N. GEOLOGY, SOILS, AND SEISMICITY

This section describes the geology, soils, and seismicity characteristics of the project area as they relate to the proposed project. This analysis is based on a *Geotechnical Feasibility Assessment* (Geotechnical Assessment) conducted by Treadwell & Rollo on September 8, 2008.[1] The scope of the report consisted of reviewing existing data presented on foundation plans for the existing buildings, as well as reviewing the geotechnical data collected during a previous investigation at the site for past improvements to the hotel's Tonga Room.[2] Geologic maps and reports available from the City and County of San Francisco, the California Geological Survey (CGS; formerly California Division of Mines and Geology), as well as the Association of Bay Area Governments (ABAG) were evaluated as part of this report. This section assesses potential project impacts related to strong ground shaking, liquefaction, differential settlement, and unstable or expansive soils.

SETTING

GEOLOGIC SETTING

The project site is located within the Coast Ranges geomorphic province, a relatively young geologically and seismically-active region on the western margin of the North American plate. In general, the Coast Ranges comprise a series of discontinuous northwest-southeast trending mountain ranges, valleys, and ridges.[3] San Francisco rests on a foundation of Franciscan formation bedrock in a northwest-trending band that cuts diagonally across the city. This geologic formation known as the Franciscan Formation is composed of many different types of rock including greywacke, shale, greenstone (altered volcanic rock), basalt, chert (ancient silica-rich ocean deposits), and sandstone that originated as ancient sea floor sediments.[4] The project site is underlain by the Franciscan Formation of Cretaceous Age, described as a chaotic mixture of fragmented rock.[5]

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1 Treadwell & Rollo, 2008, *Geotechnical Feasibility Assessment for Fairmont Hotel*, September 8. This document is available for review at the Planning Department, 1650 Mission Street, Suite 400, as part of Case No. 2008.0081E.

2 Treadwell & Rollo, 1999, *Geotechnical Investigation, Fairmont Hotel, San Francisco, CA*, July 2. This document is available for review at the Planning Department, 1650 Mission Street, Suite 400, as part of Case No. 2008.0081E.

3 California Geographic Survey (CGS), 2002, California Geomorphic Provinces, Note 36.

4 Ibid.

5 ATC Associates Inc., 2006, *Phase I Environmental Site Assessment*, September 21. This document is available for review at the Planning Department, 1650 Mission Street, Suite 400, as part of Case No. 2008.0081E, p.9.

The Fairmont Hotel complex is situated along an east-west ridge on the eastern flank of Nob Hill. The project site occupies a portion of the top of Nob Hill and slopes downward toward the east at a grade of 12 percent along California Street and 17 percent along Sacramento Street. Mason Street adjacent to the project site to the west is relatively flat; however, Powell Street slopes towards the south at a grade of 5 to 10 percent where it is adjacent to the site to the east. According to a USGS topographic map, the project site is located at an elevation of approximately 200 feet above mean sea level.[6]

Surface soils typically exhibit various characteristics dependent on location, slope, parent rock, climate, and drainage. According to the *Soil Survey of San Mateo County, Eastern Part, and San Francisco County, California* (1991), urban land consists of areas that are completely covered by asphalt, concrete, buildings, and other structures. The soil type in the project area is identified as Urban-land-Orthents The Urban-land-Orthents soil unit consists of very deep and poorly drained soils that have been filled, and are composed of gravel, broken cement and asphalt, bay mud, and solid waste material. Additionally, included in the Urban-land-Orthents soil unit are small areas of Novato clay, Reyes clay, and Orthents (soils which exhibit a lack of horizon development due to a lack of weatherable minerals in their parent material or, in the case of the project site, steep slopes), all of which make up approximately five percent of the total acreage.[7]

The site-specific Geotechnical Assessment notes that the portion of the site to be redeveloped is blanketed by about four to ten feet of fill over one to three feet of native clay or sandy clay. The fill consists predominantly of loose to medium-dense sand and the native clay is medium stiff to stiff. Bedrock, consisting of deeply weathered sandstone of low hardness with occasional interbedded shale, underlies the native soil and generally slopes down from southwest to northeast. Bedrock was observed at about Elevation 249 feet at the western extent of the Tonga Room and at Elevation 187.5 feet near the southwest corner of Sacramento and Powell Streets.[8]

According to the Phase I ESA[9] prepared for the Fairmont Hotel, estimated groundwater levels are from 60 to 70 feet below ground surface (bgs), with shallow groundwater flow expected to follow the slope of the surface elevation towards the east. The site-specific Geotechnical Assessment,[10] conducted for the proposed project, noted that groundwater was not encountered in borings up to depths of 249 feet bgs;

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6 ATC Associates, Inc., 2006, p.9.
7 Ibid, p. 9.
8 Treadwell & Rollo, 2008, op. cit., p.2.
9 ATC Associates, Inc., 2006, op. cit., p.9.
10 Treadwell & Rollo, 2008, op. cit., p. 2.

however, it is likely that groundwater is present at the soil-bedrock interface (Elevation 249 feet at the western extent of the Tonga Room and Elevation 187.5 feet at the southwestern corner of the intersection of Sacramento Street and Powell Street), and in seams and fractures in the rock.[11] The depth to groundwater on site may vary due to seasonal precipitation and infiltration rates.

According to the soil type and earthquake shaking hazard map for the San Francisco Bay Area, which illustrates a rough estimate of surface geology, the project site soil is characterized as soil type A (the most stable classification of rock or soil) or B (rock or soil less stable than type A). Soil types A and B are not expected to contribute greatly to shaking amplification in the event of an earthquake.[12]

GEOLOGIC HAZARDS

Subsidence

Land subsidence is the loss of surface elevation due to the removal of subsurface support. Land subsidence is typically caused by compression of soft, geologically young sediments or activities related to fluid extraction (e.g., groundwater or petroleum), such as agricultural practices or the overdraft of an aquifer for municipal uses. Subsurface exploration at the project site did not reveal soft, compressible sediment, which would be susceptible to subsidence.[13] San Francisco does not pump groundwater from within City limits and no petroleum wells are located within the City. Additionally, no supply wells are known to exist or were observed in vicinity of the project site. Thus, subsidence is not a hazard at the project site.

Expansive Soils

Expansive soils are those that shrink or swell substantially with changes in moisture content and generally contain a high percentage of clay particles. Expansive soils can occur in any climate; however, arid and semi-arid regions and those with distinct wet and dry seasons, such as San Francisco experiences, are subject to more extreme cycles of expansion and contraction than more consistently moist areas. Structural damage to buildings can occur over a long period of time, usually as a result of inadequate soil and foundation engineering or the placement of structures directly on expansive soils. San Francisco is located within a geological area where less than 50 percent of the soil consists of clay having high swelling potential. The site specific Geotechnical Assessment determined that there was a one- to three-

[11] Ibid, p. 2.

