Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

November 27, 2018
Project No. 403394001

Ms. Karen Hager
City of Burlingame
850 Burlingame Avenue
Burlingame, California 94010

Subject: Pavement Design Recommendations
Ray Park Play Area Renovation Project
1525 Balboa Way
Burlingame, California

Dear Ms. Hager:

Ninyo & Moore is pleased to present this letter providing pavement design recommendations for the proposed parking lot extension at Ray Park at 1525 Balboa Way in Burlingame, California (Figure 1). Based on the information provided to us, we understand that the City of Burlingame plans on expanding the existing parking lot at Ray Park. This letter report provides geotechnical recommendations for design and construction of the proposed asphalt paved parking lot.

SCOPE OF SERVICES

Our scope of services included the following:

- Subsurface exploration consisting of one (1) hand-auger boring to a depth of 5 feet. A representative of Ninyo & Moore logged the subsurface conditions exposed in the boring and collected bulk soil samples for laboratory testing.
- Laboratory testing of representative soil samples. Laboratory tests included evaluation of in-situ moisture content, Atterberg limits, expansion index, and R-value.
- Data compilation and engineering analysis of the information obtained from our background review, subsurface evaluation, and laboratory testing.
- Preparation of this geotechnical letter report presenting our findings, conclusions, and geotechnical recommendations for the project.

SUBSURFACE CONDITIONS AND LABORATORY TESTING

The following sections provide a generalized description of the geologic and geotechnical conditions based on the results of our subsurface evaluation at the site. More detailed descriptions are presented on the boring log in Appendix A. The approximate location of the boring is shown on Figure 2.

Artificial Fill

Artificial fill was encountered in the boring from the ground surface to a depth of about 2 feet. The fill is considered undocumented and generally consisted of black, moist, firm, lean clay.

Alluvium

Alluvium was encountered in the boring from beneath the artificial fill to the depth explored of 5 feet. The alluvium generally consisted of black and dark brown, moist, firm, lean clay.

Laboratory testing indicates that the near-surface soil on site consists of lean clay and has a high expansion potential. The results of an evaluation of the corrosivity of the on-site material indicate that the site does not meet the definition of a corrosive environment (Caltrans, 2018).

RECOMMENDATIONS

Recommendations for design and construction of asphalt pavement are presented in the following sections.

Site Preparation

Site preparation should begin with the removal of vegetation, utility lines, debris and other deleterious materials from areas to be graded. Tree stumps and roots should be removed to such a depth that organic material is generally not present. Clearing and grubbing should extend to the outside of the proposed excavation and fill areas. Rubble and excavated materials that do not meet criteria for use as fill should be disposed of in an appropriate landfill. Excavations resulting from removal of buried utilities, tree stumps, or obstructions should be backfilled with compacted fill in accordance with the recommendations in the following sections. Unsuitable materials include, but may not be limited to dry, loose, soft, wet, expansive, organic, or compressible natural soil; and undocumented or otherwise deleterious fill materials. Unsuitable materials should be removed from below pavement bearing surfaces to a depth at which suitable subgrade, as evaluated in the field by Ninyo & Moore, is exposed. Based on the results of our laboratory testing, on-site materials may need to be dried out to achieve adequate compaction.

Subgrade Preparation

Subgrade below pavements should be prepared as per the recommendations in Table 1. Prepared subgrade should be maintained in a moist (but not saturated) condition by the periodic sprinkling of water prior to placement of additional overlying fill or aggregate base.

Table 1 – Subgrade Preparation Recommendations

Subgrade Location	Preparation Recommendations
Below Pavement	• After clearing and grubbing, check for unsuitable materials. • Scarify 8 inches then moisture condition and compact. • Proof roll compacted subgrade with loaded water truck under the observation of the geotechnical engineer prior to placing aggregate base. Mitigate yielding areas in accordance with the recommendations of the engineer. • Keep in moist condition by sprinkling water.

Subgrade that has been permitted to dry out and loosen or develop desiccation cracking, should be scarified, moisture-conditioned, and recompacted as per the requirements above.

