13 October 2017

Eugene T. Flannery
Mayor's Office of Housing and Community Development
1 South Van Ness Avenue, 5th Floor
San Francisco, California 94103

Subject: Preliminary Geotechnical Study
730 Stanyan Street
San Francisco, California
Langan Project No.: 731639401

Dear Mr. Flannery:

This letter presents the results of our preliminary geotechnical study for the proposed development at 730 Stanyan Street in San Francisco, California. Our services were performed in accordance with our proposal dated 28 August 2017. The objectives of our study were to evaluate available subsurface information in the site vicinity and develop preliminary conclusions and recommendations regarding the geotechnical aspects of the project for conceptual design. During the design development phase of the project, we should perform a design-level geotechnical investigation that should include field exploration and laboratory testing.

1.0 PROJECT DESCRIPTION

The project site is bound by Stanyan Street to the west, Waller Street to the south, Haight Street to the north, and buildings to the east, as shown on Figure 1. Currently, the site is occupied by McDonald's and a paved parking lot.

We understand the proposed project entails the demolition of the McDonald's and paved parking lot and the construction of an eight-story concrete residential building with 176 affordable dwelling units and ground floor commercial space, youth programs space, bike storage, and a 4,000 square foot at-grade open space. The proposed project does not include vehicular parking. The structure will be at-grade.

We performed a preliminary environmental study for the proposed development and presented the results in a separate report.

2.0 SCOPE OF SERVICES

We reviewed the results of available subsurface information in the site vicinity to evaluate subsurface site conditions and develop preliminary conclusions and recommendations regarding the geotechnical aspects of the proposed development, including:

- subsurface information including depth to groundwater
- site seismicity and seismic hazards, including fault rupture, liquefaction, and densification potential
- feasible foundation types and preliminary design values for foundation design
- underpinning of adjacent structures, as needed
- 2016 California Building Code mapped values
- geotechnical construction related issues

3.0 SUBSURFACE CONDITIONS

To evaluate subsurface conditions at the site, we reviewed geologic and seismic hazard maps and geotechnical investigations performed by Treadwell & Rollo (our predecessor firm) and others in the vicinity of the site. The documents we reviewed include:

- Map titled "State of California Seismic Hazard Zones, City and County of San Francisco Official Map" by the California Department of Conservation, Division of Mines and Geology, 17 November 2001.

- Schlocker, J., "Geology of the San Francisco North Quadrangle, California."1974.

- Geotechnical Engineering Inc. "Geotechnical Review of Foundation Plan and Details, Planned Shear Wall Addition to Existing Building, 1855 Haight Street, San Francisco, California." 3 March 1997.

- Geotechnical Engineering Inc. "Report Soil Investigation, Planned Shear Wall Addition to Existing Building, 1855 Haight Street, San Francisco, California." 11 February 1997.

- Earth Mechanics Consulting Engineers "Report, Geotechnical Investigation Planned Development at 798 Stanyan Street, San Francisco, California," 6 March 2000.

- Treadwell & Rollo, "Geotechnical Investigation, Kezar Pavilion, San Francisco, California," project number 3976.01, 3 December 2004.

The sites with available subsurface information are shown on the site plan, Figure 2. Figure 3 shows the regional geology of the San Francisco North Quadrangle. Figure 4 shows the seismic hazard map of San Francisco. Boring logs from the investigations that we used in our evaluation are included in Appendix A.

We anticipate foundations and other elements from previous developments are likely present in the near surface soil. We anticipate the site is covered by 5 to 20 feet of loose to medium dense sandy fill. Fill thickness likely increases from northeast to southwest. The fill may be underlain by stiff sandy clay about 5 feet thick or medium dense to dense dune sand. The fill and dune sand, and clay if present, are likely underlain by sandy clay and bedrock of the Franciscan formation. We anticipate the groundwater level is deeper than 20 feet from existing site grades. Where clay is present below the fill, a perched groundwater may be present. The site is not within a mapped area of potential seismic hazard as shown on Figure 4.

4.0 REGIONAL SEISMICITY

The project site is in a seismically active region. Numerous earthquakes have been recorded in the region in the past, and moderate to large earthquakes should be anticipated during the service life of the proposed development. The San Andreas, San Gregorio, and Hayward Faults are the major faults closest to the site. These and other faults of the region are shown on Figure 5. For each of these faults, as well as other active faults within about 50 kilometers (km) of the site, the distance from the site and estimated mean characteristic Moment magnitude[1] [Working Group on California Earthquake Probabilities (WGCEP) and Cao et al. (2003)] are summarized in Table 1.

TABLE 1
Regional Faults and Seismicity

Fault Segment	Approximate Distance from Site (km)	Direction from Site	Mean Characteristic Moment Magnitude
N. San Andreas – Peninsula	8	West	7.23
N. San Andreas (1906 event)	8	West	8.05
N. San Andreas – North Coast	11	West	7.51
San Gregorio Connected	14	West	7.50
Total Hayward	21	Northeast	7.00
Total Hayward-Rodgers Creek	21	Northeast	7.33
Rodgers Creek	35	North	7.07
Mount Diablo Thrust	38	East	6.70
Point Reyes	39	West	6.90
Total Calaveras	39	East	7.03
Monte Vista-Shannon	41	Southeast	6.50
Green Valley Connected	43	East	6.80
West Napa	48	Northeast	6.70

1 Moment magnitude is an energy-based scale and provides a physically meaningful measure of the size of a faulting event. Moment magnitude is directly related to average slip and fault rupture area.

Figure 5 also shows the earthquake epicenters for events with magnitude greater than 5.0 from January 1800 through August 2014. Since 1800, four major earthquakes have been recorded on the San Andreas Fault. In 1836 an earthquake with an estimated maximum intensity of VII on the Modified Mercalli (MM) scale (Figure 6) occurred east of Monterey Bay on the San Andreas Fault (Toppozada and Borchardt 1998). The estimated Moment magnitude, $M_{w,}$ for this earthquake is about 6.25. In 1838, an earthquake occurred with an estimated intensity of about VIII-IX (MM), corresponding to an M_w of about 7.5. The San Francisco Earthquake of 1906 caused the most significant damage in the history of the Bay Area in terms of loss of lives and property damage. This earthquake created a surface rupture along the San Andreas Fault from Shelter Cove to San Juan Bautista approximately 470 kilometers in length. It had a maximum intensity of XI (MM), an M_w of about 7.9, and was felt 560 kilometers away in Oregon, Nevada, and Los Angeles. The Loma Prieta Earthquake occurred on 17 October 1989 in the Santa Cruz Mountains with an M_w of 6.9, the epicenter of which is approximately 96 km from the site. The most recent earthquake to affect the Bay Area occurred on 24 August 2014 and was located on the West Napa fault, approximately 52 kilometers northeast of the site, with an M_W of 6.0.

In 1868 an earthquake with an estimated maximum intensity of X on the MM scale occurred on the southern segment (between San Leandro and Fremont) of the Hayward Fault. The estimated M_w for the earthquake is 7.0. In 1861, an earthquake of unknown magnitude (probably an M_w of about 6.5) was reported on the Calaveras Fault. The most recent significant earthquake on this fault was the 1984 Morgan Hill earthquake ($M_w = 6.2$).

The 2014 Working Group for California Earthquake Probabilities (WGCEP) at the U.S. Geologic Survey (USGS) predicted a 72 percent chance of a magnitude 6.7 or greater earthquake occurring in the San Francisco Bay Area in 30 years (WGCEP 2015). More specific estimates of the probabilities for different faults in the Bay Area are presented in Table 2.

TABLE 2

WGCEP (2015) Estimates of 30-Year Probability (2014 to 2043) of a Magnitude 6.7 or Greater Earthquake

Fault	Probability (percent)
Hayward-Rodgers Creek	32
N. San Andreas	33
Calaveras	25
San Gregorio	6

5.0 SEISMIC HAZARDS

During a major earthquake on a segment of one of the nearby faults, strong to very strong shaking is expected to occur at the site. Strong shaking during an earthquake can result in ground failure such as that associated with soil liquefaction[2], lateral spreading[3], and seismic densification[4]. These and other hazards are discussed in the remainder of this section.

Historically, ground surface displacements closely follow the traces of geologically young faults. The site is not within an Earthquake Fault Zone, as defined by the Alquist-Priolo Earthquake Fault Zoning Act; no known active or potentially active faults exist on the site. In a seismically active area, the remote possibility exists for future faulting in areas where no faults previously existed; however, we conclude the risk of surface faulting at the site is low.

As shown on Figure 4, the site is not within a seismic hazard area. Groundwater is not anticipated within the upper 20 feet of the site, and the sand below this depth should be dense to very dense. We therefore conclude the potential for liquefaction and lateral spreading is low at the project site. This should be confirmed during the design level investigation.

Seismic densification can occur during strong ground shaking in loose, clean granular deposits above the water level, resulting in ground surface settlement. The available geotechnical reports indicate that nearby structures experienced differential settlement from the Loma Prieta earthquake in 1989. We anticipate loose and medium dense sand at the project site will experience densification during a major seismic event on a nearby active fault. We anticipate the amount of settlement could be on the order of six inches depending on the amount of fill, fines, and earthquake magnitude. Differential settlement of the fill may be large and erratic. Seismic densification at the project site should be further evaluated during the design geotechnical investigation.

6.0 PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

On the basis of our preliminary evaluation, we conclude the proposed development is feasible from a geotechnical standpoint. The main preliminary geotechnical issues for the proposed development are:

- presence of loose fill and loose dune sand in the upper 20 feet of the site

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2 Liquefaction is a transformation of soil from a solid to a liquefied state during which saturated soil temporarily loses strength resulting from the buildup of excess pore water pressure, especially during earthquake-induced cyclic loading. Soil susceptible to liquefaction includes loose to medium dense sand and gravel, low-plasticity silt, and some low-plasticity clay deposits.

