12 September 2018

Mr. Jeff Smith
Sares Regis
901 Mariners Island Boulevard, Suite 700
San Mateo, California 94404

SUBJECT: Preliminary Geotechnical Evaluation
505 East Bayshore Road
Redwood City, California
Langan Project No. 770655202

Dear Mr. Smith:

This report presents a preliminary geotechnical evaluation for the proposed development at 505 East Bayshore Road in Redwood City, California. The site is bound by East Bay Shore Road to the west, a water channel to the north, a former movie theatre to the east and a car dealership to the south, as shown on Figures 1 and 2.

The site is approximately 2.5-acres and is currently occupied by four warehouse buildings along the southern and western sides of the site; the northeastern part of the site is undeveloped. We understand that Sares Regis would like to redevelop the site with residential structures, such as at-grade town homes or concrete podium garage building with townhomes above.

1.0 SCOPE OF SERVICES

This letter report was prepared based on the scope presented in our proposal dated 1 August 2018. We reviewed and evaluated available subsurface information in the site vicinity and developed preliminary conclusions and recommendations regarding the geotechnical aspects of the project, as listed below:

- soil and groundwater conditions;
- possible site seismicity and seismic hazards, if any;
- probable foundation type(s) for the proposed building(s);
- preliminary design parameters for the recommended foundation type(s);
- subgrade preparation for slab-on-grade floors;
- construction considerations

- site grading and excavation, including criteria for fill quality and compaction; and
- 2016 California Building Code (CBC) soil profile type and mapped values S_S and S_1 and coefficients F_a and F_v

Our scope is limited to reviewing available geotechnical data, consulting with you regarding the geotechnical aspects of the property, and assisting you with your due diligence study. Field exploration was excluded from our scope of services.

2.0 SITE AND SUBSURFACE CONDITIONS

To evaluate the site and subsurface conditions at the site, we reviewed available geologic and seismic hazard maps and the results of geotechnical and environmental investigations previously performed by Langan and others in the site vicinity. The documents we reviewed include:

- Geotechnical Investigation, 557 East Bayshore Road, Redwood City, California, by Langan, dated 4 December 2017.
- Revised Geotechnical Investigation, One Marina, Phase 2, 3 and 4, Redwood City, California, by Langan, dated 4 May 2012.
- Geotechnical Evaluation of Project for EIS, Whipple Avenue and Route 101 South, Redwood City, California, by California Department of Transportation, dated 16 May 1978.
- Phase I Environmental Site Assessment and Limited Phase II Subsurface Investigation at 505 East Bayshore Boulevard, Redwood City, California 94063, by Stellar Environmental Solutions, Inc., dated January 2016.
- Seismic Hazard Zone Map for the Palo Alto 7.5-Minute Quadrangle, San Mateo County, California, by the California Geological Survey (CGS), dated 2006.
- Geologic Map for the Palo Alto 7.5-Minute Quadrangle, San Mateo County, California, by the United States Geological Survey (USGS), dated 2006.

In addition, we reviewed the environmental borings drilled for the current Phase I and Phase II investigations by Langan on 18 August 2018. The approximate locations of the borings, designated as EB-1 through EB-10, are shown on Figure 2. The environmental borings will be published under a separate cover.

The following is a summary of the site and subsurface conditions at the site.

2.1 Site Conditions

The site is approximately 2.5-acres and is currently owned and occupied by the Alan Steel & Supply Company, who operates a metal recycling and supply facility. The site is occupied by four warehouse buildings (Buildings 1 through 4) along the southern and western side of the site, as shown on Figure 2. The foundation systems of the existing buildings are currently unknown. There are outdoor metal racking and storage areas between these buildings; the storage yard is covered with steel plates and asphalt. The northeastern part of the site is unpaved.

A water channel runs along the northern property line of the site. There is a small soil berm along the eastern portion of the north property line along the water channel. Smith Slough is approximately 75 feet north of the northern boundary of the site.

2.2 Subsurface Conditions

On the basis of our review of these reports, log of test borings and maps, we anticipate subsurface conditions beneath the site to generally consist of approximately 3 to 15 feet of fill consisting of medium stiff to very stiff clay with occasional loose to medium dense sand and gravel. Underlying the fill is approximately 5 to 10 feet of soft compressible marine clay locally referred to as Bay Mud. Based on laboratory tests of the Bay Mud at nearby sites, the Bay Mud may be slightly overconsolidated[1]. The Bay Mud is underlain by medium stiff to very stiff clay with varying amount of sand and loose to very dense sand and gravel layers with varying type and amount of fines. Fill material that is present near the ground surface is expected to be moderately compressible and potentially have moderate to high expansion potential[2]. Corrosivity analyses performed at nearby sites classify the fill as corrosive and Bay Mud as severely corrosive.

Groundwater was measured at the site in Borings LB-3, LB-5, LB-9 and SES-1 at depths of approximately 3 to 9½ feet below ground surface (bgs). Groundwater was encountered at nearby sites at depths between approximately 7 and 12 feet bgs. In some instances, these depths were recorded during and immediately after drilling and may not represent stabilized levels. Groundwater levels at the site are also influenced by fluctuations in weather and tides. The historic high groundwater level based on the California Geological Survey (CGS) Seismic Hazard Zone Report for the Palo Alto Quadrangle (CGS, 2006) is approximately 0 feet bgs.