The excavation bottoms may become unstable and subject to pumping under heavy equipment loads if the excavation subgrade has a high moisture content or is exposed to water. The contractor should be prepared to stabilize the bottom of the excavations. In general, unstable bottom conditions may be mitigated by scarifying the subgrade and aerating the soil to achieve a moisture content near the optimum, overexcavating to a suitable depth and replacing the wet material with suitable fill, compacting a layer of crushed rock fill into the subgrade, or using a geotextile to stabilize additional fill. Specific recommendations for excavation stabilization will be influenced by the nature of the excavation and the conditions encountered during construction.

Fill Placement and Compaction

Materials used during earthwork, grading, and paving operations should be evaluated by the geotechnical engineer for suitability prior to use. Import soil, if needed, should have either an expansion Index of 50 or less, plasticity Index of 12 or less, or less than 10 percent, by dry weight, passing the No. 200 sieve. Aggregate base should comply with the California Department of Transportation (Caltrans) California Standard Specifications (CSS) 26-1.02B for ¾-inch maximum Class 2 aggregate base (2015). The contractor should notify the geotechnical consultant 72 hours prior to import of materials or use of on-site materials to permit time for sampling, testing, and evaluation of the proposed materials. Fill and backfill should be compacted in horizontal lifts in

conformance with the recommendations presented in Table 2. The allowable uncompacted thickness of each lift of fill depends on the type of compaction equipment utilized, but generally should not exceed 8 inches in loose thickness.

Table 2 – Fill Placement and Compaction Recommendations

Fill Type	Location	Compacted Density[1]	Moisture Content[2]
Subgrade	Below pavement (within 2 feet of finished grade)	95 percent or above	+ 2 percent or above
	In locations not already specified	90 percent or above	+ 2 percent or above
Aggregate Base	Pavement section	95 percent or above	Near Optimum
Asphalt Concrete	Pavement section	91 to 97 percent	Not Applicable

Notes:
1 Expressed as percent relative compaction or ratio of field density to reference density (typically on a dry density basis for soil and aggregate and on a wet density basis for asphalt concrete and lime treated subgrade). The reference density of soil, lime-treated subgrade, and aggregate should be evaluated by ASTM D 1557. The reference density of asphalt concrete should be evaluated by ASTM D 2041.
2 Target moisture content at compaction relative to the optimum as evaluated by ASTM D 1557.

Compacted fill should be maintained in a moist (but not saturated) condition by the periodic sprinkling of water prior to placement of additional overlying fill or construction of footings and slabs. Fill that has been permitted to dry out and loosen or develop desiccation cracking, should be scarified, moisture conditioned, and recompacted as per the requirements above.

Asphalt Pavements

The design R-value used to evaluate the pavement sections was selected based on R-value testing performed on a sample collected during our subsurface exploration. The pavement subgrade should be observed by the geotechnical engineer during grading to check that the exposed materials are consistent with the findings from our subsurface exploration and the support characteristics assumed for pavement design. Additional R-value testing may be needed, based on these observations, with subsequent revision to the pavement sections. Recommendations for preparation of subgrade are presented herein.

Pavement sections were evaluated for a range of traffic indexes or loading conditions. The designer may interpolate between the values provided once a traffic index or loading condition has been selected.

Ninyo & Moore conducted an analysis to evaluate appropriate asphalt pavement structural sections following the methodology presented in the Highway Design Manual (Caltrans, 2016). Alternative sections were evaluated. The pavement sections were designed for a 20-year service life presuming that periodic maintenance, including crack sealing and resurfacing will be performed during the service life of the pavement. Premature deterioration may occur without periodic maintenance. Our recommendations for the pavement sections are presented in Table 3.

