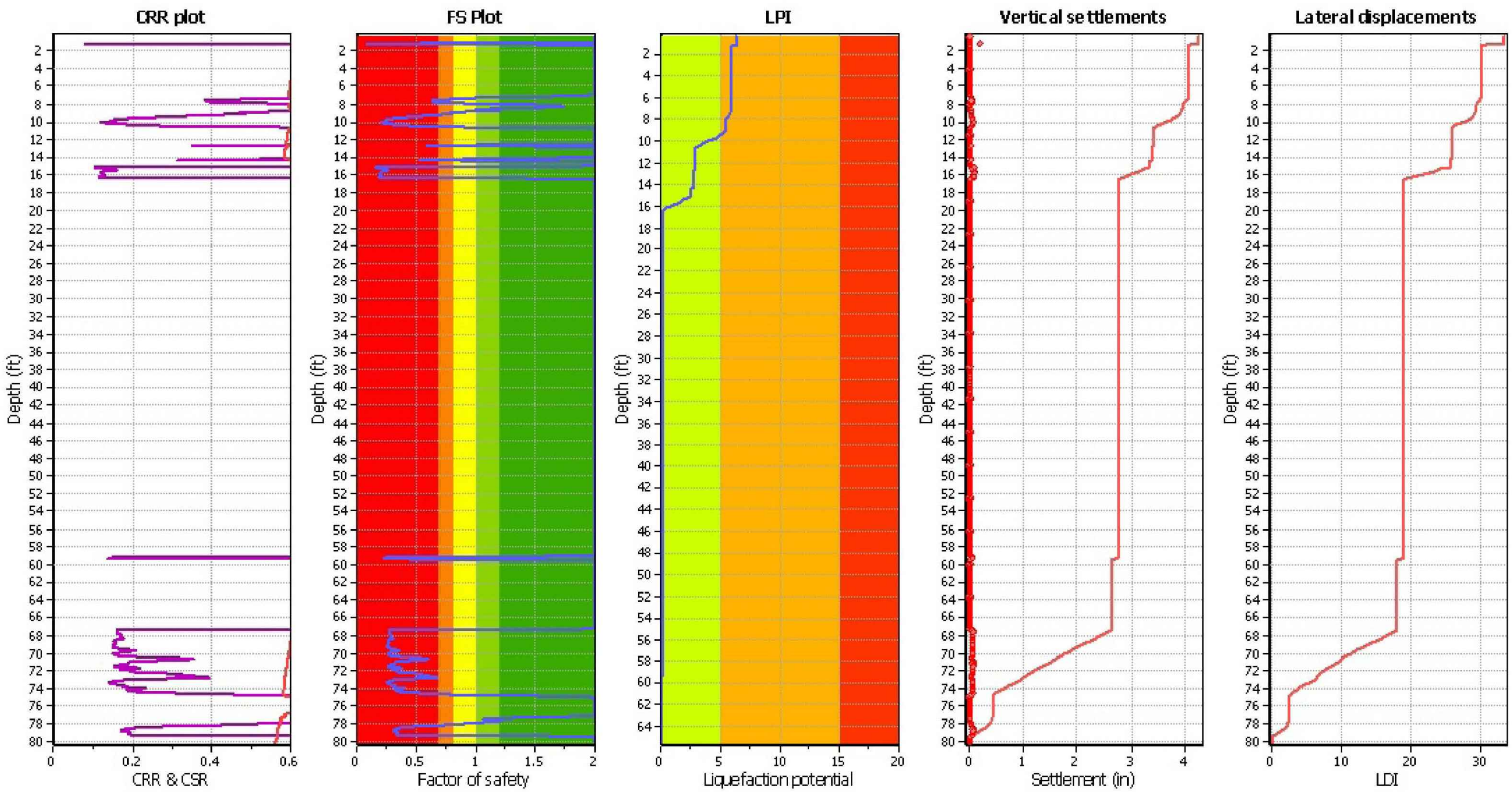
CPT name: CPT-01

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:	0.54	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.00 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: 4/19/2017, 9:59:57 AM
Project file: H:\Jobs\1900-1999\1911.035 Earhart ES Classrooms\Analyses\1911.035 CPTLiq.clq

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CPT-1 LIQUEFACTION ANALYSIS

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5
FIGURE

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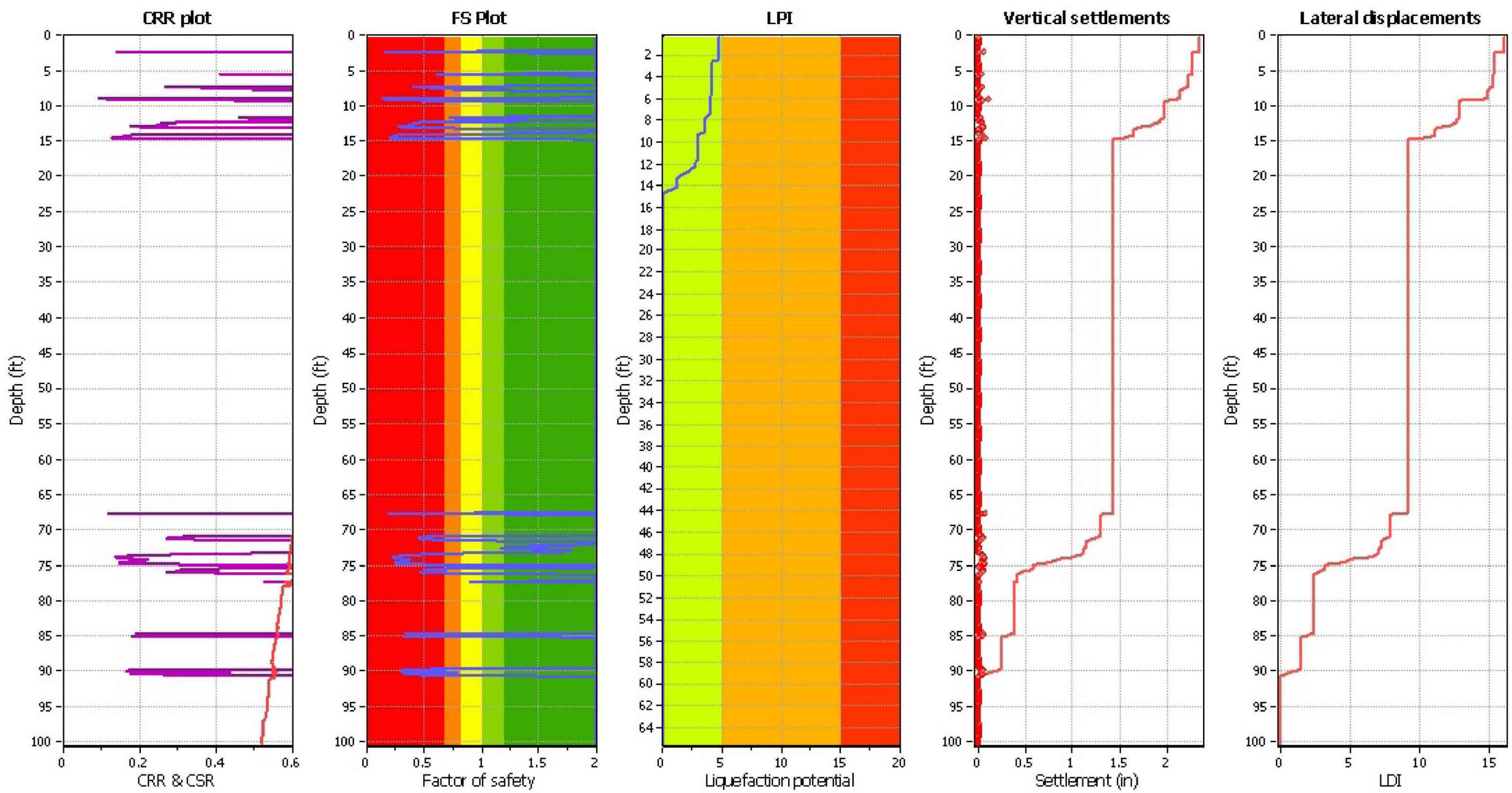
Liquefaction analysis overall plot