3.0 SEISMICITY

The major active faults in the area are the Monte Vista-Shannon, San Andreas, San Gregorio, and Hayward faults. These and other faults of the region are shown on Figure 3. For each of the active faults within 50 kilometers of the site, the distance from the site and estimated mean characteristic Moment magnitude[3] [Working Group on California Earthquake Probabilities (WGCEP) (2008) and Cao et al. (2003)] are summarized in Table 1.

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[1] An overconsolidated clay has experienced a pressure greater than its current load

[2] Expansive soil undergoes volume changes with changes in moisture content.

[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 Name	Distance (km)	Direction from Site	Mean Characteristic Moment Magnitude
Monte Vista-Shannon	7	South	6.50
N. San Andreas - Peninsula	7	West	7.23
N. San Andreas (1906 event)	7	West	8.05
San Gregorio Connected	21	West	7.50
Total Hayward	23	Northeast	7.00
Total Hayward-Rodgers Creek	23	Northeast	7.33
Total Calaveras	33	East	7.03
N. San Andreas - Santa Cruz	41	Southeast	7.12
Mount Diablo Thrust	43	Northeast	6.70
N. San Andreas - North Coast	44	Northwest	7.51
Green Valley Connected	50	Northeast	6.80

Figure 3 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 3) 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, approximately 60 km away 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 a 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 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 by 2043. More specific estimates of the probabilities for different faults in the Bay Area are presented in Table 2.

TABLE 2

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

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

4.0 SEISMIC AND GEOLOGIC HAZARDS

The seismicity of the site is governed by the activity of the nearby active faults. The intensity of earthquake ground motion at the site will depend upon the characteristics of the generating fault, distance to the earthquake epicenter, magnitude and duration of the earthquake, and specific subsurface conditions. On the basis of our knowledge of subsurface conditions, we conclude ground shaking at the site during a major earthquake will be strong to violent.

Shaking during an earthquake can result in ground failure such as that associated with soil liquefaction[4], lateral spreading[5], and seismic densification[6]. These and other hazards are discussed in the remainder of this section.

4.1 Soil Liquefaction and Seismic Densification

The site is within a seismic hazard zone as designated by a map titled *State of California Seismic Hazard Zones, Palo Alto Quadrangle* by the California Geologic Survey (CGS) (as shown on Figure 5) and as such an evaluation of liquefaction potential and seismically-induced settlement in accordance with State of California Special Publication 117A, *Guidelines for Evaluation and Mitigation of Seismic Hazards in California* (SP-117A) should be performed as part of a geotechnical investigation for any proposed redevelopment.

The available subsurface information indicates that layers of loose to medium dense sand with varying silt and clay content are likely present below the groundwater level. The combined thickness of these layers of loose to medium dense sand are likely to range from about a few

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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 compacted by earthquake vibrations, causing differential settlement.

inches to up to 10 feet. Loose to medium dense sand, where present, could liquefy during a major earthquake on a nearby active fault.

On the basis of nearby data and our experience in the vicinity, we conclude there is the potential for liquefaction in the loose to medium dense sand layers during a major earthquake. We estimate liquefaction-induced ground settlement on the order of one inch could occur during a major earthquake on a nearby active fault. This settlement is expected to be erratic and vary significantly across the site. We anticipate potentially liquefiable soil layers in the area to be discontinuous. Because of the variable nature of the deposits, differential settlements of about one inch may occur during an earthquake. These estimates should be confirmed as part of a final geotechnical investigation that includes either drilled borings or Cone Penetration Tests (CPTs).

Seismic densification can occur during strong ground shaking in loose, clean granular deposits above the water table, resulting in ground surface settlement. The soil above the groundwater table at the site is likely clayey fill, but occasional layers of granular material may also be encountered. The soil deposits above the water table are anticipated to have low to moderate potential for seismic densification. The potential for seismic densification should be confirmed as part of a final geotechnical investigation.

4.2 Lateral Spreading and Slope Stability

Lateral spreading is associated with liquefaction. In general, the parameters used to estimate the magnitude of horizontal ground movement resulting from lateral spreading include the relative density and thickness of the liquefiable layer, the fines content and mean grain-size diameter of the liquefiable soil, the magnitude and distance of the earthquake from the site, the slope of the ground surface, and boundary conditions (such as free face of a channel). The site is adjacent to a water channel and Smith Slough along the north side of the property. The channel slopes should be considered a free face. We recommend further investigation be performed to evaluate the potential for lateral spreading and the stability of the channel slopes. A bathymetric survey should be performed to provide information regarding slope inclinations and bottom of channel elevations.

4.3 Fault Rupture

Historically, ground surface displacements closely follow the traces of geologically young faults. The property 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 and consequent secondary ground failure at the site is low.

4.4 Flooding

The project is located within Federal Emergency Management Agency (FEMA) Flood Zone X and Flood Zone AE. The southwest portion of the site is within FEMA Flood Zone X. Zone X is used for areas with minimal flood hazard. The northeast portion of the site is within FEMA

Flood Zone AE, designated as "special flood hazard areas," which are "subject to inundation by the 1-percent-annual-chance flood" (FEMA 2009). A base flood elevation of 10 feet[7] is reported by FEMA.

The site is near a water channel that borders the north side of the project. In addition, there is a levee that separates the water channel and Smith Slough. The potential for dike failure flooding should be evaluated as part of a final geotechnical investigation.

