Treadwell&Rollo

29 May 2008
Project No. 4086.22

Ms. Terezia Nemeth
Alexandria Real Estate Equities
1700 Owens Street, Suite 500
San Francisco, California 94158

Subject: Preliminary Geotechnical Evaluation
Blocks 33-34
San Francisco, California

Dear Ms. Nemeth:

This letter presents the results of our preliminary geotechnical evaluation for Blocks 33 and 34 in Mission Bay, San Francisco, California. This evaluation was performed in accordance with our proposal dated 7 March 2008. We previously performed geotechnical investigations for others for Block X4, Blocks 29, 30, 31 and 32 (Blocks 29-32) Public Improvements, and Blocks 33 and 34 Public Improvements and published the results in reports dated 8 September 2006, 7 April 2008, and 1 May 2008, respectively.

Blocks 33 and 34 are located in San Francisco in an area known locally as Mission Bay. The approximate location of the site is shown on Figure 1 as attached. The site is bounded by 16th Street to the north, Illinois Street to the east, Mariposa Street to the south, and Third Street to the west. Currently, Block 33 is occupied by a large stockpile of soil removed during the excavation of the foundation for the building on the adjacent Block X4. Based on our observations, we estimate the stockpile occupies approximately 90 percent of Block 33 and is approximately 10 to 15 feet in height. Block 34 is currently occupied by an in-service concrete plant operated by Cemex Concrete. As previously noted, we performed geotechnical investigations for Blocks X4, Blocks 29-32 Public Improvements, and Blocks 33 and 34 Public Improvements. Block X4 is located to the east of Block 33, Block 31 (part of Blocks 29-32 Public Improvements) and 16th Street (part of Blocks 33 and 34 Public Improvements) to the north of Block 33, and Illinois Street (part of Blocks 33 and 34 Public Improvements) to the east of Blocks 33 and 34.

We began our geotechnical evaluation by reviewing the results of previous studies at and in the vicinity of the site. Treadwell & Rollo (T&R) has performed numerous investigations in the vicinity. In addition, we have developed a database of boring logs from various sources for the Mission Bay area in our files. Locations of test borings and cone penetration tests (CPTs) performed during previous investigations in the site vicinity are shown on Figure 2. The logs for borings and CPT that were previously drilled for Catellus have been included in Appendix A and logs from previous investigations for others and by others are not presented. Many of the logs of the boring in our database are generally not of sufficient quality to provide quantitative engineering information, but they provide qualitative data for use in our subsurface evaluation.

SCOPE OF SERVICES

We performed a preliminary evaluation of subsurface conditions by reviewing available soil data located at and in the vicinity of the site. Based on our findings, we have developed preliminary conclusions regarding:

- anticipated soil and groundwater conditions at the site
- most appropriate foundation type(s)

- anticipated settlement issues
- issues associated with floor slabs
- site seismicity and seismic hazards (specifically the potential for liquefaction to occur at the site)
- preliminary recommendations for seismic design.

As previously noted, we performed geotechnical investigations for Blocks X4, Blocks 29-32 Public Improvements, and Blocks 33 and 34 Public Improvements. We judge the results of these investigations provide sufficient data for the purposes of this preliminary evaluation. However, prior to development of Blocks 33 and 34, we recommend detailed site specific investigations that include additional subsurface exploration be performed.

SUBSURFACE CONDITIONS

The results of our preliminary subsurface evaluation indicate that the site is underlain by the following soil and rock units:

Fill Fill is heterogeneous and consists of very loose to dense sand and gravel and soft to medium stiff clay with varying amounts of rock fragments. Where explored, the fill varies in thickness between 12 and 21 feet. Corrosivity testing performed on samples obtained from the previous investigations at Blocks 29-32 Public Improvements and Blocks 33-34 Public Improvements indicate the fill is "corrosive". Fill deposits at in the site will also likely fall within this category.

Bay Mud The fill is underlain by recent bay deposits that consist of a weak and compressible clay, known locally as Bay Mud. Where encountered, the Bay Mud ranges from 0 to 16-1/2 feet thick. In general the Bay Mud increases in thickness to the south. Based on laboratory tests previously performed on samples obtained from our previous investigations at Blocks 29-32 Public Improvements and Blocks 33-34 Public Improvements, we anticipate the Bay Mud at Block 33 is normally consolidated to slightly overconsolidated[1] and the Bay Mud at Block 34 is overconsolidated. In our experience, tests performed on samples of Bay Mud from other sites have shown it to be severely corrosive.

Sand and Clay Based on existing information we anticipate the Bay Mud is underlain by a medium dense to dense silty sand, clayey sand, and sand with clay and very stiff to hard clay, sandy clay. Where encountered in previous borings, this sand and clay layer is 23 to 29 feet thick.

1 A normally consolidated clay has completed consolidation under existing load; and an overconsolidated clay has experienced a pressure greater than it current load.

Colma Formation Where encountered in previous borings, medium dense to very dense silty sand from Colma Formation exists above bedrock, and the thickness is approximately 0 to 20 feet. The Colma Formation is encountered near the southwestern corner and east end of Block 34.