3 Lateral spreading is a phenomenon in which surficial soil displaces along a shear zone that has formed within an underlying liquefied layer. Upon reaching mobilization, the surficial blocks are transported downslope or in the direction of a free face by earthquake and gravitational forces.

4 Seismic densification is a phenomenon in which non-saturated, cohesionless soil is compacted by earthquake vibrations, causing differential settlement.

- total and differential of ground settlement at the site during a major earthquake on a nearby active fault
- selection of feasible foundation(s) for the proposed structure

The existing fill and native loose to medium dense dune sand anticipated at the site are not suitable for building support. The proposed structure should be supported shallow footings bearing on improved soil, or, on a deep foundation system. Feasible ground improvement techniques include fill removal and replacement with engineered fill, drilled displacement columns and deep soil mixing. Feasible deep foundation types include drilled shafts and auger-cast piles (displacing or non-displacing). A structurally supported slab will likely be required with deep foundations unless ground improvement is performed to mitigate seismic densification.

Drilled shafts or other techniques involving open-hole drilling should consider the potential for caving caused by loose sandy soils and shallow groundwater. Considering that several structures previously occupied the site, old foundations, utilities, and other buried obstructions may be present. For the option to support the structure on engineered fill, fill compaction will need to be performed with vibrations off.

Deep foundations or ground improvement should extend through the fill anticipated in the upper 20 feet of the site. The performance of the soil under the anticipated building and earthquake loads should be evaluated during the design-level investigation to confirm its settlement can be accommodated in the foundation design. The performance of the soils and the foundation system selected will also impact the seismic parameters used for structural design. If groundwater is found at a higher than anticipated depth, then there may be a potential for liquefaction. If liquefiable soils are left unmitigated, site-specific response spectra may be required.

Feasible foundation options are discussed in the following subsections. The design-level geotechnical investigation should include recommendations for the design of the selected foundation system, seismic design, site grading, and other geotechnical aspects of the project.

6.1 Shallow Foundations Supported on Mechanically Improved (Engineered) Fill

If the fill and native loose to medium dense sand are of uniform thickness across the site, footings and the building slab can be supported directly on engineered fill. This option will require removal of the fill and loose to medium dense sand in their entirety, and their placement as engineered fill. In addition, where sloping is not feasible, shoring will be required. Underpinning will be required where the excavation extends below the bottom of existing footings. Systems that involve impact driving or large vibrations are likely not feasible because of the potential impacts to adjacent structures.

A maximum allowable soil bearing pressure of 3,500 pounds per square foot (psf) for dead plus live loads may be used for shallow footings supported on engineered fill.

Soil excavation will likely require shoring and underpinning. A feasible shoring system is a soldier-pile with wood-lagging shoring system. This system consists of steel piles that are placed in predrilled holes; the annulus between the piles and the sides of the hole are backfilled with concrete. Wood lagging is placed between the soldier piles as excavation proceeds. Tiebacks or internal bracing should be installed to provide lateral resistance and limit deflection, as appropriate.

Buildings adjacent to the site that have foundations above the excavation depth should be underpinned. Hand-excavated, end-bearing piers or slant drilled piers should be used to underpin the building. Depending on the depth of the underpinning, tiebacks or internal bracing may need to be installed to laterally support the underpinning.

During excavation, the temporary shoring system may yield and deform, which can cause surrounding improvements to settle and move laterally. The magnitude of shoring movements and resulting ground deformations are difficult to estimate because they depend on many factors, including the contractor's skill and quality control in the shoring installation.

6.2 Shallow Foundations Supported on Improved In-Place Fill

Onsite fill may be improved by installing drilled displacement columns (DDCs) or deep soil mixing as discussed in this section. Settlement of foundations supported on improved soil (soil-cement columns or DDCs) should be evaluated by the design-build contractor based on the anticipated building loads. Settlement of foundations supported on soil-cement columns or on DDCs that extend into competent soil is typically less than 1 inch; differential settlement should be on the order of ½ inch between adjacent columns. The majority of the settlement should occur during construction.

6.2.1 Deep Soil Mixing

Deep soil mixing (also referred to as soil-cement columns) is in-place soil treatment with cement grout using mixing shafts consisting of auger cutting heads, discontinuous flight augers, or blades/paddles. Soil-cement mixing may be installed in a variety of patterns including cellular blocks, a grid pattern, or columns. Typical soil-cement columns have a minimum diameter of three feet. The soil-cement columns should be installed in a pattern that adequately resists the anticipated lateral forces and transfers building loads into the medium dense to very dense native sand. Resistance to lateral loads will be developed by friction along the contact area between the soil-cement column shafts and bottom of the foundation. Use of soil cement columns will require testing to confirm the strength of deep soil mixing. The soil replacement ratio of deep soil mixing can vary from 40 to 60 percent, depending on the building loads and subsurface soil.

6.2.2 Drilled Displacement Columns (DDCs)

DDCs are installed at footing locations to transfer the support of building loads through the fill into deeper, competent soil. DDCs also improve the adjacent soil during installation. DDCs are constructed by using a displacement auger to create a soil shaft that is filled with CLSM (Controlled Low Strength Material) injected under pressure as the displacement auger is withdrawn from the hole. DDCs vary from 18 to 36 inches in diameter; the selected diameter is based on building loads and number of columns per footing location. Strengths of the CLSM typically range from 100 to 500 psi at 28 days, depending on the foundation load requirements. Installation of DDCs produces minimal soil cuttings because the soil is displaced during column installation. Use of DDCs will require performance of load tests to confirm estimated capacities.

6.3 Drilled Piers

Drilled shafts gaining support in the native dense sand, below the fill and loose native sand may be designed using a preliminary allowable skin friction value of 1,000 psf. We anticipate total and differential settlement for drilled piers will be on the order inch and ½ inch, respectively. Drilled piers should have a minimum diameter for 18 inches, and be spaced no closer than three diameters, center- to-center.

6.4 Auger-Cast Piles Extending to Dense Sand below Sandy Fill

Auger cast piles are installed by rotating a continuous-flight hollow shaft auger into the soil to a specified depth. High strength cement grout is pumped under pressure through the hollow shaft as the auger is slowly withdrawn. The resulting grout column hardens and forms an auger cast pile, typically 16- to 20-inches in diameter. Reinforcing is installed while the cement grout is still fluid. Auger cast piles extending at least 20 feet into dense sand are capable of supporting allowable dead-plus-live loads on the order of 200 kips. The design of the auger cast piles would be performed by the designer of a specialty contractor with input from us and the project structural engineer.

7.0 SEISMIC DESIGN CRITERIA

For seismic design of the structure in accordance with the provisions of 2016 San Francisco Building Code, we recommend using Site Class D (stiff soil) for foundations supported on improved soil. The seismic parameters for Site Class D are listed below:

- Risk Targeted Maximum Considered Earthquake (MCE) S_s and S_1 of 1.62 g and 0.75g, respectively
- Site Coefficients F_a and F_v of 1.0 and 1.5
- Maximum Considered Earthquake (MCE) spectral response acceleration parameters at short periods, S_{MS}, and at one-second period, S_{M1}, of 1.62g and 1.12g, respectively.
- Design Earthquake (DE) spectral response acceleration parameters at short period, S_{DS}, and at one-second period, S_{D1}, of 1.08g and 0.75g, respectively.

8.0 CONSTRUCTION CONSIDERATIONS

We anticipate the onsite soil can be excavated using conventional earth moving equipment. Remnants of previous buildings (foundations, slabs, walls), building debris, and other obstructions may be encountered during shoring, excavation, and deep foundation installation.

9.0 LIMITATIONS

The conclusions and recommendations presented herein are preliminary and should not be relied upon for design. A design–level geotechnical investigation should be performed to evaluate subsurface conditions and for the development of recommendations regarding the geotechnical aspects of the project.

If you have any questions, please contact us.

Sincerely,
Langan Engineering & Environmental Services, Inc.

