J. Geology, Soils, and Seismicity

This section describes geologic and seismic conditions in the project vicinity and evaluates the potential for the proposed project to result in significant impacts related to exposing people or structures to unfavorable geologic hazards, soils, and/or seismic conditions. Potential impacts are discussed and evaluated, appropriate standard conditions of approval are identified, and mitigation measures are prescribed, as necessary.

Setting

Topography

The city of Oakland includes the mountainous uplands of the Oakland-Berkeley Hills and an alluvial plain that slopes gently westward away from these hills to meet the flat marginal baylands of the San Francisco Bay. The project area is located on the alluvial plain, approximately ½ mile north of the Oakland Estuary. The ground surface in and around the project site is relatively flat and slopes gently southwest towards Highway 880. Ground elevations range from approximately 30 to 40 feet above mean sea level (msl).

Geology

The project area lies within the geologic region of California referred to as the Coast Ranges geomorphic province.[1] The natural region of the Coast Ranges is between the Pacific Ocean and the Great Valley and stretches from the Oregon border to the Santa Ynez River near Santa Barbara. Discontinuous northwest-trending mountain ranges, ridges, and intervening valleys characterize this province. Much of the Coast Range province is composed of marine sedimentary and volcanic rocks that form the Franciscan Assemblage. The Franciscan Assemblage in this region of California represents some of the oldest rocks in the region, and consists primarily of greenstone (altered volcanic rocks), basalt, chert (ancient silica-rich ocean deposits), and sandstone that originated as ancient sea floor sediments.

The San Francisco Bay is located in a broad depression in the Franciscan bedrock resulting from an east-west expansion between the San Andreas and the Hayward fault systems. The bedrock surface can be found at elevations of 200 to 2,000 feet below msl across the Bay Area. Sedimentary deposits overlie the Franciscan bedrock that originated from millions of years of erosion, deposition, and changes in sea level. Geologists categorize these sedimentary deposits into geologic formations based on the period of deposition and material type, as described below for the San Francisco Bay region.

- The Alameda Formation is the deepest and oldest of these sedimentary deposits and consists of a mixture of clay, silt, sand, gravel, and some shells with predominantly silt and clay sediments surrounding discontinuous layers of sand and gravel;

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1 A geomorphic province is an area that possesses similar bedrock, structure, history, and age. California has 11 geomorphic provinces.

- Overlying the Alameda Formation is the San Antonio Formation which consists of sandy clays, gravelly clays, clayey sands and gravels with interbedded silty clay deposits.

- Younger alluvial deposits once referred to as the Temescal Formation are deposited on top of the San Antonio and consist of sandy clays, clayey sands, sands and gravels. The source material for these alluvial deposits comes from the Berkeley Hills.

The underlying geology of the project site is mapped as alluvial fan and fluvial deposits of Holocene times. These deposits are characterized as unconsolidated, plastic, moderately to poorly-sorted silt and clay rich in organic material that formed from streams draining the nearby hillsides and standing floodwaters from the Bay (USGS, 2000).

Site Soils

According to the Soil Survey of Alameda County, Western Part, site soils belong to the Urban land-Clear Lake complex. This complex is comprised primarily of approximately 55 percent Urban land and 35 percent Clear Lake clay. Urban-land Clear Lake complex is characterized as very deep and poorly drained soils having no hazard of erosion, high shrink-swell potential, and high potential for differential settlement. The Urban land soil mapping unit occurs in areas where the soil material has been altered or mixed during urban development and consists of soils that are covered by structures and other development. The Clear Lake soil unit consists of clay and silty clay formed in alluvium that derived mainly from sedimentary rock (USDA, 1981).

Seismicity

The San Francisco Bay Area region contains both active and potentially active faults and is considered a region of high seismic activity (**Figure IV.F-1**).[2] The 1997 Uniform Building Code locates the entire Bay Area within Seismic Risk Zone 4. The U.S. Geological Survey (USGS) Working Group on California Earthquake Probabilities has evaluated the probability of one or more earthquakes of Richter magnitude 6.7 or higher occurring in the San Francisco Bay Area within the next 30 years. The result of the evaluation indicated a 62 percent likelihood that such an earthquake event will occur in the Bay Area between 2003 and 2032 (USGS, 2003). The magnitude (M) is a measure of the energy released in an earthquake. The estimated magnitudes, described as moment magnitudes (Mw) represent *characteristic* earthquakes on particular faults (**Table IV.J-1**).[3] Intensity is a measure of the ground shaking effects at a particular location. However, ground movement during an earthquake can vary depending on the overall magnitude,

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2 An “active” fault is defined by the State of California as a fault that has had surface displacement within Holocene time (approximately the last 10,000 years). A “potentially active” fault is defined as a fault that has shown evidence of surface displacement during the Quaternary (last 1.6 million years), unless direct geologic evidence demonstrates inactivity for all of the Holocene or longer. This definition does not, of course, mean that faults lacking evidence of surface displacement are necessarily inactive. “Sufficiently active” is also used to describe a fault if there is some evidence that Holocene displacement occurred on one or more of its segments or branches (Hart, 1997).