Bedrock Where encountered in previous borings, the bedrock consists of serpentinite and sandstone of the Franciscan Complex. The rock encountered is intensely fractured, soft to hard, friable to moderately strong, and slightly to deeply weathered. Based on existing subsurface data in vicinity of Block 33 and bedrock contours around Block 33, we estimate the bedrock ranges approximately from Elevation 40 to 90 feet[2]. However, very limited bedrock information is available from previous borings in vicinity of Block 34. Borings from Blocks 33 and 34 Public Improvements (near the northeastern and southeastern corners of Block 34) were explored to maximum depths of 48 and 71-1/2 feet bgs (corresponding to Elevations 54 and 31, respectively) and bedrock was not encountered in these two borings. Bedrock was encountered approximately 30 to 40 feet bgs (corresponding to Elevations 75 and 70, respectively) near the southwestern corner. Therefore, we anticipate the top of bedrock can vary significantly across Block 34, from 30 to more than 70 feet bgs.

Groundwater Groundwater was encountered during previous investigations at elevations ranging between 93 and 96 feet. This level is likely susceptible to seasonal and tidal variations.

The Bay Mud is known to be expansive; however, it is below the zone of moisture change and should have no adverse effect on the proposed development. No expansive soil is expected in the fill layer at the site.

REGIONAL SEISMICITY AND FAULTING

The major active faults in the area are the San Andreas, Hayward, and San Gregorio Faults. These and other faults of the region are shown on Figure 3. For each of the active faults, the distance from the site and estimated mean characteristic Moment magnitude[3] [2007 Working Group on California Earthquake Probabilities (WGCEP) (2007) and Cao et al. (2003)] are summarized in Table 1.

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2 Elevations based on San Francisco City Datum plus 100 feet.

3 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.

TABLE 1
Regional Faults and Seismicity

Fault Segment	Approximate Distance from Site (km)	Direction from Site	Maximum Magnitude
San Andreas – 1906 Rupture	12.4	West	7.90
San Andreas – Peninsula	12.4	West	7.15
San Andreas – North Coast South	16	West	7.45
North Hayward	17	Northeast	6.49
Total Hayward	17	Northeast	6.91
Total Hayward-Rodgers Creek	17	Northeast	7.26
South Hayward	17	East	6.67
Northern San Gregorio	19	West	7.23
Total San Gregorio	19	West	7.44
Mt. Diablo	33	East	6.65
Total Calaveras	34	East	6.93
Rodgers Creek	36	North	6.98
Concord/Green Valley	38	East	6.71
Monte Vista-Shannon	39	Southeast	6.80
Point Reyes	44	West	6.80
West Napa	46	Northeast	6.50

Figure 3 also shows the earthquake epicenters for events with magnitude greater than 5.0 from January 1800 through January 1996. 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 4) 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 most recent earthquake to affect the Bay Area was the Loma Prieta Earthquake of 17 October 1989 with an M_w of 6.9. This earthquake occurred in the Santa Cruz Mountains, approximately 50 km from the site.

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 2007 WGCEP at the U.S. Geologic Survey (USGS) predicted a 63 percent chance of a magnitude 6.7 or greater earthquake occurring in the San Francisco Bay Area in 30 years. More specific estimates of the probabilities for different faults in the Bay Area are presented in Table 2.

TABLE 2
WGCEP (2007) Estimates of 30-Year Probability of a Magnitude 6.7 or Greater Earthquake

Fault	Probability (percent)
Hayward-Rodgers Creek	31
N. San Andreas	21
Calaveras	7
San Gregorio	6
Concord-Green Valley	3
Greenville	3
Mount Diablo Thrust	1

CONCLUSIONS AND PRELIMINARY RECOMMENDATIONS

On the basis of the available subsurface information, it is our opinion the site can be developed as planned. Our preliminary conclusions regarding geologic hazards, foundations, excavation, temporary shoring, basement walls, underpinning, and seismic design are presented in the remainder of this letter.

Geologic 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 project site. Strong shaking during an earthquake can result in ground failure such as that associated with soil liquefaction,[4] lateral spreading,[5] and seismic densification.[6]

The California Geologic Survey (CGS) has prepared a map titled *State of California Seismic Hazard Zones, City and County of San Francisco, Official Map*, dated 17 November 2001. This map was prepared in accordance with the Seismic Hazards Mapping Act of 1990. The project site is within one of the designated liquefaction hazard zones. CGS has also recommended the content for site investigation reports within seismic hazard zones in State of California Special Publication 117 (SP 117) titled *Guidelines for Evaluating and Mitigating Seismic Hazard Zones in California*, dated 13 March 1997. Therefore, in order to properly assess the potential for liquefaction and the amount of settlement and lateral spreading that may occur during and after a major seismic event, the final geotechnical investigation for Blocks 33 and 34 should be performed in accordance with these guidelines. The site is flat and the seismic hazard zone map indicates the site is not in an area were the previous occurrence of landslides have been observed after a seismic event, therefore the risk of a landslide at the site following a large seismic event is nil.

Based on subsurface information in site vicinity, the fill deposits below the groundwater include very loose to medium dense clayey sand, silty sand and sand with gravel, and gravel with sand with thickness ranging from 4-1/2 to 11 feet. This soil could liquefy in a major earthquake. Based on engineering analyses from previous investigations, earthquake-induced liquefaction settlements of approximately ½ to 7 inches were estimated, depending on the layer thickness and relative density. Liquefaction-induced settlement with approximately similar magnitude may occur at the site. Therefore, a full geotechnical investigation should be performed at the site to adequately assess the potential for liquefaction for the fill below the groundwater table. Any basement or below-grade permanent walls will need to accommodate additional earth pressures due to liquefaction of the surrounding soil.

