

## **APPENDIX E**

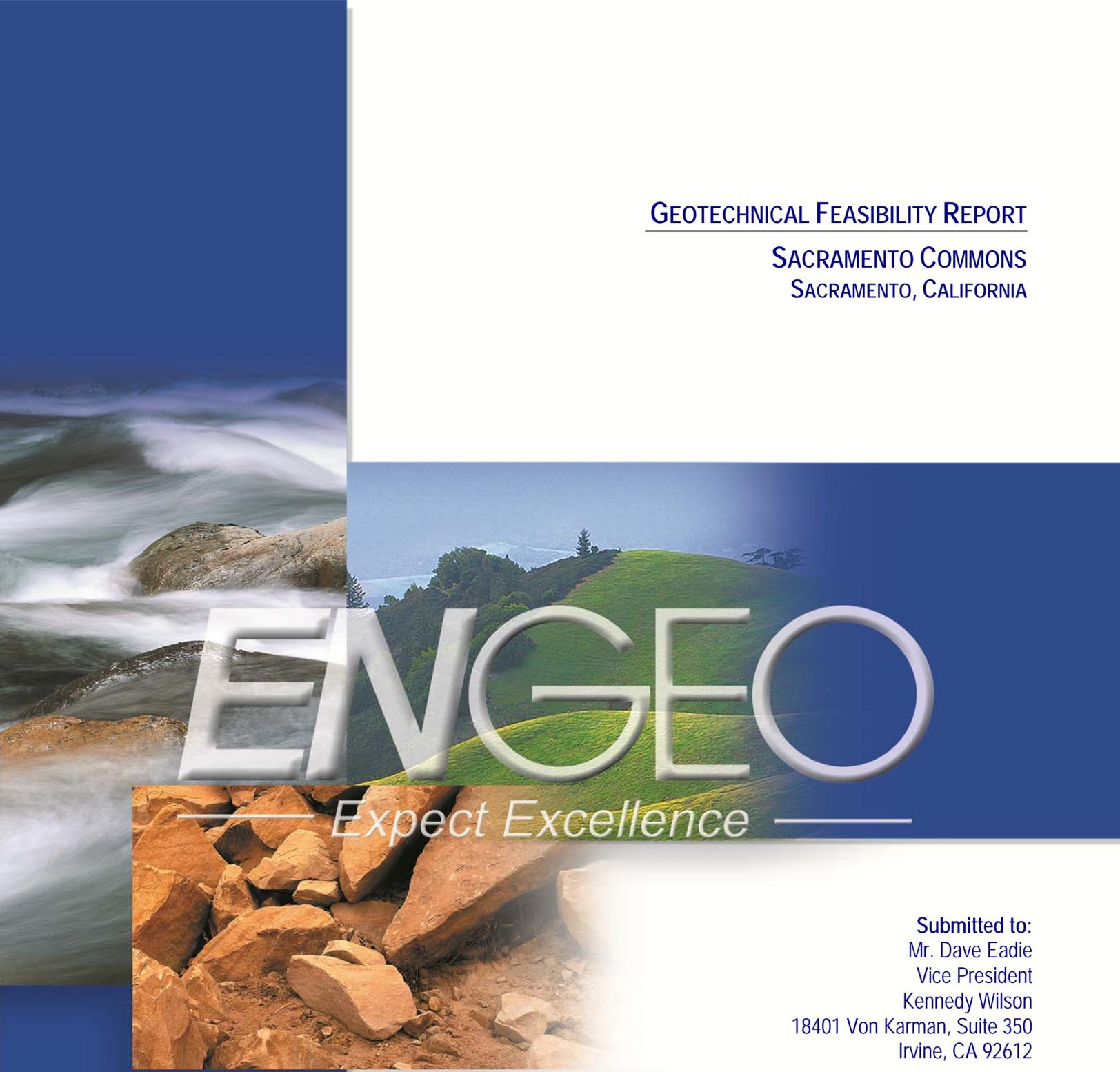
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Sacramento Commons Geotechnical Feasibility Report



GEOTECHNICAL FEASIBILITY REPORT

SACRAMENTO COMMONS  
SACRAMENTO, CALIFORNIA



ENGEO

*Expect Excellence*

**Submitted to:**  
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**Prepared by:**  
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**April 16, 2014**  
**Revised May 27, 2014**

**Project No:**  
10764.000.000

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Kennedy Wilson  
18401 Von Karman, Suite 350  
Irvine, CA 92612

Subject: Sacramento Commons  
Sacramento, California

## **GEOTECHNICAL FEASIBILITY REPORT**

Dear Mr. Eadie:

ENGEO prepared this geotechnical feasibility assessment report for the Sacramento Commons project as outlined in our agreement dated March 7, 2014. We reviewed existing subsurface data in the vicinity of the site and characterized the subsurface conditions to provide the enclosed geotechnical and geologic information for preliminary planning.

If you have any questions or comments regarding this report, please call and we will be glad to discuss them with you.

Sincerely,

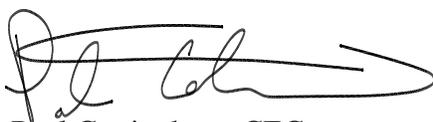
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## **1.0 INTRODUCTION**

### **1.1 PURPOSE AND SCOPE**

ENGEO prepared this geotechnical feasibility report for the Sacramento Commons project located in Sacramento, California. Our services were performed as outlined in our agreement dated March 7, 2014, and included the following scope of services:

- Review of published geologic maps, historical topographic maps, and aerial photographs.
- Review of in-house geotechnical documents, including the nearby 28-story US Bank Tower, the Railyards Rail Relocation Project, and the Sac RT Light Rail Green Line Extension.
- Geotracker database and City of Sacramento research and review of pertinent geotechnical data.
- Report preparation regarding potential geotechnical and geological impacts to the project.

For our use, we received a Tentative Subdivision Map prepared by Wood Rodgers, dated March 21, 2014. In addition, we received preliminary structural information in the May 21, 2014 letter prepared by Englekirk Structural Engineers. This report was prepared for the exclusive use of our client and their consultants for preliminary project evaluation. In the event that any changes are made in the character, design or layout of the development, we should be contacted to review the conclusions and recommendations contained in this report to determine whether modifications are necessary.

### **1.2 PROJECT LOCATION AND DESCRIPTION**

Figure 1 displays a Site Vicinity Map. The site is located between the State Capitol building and the Sacramento River in downtown Sacramento. Figure 2 shows site boundaries, proposed building and pavement areas, as well as nearby subsurface exploration logs that we reviewed in preparing this report. The site is bordered by 7<sup>th</sup> Street to the east, N Street to the north, P Street to the south, and a portion by 5<sup>th</sup> Street.

Based on our discussion with the team and review of the Tentative Subdivision Map, we understand the approximately 11.17-acre site will consist of Parcels 1, 2A, 2B, 3, 4A and 4B. At this time, the proposed improvements will likely consist of various high-rise residential, mid-rise residential, condominium, hotel, parking and retail structures including the following:

- Parcel 1 – 24-story high-rise residential
- Parcel 2A – 7-story mid-rise residential
- Parcel 2B – 7-story mid-rise residential
- Parcel 3 – 22-story high-rise residential or mixed use with hotel
- Parcel 4A – 15-story existing Capitol Tower
- Parcel 4B – 7-story mid-rise residential and live-work

Long- and short-span parking structures up to five stories are also considered. The Tentative Subdivision Map indicates the proposed land use will result in approximately 1,100 to 1,400 apartment homes, up to 300 condominiums, 200 to 400 hotel rooms, 35,000 to 63,000 square feet of retail space, and 37,000 to 59,000 square feet of live/work space. Based on discussions with the project team, we understand one structure may have an elevator shaft that would extend one level below the ground surface, with the other structures at grade. Improvements will also include paved streets, parking, drive lanes, flatwork, and underground utilities.