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Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.54	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.00 ft	Fill height:	N/A	Limit depth:	N/A

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LPI color scheme

- Very high risk
- High risk
- Low risk

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12

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CPT-2 LIQUEFACTION ANALYSIS

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FIGURE 6

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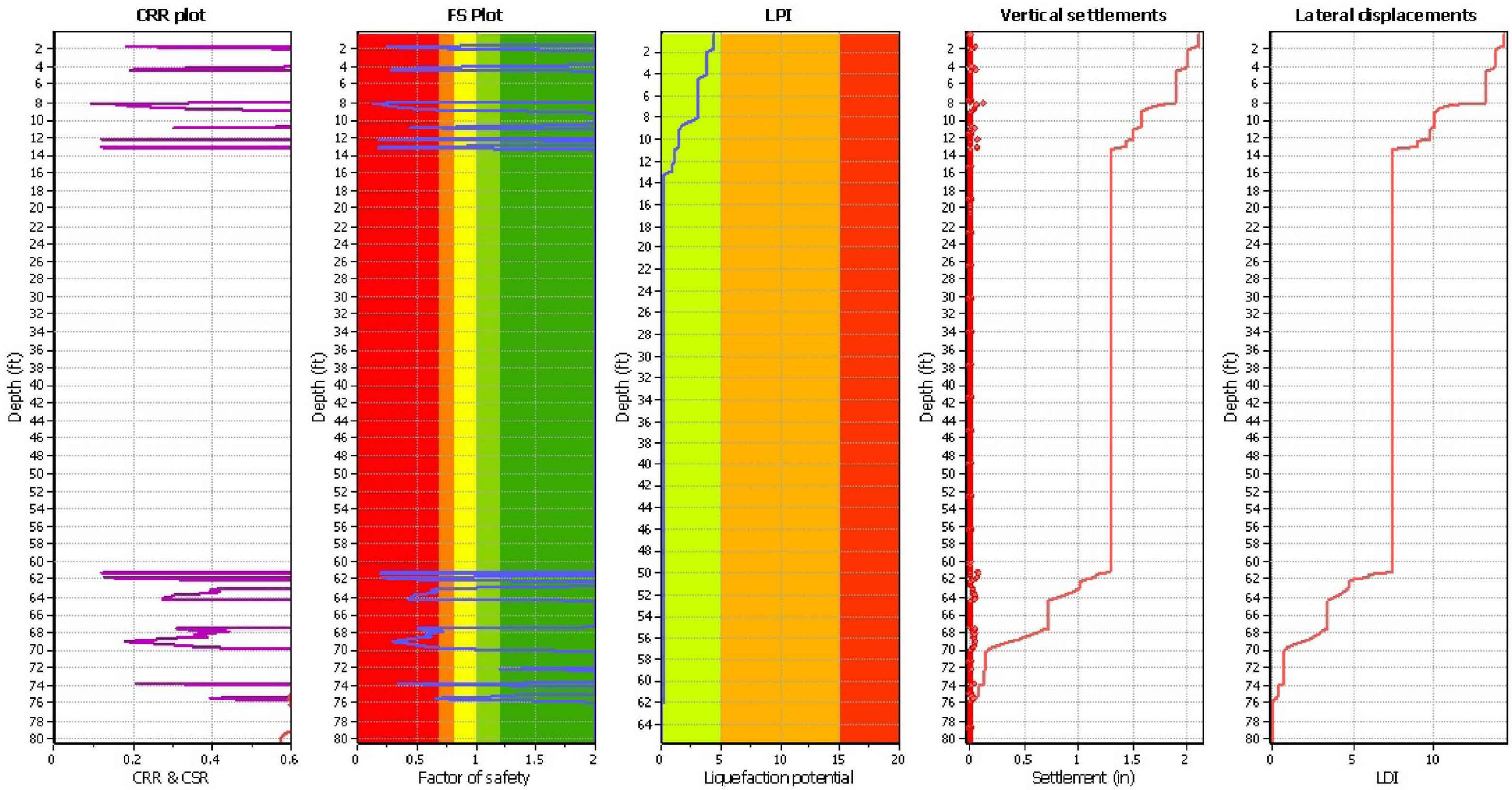
Liquefaction analysis overall plot



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Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.54	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.00 ft	Fill height:	N/A	Limit depth:	N/A

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LPI color scheme

- Very high risk
- High risk
- Low risk

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19

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CPT-3 LIQUEFACTION ANALYSIS

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FIGURE

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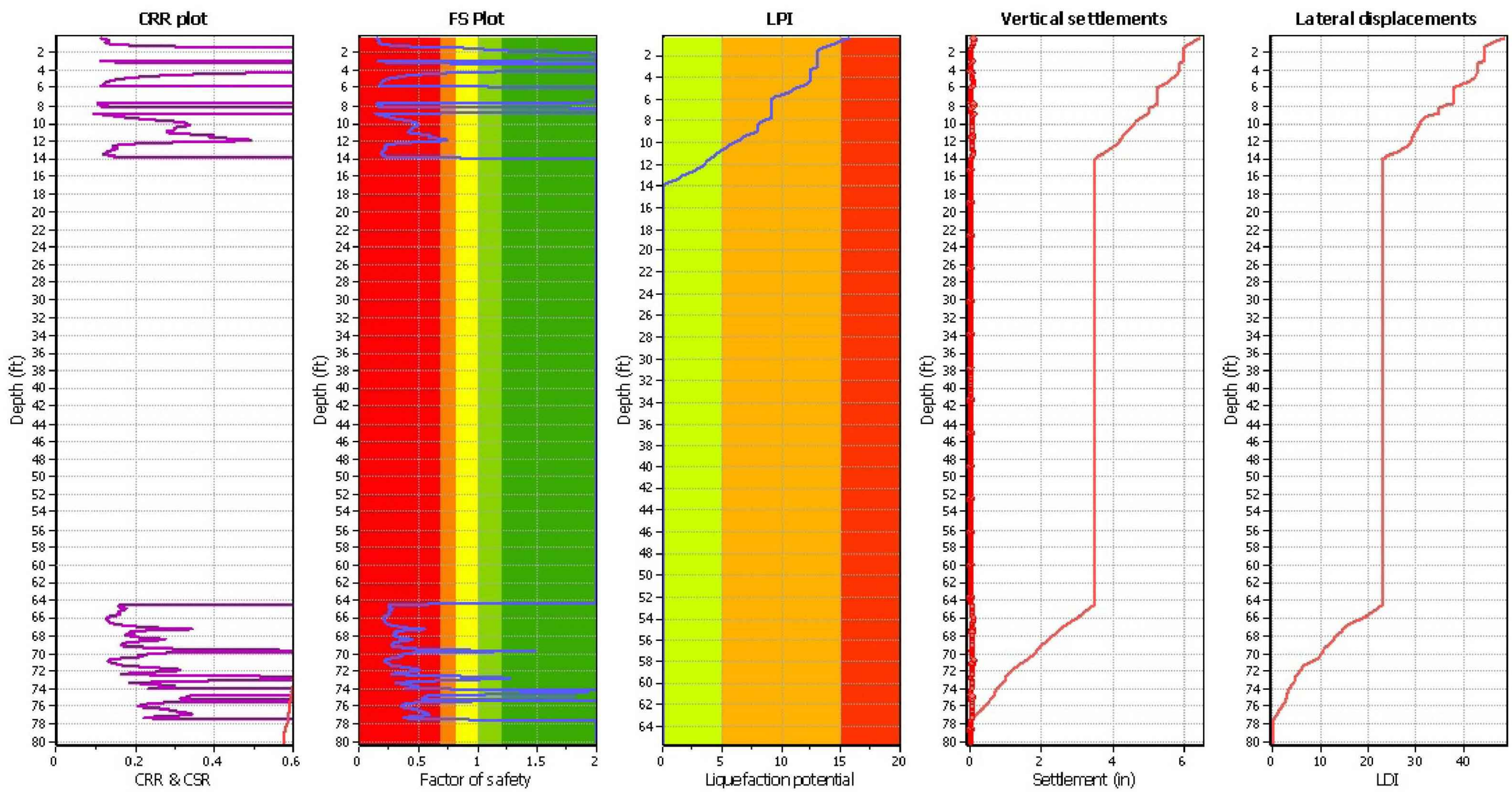
CPT name: CPT-04