The property is not within a potential tsunami flood area as shown on a map prepared jointly by the California Emergency Management Agency, the California Geological Survey, and the University of Southern California (2009).

The project civil engineer should further evaluate the future effects of sea level rise and the potential for flooding and the potential risk of inundation from a tsunami at the project site.

5.0 PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

We preliminarily conclude that, from a geotechnical standpoint, the project can be developed as planned. The primary geotechnical issues are:

- presence of undocumented, potentially moderately to highly expansive fill
- presence of weak and compressible Bay Mud and underlying medium stiff to hard clay which have the potential to settle under new fill and building loads
- slope stability along water channel
- potential for seismic hazards, including layers of loose to medium dense sand below the Bay Mud that may liquefy during a major earthquake on a nearby fault
- potential for flooding
- presence of shallow groundwater.

Our preliminary conclusions and recommendations regarding the geotechnical aspects of the proposed development are presented in the remainder of this report. These conclusions and recommendations are to assist you with your due diligence and should not be used for final design plans. A final geotechnical investigation that includes field exploration (borings, test pits, Cone Penetration Tests and/or laboratory testing) should be performed to evaluate the subsurface characteristics and develop final geotechnical recommendations for the proposed development/improvements.

[7] Elevation referenced to the North American Vertical Datum of 1988.

5.1 Expansive Near Surface Soil

Based on our review of geotechnical investigation reports of nearby projects, the near-surface soil likely has moderate to high expansion potential[8]. Moisture fluctuations in near-surface expansive soil could cause the soil to expand or contract resulting in movement and potential damage to improvements that overlie them. Potential causes of moisture fluctuations include drying during construction, and subsequent wetting from rain, capillary rise, landscape irrigation, and type of plant selection.

The volume changes from expansive soil can cause cracking of foundations, floor slabs and exterior flatwork. Any proposed new foundations, exterior slabs and concrete flatwork should be designed and constructed to resist the effects of the expansive soil. These effects can be mitigated by moisture conditioning the expansive soil below slabs/mat foundations, providing select, non-expansive fill below flatwork and other at-grade improvements, supporting foundations below the zone of severe moisture change, and providing additional reinforcing steel. We preliminarily conclude where moderately to highly expansive soil is encountered, that it should be capped by at least 12 inches of imported (select) fill to construct any new building pads; 8 inches of select fill material should be placed beneath any proposed exterior concrete flatwork, including patio slabs and sidewalks. The select fill should extend at least two feet beyond the slab edges.

5.2 Settlement and Foundations

A grading plan is currently not available. Placement of new fill across the site and supporting buildings within the fill will increase the load on the Bay Mud, causing the Bay Mud to consolidate, which will result in settlement of the ground surface and the new structures.

We judge the settlement under the weight of the existing fill is complete. However, for every foot of new fill placed, the settlement of the Bay Mud will continue. Table 3 presents preliminary settlement estimates if new fill is placed to grade the project site.

TABLE 3
Preliminary Settlement Estimate from New Fill

Height of New Fill (feet)	Estimated Consolidation Settlement (inch)
1 to 2	¼ to ½
3	1 to 1½
4	2½ to 3
5	4 to 4½

8 Moderately expansive soil undergoes moderate volume changes with changes in moisture content. Highly expansive soil undergoes large volume changes with changes in moisture content.

Settlement is also expected to vary across the site because the soft compressible clay likely becomes thicker toward the north (near the water channel).

We understand from conceptual plans (Dahlin, 2018), Sares Regis is considering developing the site with townhomes that will be wood-framed or a residential structure that have wood-framed units over a concrete podium. In addition, the conceptual plans have options that place buildings within an easement zone that extends 50 feet south from at the northern property line.

The heights of the proposed buildings have not been determined. However, for this preliminary study, we have assumed the following:

- Townhomes: two- to three-story wood-framed structure at-grade with dead plus live load of 300 pounds per square foot (psf) and
- Podium Structure: three- to four-story wood-framed structure over one level concrete podium at-grade with dead plus live loads of 600 psf.

Based on these assumptions, our preliminary conclusions for the foundation systems are summarized in Table 4.

TABLE 4
Preliminary Recommendations for Foundation Types

Height of New Aerial Fill (feet)	Buildings Within 50 foot Easement Zone[1]	Buildings Outside 50 foot Easement Zone[1]
1 to 2	Deep Foundations	Shallow Foundations/ Deep Foundations
3 to 5	Deep Foundations	Deep Foundations

Note:
1. The easement zone is the zone along the channel that extends 50 feet south of the northern property line.

A surcharge program consisting of surcharge load with/without wick drains could be used to reduce the settlements, but it would take time (potentially up to one year). This would need to be evaluated as part of a final geotechnical investigation.

Discussion for the proposed foundation types are discussed in the subsections below. These conclusions are preliminary. The final foundation type and settlements will need to be verified once site-specific laboratory data and building loads are available.

5.2.1 Shallow Foundations

If the site is graded with one to two feet of new fill and the proposed buildings are outside the 50 foot easement along the northern border of the site, we preliminarily conclude the townhomes and possibly the podium structure may be supported on shallow footings that are founded near the bottom of the zone of severe moisture change or post-tensioned (P-T) slabs over select fill, provided the anticipated settlements are acceptable.