3 Moment magnitude is related to the physical size of a fault rupture and movement across a fault. The Richter magnitude scale reflects the maximum amplitude of a particular type of seismic wave. Moment magnitude provides a physically meaningful measure of the size of a faulting event (CDMG, 1997b). The concept of “characteristic” earthquake means that we can anticipate, with reasonable certainty, the actual earthquake that can occur on a fault.

TABLE IV.J-1
ACTIVE FAULTS IN THE PROJECT SITE VICINITY

Fault	Distance and Direction from Project Area	Recency of Movement	Fault Classification[a]	Historical Seismicity[b]	Maximum Moment Magnitude Earthquake (Mw)[c]
Hayward	3 miles east	Historic (1836; 1868 ruptures) Holocene	Active	M6.8, 1868 Many <M4.5	7.1
Calaveras	16 miles east	Historic (1861 rupture) Holocene	Active	M5.6–M6.4, 1861 M4–M4.5 swarms 1970, 1990	6.8
San Andreas	18 miles west	Historic (1906; 1989 ruptures) Holocene	Active	M7.1, 1989 M8.25, 1906 M7.0, 1838 Many <M6	7.9
Marsh Creek - Greenville	29 miles east	Historic (1980 rupture) Holocene	Active	M5.6 1980	6.9
Concord - Green Valley	22 miles northeast	Historic (1955) Holocene	Active	Historic active creep	6.9
Rodgers Creek	28 miles north	Historic Holocene	Active	M6.7, 1898 M5.6, 5.7, 1969	7.0

[a] See Footnote 4.
[b] Richter magnitude (M) and year for recent and/or large events. The Richter magnitude scale reflects the maximum amplitude of a particular type of seismic wave.
[c] Moment magnitude (Mw) is related to the physical size of a fault rupture and movement across a fault. Moment magnitude provides a physically meaningful measure of the size of a faulting event (CDMG, 1997). The Maximum Moment Magnitude Earthquake, derived from the joint CDMG/USGS Probabilistic Seismic Hazard Assessment for the State of California, 1996. (USGS, 1996).

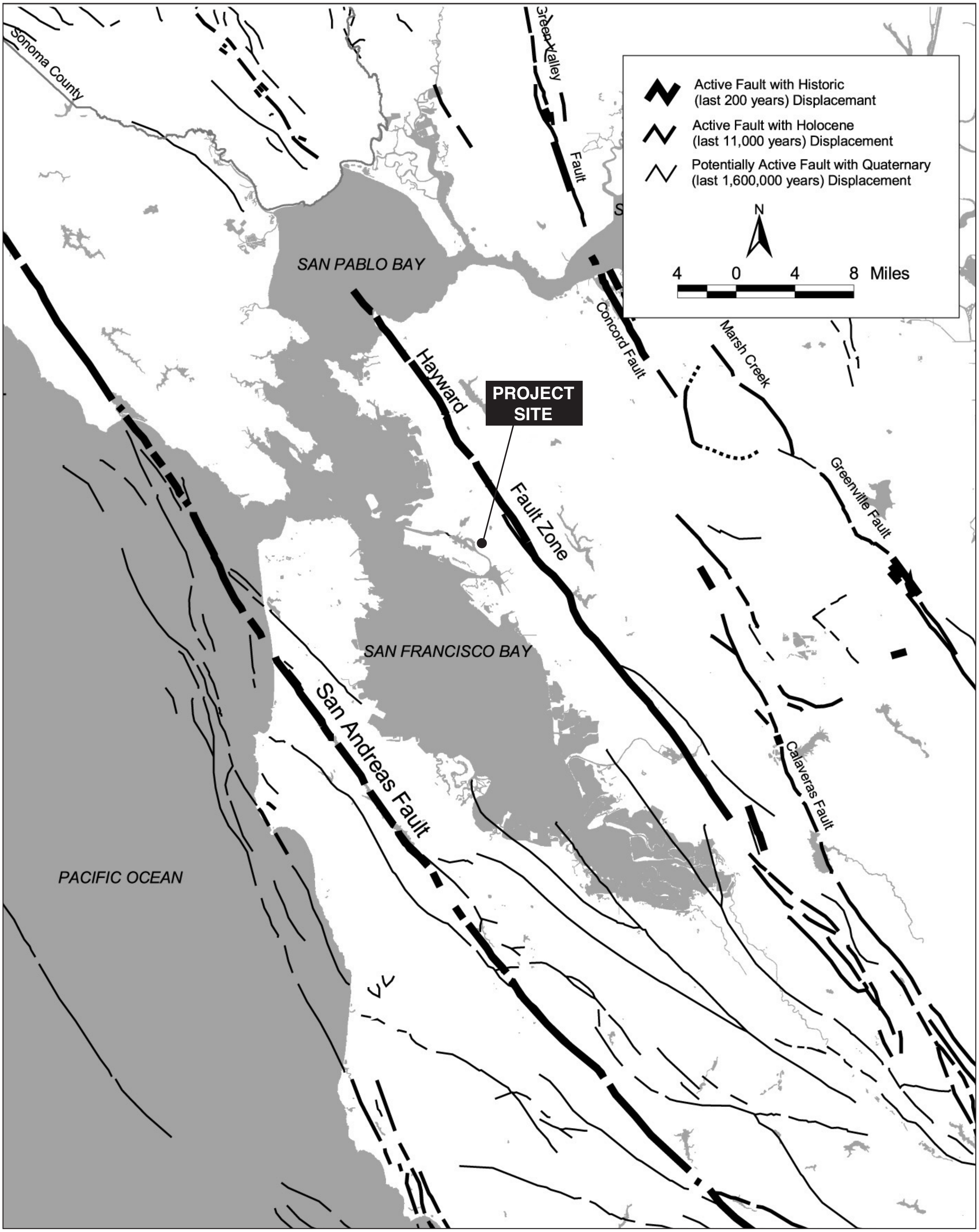
SOURCES: Hart, 1997; Jennings, 1994; Peterson et al, 1996.