Liquefaction analysis overall plot



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Peak ground acceleration:	0.54	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.00 ft	Fill height:	N/A	Limit depth:	N/A

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LPI color scheme

- Very high risk
- High risk
- Low risk

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CPT-4 LIQUEFACTION ANALYSIS

Earhart Elementary School
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FIGURE 8

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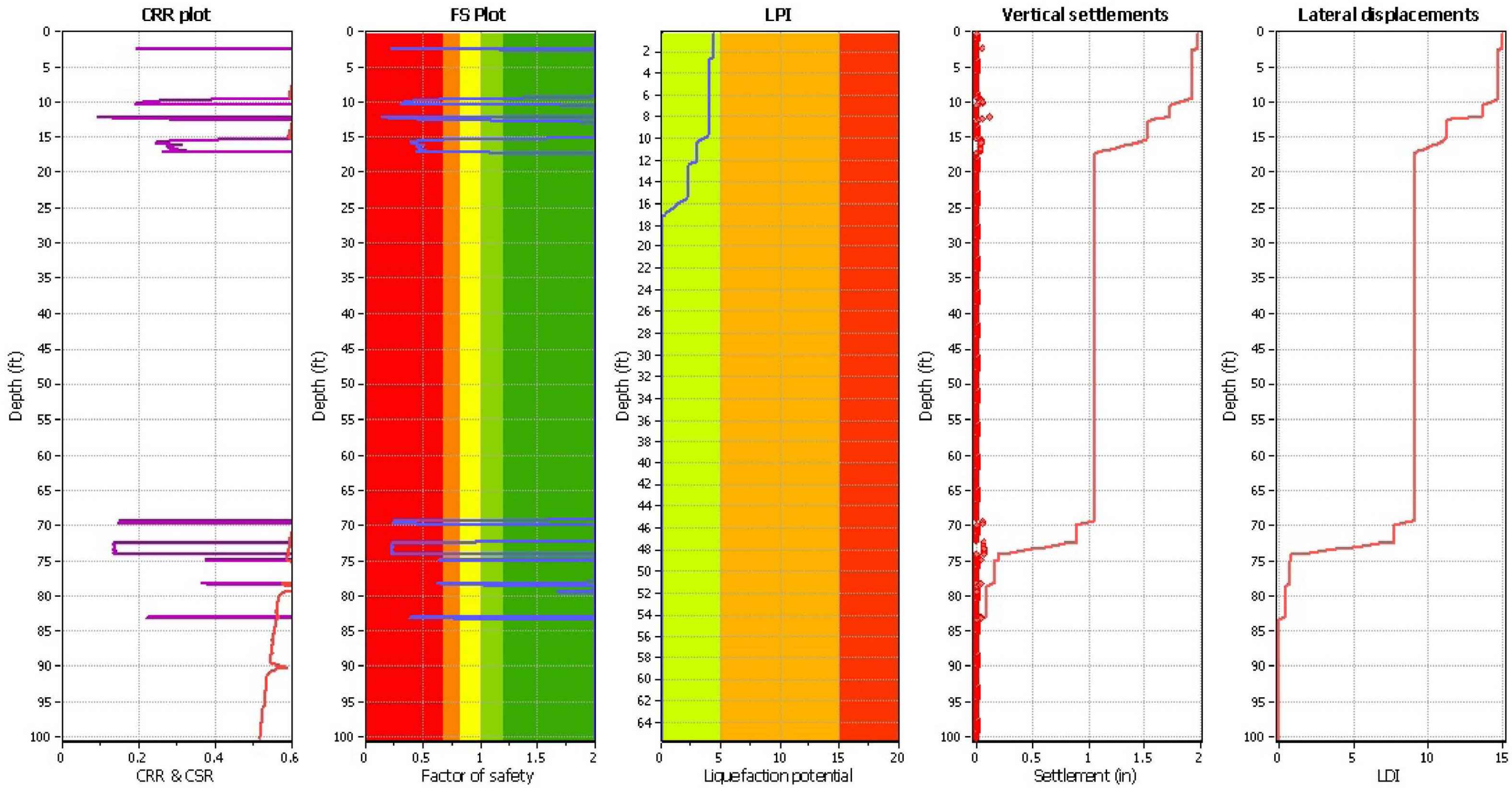
CPT name: CPT-05

Liquefaction analysis overall plot



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Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.54	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.00 ft	Fill height:	N/A	Limit depth:	N/A

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LPI color scheme

- Very high risk
- High risk
- Low risk

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33

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CPT-5 LIQUEFACTION ANALYSIS

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FIGURE

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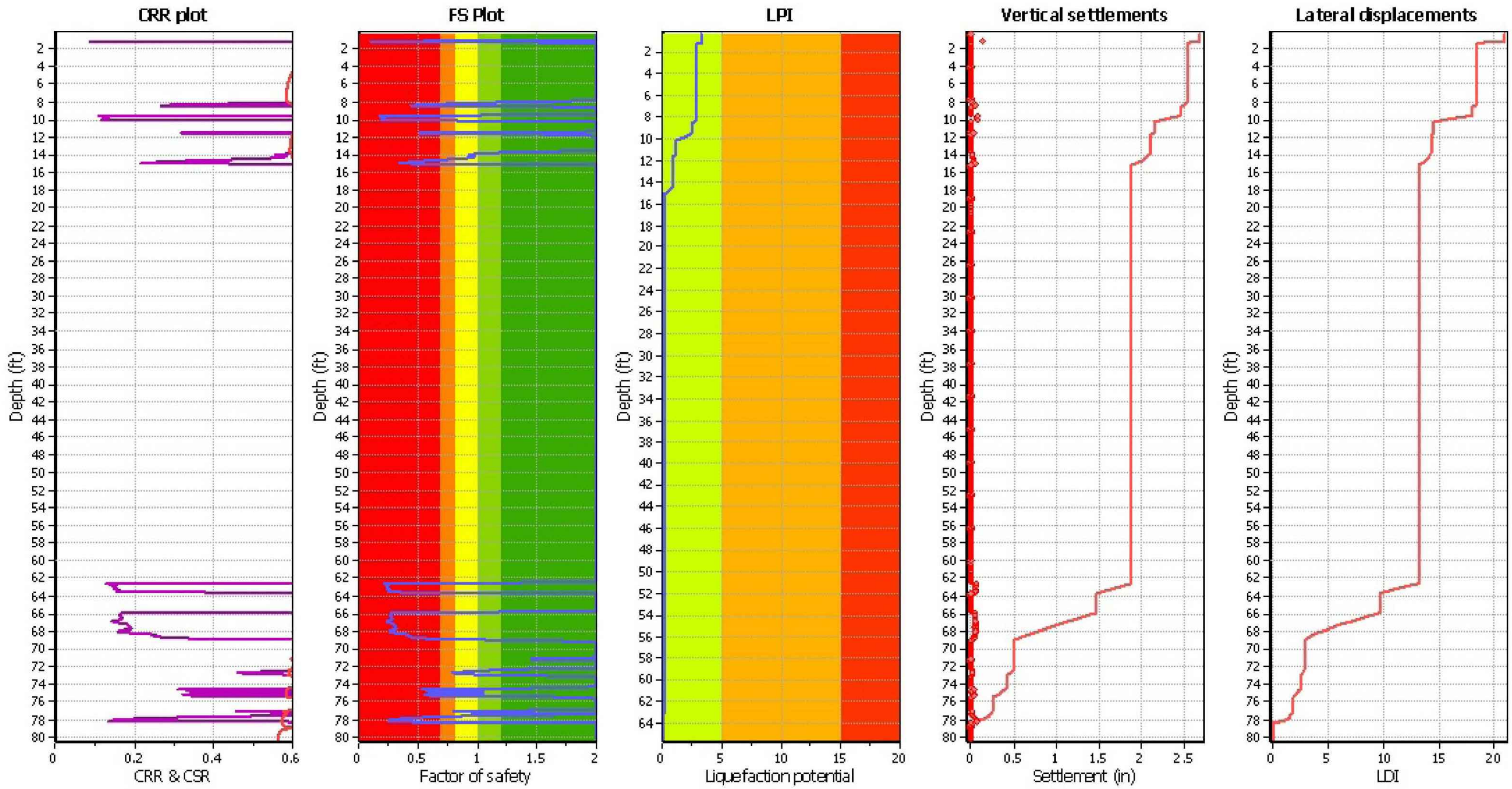
CPT name: CPT-06