The site is located outside of the Alquist-Priolo Earthquake Fault Zone and published data indicate neither known active faults nor extensions of active faults exist beneath the site. Therefore, we judge the potential of surface rupture occurring at the site is low.

The site is approximately 400 feet from San Francisco Bay. Based on the geotechnical reports in site vicinity as previously noted, we concluded lateral spreading is unlikely to occur in Block X4 and unlikely on a large scale in Blocks 33 and 34 Public Improvements. The potentially liquefiable soil in these two sites was judged not to fall within the parameters applicable to the Youd, Hansen, and Bartlett (1999)

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4 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.

5 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.

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

lateral spread model; according to Youd, Hansen, and Bartlett (1999), for significant lateral spreading displacement to occur, the soils should consist of saturated cohesionless sandy sediments with $(N_1)_{60}$ less than 15. Therefore, we judge the risk of lateral spreading at the site is low.

Furthermore, the site should not be subject to landslides or erosion. No springs or seepages were observed on site.

Settlement

Bay Mud at the site varies greatly in thickness from 0 to 16-1/2 feet. We anticipate the Bay Mud at Block 33 is normally consolidated to slightly overconsolidated and is not still consolidating under the weight of the existing fill; only secondary compression should be occurring. The Bay Mud at Block 34 is overconsolidated and the primary consolidation of the Bay Mud under the weight of existing fill should be complete, resulting in little remaining settlement due to secondary compression. Based on the engineering studies for Blocks 33 and 34 Public Improvements, very little settlement was estimated due to placement of new fill because the Bay Mud is relatively thin and is normally to overconsolidated. Settlement of up to approximately 1¼ inches was estimated in 50 years if two feet of new fill is placed. We judge these values are applicable as preliminary estimates for settlement at Blocks 33 and 34 if new fill will be placed.

During an earthquake, additional settlement due to seismic densification will likely occur in some areas of the site. The amount of settlement will depend on the quality and thickness of the loose fill above the groundwater. Engineering analysis performed for Blocks 33 and 34 Public Improvements indicates that approximately 3-1/2 inches settlement due to seismic densification could occur at the site in a major earthquake in addition to earthquake-induced liquefaction settlements of approximately ½ to 7 inches as previously discussed. We judge these values are applicable as preliminary estimates for the amount of settlement due to seismic densification and liquefaction that will occur at the site.

Because of the anticipated settlement and poor quality of the fill, the proposed building will need to be pile supported, as discussed in the later foundations section. We anticipate that less than one inch of building settlement will occur for a properly installed pile foundation. Therefore, abrupt differential settlement should be expected between pile-supported structures and the ground surface.

Settlement could have adverse effects on site drainage, hardscape improvements, transitions between on-grade and pile-supported structures. Settlement will also create a downward frictional load on piles, as will be discussed in the Foundations section.

Foundations

The fill in its present condition is not capable of providing adequate bearing for a shallow foundation system. Unpredictable and erratic settlement would occur. Furthermore, the Bay Mud will consolidate under the weight of the existing and new fill and proposed building loads; the magnitude of settlement at the project site will be influenced by several factors including the thickness of the fill and Bay Mud. Therefore, shallow foundations are not considered appropriate for any proposed structures at this site. On the basis of the results of our study and our experience with similar projects in Mission Bay, we conclude a deep foundation consisting of driven piles is the most appropriate and economical system for support of the proposed buildings and floor slab. The piles should extend below the fill and Bay Mud and gain support primarily from end bearing in bedrock. If noise and/or vibrations are unacceptable, alternative types of deep foundations such as Tubex, torque-down piles, and auger-cast piles may be considered.

Piles typically encounter refusal in very dense, relatively clean sand layers, at least 10 feet thick. Existing subsurface data in the site vicinity indicates that there are no relatively clean sand layers at least 10 feet thick beneath the site. Therefore, the piles most likely will be driven to refusal in bedrock. The bedrock surface varies from depths of 10 to 60 feet bgs in Block 33 (assuming the stockpile soil will be removed to Elevation 100 feet). The bedrock surface in Block 34 cannot be estimated due to very limited data; however, data indicates it is deeper than 48 and 71 feet near the northeastern and southeastern corners, respectively. Further investigation and an indicator pile program performed within Blocks 33 and 34 will help evaluate the presence of a bearing sand layer (if it exists), the depth to top of bedrock, and the length of piles. Based on existing subsurface data we estimate piles driven to refusal in bedrock in Block 33 will range from about 15 to 70 feet in length, and the pile length in Block 34 cannot be estimated at present time; however, piles could be on the order of approximately 35 to 40 feet long near the southwestern corner of Block 34 and greater than 70 feet elsewhere on site.

The existing subsurface data indicates that the piles should be driven to refusal in bedrock and the bedrock surface and hardness vary dramatically across the site. Therefore, we judge steel piles to be more appropriate for the site because steel piles can be lengthened or shortened as needed.

As previously discussed, piles driven to refusal in bedrock will range from about 15 to 65 feet long in Block 33 and pile length in Block 34 cannot be estimated at present time; however, piles could be approximately 35 to 40 feet long near the southwestern corner of Block 34. We previously provided dead plus live load capacities for the driven piles driven to refusal at Blocks X4 in our geotechnical reports. The dead plus live load capacity of 300 kips provided for piles driven at Block X4 may be used as a preliminary capacity for piles driven at the site. This capacity does not account for the downdrag load, which may be on the order of 0 to 50 kips. The final capacities for piles driven at the site should be evaluated during a final geotechnical investigation at these blocks.