[12] U.S. Geological Survey (USGS), 2009, *Soil Type and Shaking Hazard in the San Francisco Bay Area* Interactive map. Available at: http://earthquake.usgs.gov/regional/nca/soiltype/

[13] Treadwell & Rollo, 2008, op. cit., p. 2.

foot layer of clay in the soil beneath the project site with a low expansion potential.[14,15,16] Therefore, expansive soil hazards are low for the site.

Collapse

Soil collapse occurs when sediment moisture content is substantially increased leading to the densification of the soil. Typical causes of soil collapse include infiltration resulting from poor surface drainage, irrigation water, or leaking pipes into low density, silty, sandy soil in semi-arid and arid climates that are not regularly subjected to saturation. The soil beneath the project site was determined to be loose to medium-dense sandy fills and medium-stiff to stiff clays overlying bedrock. The density of the soil beneath the site does not indicate susceptibility to collapse and accordingly, the risk of collapse at the site is considered low.

Soil Erosion

Erosion is the wearing away of soil and rock by processes such as mechanical or chemical weathering, mass wasting, the action of waves, wind, and underground water. Excessive soil erosion can eventually lead to damage of building foundations and roadways. Construction activities such as grading and excavation can remove stabilizing vegetation or cover materials (such as asphalt and cement) and expose areas of loose soil that, if not properly stabilized, can be subject to soil loss and erosion by wind and stormwater runoff. Newly constructed and compacted engineered slopes can also undergo substantial erosion through dispersed sheet flow runoff (a wide runoff area created to encourage runoff to occur over a large area and avoid concentrated linear flows), and more concentrated linear runoff can result in the formation of erosional channels and larger gullies, each compromising the integrity of the slope and resulting in substantial soil loss. The project site is almost entirely paved or developed with buildings such that current soil erosion hazard is negligible. Removal of the cover could expose the underlying soil to erosion.

SEISMIC SETTING

An earthquake can be classified by the quantitative amount of energy released or the qualitative intensity of its effects on the surface. Quantified releases of energy are directly related to the amount and size of slip along a fault. The amount of energy released during a seismic event has traditionally been quantified

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[14] W.W. Olive, A.F. Chleborad, C.W. Frahme, Julius Schlocker, R.R. Schneider, and R.L Shuster; United States Geological Survey publication, 1989, *Swelling Clays Map of the Conterminous United States, Soils of California*, 1989.

[15] Treadwell & Rollo, 2008, op. cit., p.2.

[16] Treadwell & Rollo, 1999, p. 7.

using the Richter scale. Recently, seismologists have begun using a moment magnitude (Mw) scale, developed in 1979, because it provides a more accurate measurement of the size of major and great earthquakes. For earthquakes of less than Mw 7.0, the moment magnitude and Richter magnitude scales are nearly identical. For earthquake magnitudes greater than Mw 7.0, readings on the moment magnitude scale are slightly greater than a corresponding Richter magnitude.[17]

The project site, like the entire Bay Area, lies within an area that contains many active and potentially active faults and is considered to be an area of high seismic activity.[18] The USGS Working Group on California Earthquake Probabilities evaluated the probability of one or more earthquakes of Mw 6.7 or higher occurring in the San Francisco Bay Area within the next 30 years.[19] 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.[20] Ground movement during an earthquake can vary depending on the overall magnitude, 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. For this reason, earthquake intensities are also measured in terms of their observed effects at a given locality. The Modified Mercalli Intensity (MMI) Scale is commonly used to measure earthquake damage due to ground shaking. The MMI values for intensity range from I (earthquake not felt) to XII (damage nearly total), and earthquake will vary over the region of a fault and generally decrease with distance from the epicenter of the earthquake.

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[17] Southern California Seismic Network (SCSN), 2006, *Magnitude Determination*, Available at: http://www.scsn.org/magnitude.html

[18] An "active" fault is defined by the State of California as a fault that has had surface displacement within Holocene time (approximately the last 11,000 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, E. W., Fault-Rupture Hazard Zones in California: Alquist-Priolo Special Studies Zones Act of 1972 with Index to Special Studies Zones Maps, California Division of Mines and Geology, Special Publication 42, 1990, revised and updated 1997).

[19] United States Geological Survey (USGS) Working Group on California Earthquake Probabilities (WG02), 2003, Open File Report 03-214, *Earthquake Probabilities in the San Francisco Bay Region: 2002-2031,* Available at: http://pubs.usgs.gov/of/2003/of03-214/. Richter magnitude is a measure of the size of an earthquake as recorded by a seismograph. Richter magnitudes vary logarithmically, with each whole number step representing a ten-fold increase in the amplitude of the recorded seismic waves. Earthquake magnitudes are also measured by their moment magnitude which is related to the physical characteristics of a fault including the rigidity of the rock, the size of fault rupture, and movement or displacement across a fault.

[20] United States Geological Survey (USGS) Working Group on California Earthquake Probabilities, 2007, Fact Sheet 2007-3027, *Forecasting California's Earthquakes; What Can We Expect in the Next 30 Years?,* Available at: http://pubs.usgs.gov/fs/2008/3027/fs2008-3027.pdf, p. 1.

The San Francisco Bay Area is characterized by numerous geologically young faults. These faults can be classified as historically active, active, sufficiently active, or inactive, as defined below:

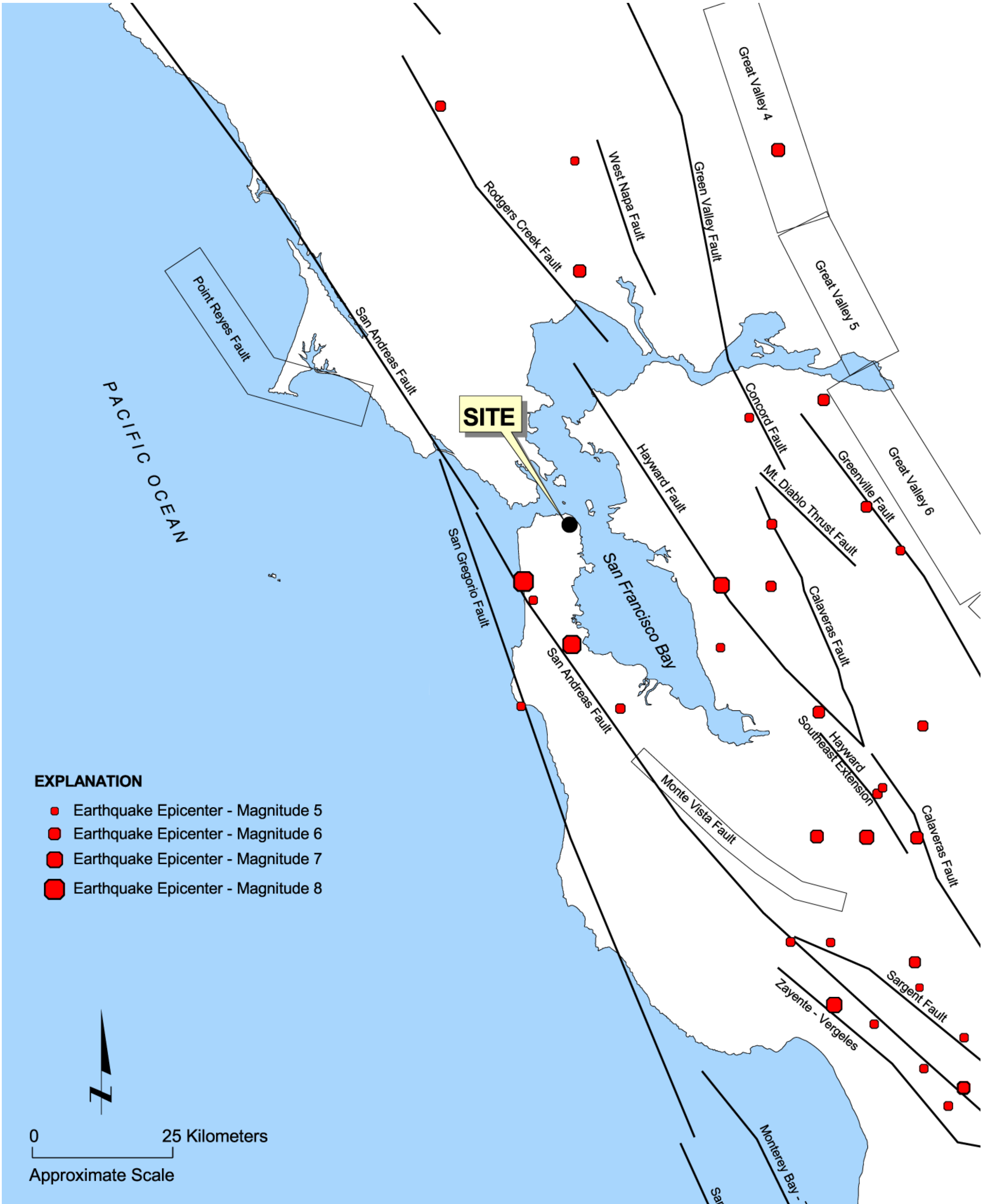
- Faults that have generated earthquakes accompanied by surface rupture during historic time (approximately the last 200 years) and faults that exhibit a seismic fault creep (movement along a fault that does not entail earthquake activity) are defined as historically active;
- Faults that show geologic evidence of movement within Holocene time (approximately the last 11,000 years) are defined as active;
- Faults that show geologic evidence of movement during the Holocene along one or more of its segments or branches and whose trace may be identified by direct or indirect methods are defined as sufficiently active and well-defined; and
- Faults that show direct geologic evidence of inactivity during all of Quaternary time or longer are classified as inactive.

Although it is difficult to quantify the probability that an earthquake will occur on a specific fault, this classification is based on the assumption that if a fault has moved during the last 11,000 years, it is likely to produce earthquakes in the future. The San Andreas, Hayward, and Calaveras faults pose the greatest threat of substantial damage in the Bay Area according to the USGS Working Group.[21] These faults are discussed further below and are shown on **Figure IV.N-1: Map of Major Faults and Earthquake Epicenters in the San Francisco Bay Area**, along with other faults of the region. For each active fault within 50 kilometers (30 miles) of the site, the distance from the site and estimated mean characteristic moment magnitude are summarized in **Table IV.N-1, Regional Faults and Seismicity**.[22]

[21] USGS, 2007, op. cit., p.4.

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

Figure IV.N-1
Map of Major Faults and Earthquake Epicenters in the San Francisco Bay Area



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

Source: Treadwell & Rollo, 2008.

Table IV.N-1
Regional Faults and Seismicity

Fault Segment	Approx. Distance of Project Site from Fault (miles)	Direction from Site	Mean Characteristic Moment Magnitude
San Andreas – 1906 Rupture	7	West	7.9
San Andreas – Peninsula	7	West	7.2
San Andreas – North Coast South	8	West	7.5
North Hayward	10	East	6.5
Total Hayward	10	East	6.9
Total Hayward-Rodgers Creek	10	East	7.3
South Hayward	11	East	6.7
Northern San Gregorio	11	West	7.2
Total San Gregorio	11	West	7.4
Rodgers Creek	20	North	7.0
Mt. Diablo – MTD	21	East	6.7
Total Calaveras	22	East	6.9
Concord/Green Valley	24	East	6.7
Point Reyes	25	West	6.8
Monte Vista – Shannon	26	Southwest	6.8
West Napa	27	Northeast	6.5

Source: Treadwell & Rollo, 2008, *Geotechnical Feasibility Assessment for Fairmont Hotel*, September 8, p.3.

San Andreas Fault

The San Andreas fault zone is a major structural feature located at the boundary between the North American and Pacific tectonic plates. It extends from the Salton Sea in Southern California near the border with Mexico to north of Point Arena, where the fault trace extends out into the Pacific Ocean. The main trace of the San Andreas fault runs through the Bay Area and trends northwest through the Santa Cruz Mountains along the western side of the San Francisco Peninsula. As the principal fault boundary between the Pacific plate to the west and the North American plate to the east, the San Andreas fault is often a highly visible topographic feature, such as between Pacifica and San Mateo Counties, where Crystal Springs Reservoir and San Andreas Lake clearly overlie the rupture zone. Near San Francisco, the San Andreas fault trace is located immediately offshore near Daly City and continues northwest through the Pacific Ocean approximately six miles due west of the Golden Gate Bridge.[23] No trace of the San Andreas fault is located within San Francisco urban areas. The San Andreas fault is considered active and was the source of the 1906 earthquake that destroyed and damaged widespread parts of San Francisco and led to the Great Fire that destroyed most of Nob Hill. The original Fairmont Hotel was all but completely destroyed by the fire.