distance to the fault, focus of earthquake energy, and type of geologic material. The composition of underlying soils, even those relatively distant from faults, can intensify ground shaking. The Modified Mercalli (MM) intensity scale (**Table IV.J-2**) is commonly used to measure earthquake effects due to ground shaking. The MM values for intensity range from I (earthquake not felt) to XII (damage nearly total), and intensities ranging from IV to X could cause moderate to significant structural damage.[4] For comparison, the 1906 San Francisco earthquake (Mw 7.9) produced strong (VII) shaking intensities, while the 1989 Loma Prieta earthquake, with an Mw of 6.9 produced moderate (VI) shaking intensities in the project area. (ABAG, 2005a,b).

Regional Faults

The two main earthquake faults in the region are the San Andreas Fault Zone on the San Francisco Peninsula and the Hayward Fault Zone that extends along the east bay plain. These two faults are within the San Andreas Fault System, which marks the boundary between two

[4] The damage level represents the estimated overall level of damage that will occur for various MM intensity levels. The damage, however, will not be uniform. Some buildings will experience substantially more damage than this overall level, and others will experience substantially less damage. Not all buildings perform identically in an earthquake. The age, material, type, method of construction, size, and shape of a building all affect its performance.



SOURCES: California Department of Conservation, Division of Mines and Geology (After Jennings, 1994)

Figure IV.J-1
Regional Fault Map

TABLE IV.J-2
MODIFIED MERCALLI INTENSITY SCALE

Intensity Value	Intensity Description	Average Peak Acceleration
I	Not felt except by a very few persons under especially favorable circumstances.	< 0.0017 g[a]
II	Felt only by a few persons at rest, especially on upper floors on buildings. Delicately suspended objects may swing.	< 0.014 g
III	Felt noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly, vibration similar to a passing truck. Duration estimated.	< 0.014 g
IV	During the day felt indoors by many, outdoors by few. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.	0.014–0.04 g
V	Felt by nearly everyone, many awakened. Some dishes and windows broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles may be noticed. Pendulum clocks may stop.	0.04–0.09 g
VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; and fallen plaster or damaged chimneys. Damage slight.	0.09–0.18 g
VII	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.	0.18–0.34 g
VIII	Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed.	0.34–0.65 g
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.	0.65–1.24 g
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from riverbanks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.	> 1.24 g
XI	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.	> 1.24 g
XII	Damage total. Practically all works of construction are damaged greatly or destroyed. Waves seen on ground surface. Lines of sight and level are distorted. Objects are thrown upward into the air.	> 1.24 g

[a] g (gravity) = 980 centimeters per second squared. 1.0 g of acceleration is a rate of increase in speed equivalent to a car traveling 328 feet from rest in 4.5 seconds.