## **2.0 SITE BACKGROUND**

Development in the Sacramento area began in 1839 with the establishment of the New Helvetia settlement by John Sutter. Sacramento development then accelerated with the onset of the gold rush following the gold discovery at Sutter's Mill in 1848. A historic map of the City of Sacramento dated 1854 shows the site was developed with established streets around and through the site. In response to devastating floods in 1861 and 1862, the residents of Sacramento elected to raise the City street grades 8 to 10 feet converting the ground floor of many businesses into basements. The earth was moved from near the confluence of the American and Sacramento Rivers and used to raise city blocks beginning in 1868. Streets east of the Sacramento River to about 12th street were raised. Grading and paving of the new streets was fully completed by 1873 (Severson, 1973).

A USGS topographic map published in 1901 shows the site at an elevation of 21 feet (MSL). The 1901 map shows O Street and 6<sup>th</sup> Street crossing through the site as well as structures fronting the streets. A 1957 aerial photograph shows the site developed with closely spaced buildings of various sizes. In a 1961 aerial photograph, the site has been redeveloped to include the current two-story apartment buildings, and in a 1964 photograph, the Capitol Tower Apartment building is visible. In subsequent aerial photos, the site appears to be relatively unchanged to 2013.

## **3.0 REGIONAL AND LOCAL GEOLOGY**

The downtown Sacramento area is located in the Great Valley geomorphic province. The Great Valley is an elongate, northwest-trending structural trough bound by the Coast Range on the west and the Sierra Nevada on the east. The Great Valley has been and is presently being filled with sediments primarily derived from the Sierra Nevada. The impact of periodic glaciation of the Sierra Nevada during the last global climate change was strongly felt by the Sacramento Valley River systems. Huge quantities of sediments were moved through the river systems fed by alpine glaciers during the last period of glaciation. As these periods of glaciation ended, rivers draining the Sierra Nevada were made even more powerful by the considerably wetter climate and abundant meltwater. Abundant sediments left from the retreating glaciers were carried downstream into the Sierra Foothills and into the Sacramento Valley. At least four pulses of glacial outwash deposition took place during glacial episodes of the past 2 million years (Harden, 1997). These deposits extend to depths of up to 10 miles on the western side of the Sacramento Valley and gradually thin out on the eastern side (Oakeshott, 1978).

Surface deposits at the site are mapped as Holocene Alluvium (Helley and Harwood, 1985). Holocene alluvium is described as young unweathered gravel, sand, and silt up to 30 feet thick deposited by the historic Sacramento and American Rivers. Below the young Holocene Alluvium is older Pleistocene Alluvium that consists of more consolidated and weathered gravel, sand, silt, and clay deposits.

#### 4.0 SEISMIC SETTING

The site is located within a seismically active region, as California has numerous faults that are considered active. Generally, a fault is considered active if it has ruptured within the Holocene epoch (11,700 years before present). The following table summarizes the distances to mapped, active regional faults and estimated maximum magnitude within approximately 62 miles (100 kilometers) using the USGS Spatial Query tool, which is based on the USGS 2008 National Seismic Hazard Maps that were used to develop the 2013 California Building Code seismic parameters. Refer to Figure 3 for a Regional Faulting and Seismicity map that indicates nearby USGS faults and historic earthquake magnitudes.

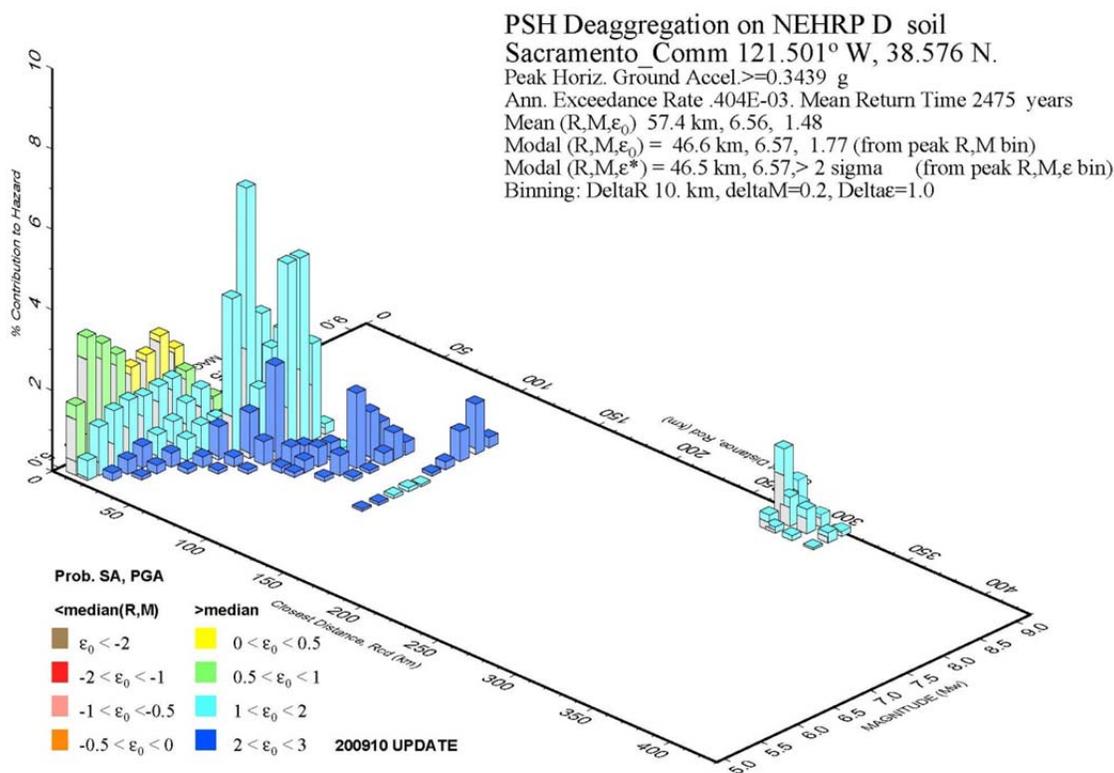
**TABLE 4.0-1**  
Distances to Mapped 2008 USGS Regional Active Faults

Fault	Distance (miles)	Maximum Moment Magnitude (Avg. of Hanks and Ellsworth)
Great Valley 4a, Trout Creek	27	6.5
Great Valley 4a, Gordon Valley	30	6.7
Great Valley 3, Mysterious Ridge	31	6.7
Great Valley 5, Pittsburg Kirby Hills	33	6.5
Hunting Creek-Berryessa	39	6.7
Green Valley Connected	39	6.6
West Napa	48	6.5
Greenville Connected	51	6.7
Great Valley 2	55.5	6.3
Mount Diablo Thrust	56.5	6.5
Great Valley 7	58	6.6
Calaveras CN+CC+CS	59	6.8
Bartlett Springs	59.5	6.9
Hayward-Rodgers RC+HN+HS	61	7.2

Although the Foothill Fault System is not mapped in the USGS database, the Cleveland Hills Fault Segment near Oroville is approximately 59 miles from the site and produced a Magnitude 5.8 earthquake in 1975. Segments of the Foothills Fault System located as close as 30 miles from the site are not considered active, but could be capable of a large magnitude earthquake.