San Gregorio

The San Gregorio fault is the northernmost of a 250-mile-long set of coastal faults lying southwest of the main trace of the San Andreas fault. The fault extends northward from Monterey Bay, joining the San Andreas fault about 12 miles northwest of San Francisco, near Bolinas Bay. The San Gregorio fault zone is mainly located offshore, west of San Francisco Bay and Monterey Bay, with a few onshore locations.[24] The fault zone is considered active with the most recent deformation occurring in the latest Quaternary period[25] and a yearly slip rate of greater than 5.0 millimeters.[26]

Hayward Fault

The Hayward fault zone is the southern extension of a fracture zone that includes the Rodgers Creek fault (north of San Pablo Bay), the Healdsburg fault (Sonoma County), and the Maacama fault (Mendocino County). The Hayward fault trends to the northwest within the East Bay, extending from San Pablo Bay in Richmond, 60 miles south to east San José. The Hayward fault in San José converges with the Calaveras fault, a similar type fault that extends north through the East Bay to Suisun Bay. The Hayward fault is designated by the Alquist-Priolo Earthquake Fault Zoning Act as an active fault. A characteristic feature of the Hayward fault is that it is well-expressed and has relatively consistent fault creep (slow continuous displacement along a fault as opposed to the rapid displacement which occurs during a large earthquake). Although large earthquakes on the Hayward fault have been rare since 1868, slow fault creep has continued to occur and has caused measurable displacement. Fault creep on the East Bay segment of

[23] United States Geological Society (USGS), 1997, *The San Andreas Fault,* Available at: http://pubs.usgs.gov/gip/earthq3/contents.html.

[24] United States Geological Society (USGS), 1990, *The San Andreas Fault System, California, USGS Professional Paper 1515*, p. 89.

[25] Quaternary Period is the most recent 2.6 million years in Earth's history. National Geographic, *Prehistoric Facts*, Available at: http://science.nationalgeographic.com/science/prehistoric-world/quaternary.html, Accessed: November 23, 2009.

[26] Bryant, W.A., and Cluett, S.E., compilers, 1999, Fault number 60a, San Gregorio fault zone, San Gregorio section, in Quaternary fault and fold database of the United States: Available at: http://earthquakes.usgs.gov/regional/qfaults, Accessed: May 11, 2009.

the Hayward fault is estimated at 9 millimeters per year.[27] However, a large earthquake could occur on the Hayward fault with an estimated moment magnitude of about Mw 7.1. The USGS Working Group on California Earthquake Probabilities includes the Hayward–Rodgers Creek Fault Systems in the list of faults that have the highest probability of generating earthquakes of magnitude Mw 6.7 or greater in the Bay Area.[28]

Calaveras Fault

The Calaveras fault is a major right-lateral, strike-slip fault that has been active during the last 11,000 years. The Calaveras fault is located in the eastern San Francisco Bay region and generally trends along the eastern side of the East Bay Hills, west of San Ramon Valley, and extends into the western Diablo Range, and eventually joins the San Andreas fa ult zone south of Hollister. The northern extent of the fault zone could be linked with the Concord fault. The Calaveras fault has been the source of numerous moderate magnitude earthquakes and the probability of a large earthquake (greater than Mw 6.7) is much lower than on the San Andreas or Hayward faults.[29] However, this fault is considered capable of generating earthquakes with upper bound magnitudes ranging from Mw 6.6 to Mw 6.8.

SEISMIC HAZARDS

Seismic hazards include those hazards that could reasonably be expected to occur at the project site during a major earthquake on any of the active faults in the region. Some hazards can be more severe than others, depending on the location, underlying materials, and level of ground shaking. Strong shaking during an earthquake can result in ground failure associated with fault rupture, seismically-induced landslides, liquefaction, lateral spreading, and settlement.

Ground Shaking

Ground shaking is a general term referring to all aspects of motion of the earth's surface resulting from an earthquake, and is normally the major cause of damage in seismic events. The extent of ground shaking is controlled by the magnitude and intensity of the earthquake, distance from the epicenter, and local geologic conditions. An earthquake on any one of the active faults mentioned earlier could potentially

[27] Peterson, M.D., Bryant, W.A., Cramer, C.H., 1996, *Probabilistic Seismic Hazard Assessment for the State of California*, California Division of Mines and Geology Open-File Report issued jointly with U.S. Geological Survey, CDMG 96-08 and USGS 96- 706, Available at: http://www.consrv.ca.gov/cgs/rghm/psha/ofr9608/Pages/index.aspx, Accessed: December 8, 2009.

[28] See footnote 19.

[29] See footnote 9.

produce a range of ground shaking intensities that could affect the site during the life of the project. Ground shaking may affect areas hundreds of miles distant from the earthquake's epicenter.

In order to quantify the estimated ground shaking that would occur at a specific location, seismic hazard analyses are conducted. Seismic hazard analyses can be deterministic when a particular earthquake scenario is assumed or probabilistic when uncertainties in earthquake size, location, and time of occurrence exist. Because the location, recurrence interval, and magnitude of future earthquakes are not known, probabilistic seismic hazard analyses are conducted to identify a uniform site-specific hazard in terms of a probability that a particular level of ground shaking will be exceeded during the life of a project. The analyses are based on the seismicity, location, and geometry of each source, along with empirical relationships that describe the rate and attenuation of strong ground motion with increasing distance from the source. The probabilistic approach offers a rational framework for risk management by taking account of the frequency, or probability of exceedance, of the ground motion against which a structure or facility is designed. Deterministic seismic hazard analysis uses the site-specific geology and seismic history of known regional faults to graphically determine the response spectrum during the strongest amount of ground motion a site would be estimated to experience resulting from the maximum magnitude earthquake regardless of time. The analyses are carried out to identify the Maximum Considered Earthquake (MCE), which is the maximum level of ground shaking estimated for a specific site. The MCE is used with site-specific response spectra and soil conditions to create design guidelines used to design a structure that will resist the maximum level of ground shaking expected for a particular site.

Like the entire Bay Area, the project site is subject to ground shaking in the event of an earthquake on the regional faults. During a major earthquake on a segment of one of the nearby faults, "strong" to "very strong" shaking is expected to occur at the site.[30] The *San Francisco General Plan* Community Safety Element contains maps that show areas of the City subject to geologic hazards (Maps 2 and 3 of the Community Safety Element).[31] The project site is located in an area subject to "strong" to "very strong" ground shaking (MMI VII to VIII) from earthquakes along the Peninsula segment of the San Andreas

[30] Treadwell & Rollo, 2008, op. cit., p.5.