SOURCE: California Geological Survey, Note 32 (CDMG, 1997), (CGS, 2003).

continental plates – the Pacific Plate to the west and the North American Plate to the east. This fault system includes many active fault zones in northern and southern California. Other principal Bay Area faults capable of producing significant ground shaking in the project area are listed on **Table IV.J-1** and include the Calaveras, Concord–Green Valley, Marsh Creek–Greenville, and Rodgers Creek. These are also strike-slip faults that are part of the San Andreas Fault System.

Most of these faults have produced historic earthquakes of varying magnitude, but the greatest threat to producing significant earthquakes is the San Andreas, the Hayward, and the Calaveras faults.

San Andreas Fault Zone

The San Andreas Fault Zone is the largest in the state, extending from the Salton Sea near the border with Mexico, to north of Point Arena where the fault trace extends into the Pacific Ocean. The main trace of the San Andreas fault through the Bay Area trends northwest through the Santa Cruz Mountains and the eastern side of the San Francisco Peninsula.

As the principle boundary between the Pacific plate and the North American plate, the San Andreas is often a highly visible topographic feature, such as the area between Pacifica and San Mateo, where Crystal Springs Reservoir and San Andreas Lake clearly mark the rupture zone.[5]

The San Andreas Fault Zone was the source of the two major seismic events in recent history that affected the San Francisco Bay region. The 1906 San Francisco earthquake was estimated at M 7.9 and resulted in approximately 170 miles of surface fault rupture. Horizontal displacement along the fault approached 17 feet near the epicenter. The more recent 1989 Loma Prieta earthquake, with a moment magnitude of M 7.1, resulted in widespread damage throughout the Bay Area. The USGS Working Group on California Earthquake Probabilities estimated there is a 21 percent chance of the San Andreas fault experiencing an earthquake of M 6.7 or greater in the next 30 years (USGS, 2003).

Hayward Fault Zone

The Hayward Fault Zone is part of the San Andreas Fault System and trends to the northwest along the eastern San Francisco Bay, extending from San Pablo Bay in Richmond, 60 miles south to San Jose. In San Jose, the Hayward fault converges with the Calaveras fault, a similar type fault that extends north to Suisun Bay. The Hayward Fault is the boundary between two distinctively different geologic formations of different age and origin. The hills to the east of the fault may be 10 million years old, while the flatlands to the west of the fault are probably less than 15,000 years old. The project area is approximately 3 miles west of the active Hayward Fault Zone and 18 miles east of the San Andreas Fault Zone (**Figure IV.F-1**). The Hayward fault is designated by the Alquist-Priolo Earthquake Fault Zoning Act as an active fault.

The Hayward fault exhibits strike-slip movement, which is the horizontal or lateral movement along fault. Expressions of fault movement along the Hayward fault can be seen in deformed curbs, cracks in pavement, offset walls and rails, and sag ponds.

5 Strike-Slip fault refers to the component of movement or slip on a fault that occurs laterally in the direction that the fault trends.

Historically, the Hayward fault generated one sizable earthquake in 1868 and possibly another in 1836.[6] The 1868, a Richter magnitude 7 earthquake on the southern segment of the Hayward Fault ruptured the ground for a distance of about 30 miles. Recent analysis of geodetic data indicates surface fault rupture may have extended as far north as the city of Berkeley. Lateral ground surface displacement during these events was at least 3 feet.

A characteristic feature of the Hayward fault is its well-expressed and relatively consistent fault creep. Although large earthquakes on the Hayward fault have been infrequent since 1868, slow fault creep has continued to occur and has caused measurable offset. Fault creep on the East Bay segment of the Hayward fault is estimated at 9 millimeters per year (mm/yr) (Peterson, et al., 1996). Although the fault creeps at a higher rate over time, the occurrence of large historical ruptures indicates that the fault is locked at depth and that energy accumulates steadily across the fault, which results in episodic earthquakes. A large earthquake could occur on the Hayward fault with an estimated magnitude of about Mw 7.1 (**Table IV.J-1**).

Geologic Hazards

Expansive Soils

Expansive soils possess a "shrink-swell" behavior. Shrink-swell is the cyclic change in volume (expansion and contraction) that occurs in fine-grained clay sediments from the process of wetting and drying. Structural damage may occur over a long period of time, usually the result of inadequate soil and foundation engineering or the placement of structures directly on expansive soils. According to the Soil Survey of Alameda County, Western Part, site soils are characterized by a high shrink-swell potential (USDA, 1981).

Soil Erosion

Erosion is the wearing away of soil and rock by processes such as mechanical or chemical weathering, mass wasting, and the action of waves, wind and underground water. In general, soils with a high percentage of fine sand and silt are the most erodible. As the clay and organic content of a soil increases, the erodibility of the soil tends to decrease. Excessive soil erosion can eventually lead to damage of building foundations and roadways. The majority of the project would be constructed on existing developed areas that are not undergoing active erosion. Thus, the potential for soil erosion at the project site will be greatest during project construction when existing pavement, structures, and vegetative cover which acts to stabilize the soil would be removed from the development area. Typically, the soil erosion potential is reduced once the soil is graded and covered with concrete, structures, or asphalt.