Historically, no significant damage in Sacramento has been caused by earthquakes; however, notable ground shaking has been felt in the past from distant events. These seismic events include the 1892 Vacaville-Winters Magnitude 6.4, the 1906 San Francisco Magnitude 7.8, and the 1989 Loma Prieta Magnitude 6.9 earthquakes.

According to the 2008 USGS Interactive Deaggregation tool for a site Class D ( $V_{s30} \sim 700$  ft/s), a modal (most probable) magnitude earthquake ( $M_w$ ) of 6.6 is appropriate for analyzing liquefaction for the site. This is consistent with the magnitudes listed above for the nearby faults.



GMT 2014 Mar 18 14:45:12 Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on soil with average vs= 215. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted

## 5.0 GEOLOGIC HAZARDS

The following sections present a discussion of geologic hazards as they apply to the site. These hazards include seismic hazards such as ground rupture, ground shaking, liquefaction, lateral spreading, ground lurching, and tsunamis, as well as other geologic hazards such as collapsible soil, landslides, volcanic hazards, naturally occurring asbestos, and flooding.

## **5.1 SEISMIC HAZARDS**

Potential seismic hazards resulting from a nearby moderate to major earthquake can generally be classified as primary and secondary. The primary effect is ground rupture, also called surface faulting. The common secondary seismic hazards include ground shaking, liquefaction, lateral spreading, ground lurching, and tsunamis.

### **5.1.1 Ground Rupture**

An earthquake is the result of the energy released when portions of the earth's crust rupture and displace or slip past one another. If this displacement reaches the ground surface, it is known as surface faulting or ground rupture. Ground rupture typically occurs along established fault lines where ground rupture has occurred in the past. Severe damage can occur to structures built across fault lines that rupture and move differentially in an earthquake. The site is not located within a currently designated Alquist-Priolo Earthquake Fault Zone and no known surface expression of active faults is believed to exist within the site. Since there are no known active faults crossing the property and the site is not located within an Earthquake Fault Special Study Zone, it is our opinion that ground rupture is unlikely at the site.

### **5.1.2 Ground Shaking**

An earthquake of moderate to high magnitude generated within the region could cause considerable ground shaking at the site, similar to that which has occurred in the past. To mitigate the shaking effects, all structures should be designed using sound engineering judgment and the 2013 California Building Code (CBC) requirements, as a minimum. Seismic design provisions of current building codes generally prescribe minimum lateral forces, applied statically to the structure, combined with the gravity forces of dead-and-live loads. The code-prescribed lateral forces are generally considered to be substantially smaller than the comparable forces that would be associated with a major earthquake. Therefore, structures should be able to: (1) resist minor earthquakes without damage, (2) resist moderate earthquakes without structural damage but with some nonstructural damage, and (3) resist major earthquakes without collapse but with some structural as well as nonstructural damage. Conformance to the current building code recommendations does not constitute any kind of guarantee that significant structural damage would not occur in the event of a maximum magnitude earthquake; however, it is reasonable to expect that a well-designed and well-constructed structure will not collapse or cause loss of life in a major earthquake (SEAOC, 1996).

### **5.1.3 Liquefaction**

Soil liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. Soils most susceptible to liquefaction are clean, loose, saturated, uniformly graded fine sands below the groundwater table. Empirical evidence indicates that loose silty sands as well as lean silts and clays are also potentially liquefiable. When seismic ground shaking occurs, the soil is subjected to cyclic shear stresses that can cause excess hydrostatic pressures to develop. If excess hydrostatic pressures exceed the effective confining stress of the soil, it is said

to have liquefied, and if the sand consolidates or vents to the surface during and following liquefaction, ground settlement and surface deformation may occur. In some cases, observed settlement has been amplified directly beneath a building, due to the cyclic rocking of the building foundation, as compared to the surrounding ground surface. This is referred to as the “ratcheting” effect and is thought to be caused by the interaction of the building foundation and the surrounding soil during seismic shaking.

Based on review of existing subsurface data near the site, it appears the site is underlain by soil deposits that could potentially liquefy in a design-level seismic event. Based on our experience in the area, liquefaction-induced ground settlements could be on the order of several inches or more for the Maximum Considered Earthquake (MCE) specified by the California Building Code. We anticipate that liquefaction-induced ground settlements under lesser earthquakes, such as using two-thirds of the MCE, would be smaller. Liquefaction of soils can induce downdrag on piles, so this will need to be considered in the design of deep foundations.

#### **5.1.4 Lateral Spreading**

Lateral spreading is a failure within a nearly horizontal soil zone due to liquefaction or cyclic softening, which causes the overlying soil mass to move toward a free face, or down a gentle slope. Based on the relatively flat topography in the vicinity of the site, it is our opinion that the risk of lateral spreading is negligible.

#### **5.1.5 Ground Lurching**

Ground lurching is a result of the rolling motion imparted to the ground surface during energy released by an earthquake. Such rolling motion can cause ground cracks to form in weaker soils that can be damaging to improvements. The potential for the formation of these cracks is considered greater at contacts between thick alluvium and shallow bedrock. Based on the depth to bedrock and vicinity to active faults, the risk of ground lurching impacts is negligible, in our opinion.

#### **5.1.6 Tsunami**

Tsunamis are long sea waves, generated by sea floor displacements associated with earthquakes. These waves can reach great heights when they encounter shallow water. Based on the vicinity of the site to the ocean and review of California Geologic Survey Tsunami Inundation Maps, it is our opinion that the risk of tsunami inundation is negligible.

### **5.2 LANDSLIDES**

Landslides are the downslope movement of earth materials and can cause severe damage to buildings or improvements. The primary factors contributing to landslide occurrence are over-steepened slopes, low strength earth materials, changes in vegetation, and pore water pressure. Based on the relatively flat topography of the site and surrounding areas, it is our opinion that the risk of landsliding is negligible.

### **5.3 VOLCANIC HAZARDS**

Volcanic hazards include lava flows, eruption blasts, pyroclastic flows, lahars, and ashfall. We reviewed the map titled “Areas subject to potential hazards from future eruptions in California” from the U.S. Geological Survey Bulletin 1847, 17p (Miller, 1989). Based on this map, the Sacramento area is not located within a potential volcanic hazard zone.

### **5.4 NATURALLY OCCURRING ASBESTOS**

Naturally occurring asbestos (NOA) is a fibrous mineral that occurs naturally in rocks and soil in some locations within California. Generally, NOA is associated with ultramafic or altered volcanic rock formations. Natural weathering and human activities may disturb NOA-bearing rock or soil and release mineral fibers into the air, which pose a human health risk by inhalation. We reviewed the Division of Mines and Geology report titled “A General Location Guide for Ultra Mafic Rocks in California – Areas more likely to Contain Naturally Occurring Asbestos” dated August 2000. Based on this map and distance from bedrock, it is our opinion that the risk of encountering NOA at the site is low.

### **5.5 FLOODING**

The City of Sacramento is located in a historic flood plain and is protected from flooding by levee systems along the American and Sacramento Rivers. The Flood Insurance Rate Map (FIRM) for the City of Sacramento, California, dated August 16, 2012, identifies the site in Zone X which is mapped as “protected from the 1-percent-annual-chance or greater flood hazard by a levee system”. Along with the river levee systems, the Sacramento Area is protected from flooding by Folsom Dam located upstream on the American River. In the event of a flood larger than the flood control system is designed for, or in the event of levee or dam failure, the site would be subject to flooding.