[31] Continued research has resulted in revisions to ABAG's earthquake hazard maps. Based on the 1995 ABAG report, an earthquake on these faults could result in "moderate" and "nonstructural" damage, respectively, in the project vicinity. However, ABAG notes. "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." For this reason, ABAG currently produces Shaking Hazard Maps that depict intensity of ground shaking, rather than estimated damage. Information regarding revised data for Maps 2 and 3 of the Community Safety Element are available on ABAG website. Available at: http://www.abag.ca.gov/bayarea/eqmaps/mapsba.html, Accessed: January 2009.

fault, and "moderate" to "strong" ground shaking (MMI VI to VII) from the Northern segment of the Hayward fault.[32]

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 (referenced in Table IV.N-1). The closest active faults to the site are the San Andreas fault, approximately seven miles west of the project site, the Hayward fault, approximately 11 miles east of the project site, and the San Gregorio fault, approximately 11 miles west of the project site.[33]

No Fault Rupture Hazard Zones are located within the City and County of San Francisco.[34] Accordingly, the project site is not in an Alquist-Priolo Earthquake Fault Zone, and no known active fault exists on the project site. The potential for surface fault rupture at the site is thus extremely low.[35]

Landsliding

Slope failures, commonly referred to as landslides, include many phenomena that involve the downslope displacement and movement of material, either triggered by static (i.e., gravity) or dynamic (i.e., earthquake) forces. A slope failure is a mass of rock, soil, and debris displaced downslope by sliding, flowing, or falling. Exposed rock slopes undergo rockfalls, rockslides, or rock avalanches, while soil slopes experience shallow soil slides, rapid debris flows, and deep-seated rotational slides. Slope stability depends on a number of complex variables, including the geology, structure, and amount of groundwater, as well as external processes such as climate, topography, slope geometry, and human activity. Landslides may occur on slopes of 15 percent or less; however, the probability is greater on steeper slopes that exhibit old landslide features such as scarps (steep slope caused by erosion), slanted trees, and transverse ridges. Landslide- susceptible areas are characterized by steep slopes and downslope creep of surface materials. Landslides occur throughout California, but the frequency of incidents increases in zones of active faulting and weak rock materials. The rate of rock and soil movement can vary from a slow creep over many years to a sudden mass movement.

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[32] Association of Bay Area Governments (ABAG), *ABAG Shaking Intensity Maps and Information*, *San Andreas and Hayward Fault Shaking Scenarios*, Available at: http://gis.abag.ca.gov/website/Shaking-Maps/viewer.htm, Accessed: January 2009.

[33] Ibid.

[34] California Geological Survey, 1997, *Fault Rupture Hazard Zones in California, Figure 4B, Index to Official Maps of Earthquake Fault Zones*, p.13.

[35] Treadwell & Rollo, 2008, op. cit., p. 5.

The site is not within an area where previous occurrence of landslide movement, or local topographic, geological, geotechnical, or subsurface water conditions indicate a potential for permanent ground displacements, as shown on the official State of California Seismic Hazards Zone Map for San Francisco.[36] However, designated Landslide Zones exist in the vicinity of the project site where previous occurrence of landslide movement, or local topographic, geological, geotechnical, and subsurface water conditions indicate a potential for permanent ground displacements. The project site is also shown to be within an area subject to potential landslide hazard, according to Map 5 of the *San Francisco General Plan* Community Safety Element.[37] No record exists of a prior landslide at the project site and the hazard likely is low.

Liquefaction

Liquefaction is the transformation of soil from a solid to a liquefied state during which saturated soil temporarily loses strength because of the buildup of excess pore water pressure, especially during the cyclic pressure experienced during an earthquake. Soils susceptible to liquefaction include saturated loose to medium-dense sands and gravels, low-plasticity silts, and some low-plasticity clay deposits. Liquefaction and associated failures could damage foundations, disrupt utility service, and damage roadways as occurred in the Marina District during the Loma Prieta earthquake. The project site is not within an area susceptible to liquefaction as mapped by the State of California[38] or the City and County of San Francisco.[39] Additionally, groundwater was not encountered at the project site to bedrock depth. Accordingly, the Geotechnical Assessment determined that the potential for liquefaction at the project site is low.[40]

Lateral Spreading

Lateral spreading is a form of ground lurching with a horizontal displacement of soil toward an open channel or other "free" face, such as an excavation boundary or a gentle slope. Lateral spreading can result from either the slump of low-cohesion, unconsolidated material or more commonly by liquefaction

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[36] California Geological Survey (formerly the Division of Mines and Geology), 2000, *State of California, Seismic Hazard Zones, City and County of San Francisco, Official Map*.

[37] City and County of San Francisco, 1974, *San Francisco General Plan, Community Safety Element: Map 5 Areas of potential landslide hazard*, Available at: http://www.sfgov.org/site/uploadedimages/planning/Codes/General_Plan/images/csa_Map5.gif

[38] California Geological Survey (formerly the Division of Mines and Geology), 2000, *State of California, Seismic Hazard Zones, City and County of San Francisco, Official Map*.

[39] City and County of San Francisco, 1997, *San Francisco General Plan, Community Safety Element: Map 4 Areas of liquefaction potential*, Available at: http://www.sfgov.org/site/uploadedimages/planning/Codes/General_Plan/images/csa_Map4.gif

[40] Treadwell & Rollo, 2008, op. cit., p. 5.

of either the soil layer or a subsurface layer underlying soil material on a slope. Lateral spreading hazards will mirror the liquefaction hazard for a given site. The potential for lateral spreading at the site was also determined to be low.[41]

Settlement/Cyclic Densification

Settlement, or cyclic densification, is a phenomenon in which non-saturated, cohesion-less soil is rapidly rearranged by earthquake vibrations, causing compaction. Settlement typically occurs in loose, uncompacted, and variable sandy sediments and can occur both uniformly and differentially (i.e., where adjoining areas settle at different rates). Damage to structures could occur if buildings or other improvements were built on low-strength foundation materials (including imported non-engineered fill) or if improvements straddle the boundary between different types of subsurface materials (e.g., a boundary between native material (Bay Mud), older, un-engineered fill and/or new engineered fill). Differential settlement is a hazard where soil materials are unequally distributed (e.g. un-engineered fill) of where a structure rests on different soil types that each settle differently. Although differential settlement generally occurs slowly enough that its effects are not dangerous to inhabitants, it can cause substantial building damage over time.

The Geotechnical Assessment encountered four to 10 feet of fill over one to three feet of native clay or sandy clay. Previous testing determined the settlement potential of the subsurface materials to be one-half to two inches in isolated areas of the site.[42]

REGULATORY SETTING

CALIFORNIA BUILDING CODE

The (2007) California Building Code (CBC) is another name for the body of regulations known as the California Code of Regulations, Title 24, Part 2, which is a portion of the California Building Standards Code. The seismic standards of the CBC require greater strength for essential facilities and for sites on soft soil where shaking intensity is increased. The CBC sets minimum requirements that ensure life safety but does not preclude earthquake damage and loss of function of structures. The CBC incorporates by reference the Uniform Building Code requirements with necessary California amendments. Title 24 is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating

[41] Treadwell & Rollo, 2008, op. cit., p. 5.
[42] Ibid, p. 5.

all building standards. Under State law, all building standards must be centralized in Title 24 or they are not enforceable.