Table 3 – Asphalt Concrete Pavement Structural Sections

Design R-Value	Traffic Index	Alternative 1	Alternative 2	Alternative 3
10	3	2 inches AC 11 inches AB	2 inches AC 6 inches AB SEG	2 inches AC 6 inches AB 8 inches TS
10	5	3 inches AC 15 inches AB	3 inches AC 8 inches AB SEG	3 inches AC 8 inches AB 8 inches TS
10	7	4 inches AC 21 inches AB	4 inches AC 12 inches AB SEG	4 inches AC 12 inches AB 8 inches TS

Notes:

[1] AC is Type A, Dense-Graded Hot Mix Asphalt complying with Caltrans Standard Specification 39-2 (2015).
[2] AB is Class II Aggregate Base complying with Caltrans Standard Specification 26-1.02 (2015).
[3] SEG is subgrade enhancement geotextile consistent with Caltrans CSS 96-1.02O Class B2.
[4] TS is chemically treated subgrade consistent with Caltrans CSS 24-2.

Paving operations and base preparation should be observed and tested by Ninyo & Moore. Subgrade enhancement geotextiles, where utilized, should be rolled out flat and tight, without folds or wrinkles, over prepared subgrade in the direction of travel. The geotextile should be pinned to the subgrade with nails and washers or u-shaped sod staples. Adjacent rolls should overlap 12 inches or more. Abutting rolls should overlap in the direction of fill placement to reduce the potential for peeling of the geotextile during fill placement. Aggregate base fill should be pushed over the geotextile into position and compacted. To reduce the potential for displacement of the geotextile or deterioration of the subgrade, construction equipment should not operate on the geotextile with less than 6 inches of aggregate base cover.

Aggregate base for pavement should be placed in lifts of no more than 8 inches in loose thickness and compacted per Table 2. Asphalt concrete should be placed and compacted per Table 2. Pavements should be sloped so that runoff is diverted to an appropriate collector (concrete gutter,

swale, or area drain) to reduce the potential for ponding of water on the pavement. Concentration of runoff over asphalt pavement should be discouraged.

LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

Ninyo & Moore appreciates the opportunity to provide services on this project.

Respectfully submitted,
NINYO & MOORE

David Seymour
Principal Engineering Geologist

Timothy P. Sneddon, PE, GE
Principal Engineer

DCS/TPS/slt

Attachments: References
Figure 1 – Site Location
Figure 2 – Boring Location
Appendix A – Boring Log

Distribution: (1) Addressee (via e-mail)

REFERENCES

American Society for Testing and Materials (ASTM), 2016, Annual Book of ASTM Standards, West Conshohocken, Pennsylvania.

California Building Standards Commission (CBSC), 2016, California Building Code (CBC): California Code of Regulations, Title 24, Part 2, Volumes 1 and 2, based on the 2012 International Building Code (IBC).