### **6.0 SUBSURFACE CONDITIONS**

We reviewed subsurface data from nearby geotechnical reports (in-house and public record) and explorations near the site available through the State of California GeoTracker database. Figure 2, Site Plan, shows the location of the subsurface borings reviewed. Although we were unable to locate any boring logs on the site, we did obtain a foundation report without logs for the existing Capitol Towers structure that had a description of the subsurface conditions.

Based on the data reviewed and our experience in the area, we anticipate the subsurface conditions at the site to consist of the following generalized stratum:

- **Fill:** Generally, compressible sandy fine-grained soil placed in the 1860s, which we anticipate to be approximately 10 feet thick. The fill may contain brick fragments, wood and other deleterious debris and may vary in thickness and consistency.

- **Weak and Compressible Soil:** Weak and compressible fine-grained soil to a depth of 30 to 45 feet below site grades underlain by variable thickness loose to medium dense sand. This sand may be potentially liquefiable and has varying thickness of approximately 3 to 20 feet.
- **Dense Sands and Gravels:** A competent layer of medium dense to very dense gravel and sand is anticipated at variable depths ranging from 40 to 60 feet below site grades. This is a potential bearing layer for deep foundations but may be discontinuous and variable across the site; this layer could contain cobbles of varying sizes. At 601 Capitol Mall, some explorations encountered a weaker and potentially compressible layer below this denser sand and gravel layer. The foundation report at 500 7<sup>th</sup> Street describes a similar potentially weak layer below the dense gravel and sand at some locations as well.
- **Hard Silts and Clays:** Hard silts, clays and dense sands are generally anticipated below a depth of about 60 feet. This layer is anticipated to be fairly consistent, thick, and suitable for support of deep foundations.

The generalized subsurface conditions are summarized in Cross Sections A-A' and B-B' on Figure 4.

## 7.0 GROUNDWATER CONDITIONS

We reviewed reported groundwater depths from select Geotracker monitoring wells in the vicinity of the site, with readings taken between 2002 and 2013. The monitoring wells indicate the typical depth to groundwater in the site vicinity is approximately 10 to 15 feet below grade or at an approximate elevation of 0 to 5 feet (Datum=MSL). Based on our review of the Tentative Subdivision Map, average site grades range from approximately elevation 15 feet in the southwest corner to elevation 18 feet along the eastern portion of the site. This depth to groundwater is consistent with the depth at which groundwater was reported to be encountered in the subsurface borings reviewed and the foundation report for the Capitol Towers building from 1961. We tabulated the reported high and low groundwater table elevations from nearby monitoring wells in the following table. The data indicates the groundwater table has risen to an elevation as shallow as 7 to 8 feet below the site grades. Due to the proximity to the Sacramento River, groundwater levels should be expected to fluctuate.

**TABLE 7.0-1**  
Geotracker Monitoring Well Groundwater Conditions

Geotracker Monitoring Well ID	Surface Elevation	Groundwater Elevation (MSL)	
	(MSL feet)	High (feet)	Low (feet)
SPW-05	16.07	8.47 (7.60 bgs)	-1.17 (17.24 bgs)
SPW-06	17.57	7.56 (10.00 bgs)	-0.75 (18.32 bgs)
SPW-22	18.2	6.19 (12.01 bgs)	-1.32 (19.52 bgs)
SPW-40	14.75	7.38 (6.37 bgs)	-3.15 (17.90 bgs)
WCC-72	15.15	7.98 (7.17 bgs)	-3.22 (18.47 bgs)
WCC-73	18.17	6.43 (11.74 bgs)	-1.78 (19.95 bgs)

## 8.0 DESIGN CONSIDERATIONS

From a geotechnical engineering perspective, the site development is feasible provided the anticipated geotechnical constraints are properly mitigated. As is common for many Downtown Sacramento multi-story building projects, the primary geotechnical constraint is the weak and compressible soil that will not support high structural column loads without excessive settlement. Secondary geotechnical constraints include potentially liquefiable soil deposits and seasonal high groundwater conditions. We provide design considerations for these constraints for preliminary project planning.

### 8.1 PROBABLE FOUNDATION SUPPORT

The project involves three categories of proposed structures: high-rise, mid-rise and parking structures. Preliminary dead plus live column loads and average bearing pressures for the various structures are summarized below:

**TABLE 8.1-1**  
 Building Types and Probable Loads

<b>Pile Type</b>	<b>Probable Dead + Live Columns Loads (kips)</b>	<b>Average Bearing Pressures for Mat Foundations (psf)</b>
High-rise Apartments and Hotel	3210	4,100
High-rise Condominiums	3570	4,600
Mid-rise Apartments	640	710
Long-span Parking Structure	910	2,500
Short-span Parking Structure	940	1,050

#### 8.1.1 High-Rise Buildings

We anticipate the high-rise structures will need to be supported on deep foundations that gain support in the deeper dense sands and gravels at the site. Deep foundation systems would also mitigate impacts associated with potentially liquefiable soil.

For preliminary planning purposes, we anticipate deep foundations would likely need to extend about 60 to 80 feet below grade, depending on foundation type and desired capacity. Several deep foundation systems could be and have been used in the Downtown Sacramento area, each with disadvantages and advantages. In addition to the cost, commonly considerations in selecting an appropriate deep foundation system in Downtown Sacramento can include:

- Noise and vibration during construction.
- Amount of soil and groundwater spoils produced during construction.
- Hazardous soil and groundwater concerns of spoils produced during construction.
- Quality control.
- Ability to advance through dense soil and cobble deposits.
- Ability to handle varying soil conditions.
- Depth to groundwater.

Below is a list of commonly used deep foundation types that may be considered for projects in Downtown Sacramento. We include general comments about advantages and disadvantages that may be considered in selecting a foundation system for this site. There are numerous proprietary foundation types that fall into the general categories below so additional or ongoing research may reveal additional systems that may be appropriate for the project.

**TABLE 8.1.1-1**  
Deep Foundation Pile Types

Pile Type	Benefits	Disadvantages
<p><b>Driven Piles:</b> Installed by driving a prefabricated steel or concrete pile</p>	<ul style="list-style-type: none"> <li>-Superior quality control during installation</li> <li>-Pile Driving Analysis provides estimate of pile capacity</li> <li>-No spoils unless pre-drilling is required.</li> <li>-Commonly used foundation system</li> <li>-Concrete piles provide superior corrosion protection</li> <li>-Steel piles can be easily cutoff and extended, if needed</li> <li>-Capable of high ultimate capacities</li> </ul>	<ul style="list-style-type: none"> <li>-Relatively high noise and vibration</li> <li>-May be difficult to advance through dense gravel stratum without pre-drilling</li> <li>-Fixed length concrete piles can require cutoffs where variable end bearing occurs</li> <li>-Steel piles may require corrosion protection</li> </ul>
<p><b>Drilled Pier (Cast in Drilled Hole):</b> Installed by drilling open hole, setting rebar, and placing concrete</p>	<ul style="list-style-type: none"> <li>-Good but intensive quality control via drilling observations and possibly tomography following installation</li> <li>-Low noise and vibration</li> <li>-Can be extended to variable lengths</li> <li>-Capable of high ultimate capacities</li> </ul>	<ul style="list-style-type: none"> <li>-Creates soil and groundwater spoils</li> <li>-Less common in Downtown Sacramento</li> <li>-Requires casing or drilling fluids below groundwater or loose soil conditions</li> <li>-Difficult to install in soft soil and loose sands below the groundwater table</li> <li>-Not suitable for high end bearing</li> <li>-Slow production rates</li> </ul>
<p><b>Torque-installed Steel Piles:</b> Installed by drilling a close-ended pipe pile into the ground using high torque and filling with concrete upon completion.</p>	<ul style="list-style-type: none"> <li>-Little to no spoils (close-ended)</li> <li>-Low noise and vibration</li> <li>-Relatively easy to splice</li> <li>-Capable of high ultimate capacities</li> </ul>	<ul style="list-style-type: none"> <li>-Can have difficulty penetrating through dense or cemented layers without predrilling</li> <li>-Less common than driven piles</li> <li>-Indirect verification of final installation through advancement rate and pressure gage</li> <li>-Load testing to verify capacities</li> </ul>