Differential Settlement

Settlement is the depression of the bearing soil when a load, such as that of a building or new fill material, is placed upon it. Soils tend to settle at different rates and by varying amounts depending on the load weight or change in properties over an area, which is referred to as

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6 Prior to the early 1990s, it was thought that a Richter magnitude 7 earthquake occurred on the northern section of the Hayward Fault in 1836. However, a study of historical documents by the California Geological Survey concluded that the 1836 earthquake was not on the Hayward Fault (Toppozada et al., 1998).

differential settlement. Differential settlement of the loose soils generally occurs slowly, but over time can amount to more than most structures can tolerate. If not properly engineered, loose, soft, soils comprised of sand, silt, and clay have the potential to settle after a building or other load is placed on the surface. Differential settlement can damage buildings and their foundations, roads and rail lines, and result in breakage of underground pipes. According to the Soil Survey of Alameda County, Western Part, site soils have a high potential for differential settlement (USDA, 1981).

Seismic Hazards

Surface Fault Rupture

Seismically induced ground rupture is defined as the physical displacement of surface deposits in response to an earthquake's seismic waves. The magnitude, sense, and nature of fault rupture can vary for different faults or even along different strands of the same fault. Ground rupture is considered more likely along active faults, which are referenced in **Table IV.J-1**.

The project area is not within an Alquist-Priolo Earthquake Fault Zone, as defined by the California State Department of Conservation, Geological Survey (CGS, formerly the Division of Mines and Geology), and no active or potentially active faults exist on or in the immediate vicinity of the site (CGS, 2002). Therefore, there is low potential that fault rupture would occur within the project area.

Ground Shaking

Historic earthquakes have caused strong ground shaking and damage in the San Francisco Bay Area, the most recent being the M 6.9 Loma Prieta earthquake in October 1989. The epicenter was approximately 32 miles south of the project site, but this earthquake nevertheless caused strong ground shaking for about 20 seconds and resulted in varying degrees of structural damage throughout the Bay Area. Strong ground shaking from a major earthquake could affect Oakland during the next 30 years. Earthquakes on the active faults (listed in **Table IV.J-1**) are expected to produce a wide range of ground shaking intensities at the project site.

Ground shaking may affect areas hundreds of miles from the earthquake's epicenter. A way to describe ground motion during an earthquake is with the motion parameters of acceleration and velocity in addition to the duration of the shaking. A common measure of ground motion is the peak ground acceleration (PGA). The PGA for a given component of motion is the largest value of horizontal ground acceleration obtained from a seismograph. PGA is expressed as the percentage of the acceleration due to gravity (g), which is approximately 980 centimeters per second squared. In terms of automobile accelerations, one "g" of acceleration is a rate of increase in speed equivalent to a car traveling 328 feet from rest in 4.5 seconds. For comparison purposes, the maximum peak acceleration value recorded during the Loma Prieta earthquake was in the vicinity of the epicenter, near Santa Cruz, at 0.64 g. The highest value measured in the east bay during Loma Prieta was 0.29 g, recorded at the Oakland Wharf near the Naval Supply Center. The lowest values recorded were 0.06 g in the bedrock on Yerba Buena Island near the San

Francisco Bay Bridge. However, an earthquake on the nearby Hayward fault could produce far more severe ground shaking at the project site than was observed during the Loma Prieta earthquake. Probabilistic seismic hazard maps indicate that peak ground acceleration in the Project area could reach or exceed 0.58 g (CGS, 2005).[7]

Liquefaction

Liquefaction hazards may be present in loose, saturated soils, such as sands or loamy sands, in which the space between individual particles is completely filled with water. These soils can behave like a dense fluid when exposed to prolonged shaking during an earthquake. Liquefaction is dominated by three main factors: depth of groundwater, soil type, and the seismicity of the area. Liquefaction can be responsible for widespread structural failure.

Per seismic hazard zone maps prepared by the California Department of Conservation, Geological Survey, the project site is located within a seismic hazard zone for liquefaction (CSF, 2005). In accordance with the Seismic Hazard Mapping Act (discussed under Regulatory Framework), a site-specific geotechnical investigation must be conducted for sites within a seismic hazard zone prior to development. At the time of this EIR, a site-specific geotechnical study has not been prepared.