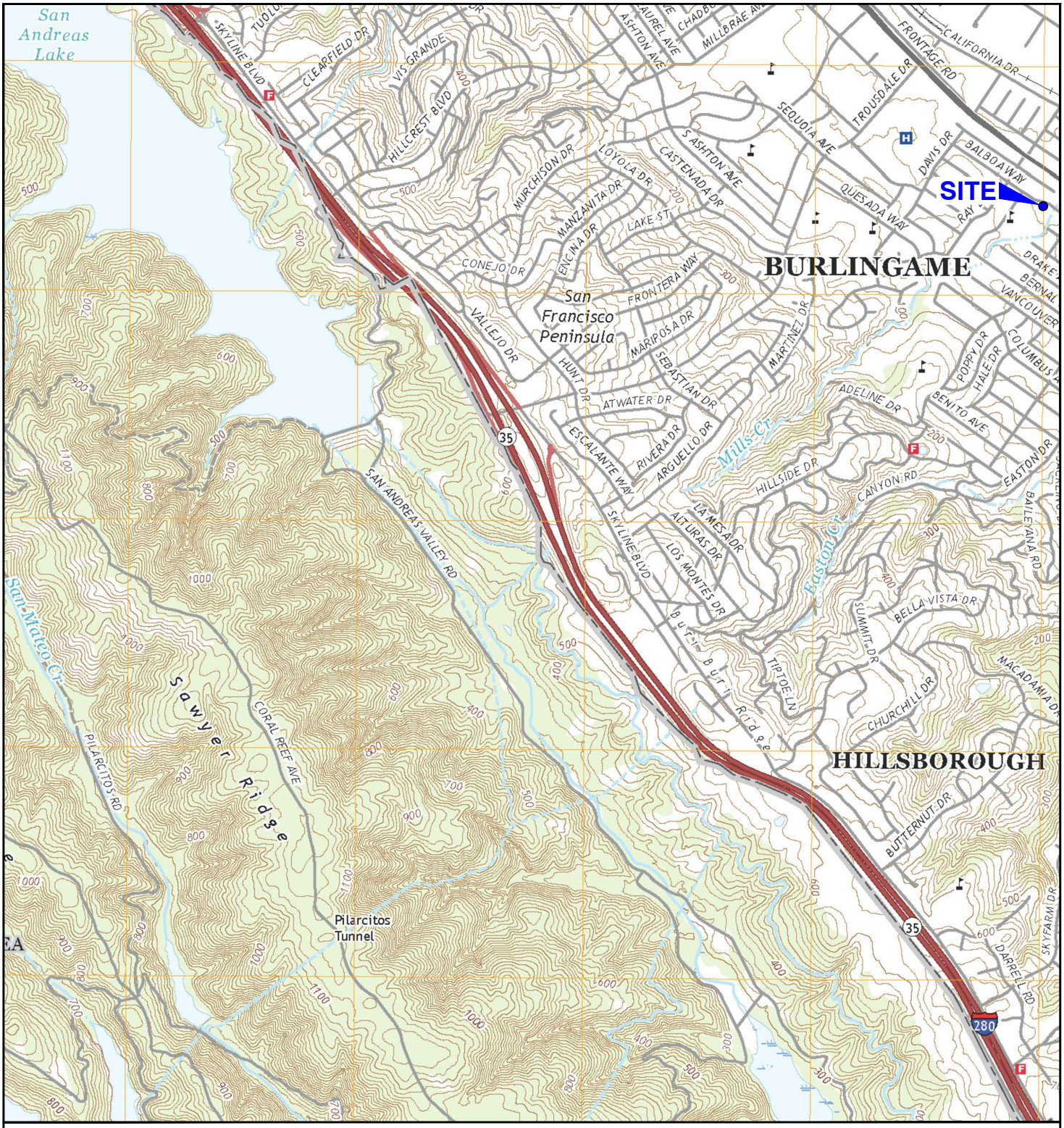
California Department of Transportation (Caltrans), 2015, Standard Specifications: dated May.

California Department of Transportation (Caltrans), 2016, Highway Design Manual, http://www.dot.ca.gov/hq/oppd/hdm/hdmtoc.htm, dated December 16.

California Department of Transportation (Caltrans), 2018, Corrosion Guidelines, Version 3.0, Division of Engineering Services, Materials Engineering and Testing Services, Corrosion Technology Branch: dated March.

Nterra Group, 2018, Ray Park Play Area Renovation, City of Burlingame, Parks & Recreation Department, Sheets 9 through 19 of 22, dated October 1.