Pile Type	Benefits	Disadvantages
<p><b>Continuous Flight Auger Piles (Auger Cast Piles)</b> Installed by drilling a hole using a continuous flight auger and then injecting grout from the bottom up while withdrawing augers and soil. A reinforcement cage is then wet set</p>	<ul style="list-style-type: none"> <li>-Can penetrate through variable dense gravel and sand layer.</li> <li>-No splicing required</li> <li>-Low noise and vibration</li> <li>-Hole is cased for full installation</li> </ul>	<ul style="list-style-type: none"> <li>-Creates spoils</li> <li>-Grout take can be highly variable (120 to 200% of the theoretical hole volume)</li> <li>-Dependent on strict quality workmanship; no direct observation of grout placement</li> <li>-Lower ultimate capacities</li> </ul>

### 8.1.2 Mid-Rise Buildings and Parking Structures

The proposed mid-rise structures and the short-span parking structure have lower column loads than the other proposed structures. As a result, we anticipate that these structures could be supported on either stiffened mat foundations combined with ground improvement techniques or a deep foundation system discussed above. Proper support for mat foundations would require ground improvement to reduce potential differential settlements from the underlying weak soil and potentially liquefiable deposits. Ground improvement could include such techniques as rammed aggregate piers, deep soil mixing, vibro-replacement (stone columns) or compaction grouting, for example.

The long-span parking structure, with estimated average allowable bearing pressures of 2,500 psf, could potentially be supported on a hybrid mat and grade beam foundation system combined with ground improvement. Once site-specific subsurface information is obtained, the feasibility of this approach can be further evaluated.

## 8.2 GROUNDWATER CONSIDERATIONS

For initial planning purposes, we anticipate the depth to seasonal high groundwater may be assumed at an elevation of 8 feet (6 to 8 feet below site grade). The foundation report for 1500 7<sup>th</sup> Street identified the anticipated highest groundwater elevation for the site as 8 feet below site grades as well.

Any excavations or structural elements extending near or deeper than this elevation could be impacted by seasonal high groundwater conditions. We anticipate structural elements, including basements that extend near this elevation, would likely require waterproofing and may need to be designed for hydrostatic uplift pressures. For deeper permanent excavations, a subdrain and dewatering system may be necessary.

## 8.3 EARTHWORK CONSIDERATIONS

We anticipate only minor earthwork will be necessary for this development. Because the site was filled in the 1860s, some portions of the fill may contain debris or other deleterious material that

may be encountered in excavations. As a result, some screening or off-haul of excavated materials may become necessary. This can be evaluated during the design-level geotechnical explorations.

For site demolition and clearing of new development areas, we generally recommend removal of all surface and subsurface deleterious materials, including existing building foundations, slabs, buried utility and irrigation lines, pavements, debris, and designated trees, shrubs, and associated roots. Any resulting excavations would need to be backfilled with engineered fill. Fills for new improvements would need to be compacted to at least 90 percent relative compaction for general earthwork and 95 percent for the pavement subgrade soil. Relative compaction refers to the in-place dry unit weight of soil expressed as a percentage of the maximum dry unit weight of the same soil, as determined by the ASTM D-1557 laboratory compaction test procedure.

#### **8.4 TEMPORARY SHORING CONSIDERATIONS**

The variable and loose nature of the existing near-surface fills and underlying soil should be considered when designing any temporary shoring. Shallow groundwater may be encountered depending on the time of year construction occurs and dewatering may be required.

Temporary shoring may be required at the subject site based on the anticipated depth of the foundation elements of the structures. The Owner and Contractor should be familiar with applicable local, state, and federal regulations, including the current Occupational Safety and Health Administration (OSHA) Excavation and Trench Safety Standards, and conform to Cal-OSHA requirements for all shoring and/or sloping and construction within the excavations.

The specific choice of shoring is commonly left to the contractor's judgment since economic considerations and/or the individual contractor's construction experience may determine which method is more economical and/or applicable. Excavations greater than 5 feet in depth could be temporarily shored as necessary using trench shields, a soldier beam and lagging or sheet pile wall shoring schemes appropriately designed by a qualified registered engineer. Depending on the depth of shoring, magnitude of lateral loads, and proximity of existing site improvements, braced or unbraced shoring may be used.

#### **8.5 SEISMIC DESIGN PARAMETERS**

Nearby subsurface shear wave velocity data indicates the site would be classified as site Class D. However, due to the presence of potentially liquefiable soil and the estimated long fundamental period of the proposed structures, the site would be classified as a site Class F according to ASCE 7-10 and the 2013 CBC. A site-specific design spectra should be developed during the design-level geotechnical exploration, following a more thorough evaluation of the liquefaction potential for the site. For preliminary design purposes, we provide the 2013 California Building Code (CBC) seismic design parameters in Table 8.5-1 below.

**TABLE 8.5-1**  
2013 CBC Seismic Design Parameters  
Latitude: 38.57614 Longitude: -121.50109

Parameter	Design Value
Site Class	D
Mapped MCE <sub>R</sub> Spectral Response Acceleration at Short Periods, S <sub>S</sub> (g)	0.68
Mapped MCE <sub>R</sub> Spectral Response Acceleration at 1-second Period, S <sub>1</sub> (g)	0.30
Site Coefficient, F <sub>A</sub>	1.25
Site Coefficient, F <sub>V</sub>	1.81
MCE <sub>R</sub> Spectral Response Acceleration at Short Periods, S <sub>MS</sub> (g)	0.86
MCE <sub>R</sub> Spectral Response Acceleration at 1-second Period, S <sub>M1</sub> (g)	0.53
Design Spectral Response Acceleration at Short Periods, S <sub>DS</sub> (g)	0.57
Design Spectral Response Acceleration at 1-second Period, S <sub>D1</sub> (g)	0.36
Mapped MCE Geometric Mean Peak Ground Acceleration (g)	0.23
Site Coefficient, F <sub>PGA</sub>	1.33
MCE Geometric Mean Peak Ground Acceleration, PGA <sub>M</sub> (g)	0.31
Long period transition-period, T <sub>L</sub>	12

## 9.0 DESIGN-LEVEL GEOTECHNICAL EXPLORATION

The information in this feasibility report is based on nearby subsurface data and contains no site-specific boring data. The design-level geotechnical exploration would include subsurface exploration, laboratory testing, engineering analysis and development of design-level recommendations. Based on our preliminary findings, the design-level geotechnical exploration would focus on characterizing the following:

- Existing fills.
- Weak compressible soils.
- Potentially liquefiable soils.
- The thickness, depth and consistency of potential competent bearing layers for deep foundations.
- Shear wave velocity measurements for assisting in site-specific design spectra.