Preliminary estimates of settlements for the townhome structures will be on the order of approximately one inch, with differential settlement between columns on the order of ½ inch. This will need to be confirmed as part of a final geotechnical report. As discussed previously, we preliminarily estimate that up to one inch of liquefaction-induced settlement may occur; differential settlement between columns may be on the order of one inch during a major earthquake. These settlements are in addition to the predicted static induced consolidation settlement. The structural engineer should evaluate the impact of liquefaction-induced settlement to the townhome structures supported on shallow foundations. If the total and differential settlements are not tolerable, then a stiffer foundation system such as an interconnected grid system, mat or deep foundations should be used.

For the heavier podium structure, we estimate static settlements of approximately 2 to 3 inches may occur if supported on shallow foundations. This assumes uniformly distributed pressure over an area with approximately placed dimensions of 110 feet by 40 feet, and a pressure of 600 psf. This is in addition to the settlements estimated from any aerial fill placed and the one inch of liquefaction-induced settlement predicted for the site. If these settlements are not tolerable, the podium structure would need to be supported on deep foundations (driven piles or auger cast displacement piles (ACDPs)) or shallow footings supported on ground improvement elements such as drilled displacement columns[9] (DDCs). DDCs are designed and installed by design-build specialty contractors.

The allowable bearing pressure of a strip or grid footing will depend on the thickness of fill, footing dimensions, and depth of footing relative to the top of Bay Mud. The preliminary allowable dead plus live load bearing capacity may range from 300 psf to 1,000 psf for spread footings without ground improvement. Based on our discussion with a local contractor that designs and installs DDCs, a 16- to 18-inch DDCs installed to depths ranging from 25 to 30 feet bgs is estimated to have a preliminary allowable bearing capacity of 4,000 psf for dead plus live loads.

These conclusions are preliminary. The final foundation type and settlements will need to be verified once site-specific laboratory data and building loads are available.

<u>5.2.2 Deep Foundations</u>

If the site is graded with more than two feet of new fill, the proposed buildings are within the 50 foot easement along the northern border of the site and/or is the podium structure, we preliminarily conclude the structures should be supported on deep foundations such as driven piles or ACDPs.

[9] 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 between 20 to 24 inches in diameter. Installation of DDCs produces minimal soil cuttings.

5.2.2.1 ACDPs

ACDPs are a low-vibration, low-noise, deep foundation option. These pile types are designed and installed by specialty contractors. ACDPs are installed by drilling to the required depth with a hollow-stem auger. The auger has a reverse tread, which results in displacement and densification of the surrounding soil and results in little to no spoils. When the auger reaches the required depth, cement grout or concrete is injected through the bottom of the hollow-stem auger. Grout or concrete is injected continuously as the auger, still rotating in a forward direction, is slowly withdrawn, replacing the displaced soil. While the grout is still fluid, a steel reinforcing cage is inserted into the shaft.

ACDPs can range in diameter; however, 16- and 18-diameter ACDPs are typical. For 16-inch and 18-inch diameter ACDPs with lengths of approximately 60 to 65 feet, the allowable dead plus live load compressive capacity are 150 kips and 180 kips. The allowable capacities may be increased by 1/3 for total loads, including wind or seismic. These preliminary design axial capacities may be used in pricing and estimating. The preliminary allowable compressive capacities and lengths are based on our discussions with contractors with experience installing these pile types in the Bay Area. Final design axial pile capacities should be determined by the specialty/design building contractor after the pile type has been chosen, and verified by a test program.

Piles should gain support primarily in side resistance below the Bay Mud. Properly constructed ACDPs gaining support below the compressible layers should have a total settlement less than one inch, with less than ½ inch of differential settlements between columns, under static conditions. Most of these static settlements are expected to occur during construction.

5.2.2.2 Driven Piles

If there are no limitations to noise and vibration, a driven pile could be used for support of the structures. Driven pile types could consist of precast, prestressed, (PCPS) concrete piles, steel H-piles or steel pipe piles. Based on our experience with similar subsurface conditions, we conclude that PCPS concrete piles are the most appropriate driven pile type for the project. To prevent damage to concrete piles from debris in the fill, predrilling through the fill should be performed, which would produce spoils.

For a 80-foot long 14-inch square PSPC concrete pile gaining support in the soil beneath the Bay Mud, we preliminarily recommend an allowable dead plus live load capacity of 200 kips. The allowable capacities may be increased by 1/3 for total loads, including wind or seismic.

Most of the settlement of piles gaining support in skin friction in the soil beneath the Bay Mud is anticipated to occur during construction. We estimate differential settlement will be less than ½ inch between adjacent columns supported on new piles.

5.3 Construction Considerations

As previously discussed, the site is underlain by moderately to highly expansive near-surface soil. If the expansive soil subgrade is exposed, allowed to dry, and is not properly moisture-conditioned prior to placement of concrete or engineered fill, significant heave may occur as soil moisture levels increase after construction. The heave could damage the improvements. Therefore, it is essential to maintain moisture of expansive soil during construction. Typically, it is necessary to spray the exposed soil subgrade, including the bottom and sides of excavations, on a daily basis to prevent drying.

In addition, if construction activities are performed during the winter/rainy season, the near-surface soils will be saturated, soft, and easily remolded. Wet soil will require significant drying before it can be used as fill or backfill.