Although the piles will be driven to refusal, foundation settlement will still occur, mainly due to elastic compression of the pile. We anticipate ½ to 1 inch of settlement may occur. Differential settlement should be less than ½ inch between any adjacent columns. Foundation settlement for the site should be evaluated during the final geotechnical investigation.

Because the fill and Bay Mud are likely corrosive to severely corrosive, piles will require protection from corrosion. The upper portion of steel piles embedded in fill and Bay Mud will be subject to corrosion. To account for corrosion potential, a larger steel section may be needed than is required for the pile design capacity. A dielectric coating of the pile may also be needed to help reduce corrosion. A corrosion subconsultant should evaluate the corrosion test results and develop recommendations during the final geotechnical investigation.

It should be noted that under the new 2006 International Building Code (IBC), all steel piles may be required to be HP14x102 sections, at a minimum.

Floor Slabs

Because of the condition of the existing fill and the potential for settlement, we judge floor slabs should be structurally supported. Although the ground surface will settle away from the slabs, the slabs will initially be in contact with the ground. Moisture is likely to condense on concrete floor slabs. Where moisture is not acceptable, structurally supported slabs should be underlain by a moisture barrier. Because the ground will settle away from the floor slabs, building entrances and utilities should be designed for the predicted settlement.

Seismic Design

Since 1 January 2008, the City of San Francisco has adopted the new 2006 IBC seismic design criteria as part of the updated 2007 California Building Code (2008 San Francisco Building Code (SFBC)). For design in accordance with 2008 SFBC, we recommend Site Class F be used at the site because of the presence of liquefiable fill. A site specific response spectrum is required for sites in this class and should be performed as part of the final investigation for the site.

We recommend that a site-specific geotechnical investigation, including additional exploration, be performed within footprint of the sites to further evaluate subsurface conditions and provide conclusions and recommendations regarding the geotechnical aspects of the project.

We appreciate the opportunity to provide services for the proposed development at Blocks 33 and 34 in Mission Bay. If you have any questions, please call.

Sincerely yours,
TREADWELL & ROLLO, INC.

REGISTERED PROFESSIONAL ENGINEER
JOO CHAI WONG
NO. C71798
Exp. 12/31/09
CIVIL
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Senior Staff Engineer

Lori A. Simpson, G.E.
Principal

REGISTERED PROFESSIONAL ENGINEER
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40862201.JCW

Attachments:
Figure 1 – Site Location Map
Figure 2 – Site Plan
Figure 3 – Map of Major Faults and Earthquake Epicenters in the San Francisco Bay Area
Figure 4 – Modified Mercalli Intensity Scale
Appendix A – Boring and CPT Logs from Previous Investigations

REFERENCES

California Geological Survey (1997). "Guidelines for Evaluating and Mitigating Seismic Hazard Zones in California." Special Publication 117.

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Toppozada, T. R. and Borchardt G. (1998). "Re-Evaluation of the 1836 "Hayward Fault" and the 1838 San Andreas Fault earthquakes." *Bulletin of Seismological Society of America*, 88(1), 140-159.

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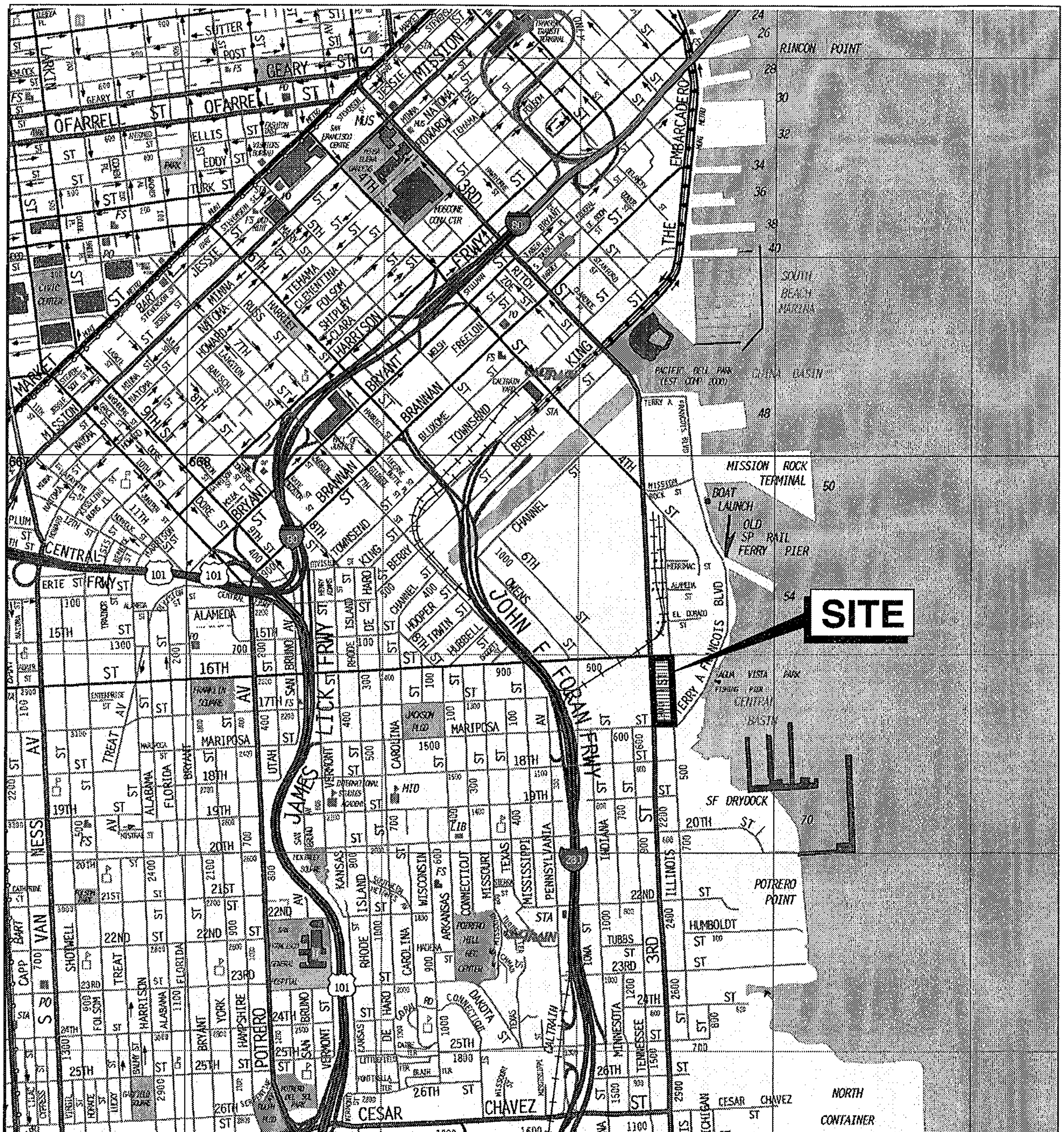
FIGURES