Earthquake-Induced Settlement

Settlement of the ground surface can be accelerated and accentuated by earthquakes. During an earthquake, settlement can occur as a result of the relatively rapid compaction and settling of subsurface materials (particularly loose, noncompacted, and variable sandy sediments) due to the rearrangement of soil particles during prolonged ground shaking. Settlement can occur both uniformly and differentially (i.e., where adjoining areas settle at different rates). Areas are susceptible to differential settlement if underlain by compressible sediments, such as poorly engineered artificial fill. Given the geologic setting of the region, the project area could be subjected to earthquake-induced settlement.

Regulatory Framework

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (formerly the Alquist-Priolo Special Studies Zone Act), signed into law December 1972, requires the delineation of zones along active faults in California. The Alquist-Priolo Act regulates development on or near active fault traces to

7 A probabilistic seismic hazard map shows the predicted level of hazard from earthquakes that seismologists and geologists believe could occur. The map's analysis takes into consideration uncertainties in the size and location of earthquakes and the resulting ground motions that can affect a particular site. The maps are typically expressed in terms of probability of exceeding a certain ground motion. These maps depict a 10% probability of being exceeded in 50 years. There is a 90% chance that these ground motions will NOT be exceeded. This probability level allows engineers to design buildings for larger ground motions that seismologists think will occur during a 50-year interval, making buildings safer than if there were only designed for the ground motions that are expected to occur in the 50 years. Seismic shaking maps are prepared using consensus information on historical earthquakes and faults. These levels of ground shaking are used primarily for formulating building codes and for designing buildings.

reduce the hazard of fault rupture and to prohibit the location of most structures for human occupancy across these traces.[8] Cities and counties must regulate certain development projects within the delineated zones, and regulations include withholding permits until geologic investigations demonstrate that development sites are not threatened by future surface displacement (Hart, 1997). Surface fault rupture, however, is not necessarily restricted to the area within an Alquist-Priolo Zone.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act was developed to protect the public from the effects of strong ground shaking, liquefaction, landslides, or other ground failure, and from other hazards caused by earthquakes. This act requires the State Geologist to delineate various seismic hazard zones and requires cities, counties, and other local permitting agencies to regulate certain development projects within these zones. Before a development permit is granted for a site within a Seismic Hazard Zone, a geotechnical investigation of the site must be conducted and appropriate mitigation measures incorporated into the project design. The project area containing sites for new construction are not located within a Seismic Hazard Zone for liquefaction or landslides, as designated by the California Geological Survey (CGS, 2005).

California Building Code

The California Building Code is contained in Title 24 of the California Code of Regulations (CCR), Title 24, Part 2, which is a portion of the California Building Standards Code (CBSC, 2005). Title 24 is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. Under state law, all building codes must be centralized in Title 24 or they are not enforceable.

Published by the International Conference of Building Officials (ICBO), the Uniform Building Code is a widely adopted model building code in the United States. The California Building Code incorporates by reference the 1997 Uniform Building Code (UBC) with necessary California amendments. These amendments include significant building design criteria that have been tailored for California earthquake conditions (CBSC, 2001).

The project site is located within Seismic Zone 4. Of the four seismic zones, Zone 4 is expected to experience the greatest effects from earthquake groundshaking and therefore has the most stringent requirements for seismic design. The national model code standards adopted into Title 24 apply to all occupancies in California except for modifications adopted by state agencies and local governing bodies.

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8 A “structure for human occupancy” is defined by the Alquist-Priolo Act as any structure used or intended for supporting or sheltering any use or occupancy that has an occupancy rate of more than 2,000 person-hours per year.

City of Oakland Regulations

Ordinances and Oakland Municipal Code

The City of Oakland implements the following regulations and ordinances aimed at reducing soil erosion and protecting water quality and water resources:

The City's Grading Ordinance (Ordinance No. 10312 is intended to reduce erosion during grading and construction activities. Pursuant to this ordinance, Chapter 13.16 of the Oakland Municipal Code requires that a project applicant obtain grading permits for earth moving activities under specified conditions of 1) volume of earth to be moved, 2) slope characteristics, 3) areas where "land disturbance" or 4) stability problems have been reported. To obtain a grading permit, the project applicant must prepare and submit to the Public Works Agency a soils report, a grading plan, and an erosion and sedimentation control plan for approval. (Oakland, 2004a)

The City also implements the Sedimentation and Erosion Control Ordinance (Ordinance No. 10446) also aimed at reducing erosion during construction and operations. Pursuant to this ordinance, Chapter 3304.2 of the Oakland Municipal Code requires any person who performs grading, clearing, and grubbing or other activities that disturb the existing soil to take appropriate preventative measures to 1) control erosion; 2) prevent sedimentation of eroded materials onto adjacent lands, public streets, or rights-of-way; and 3) prevent of the flow of eroded materials to any water course, by any route. (Oakland, 2004b)

Building Services Division

In addition to compliance with building standards set forth by the 1997 UBC, the project applicant will be required to submit to the Oakland Building Services Division an engineering analysis accompanied by detailed engineering drawings for review and approval prior to excavation, grading, or construction activities on the project site. Specifically, an engineering analysis report and drawings of relevant grading or construction activities on a project site would be required to address constraints and incorporate recommendations identified in geotechnical investigations. These required submittals and City reviews ensure that the buildings are designed and constructed in conformance with the seismic and other requirements of all applicable building code regulations, pursuant to standard City of Oakland procedures.