Kristen Lease, PE
Project Engineer

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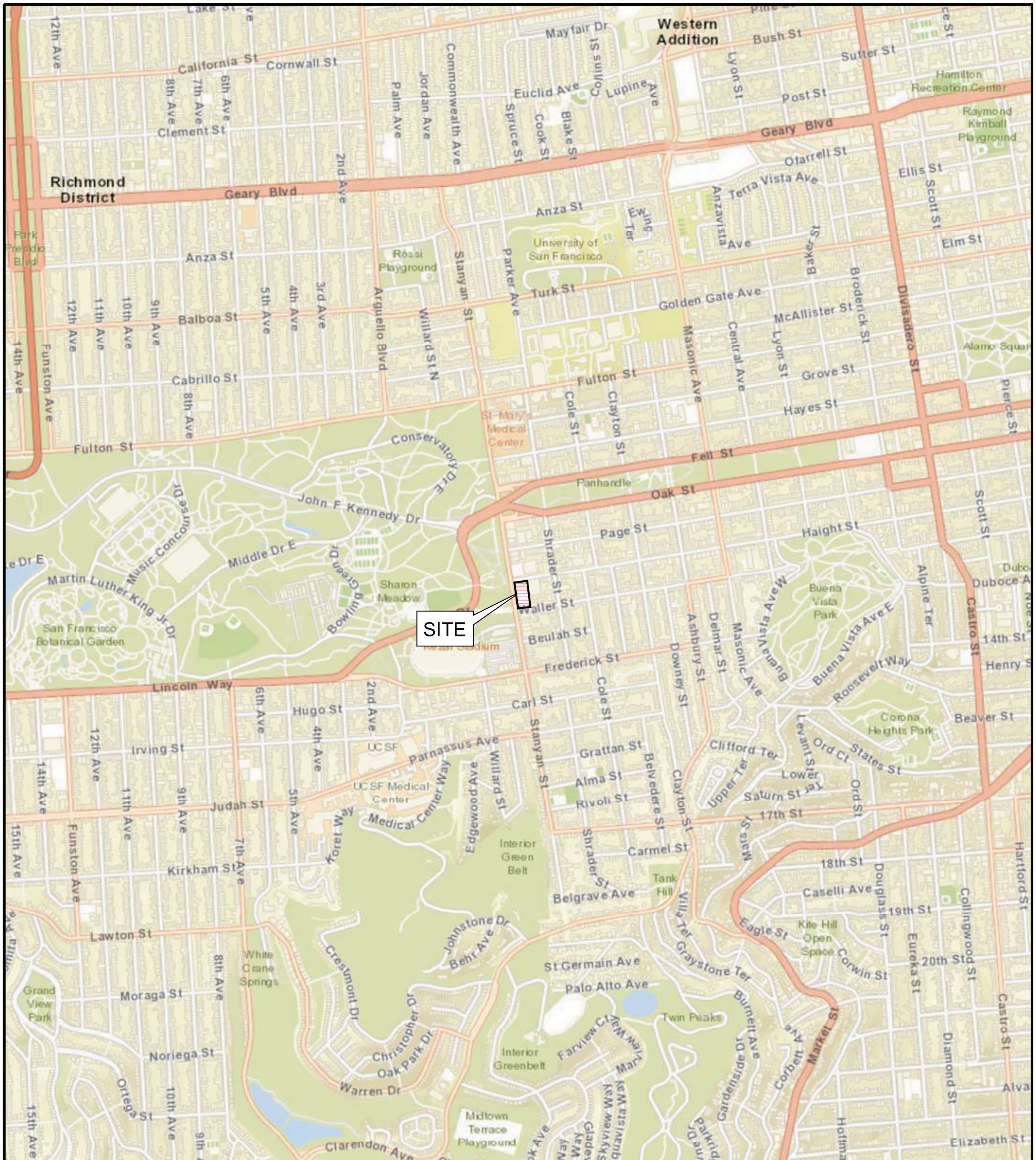
STATE OF CALIFORNIA

731637401.02_MGF_Prelim Geotech Report_730 Stanyan

Attachments: Figure 1 – Site Location Map
Figure 2 – Site Plan
Figure 3 – Regional Geologic Map
Figure 4 – Regional Hazard Zones Map
Figure 5 – Map of Major Faults and Earthquake Epicenters in the San Francisco Bay Area
Figure 6 – Modified Mercalli Intensity Scale
Appendix A – Boring Logs in the Site Vicinity

FIGURES



NOTES:

World street basemap is provided through Langan's Esri ArcGIS software licensing and ArcGIS online.
Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN.

0 1,000 2,000
Feet

N S E W

730 STANYAN STREET
San Francisco, California

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SITE LOCATION MAP

Date 09/18/17	Project No. 731639402	Figure 1

EXPLANATION

Approximate Site Boundary

0 80 Feet

Approximate scale

730 STANYAN STREET
San Francisco, California

SITE PLAN

Date 09/20/17	Project No. 731639402	Figure 2

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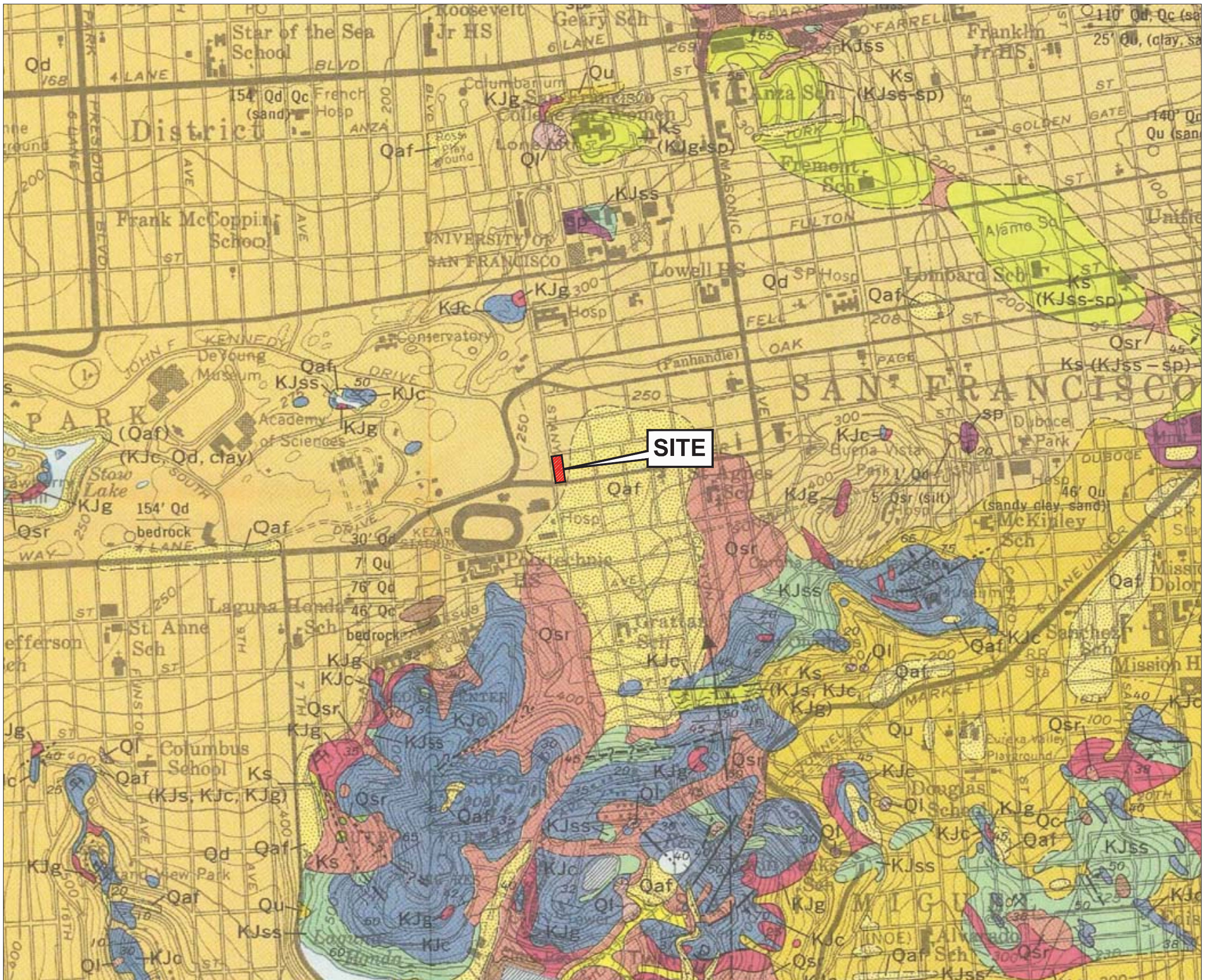

Reference: Geologic Map of the San Francisco North Quadrangle, San Francisco and Marin Counties, California, by Schlocker et al., 1974.

EXPLANATION

- **Qaf** Artificial fill
- **Qsr** Slope debris and ravine fill (Quaternary)
- **Qd** Dune sand (Quaternary)
- **Qu** Surficial deposits, undivided (Quaternary)
- **KJc** Radiolarian chert and shale (Jurasic and Cretaceous)
- **KJss** Sandstone (Jurasic and Cretaceous)

— — . . . . Geologic contact: dashed where approximate and dotted where concealed