5.4 Earthwork

Site preparation should include removal of all existing structures, foundations, slabs, pavements, and underground utilities, if any, within the footprint of the planned development. All areas to receive improvements should be stripped of vegetation and organic topsoil. Stripped materials should be removed from the site or stockpiled for later use in landscaped areas, if approved by the landscape architect. Underground utilities should be removed to the service connections and properly capped or plugged with concrete. Where existing utility lines will not interfere with the planned construction, they may be abandoned in-place, provided the lines are filled with lean concrete or cement grout to the limits of the project. Voids resulting from demolition activities should be properly backfilled with engineered fill.

Variable soil conditions will be encountered during site and subgrade preparation. Shallow groundwater, wet soil and weak Bay Mud will be encountered. Subgrades may need to be stabilized to allow for equipment; the contractor should provide a working platform capable of supporting their equipment or use lightweight equipment.

Excavations will be required for the foundations and below-grade utilities. The soil to be excavated consists predominantly of clay and sand, which can be excavated using conventional earth-moving equipment such as loaders and backhoes. Because of the cohesionless nature of the fill, vertical cuts may not stay open, and therefore, forms or shoring may be required. The soil near and below groundwater and the Bay Mud will have high moisture content. Concrete, asphalt, and other debris may be encountered in the fill. Localized dewatering may be needed for foundation excavations or utilities.

Backfill for utility trenches and other excavations is also considered fill and should be placed and compacted according to the recommendations presented below. If imported clean sand or gravel (defined as soil with less than 10 percent fines) is used as backfill, it should be compacted to at least 95 percent relative compaction. Jetting of trench backfill should not be permitted. Special care should be taken when backfilling utility trenches in pavement areas. Poor compaction may cause excessive settlements, resulting in damage to the pavement section.

If the existing expansive fill is to be used as general site fill, it should be moisture-conditioned to at least three percent above optimum moisture content, placed in horizontal lifts not exceeding eight inches in loose thickness, and compacted to between 88 and 92 percent relative compaction. Bay Mud should not be used as fill.

Select fill should consist of imported or on-site soil that is free of organic matter and hazardous material, contain no rocks or lumps larger than three inches in greatest dimension, have a liquid limit less than 40 and plasticity index less than 12, and be approved by the geotechnical engineer. Select fill should be placed in lifts not exceeding eight inches in loose thickness, moisture-conditioned to above optimum moisture content, and compacted to at least 90 percent relative compaction for total new fill thickness equal to or less than five feet and 95 percent relative compaction for total new fill thickness greater than five feet.

5.5 Ground Floor Slabs

We recommend the ground floor slabs be designed to span between pile caps and/or grade beams, and the fill and Bay Mud should not be relied upon for support.

Moisture is likely to condense on the underside of the ground floor slabs, even though it will be above the design groundwater table. A moisture barrier should be considered if movement of water vapor through the slab would be detrimental to its intended use. A typical moisture barrier consists of a capillary moisture break and a water vapor retarder. A capillary moisture break consists of at least four inches of clean, free-draining gravel or crushed rock. The vapor retarder should meet the requirements for Class C vapor retarders stated in ASTM E1745. The vapor retarder should be placed in accordance with the requirements of ASTM E1643. These requirements include overlapping seams by six inches, taping seams, and sealing penetrations in the vapor retarder. The particle size of the gravel/crushed rock should meet the gradation requirements presented in Table 5.

TABLE 5
Gradation Requirements for Capillary Moisture Break

Sieve Size	Percentage Passing Sieve
Gravel or Crushed Rock	
1 inch	90 — 100
3/4 inch	30 — 100
1/2 inch	5 — 25
3/8 inch	0 — 6

Concrete mixes with high water/cement (w/c) ratios result in excess water in the concrete, which increases the cure time and results in excessive vapor transmission through the slab. Therefore, concrete for the floor slab should have a low w/c ratio - less than 0.45. If necessary, workability should be increased by adding plasticizers. In addition, the slab should be properly cured. Before the floor covering is placed, the contractor should check that the concrete surface and the moisture emission levels (if emission testing is required) meet the manufacturer's requirements.

The existing fill is generally corrosive. Floor slabs should be designed to mitigate the effects of corrosion.

5.6 Seismic Design Criteria

Potentially liquefiable soil layers were encountered in nearby borings and CPTs, and therefore for design in accordance with the 2016 California Building Code (CBC), Site Class F should be used. Site-specific response is required for Site Class F sites, unless the fundamental period of vibration for the structure is less than or equal to 0.5 seconds, per the ASCE 7-10 Section 20.3.1 (1) exception. In this case a site class is permitted to be determined in accordance with Section 20.3 of ASCE 7-10 and the corresponding values of F_a and F_v determined from Tables 11.4-1 and 11.4-2.

For structures with fundamental periods less than or equal to 0.5 seconds, we recommend using the following parameters for design in accordance with the 2016 CBC:

- Risk Targeted Maximum Considered Earthquake (MCE_R) S_S and S_1 of 1.646g and 0.758g, respectively.
- Site Class D
- Site Coefficients, F_a and F_v of 1.0 and 1.5.
- MCE_R spectral response acceleration parameters at short period, S_{MS}, and at one-second period, S_{M1}, of 1.646g and 1.136g, respectively.
- Design Earthquake (DE) spectral response acceleration parameters at short period, S_{DS}, and at one-second period, S_{D1}, of 1.097g and 0.758g, respectively.