Liquefaction analysis overall plot



Input parameters and analysis data

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Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.54	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.00 ft	Fill height:	N/A	Limit depth:	N/A

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LPI color scheme

- Very high risk
- High risk
- Low risk

CLiq v.2.1.6.9 - CPT Liquefaction Assessment Software - Report created on: 4/19/2017, 10:00:03 AM
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CPT-6 LIQUEFACTION ANALYSIS

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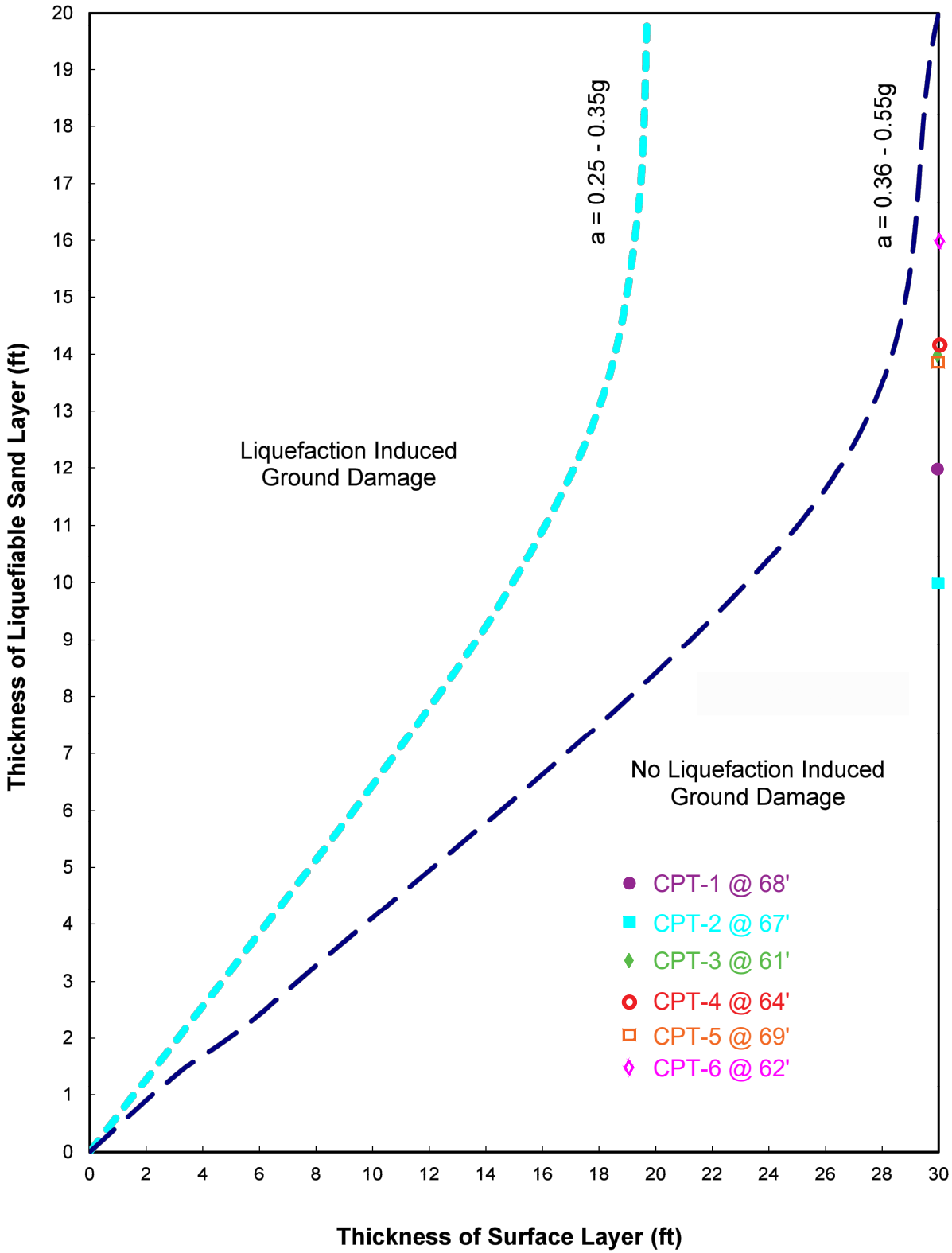
10
FIGURE

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



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LIQUEFACTION ANALYSIS - SURFACE EFFECTS

Earhart Elementary School
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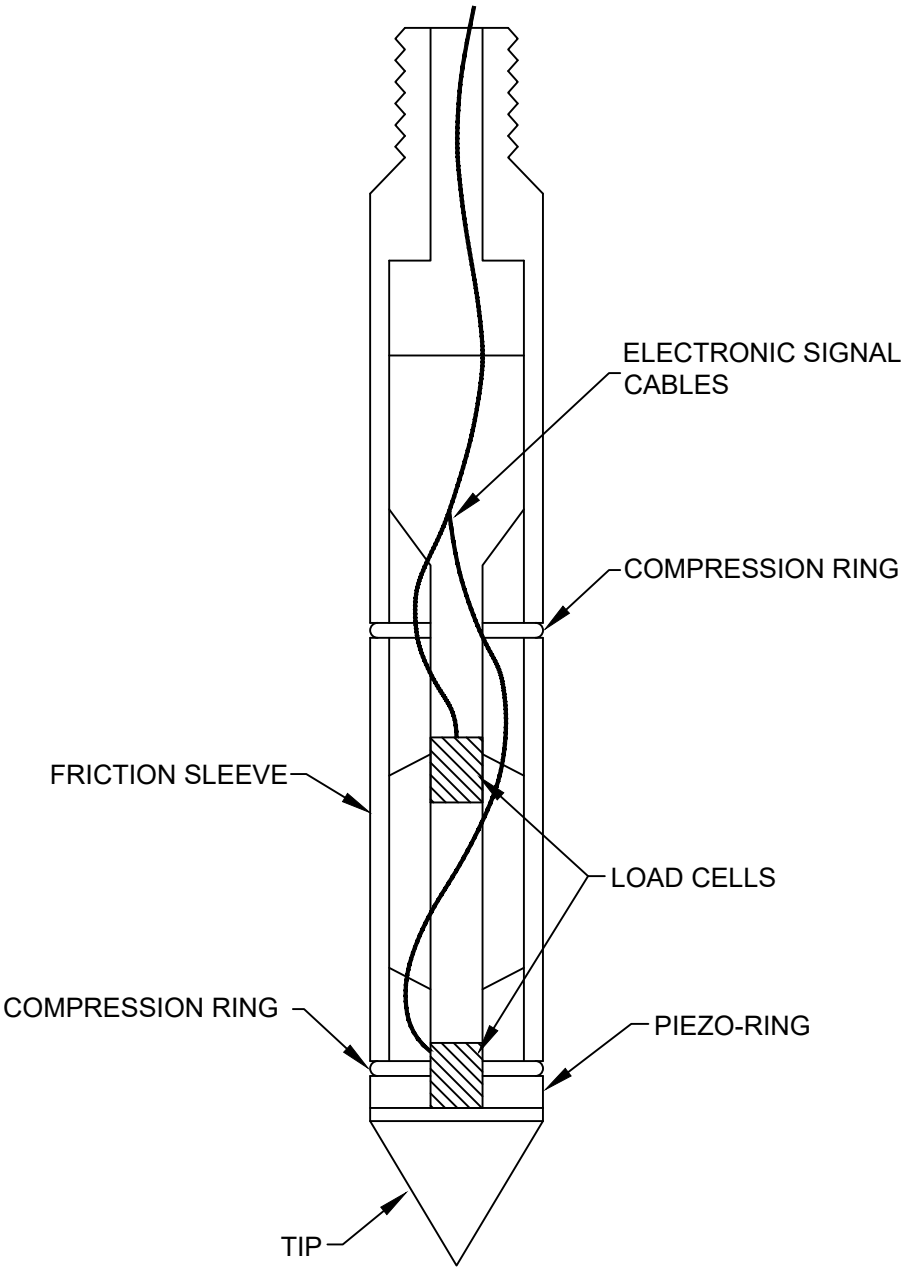
11
FIGURE