Anticline fold: dashed where approximate and dotted where concealed

32 Strike and dip

0 2000 Feet

Approximate scale

730 STANYAN STREET
San Francisco, California

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REGIONAL GEOLOGIC MAP

Date 09/20/17	Project No. 731639402	Figure 3

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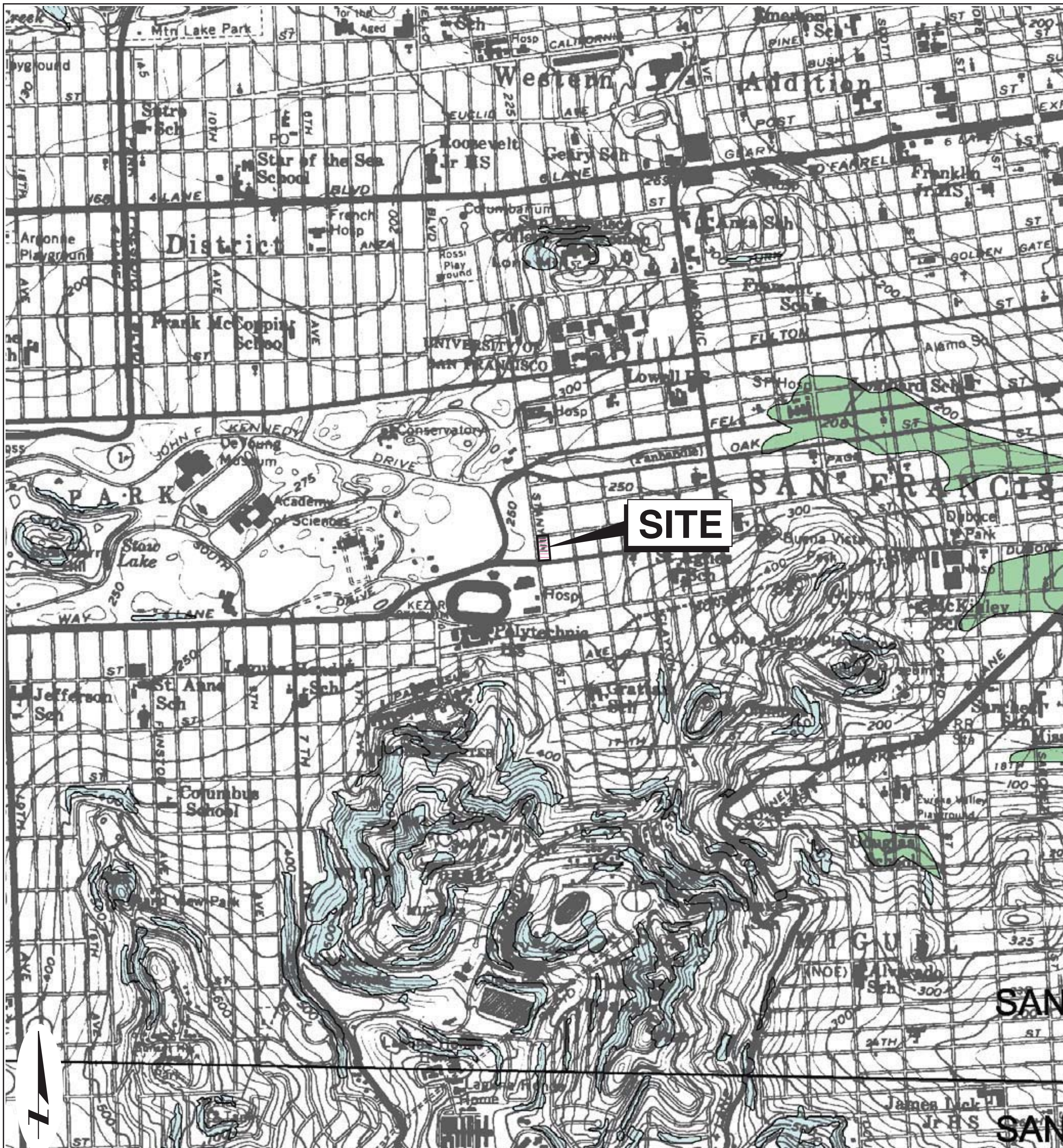

EXPLANATION

Liquefaction; Areas where historic occurence of liquefaction, or local topographic, geological, geotechnical, and subsurface water conditions indicate a potential for permanent ground displacements.

Earthquake-Induced Landslides; Areas where previous occurence of landslide movement, or local topographic, geological, geotechnical, and subsurface water conditions indicate a potential for permanent ground displacements.

0 2,000 4,000 Feet

Approximate scale

Reference:
State of California "Seismic Hazard Zones"
City and County of San Francisco
Released on November 17, 2001

730 STANYAN STREET
San Francisco, California

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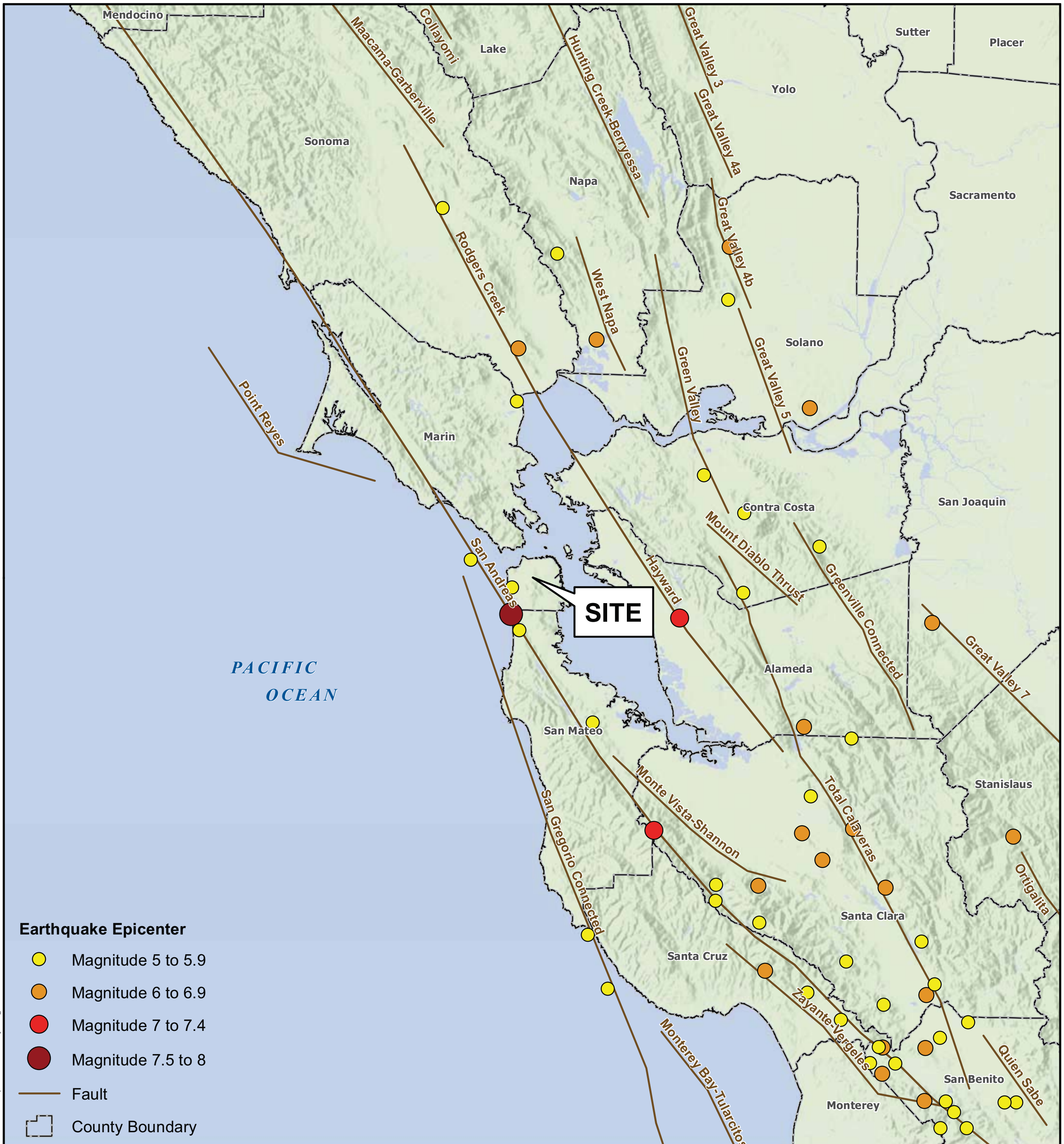
REGIONAL SEISMIC HAZARD ZONES MAP

Date 09/18/17 | Project No. 731639402 | Figure 4



Notes:

1. Quaternary fault data displayed are based on a generalized version of U.S Geological Survey (USGS) Quaternary Fault and fold database, 2010. For cartographic purposes only.
2. The Earthquake Epicenter (Magnitude) data is provided by the USGS and is current through 08/26/2014.
3. Basemap hillshade and County boundaries provided by USGS and California Department of Transportation.
4. Map displayed in California State Coordinate System, California (Teale) Albers, North American Datum of 1983 (NAD83), Meters.

0 5 10 20

Miles

N

730 STANYAN STREET
San Francisco, California

LANGAN

MAP OF MAJOR FAULTS AND EARTHQUAKE EPICENTERS IN THE SAN FRANCISCO BAY AREA

Date 9/18/2017	Project No. 731639401	Figure 5

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I **Not felt by people, except under especially favorable circumstances. However, dizziness or nausea may be experienced.**
Sometimes birds and animals are uneasy or disturbed. Trees, structures, liquids, bodies of water may sway gently, and doors may swing very slowly.

II **Felt indoors by a few people, especially on upper floors of multi-story buildings, and by sensitive or nervous persons.**
As in Grade I, birds and animals are disturbed, and trees, structures, liquids and bodies of water may sway. Hanging objects swing, especially if they are delicately suspended.

III **Felt indoors by several people, usually as a rapid vibration that may not be recognized as an earthquake at first. Vibration is similar to that of a light, or lightly loaded trucks, or heavy trucks some distance away. Duration may be estimated in some cases.**
Movements may be appreciable on upper levels of tall structures. Standing motor cars may rock slightly.

IV **Felt indoors by many, outdoors by a few. Awakens a few individuals, particularly light sleepers, but frightens no one except those apprehensive from previous experience. Vibration like that due to passing of heavy, or heavily loaded trucks. Sensation like a heavy body striking building, or the falling of heavy objects inside.**
Dishes, windows and doors rattle; glassware and crockery clink and clash. Walls and house frames creak, especially if intensity is in the upper range of this grade. Hanging objects often swing. Liquids in open vessels are disturbed slightly. Stationary automobiles rock noticeably.

V **Felt indoors by practically everyone, outdoors by most people. Direction can often be estimated by those outdoors. Awakens many, or most sleepers. Frightens a few people, with slight excitement; some persons run outdoors.**
Buildings tremble throughout. Dishes and glassware break to some extent. Windows crack in some cases, but not generally. Vases and small or unstable objects overturn in many instances, and a few fall. Hanging objects and doors swing generally or considerably. Pictures knock against walls, or swing out of place. Doors and shutters open or close abruptly. Pendulum clocks stop, or run fast or slow. Small objects move, and furnishings may shift to a slight extent. Small amounts of liquids spill from well-filled open containers. Trees and bushes shake slightly.