5.7 Flooding

The site has potential for flooding based on maps prepared by FEMA and Santa Clara County. The project civil engineer should further evaluate the potential for flooding.

5.8 Groundwater Considerations

The groundwater levels encountered at the site were reported between 3 and 9½ feet bgs and the reported historic high groundwater level is about 0 feet bgs. Variations are expected due to fluctuations in weather and tides. Groundwater could be as shallow as 1 to 2 feet bgs.

Depending on the how much new fill is placed to grade the site, groundwater may be encountered in foundation and utility trench excavations. Where localized water is present during excavation, dewatering will be needed. Where excavations encounter groundwater, wet, disturbed subgrade soil will likely require stabilization prior to placement of improvements. Groundwater encountered in foundation excavations will need to be pumped out prior to placing concrete.

5.9 Additional Subsurface Investigation

This letter-report presents the results of our preliminary geotechnical evaluation and was based on data from geotechnical investigations performed near the property and in the vicinity of the property. This assessment was performed to evaluate the general engineering characteristics of soil conditions present at the site, and to provide insight into the anticipated geotechnical issues that may affect the potential development options and design of the improvements being considered; the preliminary recommendations presented herein should not be relied on to develop final design drawings. Once more detailed development plans become available, a detailed geotechnical investigation for the proposed improvements should be performed that includes sufficient borings, test pits and/or CPTs to evaluate the subsurface characteristics, including settlement characteristics of Bay Mud.

The results of the field exploration should be used to develop design level recommendations for use in the design of proposed improvements. The number and depth of borings and CPTs will depend upon on the size and location of the proposed improvements, and should be performed to determine the presence of fill and expansive soil, estimates of total and differential settlements from static loads and seismically-induced settlements, evaluate potential variations of near surface soil characteristics beneath proposed improvements, and provide design level geotechnical recommendations.

6.0 LIMITATIONS

The conclusions and recommendations presented herein are preliminary and are based on site-specific subsurface data developed by others. They may be used to estimate costs and for preliminary schematic drawings; these conclusions and recommendations should not be used to develop final plans or drawings. A detailed geotechnical investigation for proposed improvements should be performed to confirm the existing subsurface data prior to development of final plans. Our scope of services relates solely to the geotechnical aspects of the proposed development and does not address environmental concerns.

We trust this letter-report provides the information needed at this time. If you have any questions, please call.

Sincerely,
Langan Engineering & Environmental Services, Inc.

Serena T. Jang, GE
Senior Associate/Vice President

John Gouchon, GE
Principal/Vice President

Attachments: References
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
Figure 5 – Regional Seismic Hazard Zones Map

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FIGURES

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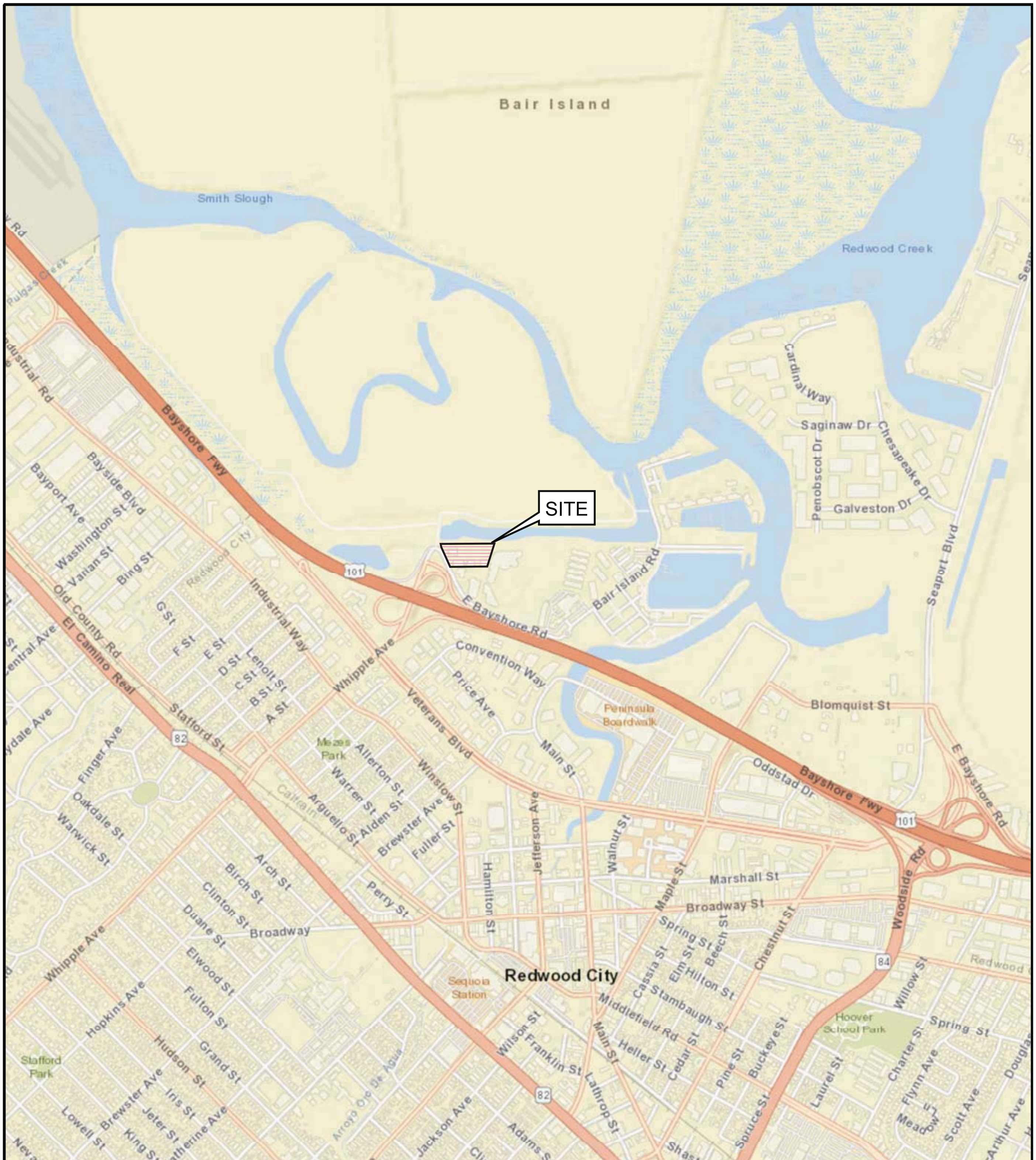