APPENDIX A



CONE PENETROMETER

(NO SCALE)

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FILENAME: 1911.035 CPT.dwg

CONE PENETROMETER

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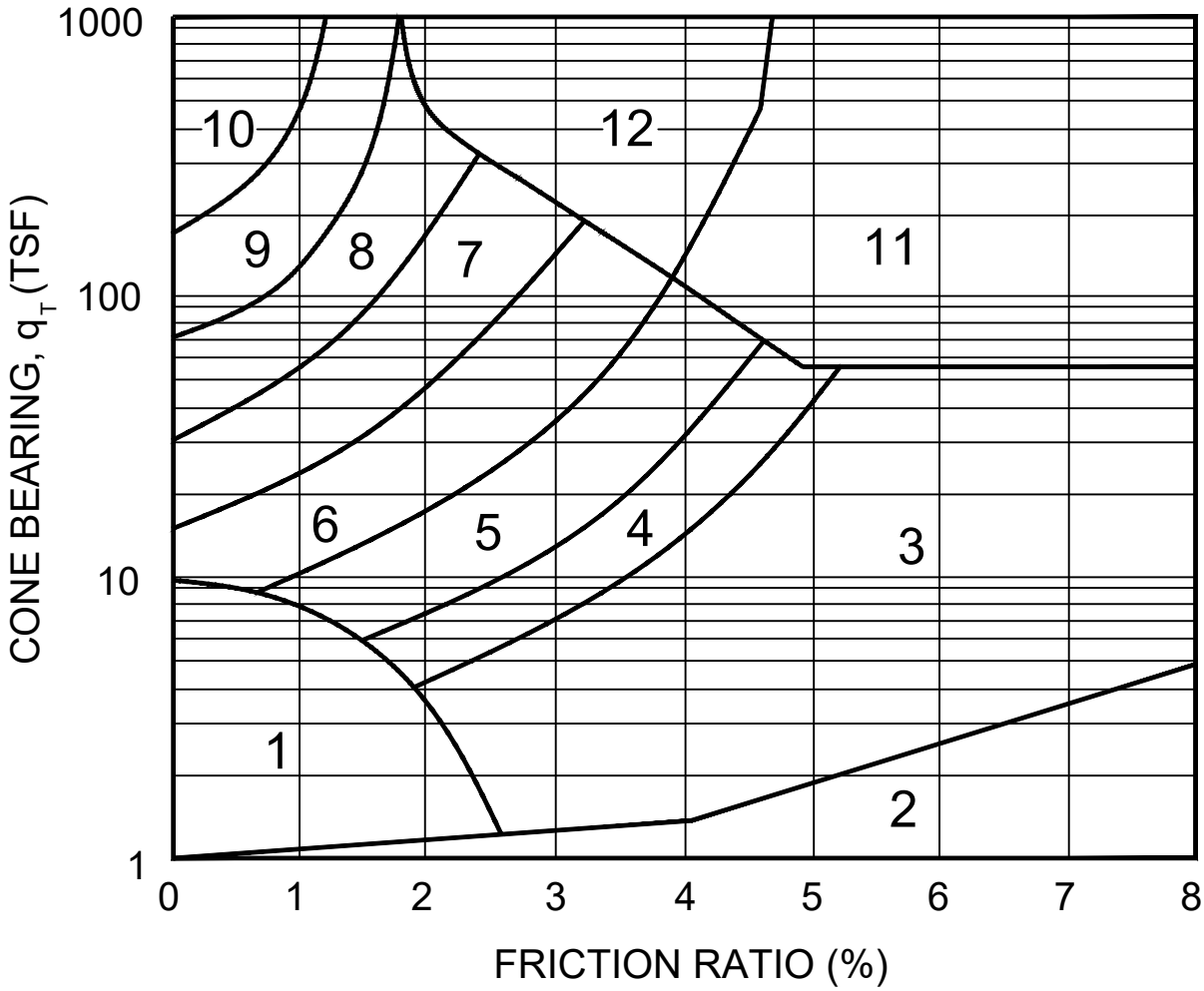
A-1
FIGURE



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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FILENAME: 1911.035 CPT.dwg

CPT SOIL INTERPRETATION CHART

Earhart Elementary School
400 Packet Landing Road
Alameda, California

Project No. 1911.035 Date: 4/7/17

Drawn MMT
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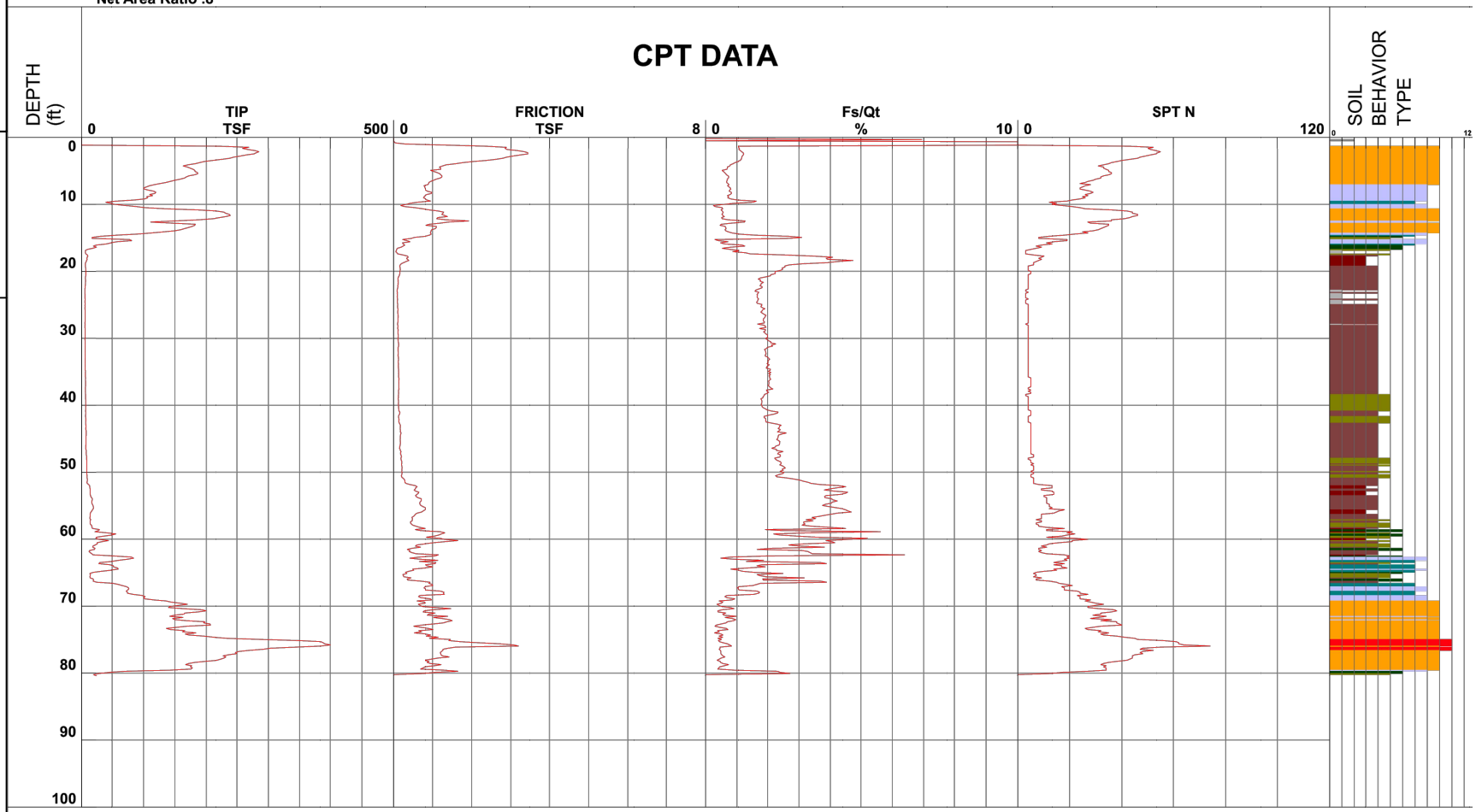
A-2
FIGURE