The design-level report would address these hazards and provide a site-specific seismic design spectra. Depending on the manner in which the construction and demolition is phased, a phased exploration may be beneficial to confirm the anticipated subsurface conditions below the existing structures that will be demolished.

## **10.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS**

We strived to perform our professional services in accordance with generally accepted geotechnical engineering principles and practices currently employed in the area; no warranty is expressed or implied. This report is based upon review of limited available data in the site vicinity; no exploration was performed to determine the actual subsurface soil and groundwater conditions at the site. We assumed that the nearby data we reviewed is representative of the actual subsurface conditions across the site.

# FIGURES

## FIGURES

**Figure 1 - Vicinity Map**

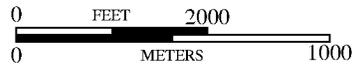
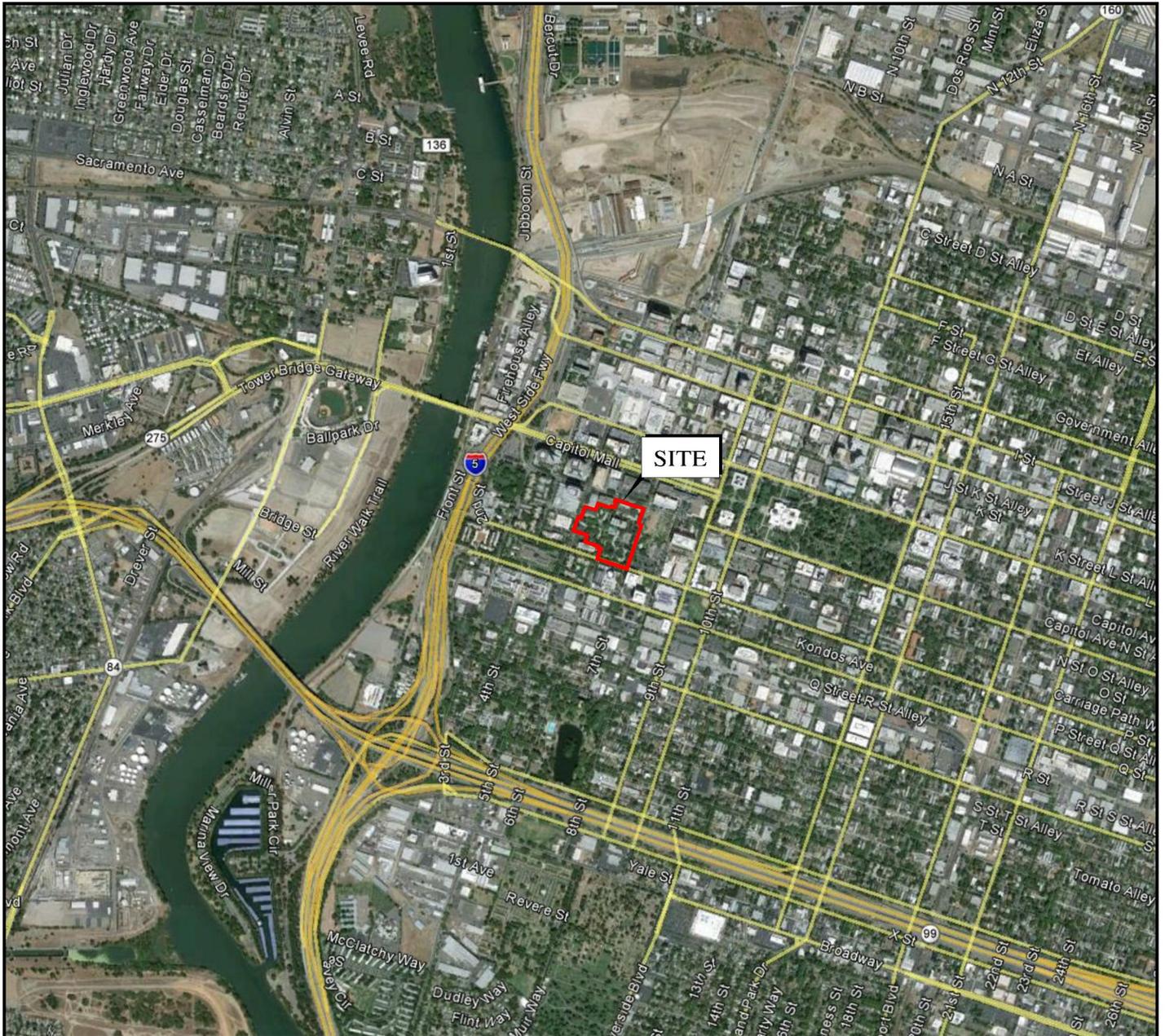
**Figure 2 - Site Plan**

**Figure 3 - Regional Faulting and Seismicity Map**

**Figure 4 – Soil Cross Sections**



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BASE MAP SOURCE: GOOGLE EARTH PRO



VICINITY MAP  
SACRAMENTO COMMONS  
SACRAMENTO, CALIFORNIA

PROJECT NO.: 10764.000.000

SCALE: AS SHOWN

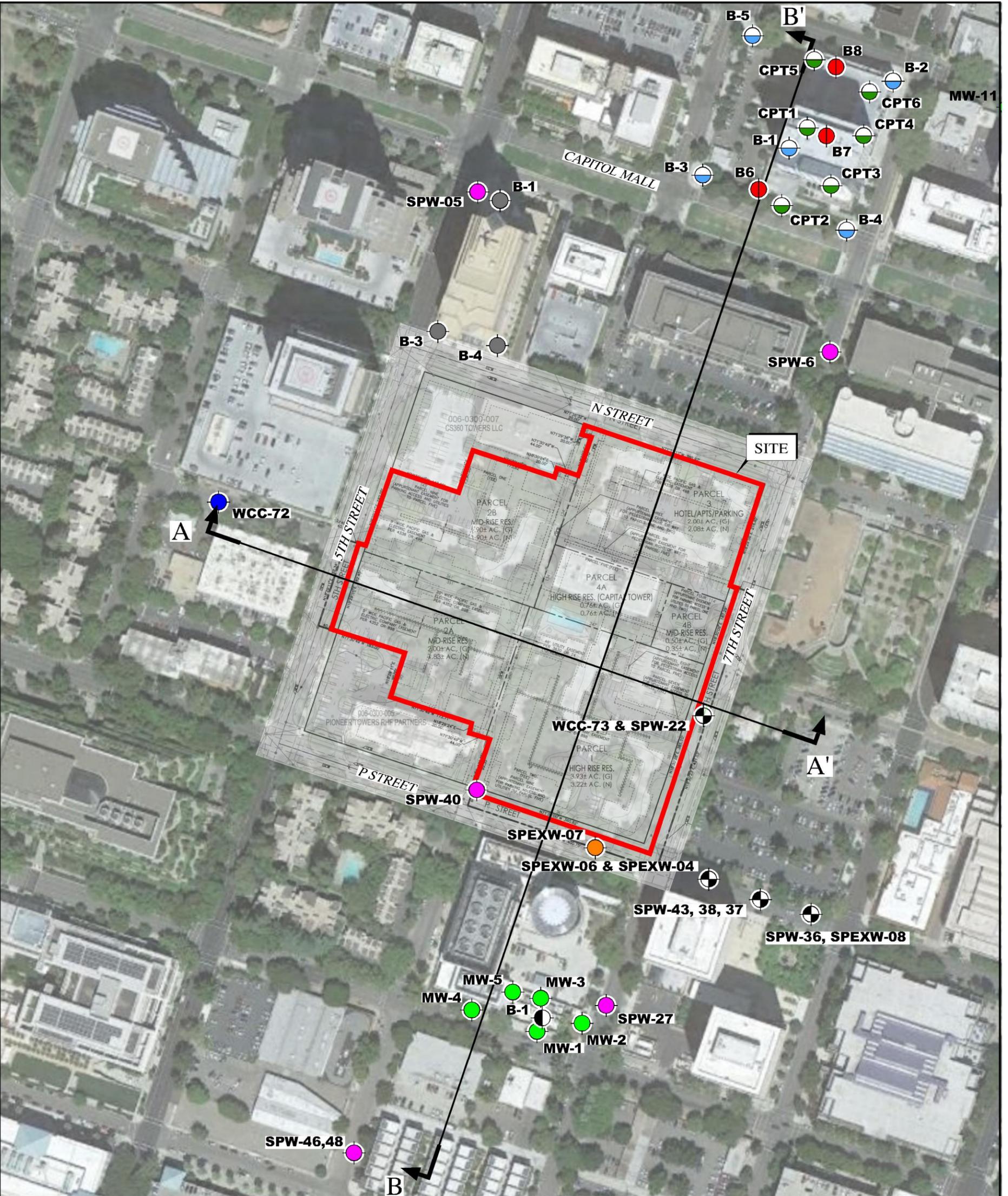
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FIGURE NO.