Base map: Google Map, 2008

0 1/4 1/2 Mile

Approximate scale

BLOCKS 33-34
MISSION BAY
San Francisco, California

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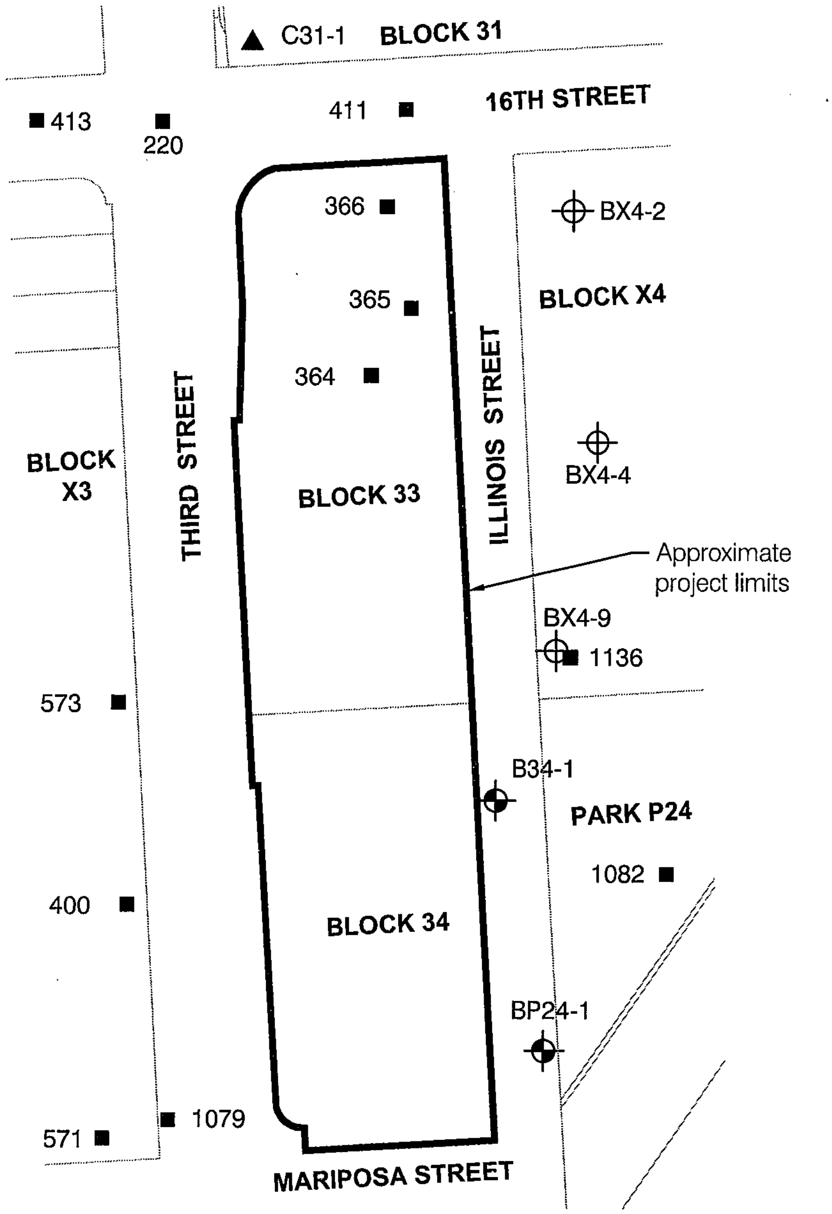
SITE LOCATION MAP