NOTES:

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 W E S

505 EAST BAYSHORE ROAD
Redwood City, California

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SITE LOCATION MAP

Date 08/13/18	Project No. 770655202	Figure 1

Reference: © 2018 Microsoft Corporation, Bing.

EXPLANATION

B-15 — Approximate location of boring by Langan, August and September 2017

CPT-14 — Approximate location cone penetration test by Langan, August 2017

LB-1 — Approximate location of environmental boring by Langan, August 2018

SES-1 — Approximate location of environmental boring by Stellar Environmental Solutions, Inc., December 2015

Site boundary

Existing 15-foot wide levee

0 60 Feet

Approximate scale

505 EAST BAYSHORE ROAD
Redwood City, California

SITE PLAN

Date 08/27/18	Project No. 770655202	Figure 2

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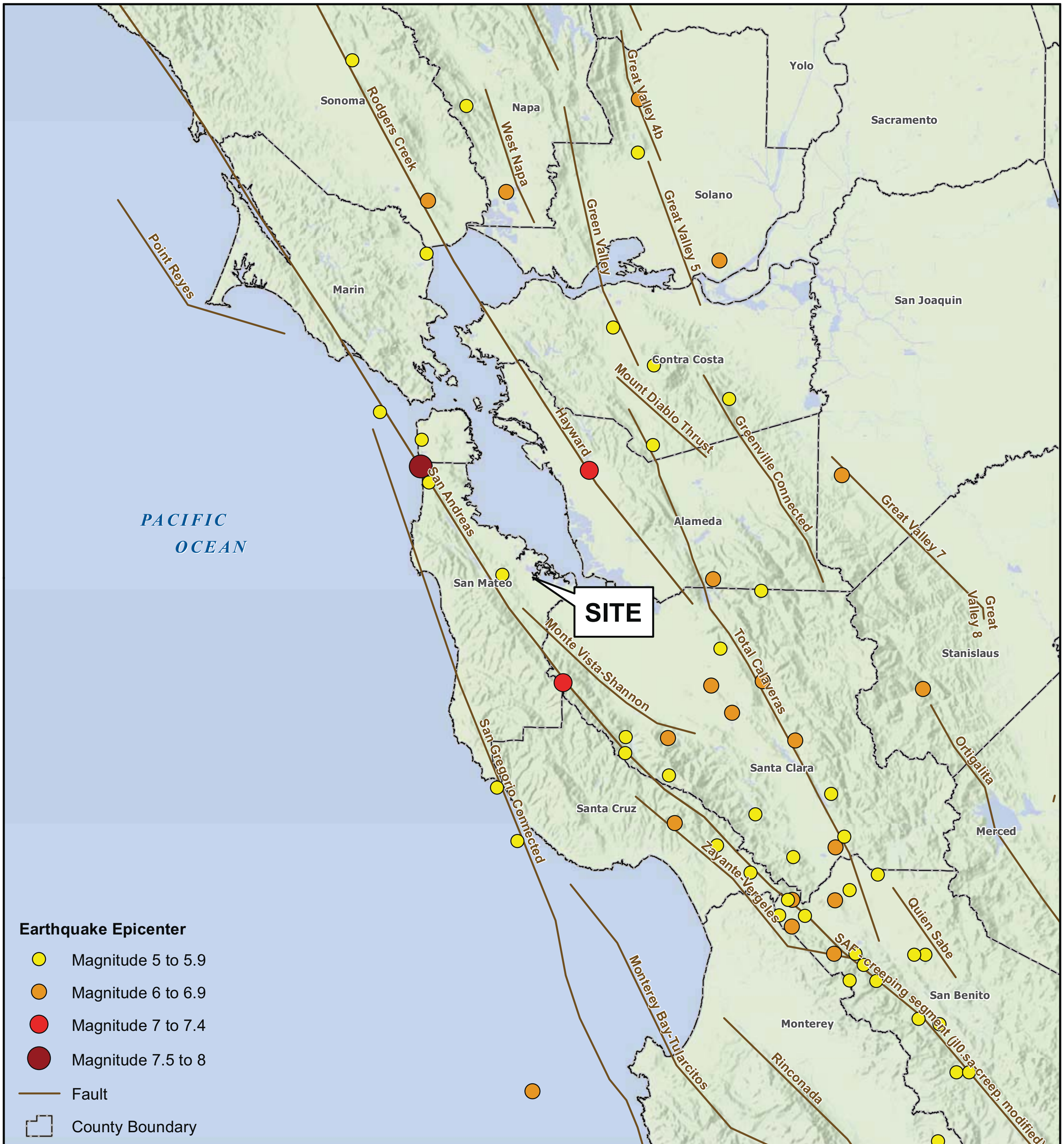

Notes:

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.