FIGURES



NOTE: DIMENSIONS, DIRECTIONS, AND LOCATIONS ARE APPROXIMATE I REFERENCE: USGS, 2018

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FIGURE 1

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SITE LOCATION

RAY PARK
1525 BALBOA WAY
BURLINGAME, CALIFORNIA

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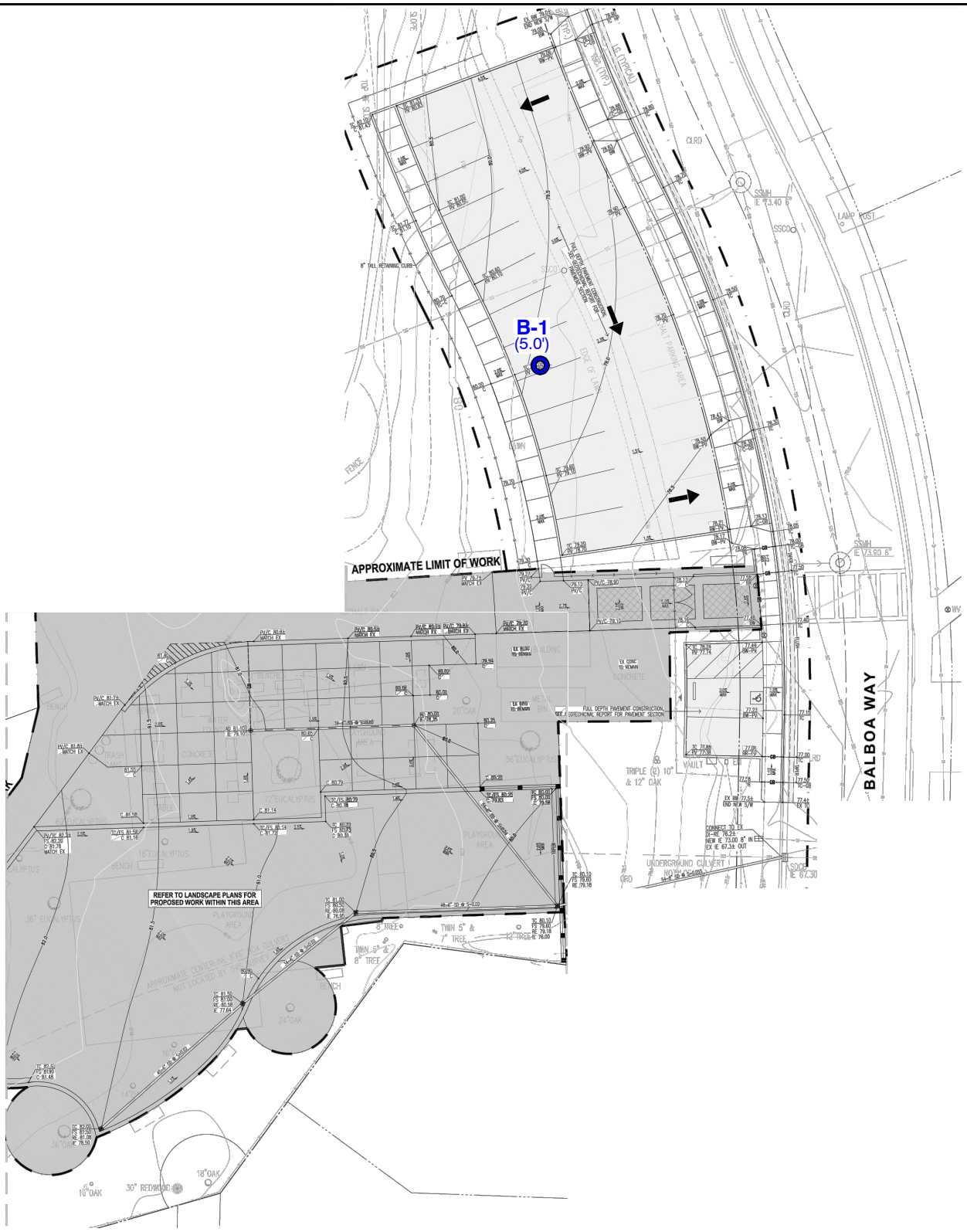

LEGEND

B-1 (5.0') HAND AUGER BORING LOCATION (TOTAL DEPTH, IN FEET)

NOTE: DIMENSIONS, DIRECTIONS, AND LOCATIONS ARE APPROXIMATE I REFERENCE: NTERRA GROUP, 2018

SCALE (FEET)

0 35 70

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FIGURE 2

Ninyo & Moore
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BORING LOCATION

RAY PARK
1525 BALBOA WAY
BURLINGAME, CALIFORNIA

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APPENDIX A

Boring Log

APPENDIX A

BORING LOGS

Field Procedure for the Collection of Disturbed Samples

Disturbed soil samples were obtained in the field using the following methods.

Bulk Samples

Bulk samples of representative earth materials were obtained from the exploratory borings. The samples were bagged and transported to the laboratory for testing.

The Standard Penetration Test (SPT) Sampler

Disturbed drive samples of earth materials were obtained by means of a Standard Penetration Test sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of 1-3/8 inches. The sampler was driven into the ground 12 to 18 inches with a 140-pound hammer free-falling from a height of 30 inches in general accordance with ASTM D 1586. The blow counts were recorded for every 6 inches of penetration; the blow counts reported on the logs are those for the last 12 inches of penetration. Soil samples were observed and removed from the sampler, bagged, sealed and transported to the laboratory for testing.