Date 04/28/08	Project No. 4086.22	Figure 1



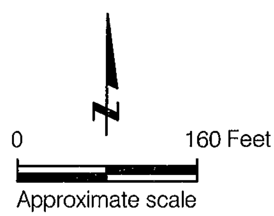
EXPLANATION

B34-1 — Approximate location of previous boring by Treadwell & Rollo, Inc., for others (boring logs included)

BX4-1 — Approximate location of previous boring by Treadwell & Rollo, Inc., for others (boring logs not included)

C31-1 ▲ Approximate location of previous cone penetration test by Treadwell & Rollo, Inc., for others (CPT log included)

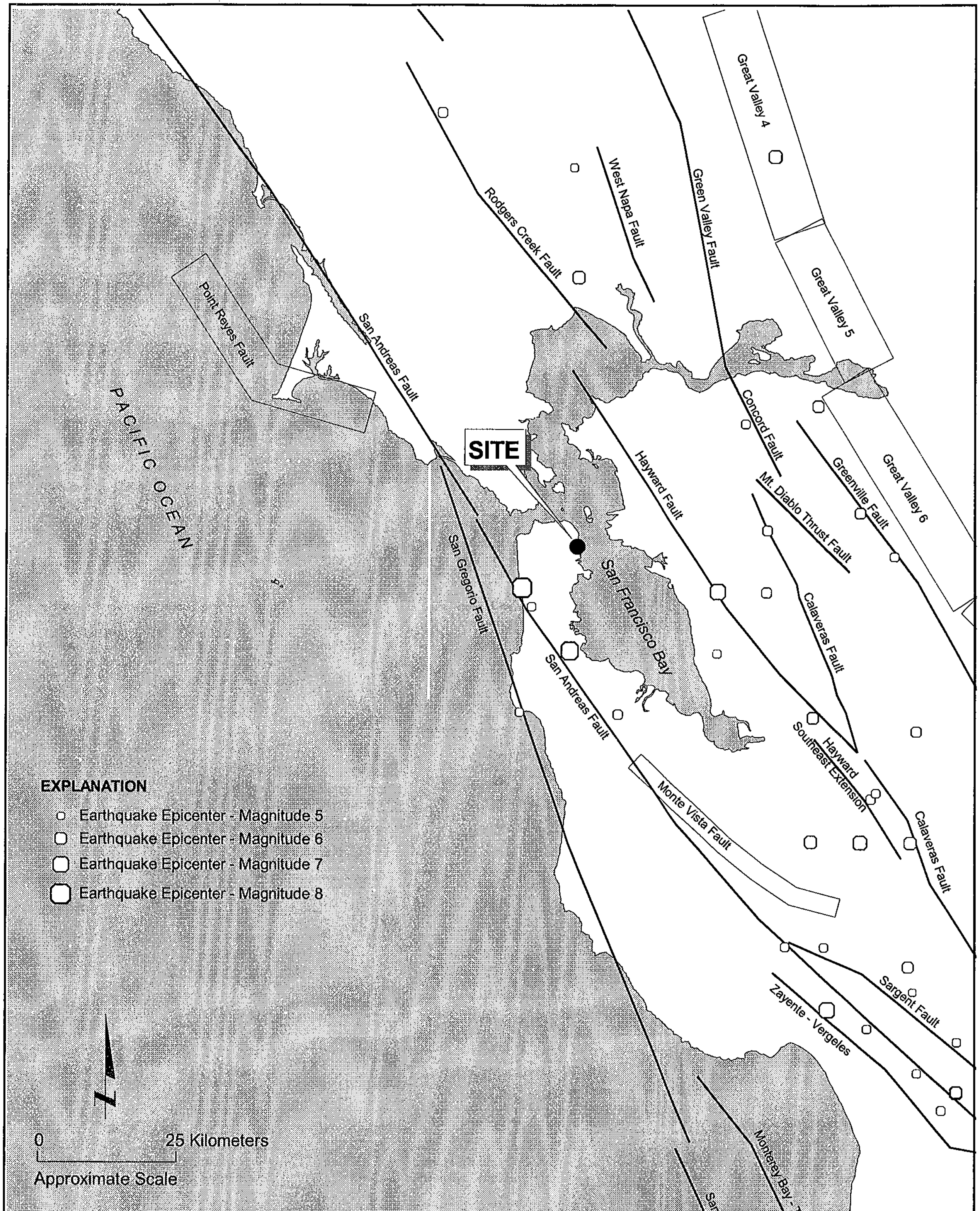
366 ■ Borings by others (database designation, boring logs not included)



Reference: Base map from "Blk 33-34 Plan Map.pdf" emailed from Alexandria Real Estate Equities on 30 April 2008.

R: Trgraphics 4000's 4086.22 4086.22 SITE PLAN.dwg 5/30/08

BLOCKS 33 AND 34 **MISSION BAY** San Francisco, California	**SITE PLAN**
Treadwell&Rollo	Date 05/20/08 | Project No. 4086.22 | Figure 2



NOTES:
Digitized data for fault coordinates and earthquake catalog was developed by the California Department of Conservation Division of Mines and Geology. The historic earthquake catalog includes events from January 1800 to December 2000.

BLOCKS 33-34
MISSION BAY
San Francisco, California

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

Date: 04/28/08	Project No. 4086.22	Figure 3

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.