Miller Pacific Engineering

Project	Earhart Elementary School	Operator	RB KK	Filename	SDF(022).cpt
Job Number	1911.035	Cone Number	DDG1379	GPS	
Hole Number	CPT-01	Date and Time	4/10/2017 10:45:07 AM	Maximum Depth	80.38 ft
EST GW Depth During Test		11.80 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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Project No. 1911.035
Date: 4/7/17

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CPT-1 PLOT

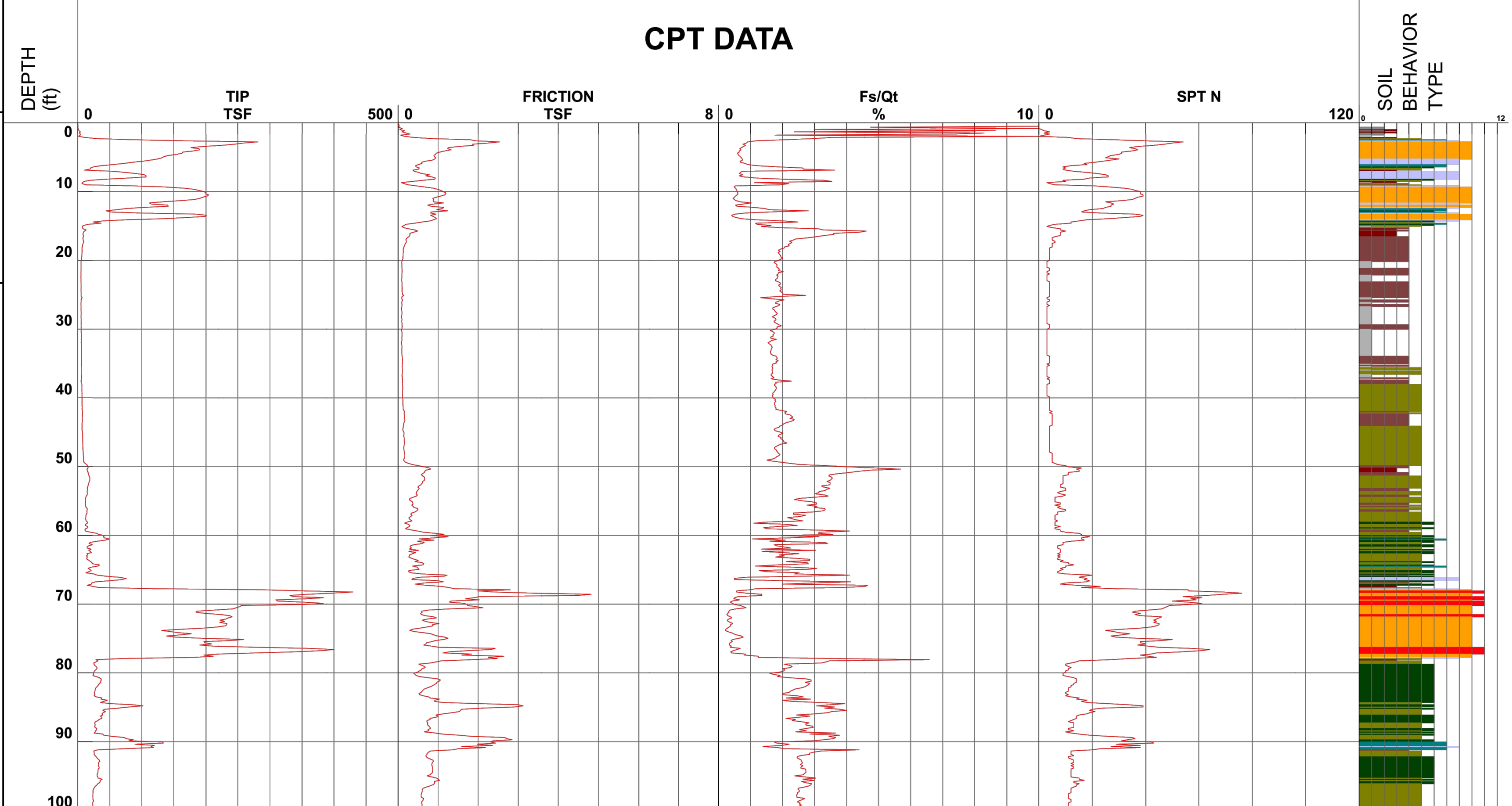
FIGURE A-3

Miller Pacific Engineering

Project	Earhart Elementary School	Operator	RB KK	Filename	SDF(020).cpt
Job Number	1911.035	Cone Number	DDG1379	GPS	
Hole Number	CPT-02	Date and Time	4/10/2017 7:10:40 AM	Maximum Depth	100.56 ft
EST GW Depth During Test		9.00 ft			

Net Area Ratio .8

CPT DATA



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

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Project No. 1911.035 Date: 4/7/17