Impacts and Mitigation Measures

Significance Criteria

The project would have a significant geologic or seismic impact if it would:

1. Expose people or structures to geologic hazards, soils, and/or seismic conditions so unfavorable that they could not be overcome by special design using reasonable construction and maintenance practices. Specifically,

   – Expose people or structures to substantial risk of loss, injury, or death involving:

a Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map or Seismic Hazards Map issued by the State Geologist for the area or based on other substantial evidence of a known fault (refer to Division of Mines and Geology Special Publications 42 and 117 and PRC §2690 et. seq.);

b Strong seismic ground shaking;

c Seismic-related ground failure, including liquefaction, lateral spreading, subsidence, collapse; or

d Landslides;

2. Result in substantial soil erosion or loss of topsoil, creating substantial risks to life, property, or creeks/waterways;

3. Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994, as it may be revised), creating substantial risks to life or property;

4. Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or offsite landslide, lateral spreading, subsidence, liquefaction or collapse;

5. Be located above a well, pit, swamp, mound, tank vault, or unmarked sewer line, creating substantial risks to life or property;

6. Be located above landfills for which there is no approved closure and post-closure plan, or unknown fill soils, creating substantial risks to life or property; or

7. Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

Geology, Soils and Seismicity Impacts

Approach to Analysis

This impact analysis focused on potential effects on geology, soils, and seismicity associated with implementation of the proposed project. The evaluation was based on review of project plans, published geologic, soils, and seismic maps and studies, and applicable regulations and guidelines.

Seismic Hazards

Impact GEO-1: Redevelopment in the project area could expose people or structures to seismic hazards such as groundshaking or liquefaction. (Less than Significant).

The proposed project is located in the San Francisco Bay Area, a region of intense seismic activity. Recent studies by the United States Geological Survey (USGS) indicate there is a 62 percent likelihood of a Richter magnitude 6.7 or higher earthquake occurring in the Bay Area before 2032. The Hayward Fault Zone, the active fault nearest the project site, is the most likely of the active Bay Area faults to experience a major earthquake. In the event of an earthquake on the nearby Hayward Fault, the project site would experience violent ground shaking. Seismic shaking can also trigger ground-failures caused by liquefaction.[9] The project site is located in a Seismic Hazard Zone for liquefaction, as designated by the CGS (CGS, 2003).

In accordance with City of Oakland requirements, the Project Sponsor would be required to prepare a geotechnical report for the project that includes generally accepted and appropriate engineering techniques for determining the susceptibility of the project site to various geologic and seismic hazards. The geotechnical report would include an analysis of ground shaking effects, liquefaction potential, and provide recommendations to reduce these hazards. Because the project site is within a Seismic Hazard Zone for liquefaction, recommendations for the mitigation and reduction of liquefaction would be prepared in accordance with CGS Guidelines for Evaluating and Mitigating Seismic Hazards (CDMG Special Publication 117, 1997). Geotechnical and seismic design criteria would conform to engineering recommendations consistent with the seismic requirements of Zone 4 of the 1994 or 1997 Uniform Building Code (UBC), and the California Building Code (Title 24) additions.

In addition to compliance with building standards set forth by the 1997 UBC, the project sponsor would be required to submit an engineering analysis accompanied by detailed engineering drawings to the City of Oakland Building Services Division prior to excavation, grading, or construction activities on the project site. This is consistent with standard City of Oakland practices to ensure that all buildings are designed and built in conformance with the seismic requirements of the City of Oakland Building Code. An engineering analysis report and drawings and relevant grading or construction activities on a project site would be required to address constraints and incorporate recommendations identified in geotechnical investigations. These required submittals ensure that the buildings are designed and constructed in conformance with the requirements of all applicable building code regulations, pursuant to standard City procedures. Standard Condition J.1, below, would ensure that the project conforms to all applicable building code regulations.

Standard Condition GEO-1: A site-specific, design level geotechnical investigation for each construction site within the project area (which is typical for any large, phased development project) shall be required as part of this project.

Specifically:

- Each investigation shall include an analysis of expected ground motions at the site from known active faults. The analyses shall be in accordance with applicable City ordinances and policies and consistent with the most recent version of the California Building Code, which requires structural design that can accommodate ground accelerations expected from known active faults.