BLOCKS 33-34 **MISSION BAY** San Francisco, California	**MODIFIED MERCALLI INTENSITY SCALE**		
Treadwell&Rollo	Date 04/28/08	Project No. 4086.22	Figure 4

Treadwell&Rollo

APPENDIX A

Boring and CPT Logs from Previous Investigations

PROJECT: **BLOCKS 33-34 PUBLIC IMPROVEMENTS MISSION BAY** San Francisco, California

Log of Boring B34-1

Boring location: See Site Plan, Figure 2

Logged by: S. Maghsoudi

Date started: 1/25/08 | Date finished: 1/25/08

Drilling method: Rotary Wash

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

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

Ground Surface Elevation: 102 feet[2]

DEPTH (feet)	Sampler Type	Blows/ 6"	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
0–0.75					9-inches Asphalt Concrete (AC)						
0.75–7.5				SC	CLAYEY SAND with GRAVEL (SC) olive gray, very loose, moist (FILL)						
6					∇ 1/25/08 at 9:10 am						
6–7.5	S&H	1, 1, 1	2								
7.5–11				GP	GRAVEL with SAND (GP) olive gray, loose, moist (FILL)						
8–9.5	SPT	8, 3, 1	5								
11–19				CH	CLAY (CH) olive gray, soft, wet (BAY MUD)						
12–15	ST		50 psi		Consolidation Test, see Figure D-1					47.3	73
19–25				CL	CLAY (CL) brown, very stiff, wet						
22–23.5	SPT	4, 7, 8	18							18.5	
25–30				CL	SANDY CLAY (CL) yellow-brown, hard, wet						
27–28.5	SPT	7, 11, 22	40								

Treadwell&Rollo

Project No.: 3349.01 | Figure: C-1a

PROJECT:	BLOCKS 33-34 PUBLIC IMPROVEMENTS MISSION BAY San Francisco, California	Log of Boring B34-1 PAGE 2 OF 2

DEPTH (feet)	Sampler Type	Sample	Blows/ 6"	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
						SANDY CLAY (CL) (continued)						
31												
32			5									
33	SPT		6	17		very stiff				52.9	21.2	
			8									
34												
35					CL							
36												
37			5			grades little to no sand						
38	SPT		7	19								
			9									
39												
40												
41						SANDY CLAY with GRAVEL (CL) yellow brown, hard, wet						
42			7		CL							
43	SPT		8	49								
			33									
44						CLAYEY SAND with GRAVEL (SC) olive-gray, dense, wet						
45												
46					SC							
47	SPT		17	46								
			18									
48			20									
49												
50												
51												
52												
53												
54												
55												
56												
57												
58												
59												
60												

SAMPLES | LABORATORY TEST DATA

Boring terminated at a depth of 48 feet below ground surface.
Boring backfilled with cement grout.
Groundwater encountered at a depth of 6.4 feet during drilling.

[1] S&H and SPT blow counts for the last two increments were converted to SPT N-Values using factors of 0.7 and 1.2, respectively to account for sampler type and hammer energy.
[2] Elevations based on San Francisco City datum plus 100 feet.

Treadwell&Rollo

Project No.: 3349.01	Figure: C-1b

TEST GEOTECH LOG 334901.GPJ TR.GDT 4/14/08

PROJECT:	BLOCKS 33-34 PUBLIC IMPROVEMENTS MISSION BAY San Francisco, California	Log of Boring BP24-1

Boring location: See Site Plan, Figure 2

Logged by: S. Maghsoudi

Date started: 1/25/08 Date finished: 1/25/08

Drilling method: Rotary Wash

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

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

Ground Surface Elevation: 102 feet[2]

DEPTH (feet)	Sampler Type	Blows/ 6"	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					9-inch Asphalt Concrete (AC)						
1–6				CL	Hand Auger 0 to 6 feet because of existing nearby utilities on Illinois Street (FILL)						
6–7.5	S&H	3, 3, 3	4	CL	CLAY with GRAVEL (CL) olive brown and olive gray, soft to medium stiff, moist ▽ 01/25/08 at 1:20 pm						
8				SC	CLAYEY SAND with GRAVEL (SC) olive gray, loose, wet						
9–10.5	SPT	3, 3, 2	6	SC					17.2	22.0	
14–15.5	SPT	3, 2, 2	5	SC							
16				CH	CLAY (CH) gray, soft, wet (BAY MUD)						
19–22	ST		50 psi	CH	Consolidation Test, see Figure D-2					84.9	49
27–30	ST		75 psi	CH	Consolidation Test, see Figure D-3					88.3	49

Treadwell&Rollo

Project No.: 3349.01

Figure: C-2a

PROJECT:	BLOCKS 33-34 PUBLIC IMPROVEMENTS MISSION BAY San Francisco, California	Log of Boring BP24-1 PAGE 2 OF 3

DEPTH (feet)	Sampler Type	Sample	Blows/6"	SPT N-Value	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
31–32					CH	CLAY (CH) (continued) — BAY MUD						
32–37					CL	SANDY CLAY (CL) olive, hard, moist						
33–34.5	SPT		5 15 17	38								
37–44					SP-SC	SAND with CLAY (SP-SC) yellow brown, dense, moist						
38–39.5	SPT		13 17 24	49								
44–60					CL	SANDY CLAY (CL) yellow brown, very stiff, wet						
48–49.5	SPT		5 8 10	22								
58–59.5	SPT		7 12 14	31		hard						

TEST GEOTECH LOG 334901.GPJ TR.GDT 4/30/08

Treadwell&Rollo

Project No.: 3349.01

Figure: C-2b

PROJECT: **BLOCKS 33-34 PUBLIC IMPROVEMENTS**
MISSION BAY
San Francisco, California

Log of Boring BP24-1

DEPTH (feet)	Sampler Type	Sample	Blows/ 6"	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
61–66					CL	SANDY CLAY (CL) (continued)						
67–71.5	SPT (70–71.5)		17 24 40	77	SC	CLAYEY SAND (SC) yellow brown, very dense, moist — RESIDUAL SOIL						
72–90												

Boring terminated at a depth of 71.5 feet below ground surface.
Boring backfilled with cement grout.
Groundwater encountered at a depth of 7.4 feet during drilling.