VI **Felt by everyone, indoors and outdoors. Awakens all sleepers. Frightens many people; general excitement, and some persons run outdoors.**
Persons move unsteadily. Trees and bushes shake slightly to moderately. Liquids are set in strong motion. Small bells in churches and schools ring. Poorly built buildings may be damaged. Plaster falls in small amounts. Other plaster cracks somewhat. Many dishes and glasses, and a few windows break. Knickknacks, books and pictures fall. Furniture overturns in many instances. Heavy furnishings move.

VII **Frightens everyone. General alarm, and everyone runs outdoors.**
People find it difficult to stand. Persons driving cars notice shaking. Trees and bushes shake moderately to strongly. Waves form on ponds, lakes and streams. Water is muddied. Gravel or sand stream banks cave in. Large church bells ring. Suspended objects quiver. Damage is negligible in buildings of good design and construction; slight to moderate in well-built ordinary buildings; considerable in poorly built or badly designed buildings, adobe houses, old walls (especially where laid up without mortar), spires, etc. Plaster and some stucco fall. Many windows and some furniture break. Loosened brickwork and tiles shake down. Weak chimneys break at the roofline. Cornices fall from towers and high buildings. Bricks and stones are dislodged. Heavy furniture overturns. Concrete irrigation ditches are considerably damaged.

VIII **General fright, and alarm approaches panic.**
Persons driving cars are disturbed. Trees shake strongly, and branches and trunks break off (especially palm trees). Sand and mud erupts in small amounts. Flow of springs and wells is temporarily and sometimes permanently changed. Dry wells renew flow. Temperatures of spring and well waters varies. Damage slight in brick structures built especially to withstand earthquakes; considerable in ordinary substantial buildings, with some partial collapse; heavy in some wooden houses, with some tumbling down. Panel walls break away in frame structures. Decayed pilings break off. Walls fall. Solid stone walls crack and break seriously. Wet grounds and steep slopes crack to some extent. Chimneys, columns, monuments and factory stacks and towers twist and fall. Very heavy furniture moves conspicuously or overturns.

IX **Panic is general.**
Ground cracks conspicuously. Damage is considerable in masonry structures built especially to withstand earthquakes; great in other masonry buildings - some collapse in large part. Some wood frame houses built especially to withstand earthquakes are thrown out of plumb, others are shifted wholly off foundations. Reservoirs are seriously damaged and underground pipes sometimes break.

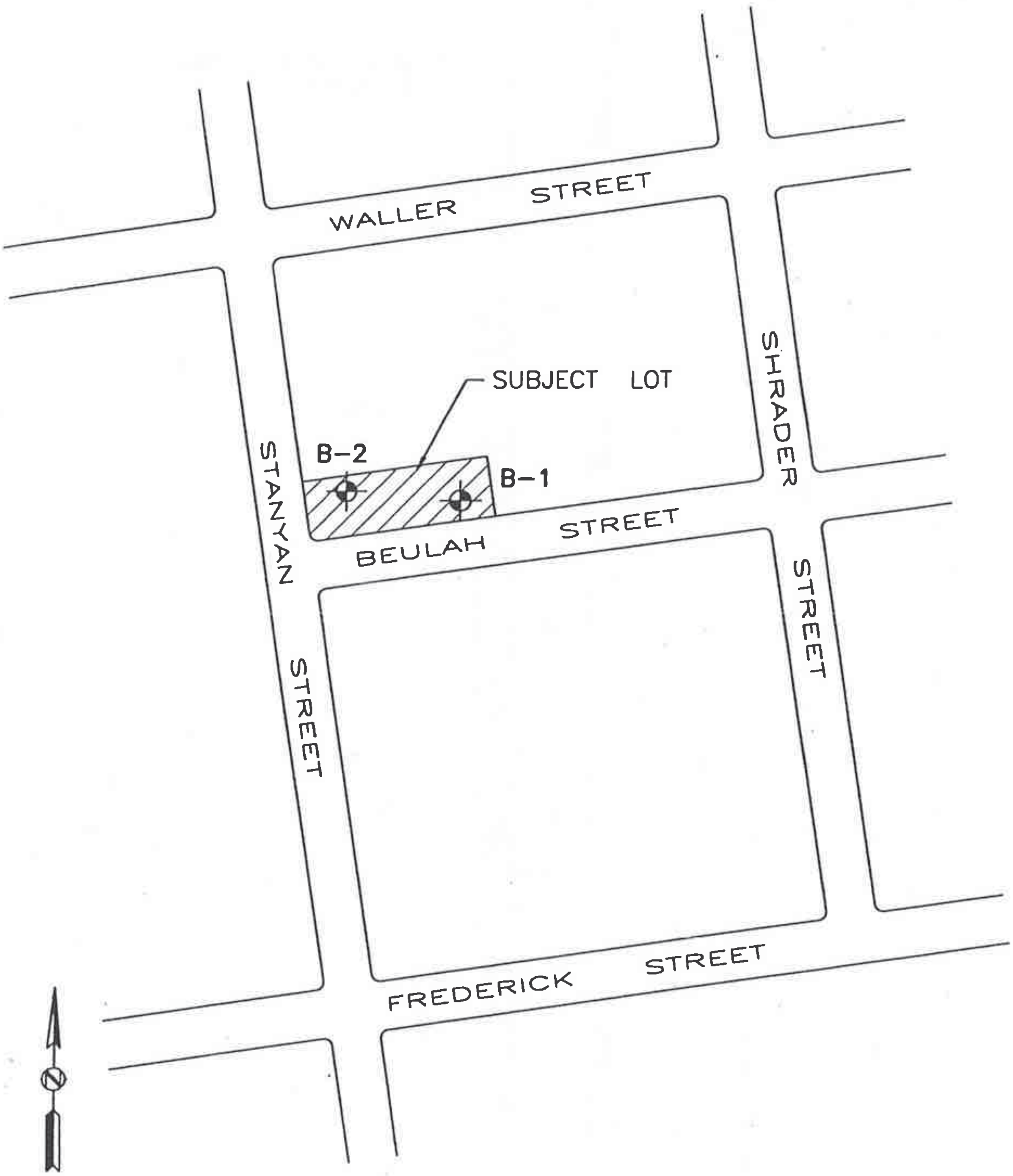
X **Panic is general.**
Ground, especially when loose and wet, cracks up to widths of several inches; fissures up to a yard in width run parallel to canal and stream banks. Landsliding is considerable from river banks and steep coasts. Sand and mud shifts horizontally on beaches and flat land. Water level changes in wells. Water is thrown on banks of canals, lakes, rivers, etc. Dams, dikes, embankments are seriously damaged. Well-built wooden structures and bridges are severely damaged, and some collapse. Dangerous cracks develop in excellent brick walls. Most masonry and frame structures, and their foundations are destroyed. Railroad rails bend slightly. Pipe lines buried in earth tear apart or are crushed endwise. Open cracks and broad wavy folds open in cement pavements and asphalt road surfaces.

XI **Panic is general.**
Disturbances in ground are many and widespread, varying with the ground material. Broad fissures, earth slumps, and land slips develop in soft, wet ground. Water charged with sand and mud is ejected in large amounts. Sea waves of significant magnitude may develop. Damage is severe to wood frame structures, especially near shock centers, great to dams, dikes and embankments, even at long distances. Few if any masonry structures remain standing. Supporting piers or pillars of large, well-built bridges are wrecked. Wooden bridges that "give" are less affected. Railroad rails bend greatly and some thrust endwise. Pipe lines buried in earth are put completely out of service.

XII **Panic is general.**
Damage is total, and practically all works of construction are damaged greatly or destroyed. Disturbances in the ground are great and varied, and numerous shearing cracks develop. Landslides, rock falls, and slumps in river banks are numerous and extensive. Large rock masses are wrenched loose and torn off. Fault slips develop in firm rock, and horizontal and vertical offset displacements are notable. Water channels, both surface and underground, are disturbed and modified greatly. Lakes are dammed, new waterfalls are produced, rivers are deflected, etc. Surface waves are seen on ground surfaces. Lines of sight and level are distorted. Objects are thrown upward into the air.

730 STANYAN STREET San Francisco, California	**MODIFIED MERCALLI INTENSITY SCALE**
LANGAN	Date 09/20/17 | Project No. 731639402 | Figure 6

APPENDIX A



LEGEND

B-2 Boring Location and Number

NOT TO SCALE

Earth Mechanics Consulting Engineers	Job. No: 99-1377 Appr: Drwn: CD Date: 2/24/00	BORING LOCATION MAP 798 Stanyan Street San Francisco, California	PLATE 1

EQUIPMENT: 4" Flight Auger | ELEVATION: **
LOGGED BY: A. Gruen | START DATE: 2-18-00
FINISH DATE: 2-18-00

Other Laboratory Tests	Pocket Penetrometer (ksf)	Moisture Content (%)	Dry Density (pcf)	% Passing #200 sieve	Blows/Foot *	Sample	DEPTH (FEET)	Description
					31		0	BROWN CLAYEY SAND (SC), dense to medium dense, moist to wet
		9.6		20			1	
					12		5	- medium dense
		14.8		44			6	
					25		10	
		14.0		27			11	
					94		15	- very dense
		17.2		18			16	
		10.8		22	62/6"		20	

BOTTOM OF BORING 1 @ 20.5 FEET
No Free Water Encountered

* Converted to equivalent standard penetration blow counts.