1

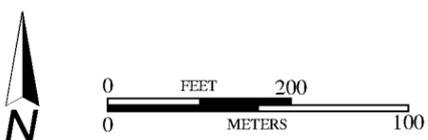
G:\Drafting\DRAWING\10764\10000 to 12999\10764\1000\GEO\10764000000-GEO-2-SITEPLAN-0414.dwg Plot Date: 4-16-14 lra



### EXPLANATION

ALL LOCATIONS ARE APPROXIMATE

- B-1** BORING LOCATION (GEOTRACKER, 2009)
- B-4** BORING LOCATION (500 CAPITOL MALL-BY OTHERS, 2009)
- B-8** BORING LOCATION (ENGEO, 2004)
- B-2** BORING LOCATION (ENGEO, 2000)
- CPT6** CONE PENETRATION TEST LOCATION (ENGEO, 2004)
- MW-11** ENVIRONMENTAL WELL LOCATION (GEOTRACKER, 2007)
- SPEXW-07** ENVIRONMENTAL WELL LOCATION (GEOTRACKER, 1994)
- SPW-31** ENVIRONMENTAL WELL LOCATION (GEOTRACKER, 1992)
- WCC-70** ENVIRONMENTAL WELL LOCATION (GEOTRACKER, 1990)
- SPW-43,38,37** AREAS WITH MULTIPLE BORING SAMPLES
- B'-B** CROSS SECTION LOCATION



BASE MAP SOURCE: GOOGLE EARTH PRO AND WOOD RODGERS, 2014



**SITE PLAN**  
SACRAMENTO COMMONS  
SACRAMENTO, CALIFORNIA

PROJECT NO.: 10764.000.000

SCALE: AS SHOWN

DRAWN BY: LL

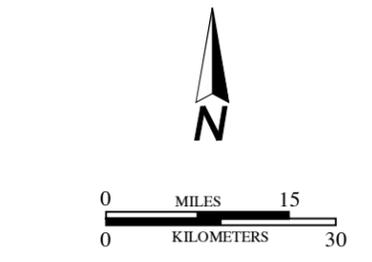
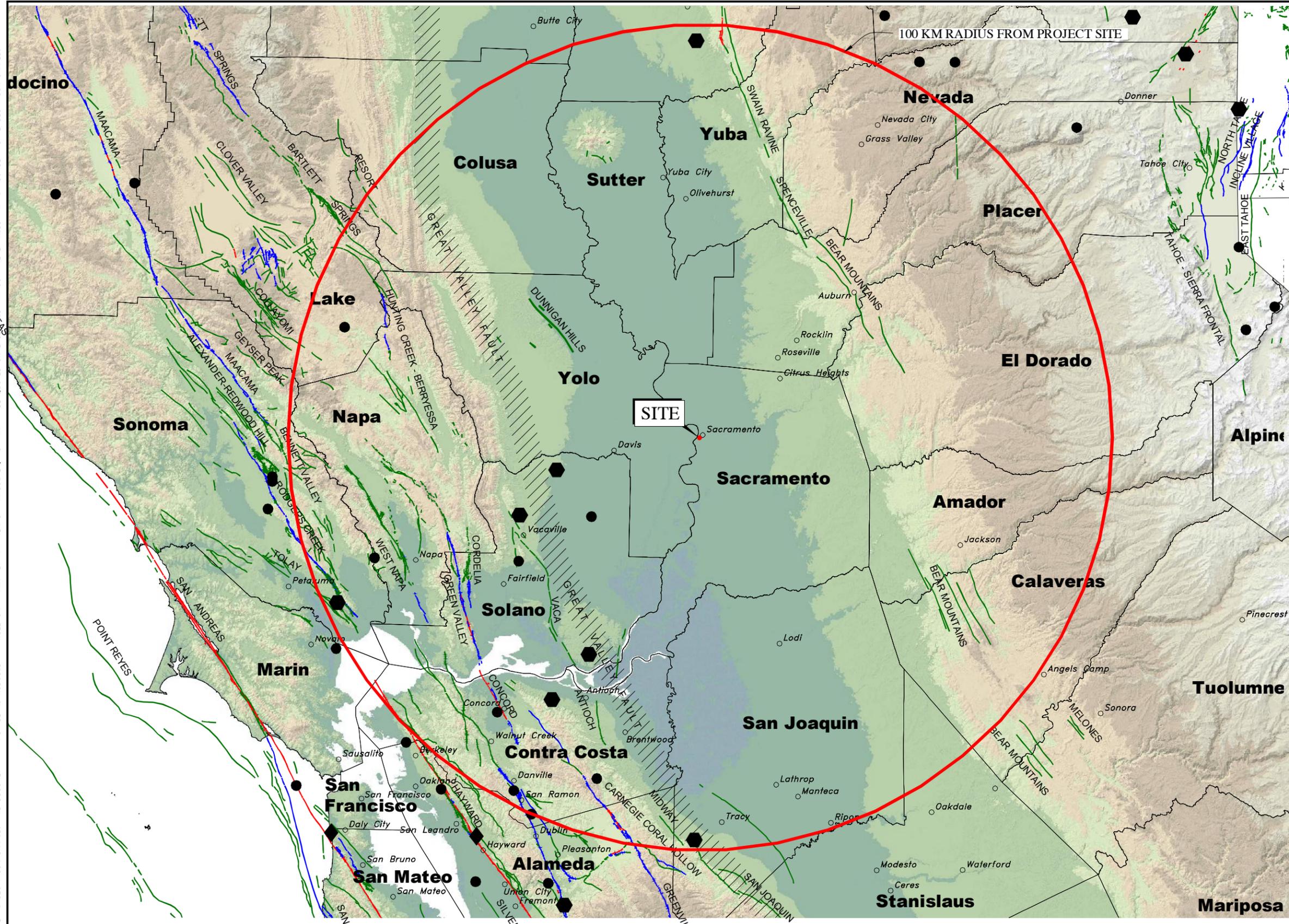
CHECKED BY: NB

FIGURE NO.