[1] S&H and SPT blow counts for the last two increments were converted to SPT N-Values using factors of 0.7 and 1.2, respectively to account for sampler type and hammer energy.
[2] Elevations based on San Francisco City datum plus 100 feet.

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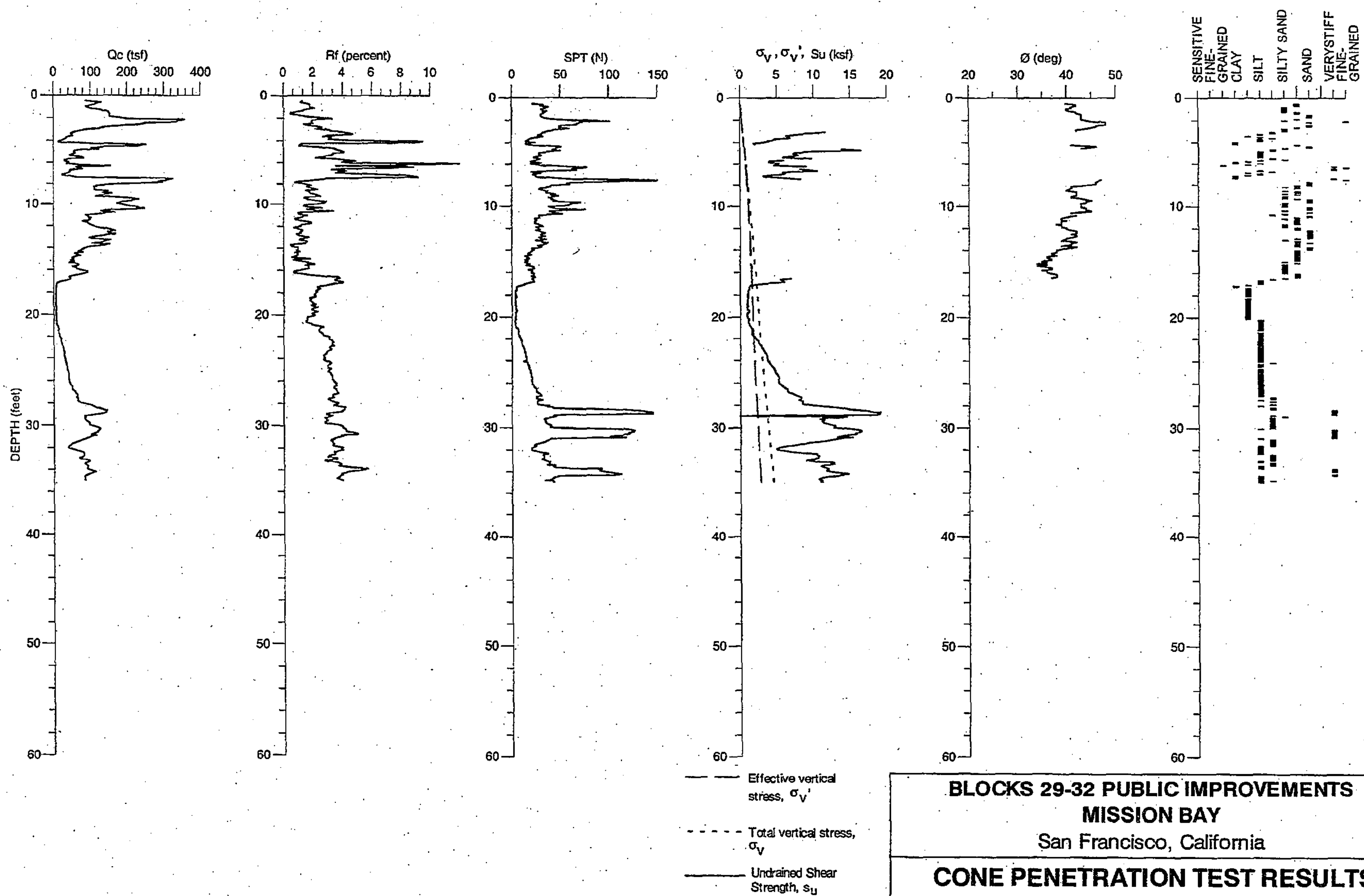
Project No.: 3349.01 | Figure: C-2c

TEST GEOTECH LOG 334901.GPJ TR.GDT 4/30/08



BLOCKS 29-32 PUBLIC IMPROVEMENTS
MISSION BAY
San Francisco, California

CONE PENETRATION TEST RESULTS
C31-1

Date 03/20/08	Project No. 3347.01	Figure F-3

Treadwell&Rollo

Terminated at 35.0 feet.
Date performed: 1/24/08.
Ground surface elevation: 102.2 feet, San Francisco City Datum plus 100 feet.