** Existing ground surface at time of drilling.

Earth Mechanics
Consulting Engineers

Job No: 99-1377
Appr:
Drwn: CD
Date: FEB 2000

LOG OF BORING 1

798 Stanyan Street

San Francisco, California

PLATE
2

EQUIPMENT: **4" Flight Auger** | ELEVATION: **
LOGGED BY: **A. Gruen** | START DATE: **2-18-00**
FINISH DATE: **2-18-00**

Other Laboratory Tests	Pocket Penetrometer (ksf)	Moisture Content (%)	Dry Density (pcf)	% Passing #200 sieve	Blows/Foot *	DEPTH (FEET)	Description
					27	0	BROWN CLAYEY SAND (SC), medium dense, moist to wet
		12.0		24		1	
					15	5	
		9.4		15		6	
						8	- brick debris
							(FILL)
						9	BROWN POORLY GRADED SAND WITH CLAY (SP-SC), loose, saturated
					7	10	
		17.6		10		11	(FILL)
						11.5	BROWN CLAYEY SAND (SC), dense to very dense, wet to saturated
					59	15	
		20.2		30		16	BOTTOM OF BORING 2 @ 16 FEET Water @ 11.5'

* Converted to equivalent standard penetration blow counts.

** Existing ground surface at time of drilling.

Earth Mechanics
Consulting Engineers

Job No: 99-1377
Appr:
Drwn: CD
Date: FEB 2000

LOG OF BORING 2

798 Stanyan Street

San Francisco, California

PLATE 3

MAJOR DIVISIONS					TYPICAL NAMES
COARSE GRAINED SOILS More than Half > #200 sieve	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW		WELL GRADED GRAVELS, GRAVEL-SAND
			GP		POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH OVER 12% FINES	GM		SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES
			GC		CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS WITH LITTLE OR NO FINES	SW		WELL GRADED SANDS, GRAVELLY SANDS
			SP		POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 12% FINES	SM		SILTY SANDS, POOORLY GRADED SAND-SILT MIXTURES
			SC		CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS More than Half < #200 sieve	SILTS AND CLAYS LIQUID LIMIT 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 CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH		INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS 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

UNIFIED SOIL CLASSIFICATION SYSTEM

			Shear Strength, psf (Confining Pressure, psf)	
Consol	Consolidation	Tx	2630 (240)	Unconsolidated Undrained Triaxial
LL	Liquid Limit (in %)	Tx sat	2100 (575)	Unconsolidated Undrained Triaxial, saturated prior to test
PL	Plastic Limit (in %)	DS	3740 (960)	Unconsolidated Undrained Direct Shear
PI	Plasticity Index	TV	1320	Torvane Shear
Gs	Specific Gravity	UC	4200	Unconfined Compression
SA	Sieve Analysis	LVS	500	Laboratory Vane Shear
■	Undisturbed Sample (2.5-inch ID)	FS	Free Swell	
◩	2-inch-ID Sample	EI	Expansion Index	
◪	Standard Penetration Test	Perm	Permeability	
⊠	Bulk Sample	SE	Sand Equivalent	

KEY TO TEST DATA

Earth Mechanics
Consulting Engineers

Job No: 99-1377
Appr:
Drwn: CD
Date: FEB 2000

SOIL CLASSIFICATION CHART AND KEY TO TEST DATA
798 Stanyan Street
San Francisco, California

PLATE 4

APPENDIX C

Field Exploration

Our field exploration consisted of a geologic reconnaissance and subsurface exploration by means of two test borings logged by our project engineer on February 18, 2000. The test borings were drilled with a truck mounted rig utilizing continuous flight, 6 inch diameter augers. The borings were drilled at the approximate locations shown on the Boring Location Map, Plate 1.

The Logs of Borings are displayed on Plates 2 and 3. Representative undisturbed samples of the earth materials were obtained from the test borings at selected depth intervals with a 2-inch diameter Standard Penetration Test (SPT) split spoon sampler.

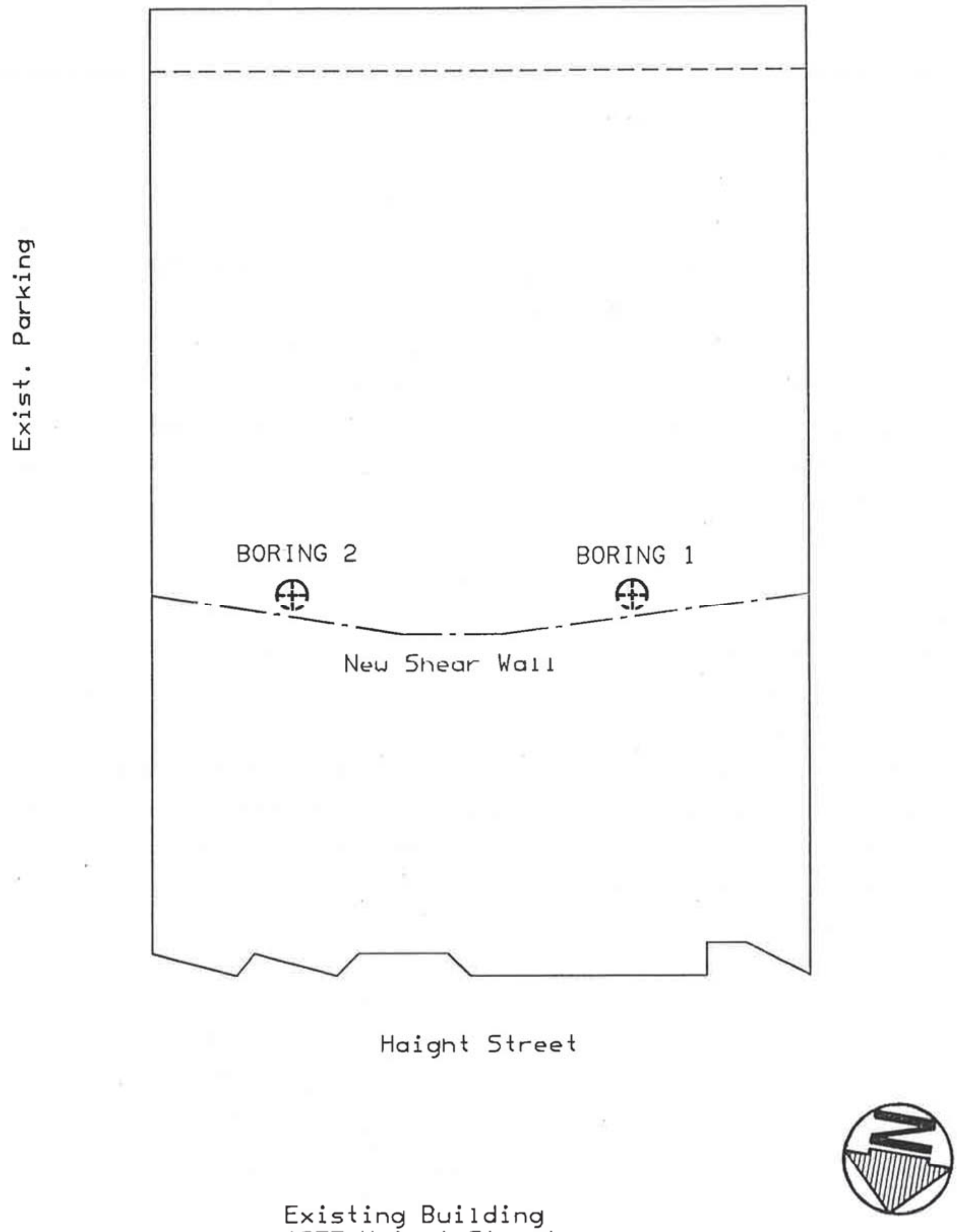
Penetration resistance blow counts were obtained by dropping a 140 pound hammer through a 30 inch free fall. The sampler was driven 18 inches or to refusal and the number of blows was recorded for each 6 inches of penetration or fraction thereof in the case of refusal. The blows per foot recorded on the boring logs represent the accumulated number of blows that were required to drive the sampler the last 12 inches or fraction thereof.

The soil classification is shown on the boring logs and is referenced on Plate 4, Soil Classification Chart and Key to Test Data.

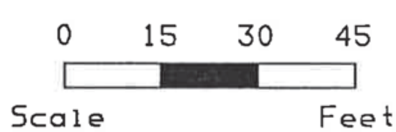
Laboratory Testing

Natural water content was determined on selected soil samples recovered from the test borings; the data are recorded at the appropriate sample depths on the boring logs. Selected samples were washed through the # 200 sieve to determine the silt and clay content. The percent passing the #200 sieve shown on the boring logs indicates the combined silt and clay content of the samples tested.