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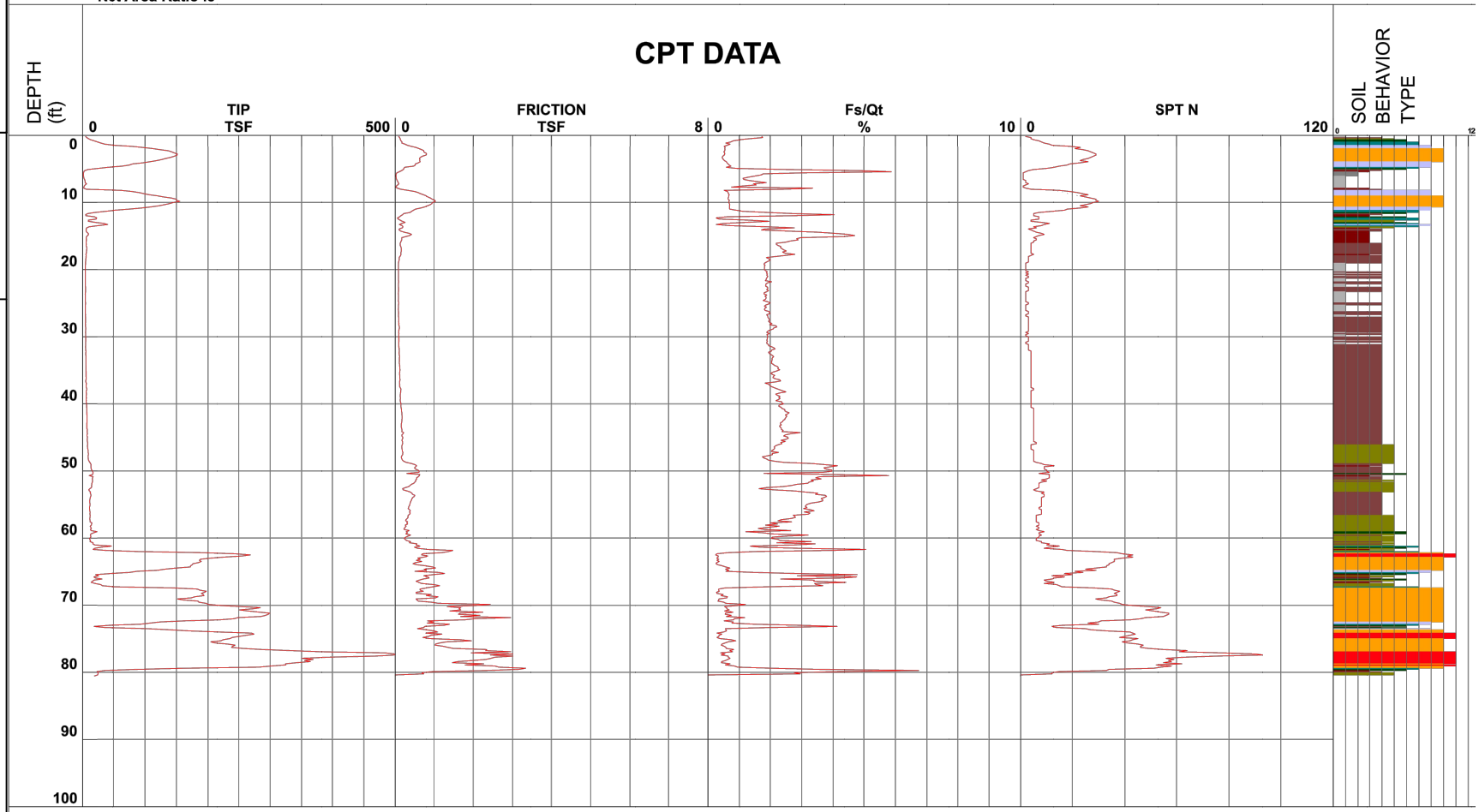
A-4
FIGURE

Miller Pacific Engineering

Project	Earhart Elementary School	Operator	RB KK	Filename	SDF(023).cpt
Job Number	1911.035	Cone Number	DDG1379	GPS	
Hole Number	CPT-03	Date and Time	4/10/2017 11:48:29 AM	Maximum Depth	80.54 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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CPT-3 PLOT

FIGURE A-5

FILENAME: 1911.035 CPT.dwg

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FIGURE A-6

CPT-4 PLOT

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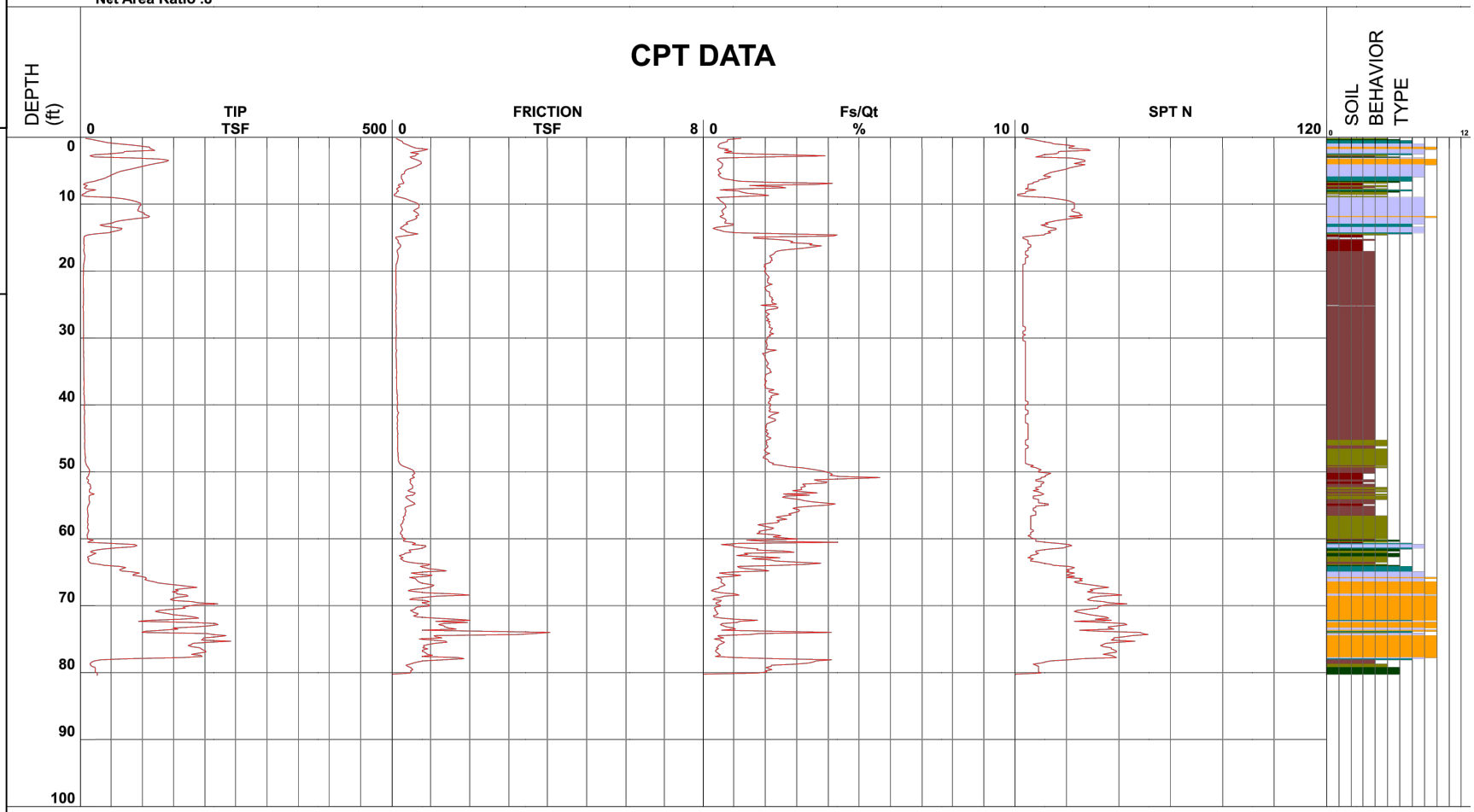
Alameda, California

Miller Pacific Engineering

Project	Earhart Elementary School	Operator	RB KK	Filename	SDF(024).cpt
Job Number	1911.035	Cone Number	DDG1379	GPS	
Hole Number	CPT-04	Date and Time	4/10/2017 12:38:28 PM	Maximum Depth	80.38 ft
EST GW Depth During Test		7.10 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