**2**

ORIGINAL FIGURE PRINTED IN COLOR

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**EXPLANATION**

◆	MAGNITUDE 7+
⬠	MAGNITUDE 6-7
●	MAGNITUDE 5-6
— (Red)	HISTORIC FAULT
— (Blue)	HOLOCENE FAULT
— (Green)	QUATERNARY FAULT
▨	HISTORIC BLIND THRUST FAULT ZONE

BASE MAP SOURCE:  
 COLOR HILLSHADE IMAGE BASED ON THE NATIONAL ELEVATION DATASET (NED) AT 30 METER RESOLUTION  
 U.S.G.S. QUATERNARY FAULT DATABASE, NOVEMBER, 2010 \*DUNNIGAN HILLS CONSIDERED QUATERNARY  
 U.S.G.S. HISTORIC EARTHQUAKE DATABASE (1800-2000)

	<b>REGIONAL FAULTING AND SEISMICITY</b> SACRAMENTO COMMONS SACRAMENTO, CALIFORNIA		<b>PROJECT NO.:</b> 10764.000.000 <b>SCALE:</b> AS SHOWN <b>DRAWN BY:</b> LL <b>CHECKED BY:</b> NB	<b>FIGURE NO.</b> <span style="font-size: 2em;">3</span>

Project No.  
**10764.000.000**

November 12, 2014

Mr. Dave Eadie  
Kennedy Wilson  
18401 Von Karman, Suite 350  
Irvine, CA 92612

Subject: Sacramento Commons  
Sacramento, California

## CONSULTATION REGARDING GROUNDWATER PLUME

Reference: ERM; 2014 Annual Groundwater Monitoring and Remediation Systems Operation and Maintenance Report, Former SPTCo Sacramento Railyard, Sacramento, California; August 29, 2014.

Dear Mr. Eadie:

As requested, we reviewed available groundwater data compiled for the Railyards South Plume within the area of the proposed Sacramento Commons project in Sacramento, California. Our purpose was to determine if the proposed site development could be affected by potential groundwater contaminants.

With regard to the Railyards South Plume, we researched the analytical data available on the State Water Resources Control Board's *Geotracker* website. We reviewed the referenced August 2014 report, prepared by ERM for the Railyards. We reviewed groundwater monitoring data for a total of 24 wells located within 500 feet of the site and summarize the data in Table 1 below.

**TABLE 1**  
**Groundwater Parameter and Well Data (ERM 2014)**

WELL NO.	LOCATION	ZONE	Total Depth (ft)	DTW (ft)	SCREEN INTERVAL (bgs)	LAST DATE	VOCs (ug/L)
SPW-18	Offsite North	LSZE	49.5	14.27	39-49	Apr-14	ND
SPW-22	East Boundary	LSZE	44.5	14.9	36-44	Apr-14	<b>0.42</b>
SPW-32	Offsite South	LSZE	55.5	13.88	45-55	Apr-14	<b>0.7</b>
SPW-35	Offsite SE	LSZE	50.5	14.46	30-50	Apr-14	<b>3.26</b>
SPW-37	Offsite SE	LSZE	50.5	13.67	30-50	Apr-14	<b>1.46</b>
SPW-40	South Boundary	LSZE	54	10.59	42-52	Apr-14	ND
SPEXW-07	South Boundary	LSZE	53	13.35	41-51	Apr-14	ND
SPEXW-06	Offsite SE	LSZE	48.4	31.93	28-48	Apr-14	<b>0.23</b>

WELL NO.	LOCATION	ZONE	Total Depth (ft)	DTW (ft)	SCREEN INTERVAL (bgs)	LAST DATE	VOCs (ug/L)
SPEXW-08	Offsite SE	LSZE	79	27.05	36-50	Apr-14	<b>4.9</b>
SPW-05	NW Boundary	GZ	85	12.23	76-86	Apr-14	ND
SPW-06	NE Boundary	GZ	80.5	14.08	70-80	Apr-14	<b>12.7</b>
SPW-27	Offsite South	GZ	82.5	14.04	67-82	Apr-14	<b>0.42</b>
SPW-36	Offsite SE	GZ	79.5	15.08	64-79	Apr-14	<b>11.5</b>
SPW-38	Offsite SE	GZ	80.5	14.87	65-80	Apr-14	<b>0.98</b>
SPW-57	North Boundary	GZ	78	NA	68-78	Apr-14	<b>8.75</b>
WCC-72	Offsite West	GZ	70.5	11.49	60-70	Apr-14	ND
WCC-73	East Boundary	GZ	72.5	15.32	62-72	Apr-14	<b>0.47</b>
SPEXW-04	Offsite SE	GZE	83	16.88	65-81	Apr-14	<b>1.35</b>
SPEXW-05	Offsite SE	GZE	79	16.14	62-77	Apr-14	<b>9.8</b>
SPW-43	Offsite SE	IBZ	130	40.9	125-130	Apr-14	<b>0.13</b>
SPW-50	Offsite NE	IBZ	113.5	15.68	103-113	Apr-14	<b>0.32</b>
SPW-56	Offsite West	IBZ	132	12.05	122-132	Apr-14	ND
SPW-58	Offsite North	IBZ	109	NA	99-109	Apr-14	<b>20.8</b>
SPEXW-10	Offsite North	IBZ	111	NA	101-111	Apr-14	<b>8.56</b>

NA - No data available  
 LSZE - Lower Sand Zone  
 GZ - Gravel Zone  
 IBZ - Interbedded Zone  
 DTW - Depth to Water  
 VOCs - Volatile Organic Compounds (cumulative)

These wells were screened within three defined water-bearing zones, as follows:

- Lower Sand Zone (LSZE - 9 wells).....28 to 55 feet below ground surface
- Gravel Zone (GZ - 10 wells).....60 to 86 feet below ground surface
- Interbedded Zone (IBZ – 5 wells).....99 to 132 feet below ground surface

Trace concentrations of total Volatile Organic Compounds (VOCs) were reported for 18 of the 24 wells, with concentrations ranging from 0.13 micrograms per liter (ug/L) to 20.8 ug/L. Several wells reported VOC concentrations slightly above remedial objectives for the South Plume; however, the wells located within 100 feet are either non-detectable for VOCs or exhibit concentrations below the applicable remedial action objectives.

## CONCLUSIONS

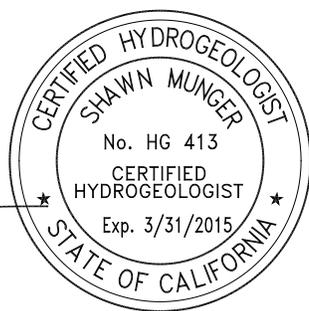
Based on this information, the proposed construction activities will not be affected by the underlying groundwater. It is our opinion that there are no significant groundwater impacts beneath the Sacramento Commons site, thus leading to a "Less Than Significant" conclusion in the environmental document.

We appreciate the opportunity to be of continued service to you with regard to the Sacramento Commons project. If you have any questions or comments, please call and we would be glad to discuss them with you.

Sincerely,

ENGEO Incorporated

  
Shawn Munger, CHG



  
Mark Gilbert, GE