ALQUIST-PRIOLO EARTHQUAKE FAULT ZONING ACT

Surface rupture is the most easily avoided seismic hazard. The Alquist-Priolo Earthquake Fault Zoning Act was passed in December 1972 to mitigate the hazard of surface faulting to structures intended for human occupancy. The Act's main purpose is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The Act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards (the Seismic Hazards Mapping Act, passed in 1990, addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides). The Act requires the State Geologist to establish regulatory zones, known as Earthquake Fault Zones, around the surface traces of active faults and to issue appropriate maps. The maps are distributed to all affected cities, counties, and state agencies for their use in planning and controlling new or renewed construction. Local agencies must regulate most development projects within the zones. Projects include all land divisions and most structures for human occupancy. Before a project can be permitted, cities and counties must require a geologic investigation to demonstrate that proposed buildings will not be constructed across active faults. An evaluation and written report of a specific site must be prepared by a licensed geologist. If an active fault is found, a structure for human occupancy cannot be placed over the trace of the fault and must be set back 50 feet from the fault trace. The project site is not located within a mapped Alquist-Priolo Earthquake Fault Zone, therefore its requirements do not apply to the project.

SEISMIC HAZARDS MAPPING ACT

In 1990, following the Loma Prieta earthquake, the California Legislature enacted the Seismic Hazards Mapping Act to protect the public from the effects of strong ground shaking, liquefaction, landslides and other seismic hazards. This Act established a state-wide mapping program to identify areas subject to violent shaking and ground failure; the program is intended to assist cities and counties in protecting public health and safety. 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. As a result, the California Geologic Survey is mapping Seismic Hazards Studies Zones and has completed seismic hazard mapping for the portions of California most susceptible to liquefaction, ground shaking, and landslides, including San Francisco. 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. As noted, a geotechnical investigation has been conducted for the project. Compliance with the Building Code ensures that the design is responsive to seismic hazards.

SAN FRANCISCO GENERAL PLAN

The Community Safety Element of the *General Plan* provides policies to ensure that the community is resilient to natural disasters. The purpose of the Community Safety Element is to reduce future loss of life, injuries, property loss, environmental damage, and social and economic disruption from natural or technological disasters. The Community Safety Element focuses on seismic hazards, because the greatest risks to life and property in San Francisco result directly from the ground shaking and ground failure associated with large earthquakes.

The existing historic 1906 Fairmont Hotel, podium structure, and hotel tower were built under previous California Building Code and City Code requirements, which were not as comprehensive as current building standards, particularly in relation to seismic hazards. The Building Code was substantially modified in California after the 1989 Loma Prieta Earthquake, and thus, new construction is significantly safer than those structures built under earlier code requirements.

The proposed project would be consistent with the applicable objectives and policies of the Community Safety Element because the project sponsor would construct a seismically compliant residential tower, mid-rise residential component, and podium structure. Portions of the building, including the Grand Ballroom, would be replaced and brought to current Building Code standards as part of this project. The proposed project would provide the infrastructure and support functions to meet current market standards to accommodate future hotel guests and the new residents. This section and Section IV.P, Hazards and Hazardous Materials, analyze topics related to these policies.

IMPACTS

The potential impacts associated with the project site geology and seismicity were evaluated through the review of prior geotechnical investigations conducted for the project site, regional and state data related to geologic, seismic, and soils conditions, and relevant federal and state regulations. This analysis relies in substantial part on a Geotechnical Assessment for the proposed project performed by the engineering firm Treadwell & Rollo, the findings of which are summarized herein. The Geotechnical Assessment concluded that "based on available geotechnical and geological information, the project is feasible from a geotechnical standpoint. The conclusion and recommendations presented are preliminary and may be used to estimate costs and for preliminary schematic drawings; however, during final design, a detailed geotechnical investigation should be performed." The report provided recommendations for seismic design in accordance with the provisions of the 2007 CBC.

SIGNIFICANCE THRESHOLDS

The thresholds for determining the significance of impacts in this analysis are consistent the environmental checklist in Appendix G of the State *CEQA Guidelines*, which has been adopted and modified by the San Francisco Planning Department. For the purpose of this analysis, the following applicable thresholds were used to determine whether implementing the project would result in a significant impact to geology, soils, and seismicity. Implementation of the proposed project would have a significant effect on geology, soils, and seismicity if it would:

N.a Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

- Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning 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 Publication 42.)
- Strong seismic ground shaking
- Seismic-related ground failure, including liquefaction
- Landslides;

N.b Result in substantial soil erosion or the loss of topsoil;

N.c 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 off-site landslide, lateral spreading, subsidence, liquefaction, or collapse;

N.d Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code, creating substantial risks to life or property;

N.e 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; or

N.f Change substantially the topography or any unique geologic or physical features of the site.

PROPOSED PROJECT

The project sponsor proposes to demolish the existing Fairmont Hotel tower and podium structure and construct a 26-story residential tower and a five-story mid-rise residential component, both above a five-story podium structure. The residential tower and podium structure would have a total height of approximately 317 feet. The proposed five-story podium would be 50 feet tall and the proposed mid-rise residential component (above the five-story podium) would measure 55 feet tall. The mid-rise residential component and podium would therefore measure 105 feet tall from street grade. The new 26-story residential tower would be located on the northeastern corner of the site above the five-story podium and would enclose the north side of the podium courtyard. The mid-rise residential component would enclose a podium courtyard along the east and south sides. In addition, an 11-foot-tall mechanical penthouse would extend above the tower. With the mechanical penthouse, the proposed tower would be approximately 328 feet in height. A 45-foot-tall flag pole is also proposed above the mechanical penthouse. The proposed development would include four levels of below-grade parking, up to a maximum depth of approximately 40 feet below the Powell Street grade at the intersection of Powell and California Streets.

The proposed podium, mid-rise residential component and residential tower would involve excavation of up to 30,000 cubic yards of soil. The deepest point of on-site excavation would be 40 feet below grade at the intersection of California and Powell Streets such that the structure would be sited directly over bedrock. Due to the depth of the groundwater under the site, encountering groundwater during construction is unlikely and dewatering is not anticipated. The foundation of the proposed structures would be supported on spread footings and drilled cast-in place concrete piers, or alternative deep foundations, such as torque-down pipe piles and auger-cast piles, should those prove to be more desirable during final site design.

IMPACT EVALUATION

Impact GE-1 The proposed project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure, including liquefaction, or landslides. (Less than Significant) *[Criterion N.a]*

Fault Rupture

As discussed above, no Fault Rupture Hazard Zones are located within the City and County of San Francisco and no known active fault exists on the project site.[43] The 2008 Geotechnical Assessment indicated that the nearest active or potentially active fault to the proposed project is the San Andreas Fault Peninsula segment and 1906 rupture segment, both approximately 7 miles to the west. The project site is not in an Alquist-Priolo Earthquake Fault Zone, and no known active fault exists on the project site. A remote possibility exists for future faulting in areas where no faults previously existed; however, the Geotechnical Assessment determined the risk of surface faulting and consequent secondary ground failure

[43] California Geological Survey, *Fault Rupture Hazard Zones in California, Figure 4B, Index to Official Maps of Earthquake Fault Zones*, 1997.

is very low.[44] Accordingly, impacts related to fault rupture at the project site would be less than significant for the proposed project.