[9] Liquefaction is the process by which saturated, loose, fine-grained, granular, soil, like sand, behaves like a dense fluid when subjected to prolonged shaking during an earthquake.

- The investigations shall determine final design parameters for the walls, foundations, foundation slabs, and surrounding related improvements (utilities, roadways, parking lots and sidewalks).

- The investigations shall be reviewed and approved by a registered geotechnical engineer. All recommendations by the project engineer and geotechnical engineer will be included in the final design.

- Recommendations that are applicable to foundation design, earthwork, and site preparation that were prepared prior to or during the project design phase, shall be incorporated in the project.

- Final seismic considerations for the site shall be submitted to and approved by the City of Oakland Building Services Division prior to the commencement of the project.

Mitigation: None Required.

Impact GEO-2: Redevelopment in the project area could expose people or structures to surface fault rupture. (Less than Significant).

The project site is not located in an Alquist-Priolo Earthquake Fault Zone, and no active or potentially active faults exist on or in the immediate vicinity of the site. Although surface fault rupture is not necessarily restricted to the area within an Alquist-Priolo Earthquake Fault Zone, the potential risk of surface rupture is highest along active faults. Thus, project impacts related to surface fault rupture would be less than significant.

Mitigation: None Required.

Geologic Hazards

Impact GEO-3: Redevelopment in the project area could be subjected to geologic hazards, including expansive soils, differential settlement, and erosion. (Less than Significant).

Soils containing a high percentage of clays are generally most susceptible to expansion. Expansive soils can damage foundations of above-ground structures, paved roads and streets, and concrete slabs. Expansive soils are common in low-lying alluvial valleys and along the shoreline of the San Francisco Bay. As previously discussed, Clear Lake soils are mapped on the project site and typically exhibit strong expansive (shrink-swell) properties.

If not properly engineered, mud and loose fine-grained sediments (clay and silt) can settle after a building or other load is placed on the surface. According to the Soil Survey of Alameda County, Western Part, site soils have a high potential for differential settlement. Settlement would be a concern in areas that have not previously supported structures and where new structures would place loads heavier than the soils could tolerate.

Although the Urban-land Clear Lake complex is not highly susceptible to erosion, urban land soils are highly variable in composition, and soil properties cannot be determined without site-specific investigation. Soil exposed by demolition, grading, and construction activities could be subject to erosion if subject to heavy winds or rain.

The City of Oakland requires preparation of a geotechnical report, as well as compliance with and implementation of the geotechnical report recommendations. Compliance with the geotechnical report recommendations, required as part of Standard Condition GEO.1, above, would reduce the potential for the project to result in geological hazards such as soil expansion, differential settlement, and erosion. Furthermore, compliance with Standard Conditions I.1a through I.1e, which is discussed in Section IV.I, Hydrology and Water Quality, would reduce the potential for substantial soil erosion or loss of topsoil during grading and construction activities to less than significant level.

Mitigation: None Required.

Cumulative Impacts

Cumulative Context

As discussed above, the project would not result in potentially significant project-level impacts related to potentially hazardous geologic and seismic conditions. Although the entire Bay Area is within a seismically active region with a wide range of geologic and soil conditions, these conditions can vary widely within a short distance, making the cumulative context for potential impacts resulting from exposing people and structures to related risks one that is more localized or even site-specific.

Cumulative Impacts on Geology, Soils, and Seismicity

Impact GEO-4: The development proposed as part of the project, when combined with other reasonably foreseeable development in the vicinity, would not result in significant cumulative impacts with respect to geology, soils or seismicity. (Less than Significant)

Development of the project, with implementation of the Standard Conditions of Approval discussed above, would have less than significant impacts related to exposing persons or structures to geologic, soils, or seismic hazards. The project, combined with other foreseeable development in the area, could result in increased population and development in an area subjected to seismic risks and hazards. While the number of people visiting, living and working in the area will increase incrementally, exposing additional people to seismic and geological hazards over a short term, the risk to people and property would be reduced through the upgrading or demolishing of older buildings that are seismically unsafe. Older buildings would be seismically retrofitted and newer buildings will be constructed to stricter building codes. Thus, implementation of the proposed project and other foreseeable projects in the area would be required to implement applicable Standard Conditions of Approval related to geology, soils, and seismicity and would be required to adhere to all federal, state, and local programs, requirements and policies pertaining to building safety and construction permitting. All projects would be required to adhere to adhere to the City's Building Code and grading ordinance. Therefore, the project, combined with other foreseeable development in the area, would not result in a cumulatively significant impact by exposing people or structures to risk related to geologic hazards, soils, and/or seismic conditions.

Mitigation: None Required.

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