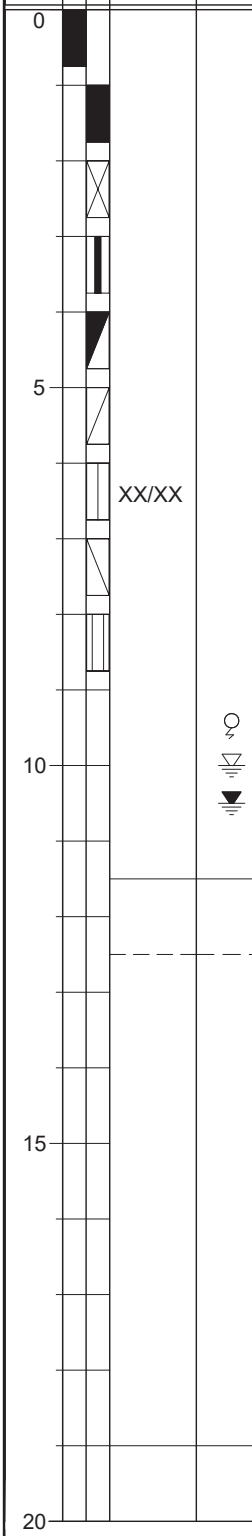
Field Procedure for the Collection of Relatively Undisturbed Samples

Relatively undisturbed soil samples were obtained in the field using the following methods.

The Modified Split-Barrel Drive Sampler

The sampler, with an external diameter of 3.0 inches, was lined with 6-inch long, thin brass liners with inside diameters of approximately 2.4 inches. The sample barrel was driven into the ground with the weight of a hammer in general accordance with ASTM D 3550. The driving weight was permitted to fall freely. The approximate length of the fall, the weight of the hammer, and the number of blows per foot of driving are presented on the boring log as an index to the relative resistance of the materials sampled. The samples were removed from the sample barrel in the brass liners, sealed, and transported to the laboratory for testing.

BORING LOG EXPLANATION SHEET



Bulk sample.

Modified split-barrel drive sampler.

No recovery with modified split-barrel drive sampler.

Sample retained by others.

Standard Penetration Test (SPT).

No recovery with a SPT.

Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.

No recovery with Shelby tube sampler.

Continuous Push Sample.

Seepage.

Groundwater encountered during drilling.

Groundwater measured after drilling.

SM

MAJOR MATERIAL TYPE (SOIL):

Solid line denotes unit change.

CL

Dashed line denotes material change.

Attitudes: Strike/Dip
b: Bedding
c: Contact
j: Joint
f: Fracture
F: Fault
cs: Clay Seam
s: Shear
bss: Basal Slide Surface
sf: Shear Fracture
sz: Shear Zone
sbs: Shear Bedding Surface

The total depth line is a solid line that is drawn at the bottom of the boring.

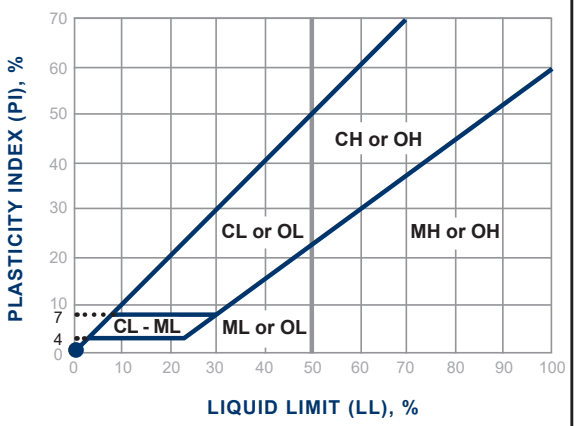
Soil Classification Chart Per ASTM D 2488