Strong Seismic Ground Shaking

As is true for the entire San Francisco Bay Area, the Fairmont Hotel complex could be affected by ground shaking in the event of an earthquake on regional active faults. During a major earthquake on a segment of one of the nearby faults, "strong" to "very strong" shaking is expected to occur at the site.[45] The *San Francisco General Plan* Community Safety Element contains maps that show areas of the city subject to geologic hazards (Maps 2 and 3 of the Community Safety Element).[46] The project site is located in an area subject to "strong" to "very strong" ground shaking (Modified Mercalli Scale - MMI VII to VIII) from earthquakes along the Peninsula segment of the San Andreas fault, and "moderate" to "strong" ground shaking (MMI VI to VII) from the northern segment of the Hayward fault.[47] Under MM VII intensity during an earthquake, standing upright is very difficult, and interiors and furnishings experience considerable damage. However, damage is negligible in buildings of very good design and construction. Under MM VIII, people are generally unable to stand upright, interiors and furnishings experience heavy damage. Damage to well designed structures is expected but would generally be small. Under both MM VII and VIII, injuries to people can be expected to occur. The amount of ground shaking at the site would depend on the magnitude of the earthquake, the distance from the epicenter, and the type of earth materials between the receptor and the epicenter.

The San Francisco Building Code contains requirements for new and replacement construction. Adherence to the Code would place the building in the category of very good design and construction (as used in the MM scale). The final building plans for the new residential tower, mid-rise residential component and podium structure would be reviewed by the San Francisco Department of Building Inspection (DBI). In reviewing building plans, DBI refers to a variety of information sources to determine

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[44] Treadwell & Rollo, 2008, op. cit., p. 5.

[45] Treadwell & Rollo, 2008, op. cit., p. 5.

[46] Continued research has resulted in revisions to ABAG's earthquake hazard maps. Based on the 1995 ABAG report, an earthquake on these faults could result in "moderate" and "nonstructural" damage, respectively, in the project vicinity. However, ABAG notes. "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." For this reason, ABAG currently produces Shaking Hazard Maps that depict intensity of ground shaking, rather than estimated damage. Information regarding revised data for Maps 2 and 3 of the Community Safety Element are available on ABAG website at: http://www.abag.ca.gov/bayarea/eqmaps/mapsba.html. Accessed: January 2009.

[47] Association of Bay Area Governments (ABAG), *ABAG Shaking Intensity Maps and Information*, *San Andreas and Hayward Fault Shaking Scenarios*, Available at: http://gis.abag.ca.gov/website/Shaking-Maps/viewer.htm, Accessed: January 2009.

existing hazards and assess requirements for mitigation. This information includes geologic maps of Special Geologic Study Areas in San Francisco as well as the building inspectors' working knowledge of areas of special geologic concern. If the need were indicated by available information, DBI would require that site-specific soils reports be prepared by a California licensed geotechnical engineer prior to construction.

The 2008 Geotechnical Assessment that was prepared for the proposed project identified site- specific geotechnical design parameters in accordance with the 2007 CBC. The seismic analysis of the site concluded that the spread footings and drilled cast-in-place concrete piers (or torque-down pipe piles and auger-cast piles) foundations for the proposed building would gain adequate support in the underlying bedrock. The project would be designed to adhere to the requirements and parameters determined by the assessment and would implement the site design and construction recommendations in this assessment. Strong earthquake shaking results in vibration being transmitted into the overlying structures. Tall narrow structures are especially susceptible to the ground induced vibrations, causing them to sway with increasing amplitude higher in the building. Such motion also is induced by high winds. The proposed tower would be subject to this type of earthquake induced ground motion. Current design and engineering requirements address these types of motion to prevent collapse or extensive damage to the structures. As noted in the Setting, the Type A and B soil materials underlying the site are not expected to result in substantial vibration transmitted into the proposed buildings. Thus, all the proposed buildings would not be expected to collapse or experience severe structural damages from a major earthquake (or high wind). Instead, earthquake induced motion at the project site could result mostly in non-structural damages such as broken windows, ruptured pipes, dislocated loose (unattached) items such as free-standing wall panels, furnishings, suspended ceilings, hanging light fixtures, etc.

Most importantly, the proposed residential tower, mid-rise component, and podium structure would be designed to meet current seismic response code requirements. As a result, the tower and podium structures constructed under earlier building codes would be replaced by stronger, more seismically safe buildings. The potential damage to the proposed new tower, mid-rise and podium from geologic hazards would be addressed through proper design and plan checks for the proposed project. DBI would also review the proposed project's building permit application for compliance with the CBC and implementation of recommendations in the site-specific Geotechnical Assessment to address seismic hazards. This analysis, review, and approval process would ensure that project effects related to ground shaking would be less than significant.

Seismic-Related Ground Failure

Seismic-related ground failure can include liquefaction, lateral spreading, settlement/densification, and landslides. As discussed above, the project site is not within an area susceptible to liquefaction as mapped by the State of California[48] or the City and County of San Francisco,[49] and groundwater was not encountered at the project site to bedrock depth (Elevation 249 feet at the western extent of the Tonga Room and Elevation 187.5 feet at the southwestern corner of the intersection of Sacramento Street and Powell Street). Accordingly, the Geotechnical Assessment determined that the potential for liquefaction at the project site is low.[50] Because lateral spreading hazards mirror the liquefaction hazard for a given site, the potential for lateral spreading at the site was also determined by the Geotechnical Assessment to be low.[51] Therefore, project impacts related to liquefaction and lateral spreading would be less than significant.

According to the Geotechnical Assessment, four to ten feet of loose to medium-dense sandy fill was encountered on the site. Previous testing for the 2008 Geotechnical Assessment determined the settlement potential of the subsurface materials to be up to 2 inches.[52] Potential settlement on the site is expected to be erratic and vary with the fill thickness. Much of this fill material would be removed during construction. Additionally, the foundation of the proposed structure would be supported on spread footings and drilled cast-in-place concrete piers (or torque-down pipe piles and auger-cast piles). These types of foundations would gain support from the underlying bedrock. Given these types of foundations proposed for the structures at the site, the Geotechnical Assessment determined that settlement would be less than one inch and the structures would not be affected by seismically-induced settlement. Impacts would be less than significant.

As discussed above, the site is not within a hazard zone for seismically-induced landslides, according to the official State of California Seismic Hazards Zone Map for San Francisco.[53] However, designated Landslide Zones exist in the project vicinity where previous landslide movement, or local topographic, geological, geotechnical, and subsurface water conditions indicate a potential for permanent ground

[48] California Geological Survey (formerly the Division of Mines and Geology), 2000, *State of California, Seismic Hazard Zones, City and County of San Francisco, Official Map*.