Ref: Prelim. drawings by Urban Edge



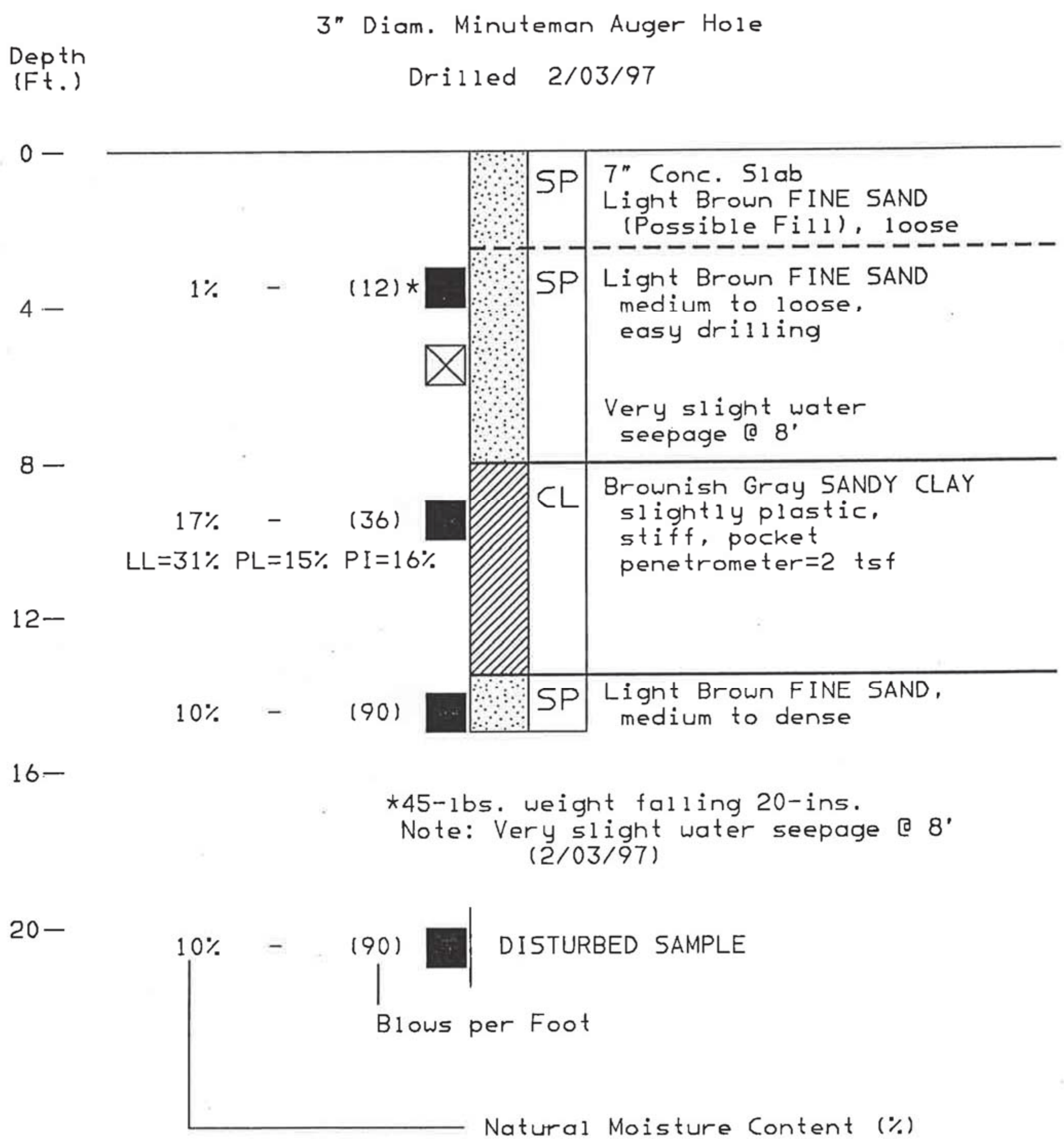
Existing Building
1855 Haight Street
San Francisco, CA



SKETCH

GEOTECHNICAL ENGINEERING, INC.
PLATE 1

BORING 1



LOG OF BORING

Scale 1" = 4'

GEOTECHNICAL ENGINEERING, INC.

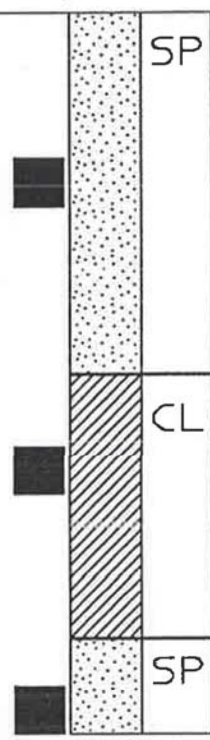
PLATE 2

BORING 2

3" Diam. Minuteman Auger Hole

Drilled 2/03/97

Depth (Ft.)	Moisture		Density	Soil Description
0				7" Conc. Slab Light Brown FINE SAND medium to loose, easy drilling
4	2%	-	(31)	
8				Red Brown & Gray SANDY CLAY, stiff, slightly plastic, friable, pocket penetrometer=1.5 tsf
	14%	-	(52)	
12				
	8%	-	(95)	Light Brown FINE SAND, dense to medium
16				
20				



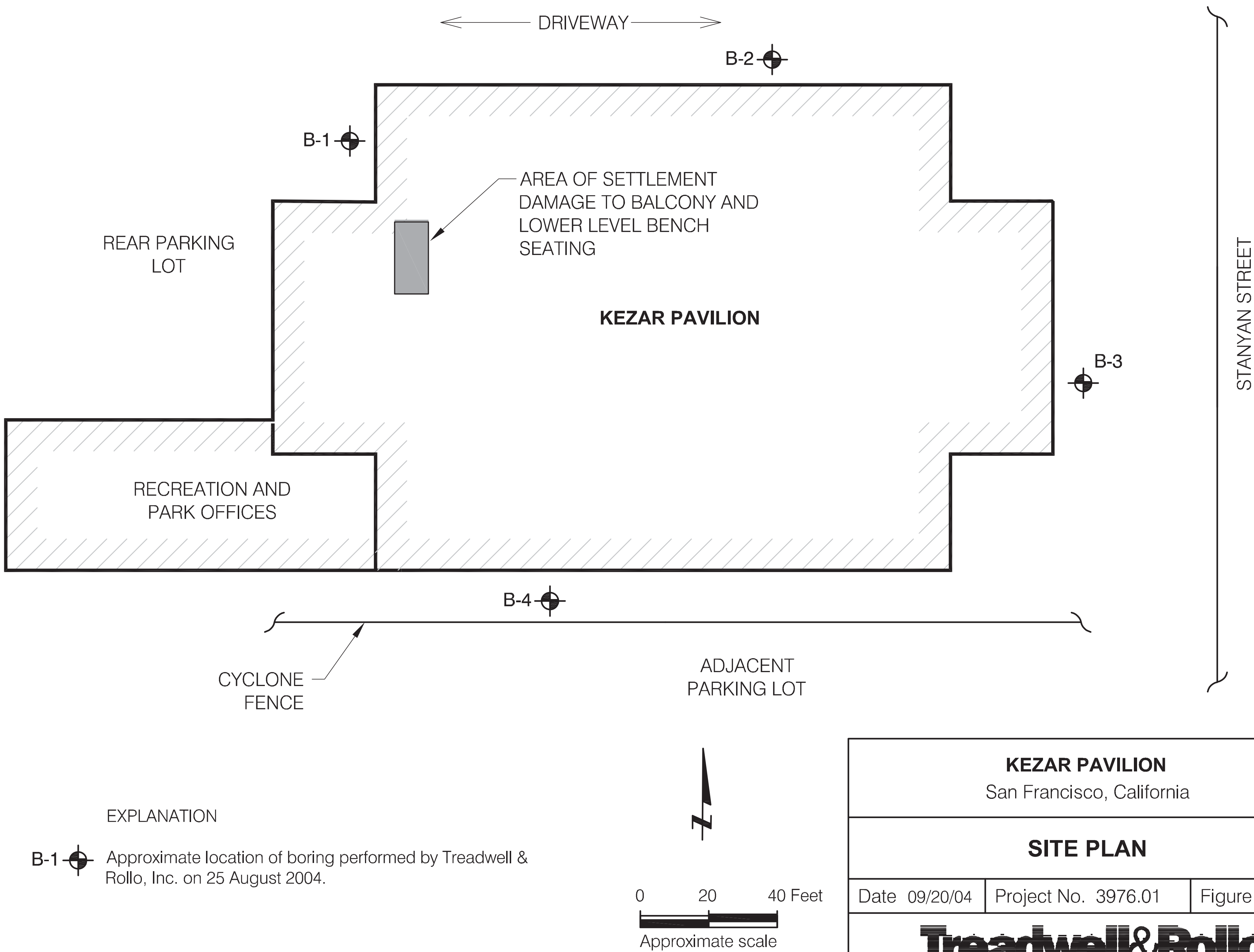
Note: Free ground water not encountered

LOG OF BORING

Scale 1" = 4'

GEOTECHNICAL ENGINEERING, INC.

PLATE 3



EXPLANATION

B-1 Approximate location of boring performed by Treadwell & Rollo, Inc. on 25 August 2004.

KEZAR PAVILION
San Francisco, California

SITE PLAN

Date 09/20/04	Project No. 3976.01	Figure 2

Treadwell&Rollo

3976.01—Site Plan.dwg

PROJECT:	**KEZAR PAVILION** San Francisco, California	**Log of Boring B-1** PAGE 1 OF 1

Boring location: See Site Plan, Figure 2

Date started: 8/25/04 — Date finished: 8/25/04

Drilling method: Hollow Stem Auger

Hammer weight/drop: 140 lbs./30-inches — Hammer type: Automatic

Sampler: Sprague & Henwood (S&H), Standard Penetration Test (SPT)

Logged by: C. Young

Ground Surface Elevation: 263 feet[2]

DEPTH (feet)	Sampler Type	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0–6			SM	SILTY SAND with GRAVEL (SM) red brown, loose, dry, fine gravel (FILL)						
3	S&H	9								
6	SPT	10								
6–13			GP	SANDY GRAVEL (GP) red brown, medium dense, moist, with trace silt (FILL)						
9	S&H	14								
13	SPT	12								
13–15			SP	SAND (SP) dark brown, medium dense, dry, fine-grained sand (FILL)						
15–17			SP	SAND (SP) yellow- brown, medium dense, dry						
17	S&H	13								
17–20.5			SC	CLAYEY SAND (SC) orange-brown, medium dense, moist, fine sand						
20.5–26.5			SM	SILTY SAND (SM) yellow-brown, dense, moist, trace medium to coarse sand						
21	SPT	36						13.4	18.9	
26	S&H	45							17.6	105

Boring terminated at 26.5 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H blow counts converted to SPT blow counts using a factor of 0.6. In addition, all blow counts are converted to SPT N-Values using a factor of 1.2 to account for the use of an automatic hammer.