Primary Divisions			Secondary Divisions	
			Group Symbol	Group Name
COARSE-GRAINED SOILS more than 50% retained on No. 200 sieve	**GRAVEL** more than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVEL less than 5% fines	GW	well-graded GRAVEL
			GP	poorly graded GRAVEL
		GRAVEL with DUAL CLASSIFICATIONS 5% to 12% fines	GW-GM	well-graded GRAVEL with silt
			GP-GM	poorly graded GRAVEL with silt
			GW-GC	well-graded GRAVEL with clay
			GP-GC	poorly graded GRAVEL with
		GRAVEL with FINES more than 12% fines	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND 50% or more of coarse fraction passes No. 4 sieve	CLEAN SAND less than 5% fines	SW	well-graded SAND
			SP	poorly graded SAND
		SAND with DUAL CLASSIFICATIONS 5% to 12% fines	SW-SM	well-graded SAND with silt
			SP-SM	poorly graded SAND with silt
			SW-SC	well-graded SAND with clay
			SP-SC	poorly graded SAND with clay
		SAND with FINES more than 12% fines	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOILS 50% or more passes No. 200 sieve	**SILT and CLAY** liquid limit less than 50%	INORGANIC	CL	lean CLAY
			ML	SILT
			CL-ML	silty CLAY
		ORGANIC	OL (PI > 4)	organic CLAY
			OL (PI < 4)	organic SILT
	SILT and CLAY liquid limit 50% or more	INORGANIC	CH	fat CLAY
			MH	elastic SILT
		ORGANIC	OH (plots on or above "A"-line)	organic CLAY
			OH (plots below "A"-line)	organic SILT
	Highly Organic Soils		PT	Peat

Grain Size

Description		Sieve Size	Grain Size	Approximate Size
Boulders		> 12"	> 12"	Larger than basketball-sized
Cobbles		3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	Coarse	3/4 - 3"	3/4 - 3"	Thumb-sized to fist-sized
	Fine	#4 - 3/4"	0.19 - 0.75"	Pea-sized to thumb-sized
Sand	Coarse	#10 - #4	0.079 - 0.19"	Rock-salt-sized to pea-sized
	Medium	#40 - #10	0.017 - 0.079"	Sugar-sized to rock-salt-sized
	Fine	#200 - #40	0.0029 - 0.017"	Flour-sized to sugar-sized
Fines		Passing #200	< 0.0029"	Flour-sized and smaller

Plasticity Chart



Apparent Density - Coarse-Grained Soil

Apparent Density	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Loose	≤ 4	≤ 8	≤ 3	≤ 5
Loose	5 - 10	9 - 21	4 - 7	6 - 14
Medium Dense	11 - 30	22 - 63	8 - 20	15 - 42
Dense	31 - 50	64 - 105	21 - 33	43 - 70
Very Dense	> 50	> 105	> 33	> 70

Consistency - Fine-Grained Soil

Consis-tency	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Soft	< 2	< 3	< 1	< 2
Soft	2 - 4	3 - 5	1 - 3	2 - 3
Firm	5 - 8	6 - 10	4 - 5	4 - 6
Stiff	9 - 15	11 - 20	6 - 10	7 - 13
Very Stiff	16 - 30	21 - 39	11 - 20	14 - 26
Hard	> 30	> 39	> 20	> 26

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USCS METHOD OF SOIL CLASSIFICATION

DATE DRILLED 11/8/2018 BORING NO. B-1

GROUND ELEVATION 36' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 3-inch Diameter Hand Auger

DRIVE WEIGHT N/A DROP N/A

SAMPLED BY SPS LOGGED BY SPS REVIEWED BY DCS

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							CL	ARTIFICIAL FILL: Black, moist, firm, lean CLAY; trace sand; occasional organics.
2.5				17.7			CL	ALLUVIUM: Black, moist, firm, lean CLAY; trace sand.
				15.5			CL	Dark brown.
5								Total Depth = 5.0 feet Groundwater, though not encountered at the time of exploration, may rise to a higher level due to season variations in precipitation and other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation.
7.5								
10								

FIGURE A- 1

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RAY PARK
1525 BALBOA WAY, BURLINGAME, CALIFORNIA
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