505 EAST BAYSHORE ROAD
Redwood City, California

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

Date 08/13/18 | Project No. 770655202 | 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.

505 EAST BAYSHORE ROAD
Redwood City, California

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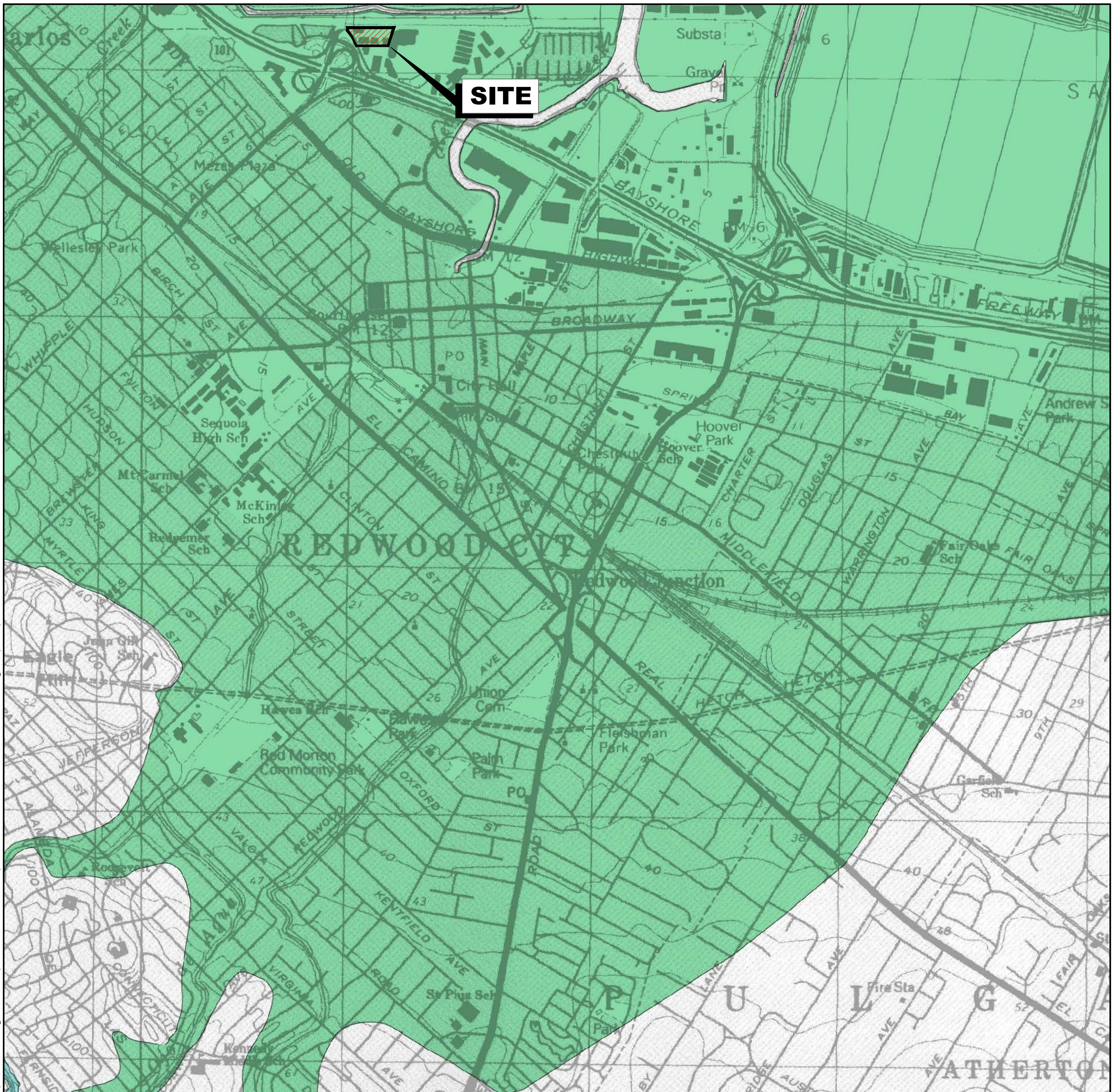
MODIFIED MERCALLI INTENSITY SCALE

Date 08/13/18 | Project No. 770655202 | Figure 4



EXPLANATION

Zone of Liquefaction Hazard Potential

Zone of Earthquake-Induced Landslide Hazard Potential

0 2000 Feet

Approximate scale

Reference:
State of California "Seismic Hazard Zones" Palo Alto Quadrangle Released on October 18, 2006.

505 EAST BAYSHORE ROAD
Redwood City, California

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REGIONAL SEISMIC HAZARD ZONES MAP

Date 08/13/18	Project No. 770655202	Figure 5

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