[2] Elevations based on San Francisco City datum (SFCD).

Treadwell&Rollo

Project No.: 3976.01 — Figure: A-1

TEST GEOTECH LOG 397601.GPJ TR.GDT 12/3/04

PROJECT: **KEZAR PAVILION**
San Francisco, California

Log of Boring B-2

Boring location:	See Site Plan, Figure 2
Date started:	8/25/04
Date finished:	8/25/04
Drilling method:	Hollow Stem Auger
Hammer weight/drop:	140 lbs./30-inches
Hammer type:	Automatic
Sampler:	Sprague & Henwood (S&H), Standard Penetration Test (SPT)
Logged by:	C. Young

Ground Surface Elevation: 265 feet[2]

DEPTH (feet)	Sampler Type	Sample	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0–1					2.5-inches Asphaltic Concrete (FILL)						
1				SM	SILTY SAND (SM) red-brown, dry, trace gravel (FILL)						
2–4.5	SPT		25	SP	SAND (SP) light brown, medium dense, dry, fine grained (FILL)						
4.5–8.25	S&H		57	SM	SILTY SAND (SM) red-yellow, very dense, dry, fine grained, trace fine gravel				30.3	8.4	120
8.25	SPT		50	SP-SM	SAND with SILT (SP-SM) red-brown, very dense, moist, slightly cemented						
12	S&H		60	SP-SM						8.0	106
16	SPT		50	SP-SM							
18				SP-SM	increased silt content						
20.5	S&H		50	SP	SAND (SP) red-brown, dense, moist, fine grained, trace medium to coarse sand, trace silt						
25	SPT		72	SP							
26–26.5				SM	SILTY SAND (SM) yellow-brown, very dense, moist, fine-grained						

Boring terminated at 26.5 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H blow counts converted to SPT blow counts using a factor of 0.6. In addition, all blow counts are converted to SPT N-Values using a factor of 1.2 to account for the use of an automatic hammer.
[2] Elevations based on San Francisco City datum (SFCD).

Treadwell&Rollo

Project No.: 3976.01

Figure: A-2

TEST GEOTECH LOG 397601.GPJ TR.GDT 12/3/04

PROJECT:	KEZAR PAVILION San Francisco, California	Log of Boring B-3 PAGE 1 OF 1

Boring location: See Site Plan, Figure 2
Date started: 8/25/04 — Date finished: 8/25/04
Drilling method: Hollow Stem Auger
Hammer weight/drop: 140 lbs./30-inches — Hammer type: Automatic
Sampler: Sprague & Henwood (S&H), Standard Penetration Test (SPT)
Logged by: C. Young

Ground Surface Elevation: 259.5 feet[2]

DEPTH (feet)	Sampler Type	Sample	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0					4-inch thick concrete sidewalk (FILL)						
0.3					2-inch thick baserock layer (FILL)						
0.5				SM	SILTY SAND (SM) red, medium dense, dry (FILL)						
3	SPT		13		becomes yellow-brown						
5				SP	SAND (SP) yellow-brown, loose, moist, fine-grained, trace silt (FILL)						
6	S&H		9								
8.5				SM	SILTY SAND (SM) yellow-brown with red-yellow mottling, medium dense, moist, fine grained						
9	SPT		16						24.9	14.8	
13	S&H		43		becomes dense, trace medium to coarse sand, trace gravel					14.0	109
17	SPT		44								
20				SP	SAND (SP) yellow-brown to light brown, dense, moist, fine-grained, trace silt						
21	S&H		47								
26	SPT		47	SM	SILTY SAND (SM) yellow-brown, dense, moist, fine-grained						

Boring terminated at 26.5 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H blow counts converted to SPT blow counts using a factor of 0.6. In addition, all blow counts are converted to SPT N-Values using a factor of 1.2 to account for the use of an automatic hammer.
[2] Elevations based on San Francisco City datum (SFCD).

Treadwell&Rollo

Project No.: 3976.01 — Figure: A-3

TEST GEOTECH LOG 397601.GPJ TR.GDT 12/3/04

PROJECT:	KEZAR PAVILION San Francisco, California	Log of Boring B-4 PAGE 1 OF 1

Boring location: See Site Plan, Figure 2	Logged by: C. Young
Date started: 8/25/04 — Date finished: 8/25/04	
Drilling method: Hollow Stem Auger	
Hammer weight/drop: 140 lbs./30-inches — Hammer type: Automatic	
Sampler: Sprague & Henwood (S&H), Standard Penetration Test (SPT)	

DEPTH (feet)	Sampler Type	SPT N-Value[1]	LITHOLOGY	MATERIAL DESCRIPTION (Ground Surface Elevation: 262 feet[2])	Type of Strength Test	Confining Pressure Lbs/Sq Ft	Shear Strength Lbs/Sq Ft	Fines %	Natural Moisture Content, %	Dry Density Lbs/Cu Ft
0				2-inch thick concreted sidewalk						
				3-inch thick baserock layer						
1–5	SPT (2–3.5)	18	GM	SILTY GRAVEL (GM) red-gray, medium dense, dry						
5–8	S&H (5–6.5)	20	GC	CLAYEY GRAVEL (GC) red-brown, red-gray, medium dense, moist, with shale fragments						
8–12	SPT (8–9.5)	7	SC	CLAYEY SAND with GRAVEL (SC) olive-gray, olive-brown, loose, moist, fine to coarse sand, fine gravel						
12–17	S&H (12–13.5); SPT (16–17.5)	17; 14	GC	CLAYEY GRAVEL (GC) mottled olive, olive-gray, gray brown, medium dense, moist						
17–20			SM	SILTY SAND (SM) red-brown to dark-brown, medium dense, moist clay lense						
20–25	S&H (20–21.5)	11	SC	SILTY, CLAYEY SAND with GRAVEL (SC) dark-brown to black, medium dense, moist, fine to coarse sand, fine gravel						
25–26.5	SPT (25–26.5)	17	SP	SAND (SP) brown, medium dense, moist, trace silt						

FILL (from about 0.4 to 25 feet)

Boring terminated at 26.5 feet below ground surface.
Boring backfilled with cement grout.
Groundwater not encountered during drilling.

[1] S&H blow counts converted to SPT blow counts using a factor of 0.6. In addition, all blow counts are converted to SPT N-Values using a factor of 1.2 to account for the use of an automatic hammer.
[2] Elevations based on San Francisco City datum (SFCD).

Treadwell&Rollo

Project No.: 3976.01 — Figure: A-4

TEST GEOTECH LOG 397601.GPJ TR.GDT 12/3/04

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions		Symbols	Typical Names
Coarse-Grained Soils (more than half of soil > no. 200 sieve size	**Gravels** (More than half of coarse fraction > no. 4 sieve size)	**GW**	Well-graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines
		GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
	Sands (More than half of coarse fraction < no. 4 sieve size)	**SW**	Well-graded sands or gravelly sands, little or no fines
		SP	Poorly-graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
Fine -Grained Soils (more than half of soil < no. 200 sieve size)	**Silts and Clays** LL = < 50	**ML**	Inorganic silts and clayey silts of low plasticity, sandy silts, gravelly silts
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays
		OL	Organic silts and organic silt-clays of low plasticity
	Silts and Clays LL = > 50	**MH**	Inorganic silts of high plasticity
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic silts and clays of high plasticity
Highly Organic Soils		**PT**	Peat and other highly organic soils

GRAIN SIZE CHART

Classification	Range of Grain Sizes	
	U.S. Standard Sieve Size	**Grain Size in Millimeters**
Boulders	Above 12"	Above 305
Cobbles	12" to 3"	305 to 76.2
Gravel	3" to No. 4	76.2 to 4.76
coarse	3" to 3/4"	76.2 to 19.1
fine	3/4" to No. 4	19.1 to 4.76
Sand	No. 4 to No. 200	4.76 to 0.074
coarse	No. 4 to No. 10	4.76 to 2.00
medium	No. 10 to No. 40	2.00 to 0.420
fine	No. 40 to No. 200	0.420 to 0.074
Silt and Clay	Below No. 200	Below 0.074

Unstabilized groundwater level

Stabilized groundwater level

SAMPLE DESIGNATIONS/SYMBOLS

Sample taken with Sprague & Henwood split-barrel sampler with a 3.0-inch outside diameter and a 2.43-inch inside diameter. Darkened area indicates soil recovered

Classification sample taken with Standard Penetration Test sampler

Undisturbed sample taken with thin-walled tube

Disturbed sample

Sampling attempted with no recovery

Core sample

Analytical laboratory sample

Sample taken with Direct Push sampler

SAMPLER TYPE

C Core barrel

CA California split-barrel sampler with 2.5-inch outside diameter and a 1.93-inch inside diameter

D&M Dames & Moore piston sampler using 2.5-inch outside diameter, thin-walled tube

O Osterberg piston sampler using 3.0-inch outside diameter, thin-walled Shelby tube

PT Pitcher tube sampler using 3.0-inch outside diameter, thin-walled Shelby tube

S&H Sprague & Henwood split-barrel sampler with a 3.0-inch outside diameter and a 2.43-inch inside diameter

SPT Standard Penetration Test (SPT) split-barrel sampler with a 2.0-inch outside diameter and a 1.5-inch inside diameter

ST Shelby Tube (3.0-inch outside diameter, thin-walled tube) advanced with hydraulic pressure

KEZAR PAVILION
San Francisco, California

Treadwell&Rollo

CLASSIFICATION CHART

Date 09/17/04 | Project No. 3976.01 | Figure A-5