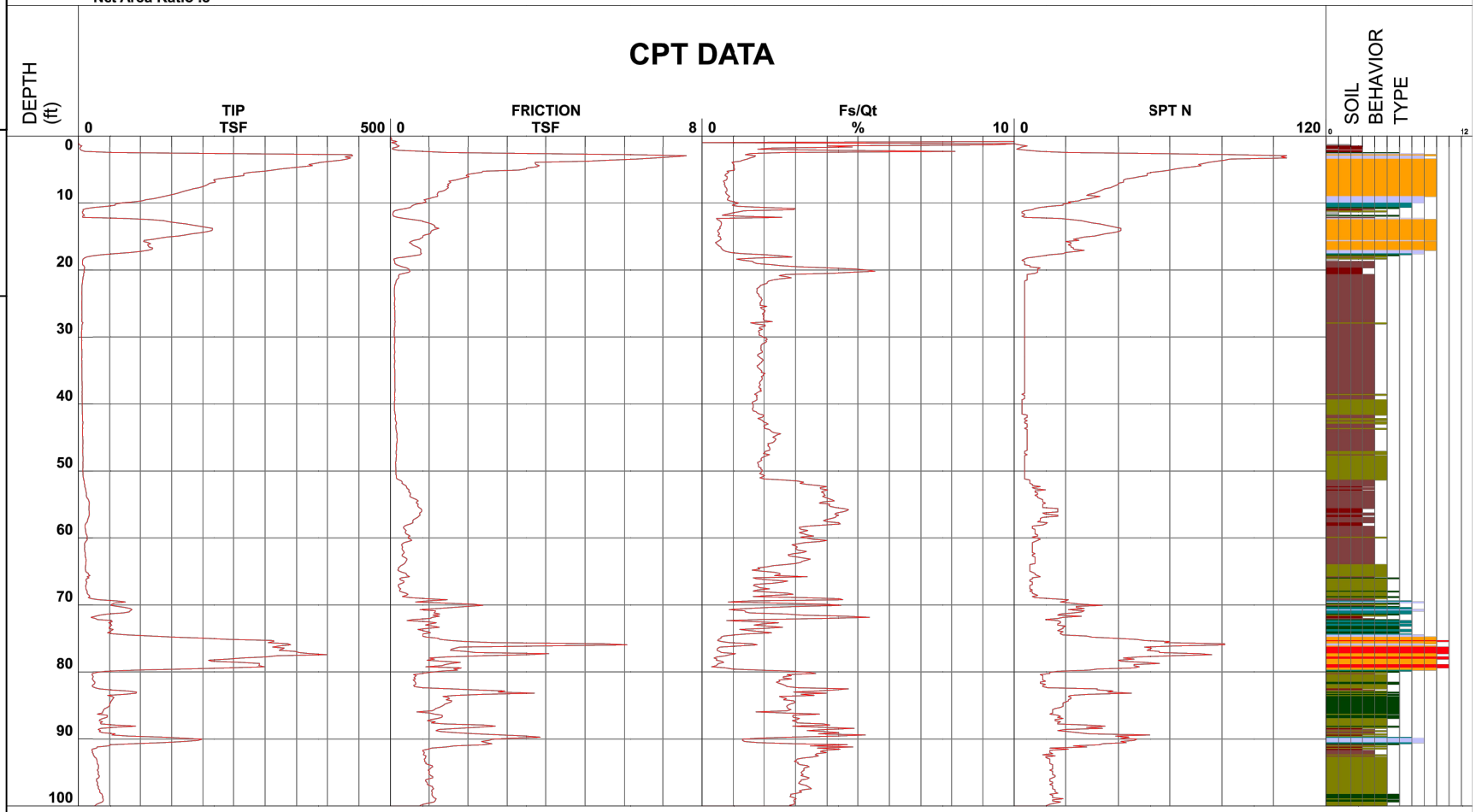
S*Soil behavior type and SPT based on data from UBC-1983

Miller Pacific Engineering

Project	Earhart Elementary School	Operator	RB KK	Filename	SDF(021).cpt
Job Number	1911.035	Cone Number	DDG1379	GPS	
Hole Number	CPT-05	Date and Time	4/10/2017 9:20:28 AM	Maximum Depth	100.56 ft
EST GW Depth During Test		9.00 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

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FILENAME: 1911.035 CPT.dwg

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Project No. 1911.035
Date: 4/7/17

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CPT-5 PLOT

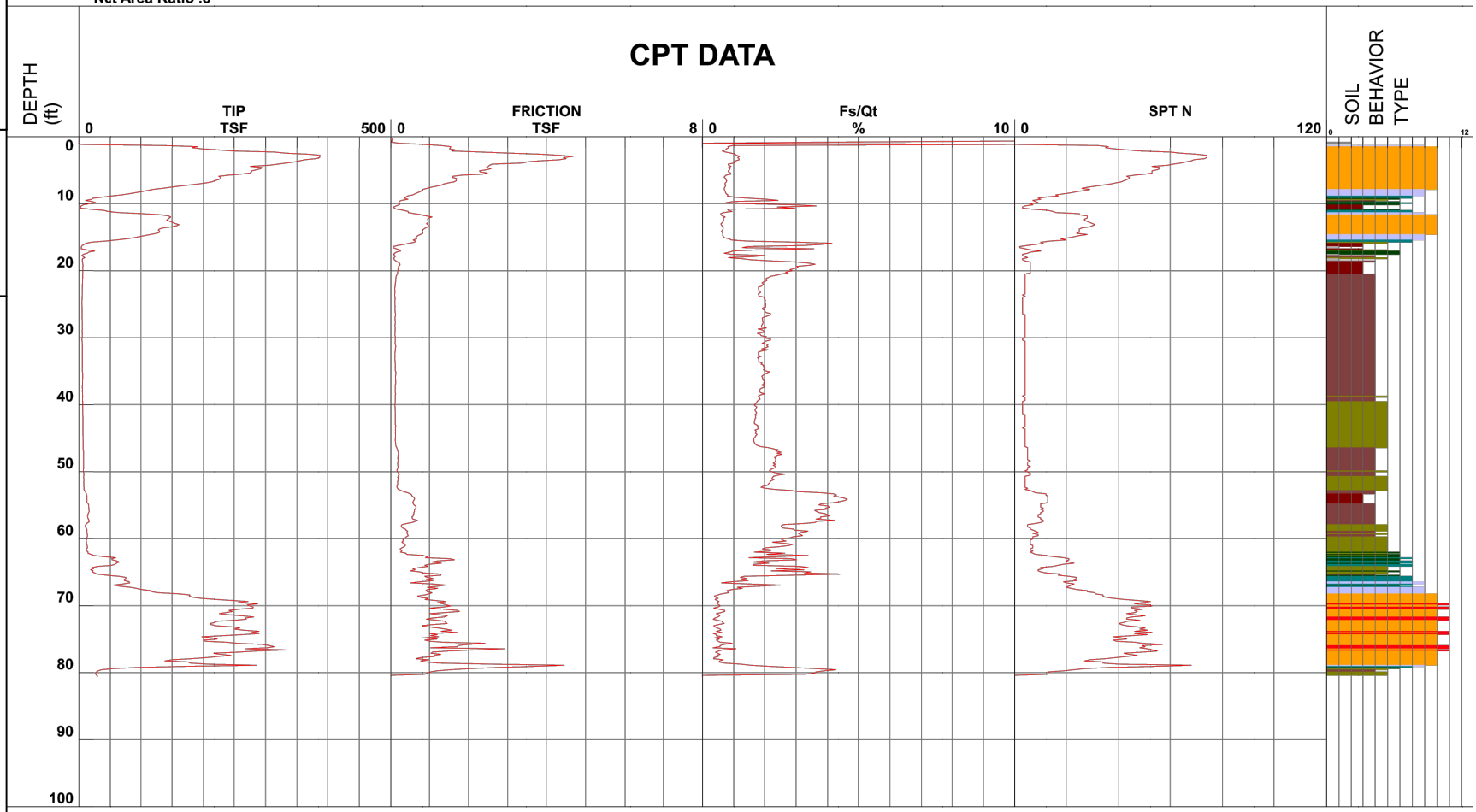
FIGURE A-7

Miller Pacific Engineering

Project	Earhart Elementary School	Operator	RB KK	Filename	SDF(025).cpt
Job Number	1911.035	Cone Number	DDG1379	GPS	
Hole Number	CPT-06	Date and Time	4/10/2017 2:08:58 PM	Maximum Depth	80.54 ft
EST GW Depth During Test		9.00 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

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CPT-6 PLOT

FIGURE A-8