[49] City and County of San Francisco, 1997, *San Francisco General Plan, Community Safety Element: Map 4 Areas of liquefaction potential*, Available at: http://www.sfgov.org/site/uploadedimages/planning/Codes/General_Plan/images/csa_Map4.gif

[50] Treadwell & Rollo, 2008, op. cit., p. 5.

[51] Ibid, p. 5.

[52] Treadwell & Rollo, 2008, op. cit., p. 5.

[53] Ibid, p. 5.

displacements. The project site is also shown to be in an area subject to potential landslide hazard according to Map 5 of the *San Francisco General Plan* Community Safety Element. However, this is likely due to the downward slope of the project area, because landslide-susceptible areas are generally characterized by steep slopes and downslope creep of surface materials.[54] Although the project site is sloped on a grade between 12 and 17 percent to the east and five to ten percent to the south, no groundwater (that lubricates landslides) was encountered in subsurface explorations to bedrock depth (Elevation 249 feet at the western extent of the Tonga Room and Elevation 187.5 feet at the southwestern corner of the intersection of Sacramento Street and Powell Street). Additionally, the proposed tower would be anchored to its foundation, which would sit atop bedrock, and the increase in total mass to the structure (compared to the existing hotel tower) would not be substantial enough to increase the risk of a landslide. Accordingly, potential risks from landslides at the project site would be low and impacts would be less than significant.

Impact GE-2 The proposed project would not result in substantial soil erosion or the loss of topsoil. (Less than Significant) *[Criterion N.b]*

Topsoil and soils of the project site would be disturbed during the construction process due to project-related excavation and grading activities. The site has been previously fully developed and no exposed loose soils are present on the site. With project development, the site would remain fully covered by development and no loose soils would be exposed on site. Exposed fill materials would be susceptible to erosion during project construction excavation. Erosion due to stormwater runoff could occur during the project construction process although most loosened and eroded soil would remain within the excavation pit. Some soil being brought off-site may be spilled or carried on construction related trucks and deposited on streets. That soil could be discharged into storm drains (See impact discussion in Section IV.O, Hydrology and Water Quality). As water quality during site preparation for construction is the primary concern related to soil erosion and loss of topsoil, these potential impacts are analyzed in detail in Section IV.O, Hydrology and Water Quality, of this Draft EIR. The project would be required to comply with the requirements of Article 4.1 of the San Francisco Public Works Code, which regulates the quantity and quality of discharges to the combined sewer system. These requirements include control of sediments and erosion and implementation of Best Management Practices (BMPs) for materials and waste management and handling in compliance with guidelines as provided by the City's Construction Site Runoff Pollution Prevention Procedures. A Stormwater Pollution Prevention Plan (SWPPP) would be

[54] City and County of San Francisco, 1974, *San Francisco General Plan*, *Community Safety Element: Map 5 Areas of potential landslide hazard*, Available at: http://www.sfgov.org/site/uploadedimages/planning/Codes/General_Plan/images/csa_Map5.gif

prepared to reduce pollution of surface water throughout the construction period of the project. Through compliance with these requirements, construction period water quality impacts related to soil erosion and stormwater runoff would be less than significant.

Impact GE-3 The proposed project would not 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 off-site landslide, lateral spreading, subsidence, liquefaction, or collapse. (Less than Significant) *[Criterion N.c]*

The project site and vicinity would not become unstable as a result of development of the proposed project, and would not result in on- or off-site landslides, lateral spreading, subsidence, liquefaction, or collapse. As discussed in the Setting and above in Impact GE-1, hazards related to liquefaction and lateral spreading are not present. The Geotechnical Assessment determined that subsurface exploration at the site did not reveal soft, compressible sediment, which would be susceptible to subsidence.[55] No supply wells are known to exist or were observed in the vicinity of the project site, and the City and County of San Francisco does not pump groundwater within City limits. Accordingly, no extensive pumping of subsurface moisture creating susceptibility to subsidence has occurred in the vicinity of the project site and could not be needed for the project construction. Additionally, the respective densities of the loose to medium-dense sandy fills and medium-stiff to stiff clays beneath the project site do not indicate susceptibility to collapse. In accordance with the recommendations of the Geotechnical Assessment and with construction BMPs, the soil would be moisture conditioned and compacted in order to prevent compaction of soil under the weight of the proposed structures. Therefore, the risk of subsidence and collapse at the site is considered low and these impacts would be less than significant.

As detailed above in Impact GE-1, the risk of seismic-related landslides would be less than significant; however, landslides can also result from adding excessive weight above the slope (such as with installation of the new mid-rise, podium, and residential tower above) or digging at mid-slope or at the foot of the slope (such as for excavation of the below-grade parking under). The site is steeply sloped and designated Landslide Zones are located downslope of the project site. If activities related to the proposed project trigger off-site landslides, these nearby Landslide Zones would be adversely affected. However, the relative weight increase, if any, would not be substantial enough to trigger an off-site landslide. All project excavations would be properly shored, in accordance with construction BMPs recommended in the 2008 Geotechnical Assessment. Accordingly, the project's impacts related to landslides would be less than significant.

[55] Treadwell & Rollo, 2008, op. cit., p. 5.

Impact GE-4 The proposed project would not be located on expansive soil creating substantial risks to life or property. (Less than Significant) ***[Criterion N.d]***

As described above on p. IV.M-3, expansive soils are clayey soils that shrink or swell substantially with changes in moisture content, and occur more frequently in arid and semi-arid regions. The City and County of San Francisco is within an area where less than 50 percent of the soil consists of clay having high swelling potential. The site-specific Geotechnical Assessment determined that a one- to three-foot layer of clay exists in the soil beneath the project site.[56,57] However, proposed footings and piers/piles for the project would be advanced into bedrock. In accordance with design BMPs, surface runoff would be directed away from foundations and moisture infiltration would be limited. Impacts related to expansive soils would thus be less than significant.

As part of the permitting requirements, a site-specific soils study would be required to determine corrositivity of soil and whether sulfate resistant concrete is needed for foundation construction. Site soils would be evaluated for corrosive properties during the civil/structural engineering studies required for the design of the perimeter and basement walls and foundations for the proposed structure. The design of the project would be required to implement the measures determined by the soils and civil/structural engineering studies to be appropriate for the project. Potential measures typically recommended based on the site-specific corrosive properties of soil can include corrosion protection for all reinforced concrete, including foundations and floor slabs, buried iron, steel, cast iron, ductile iron, galvanized steel, dielectric coated steel or iron, and buried metallic pressure piping in accordance with the critical nature of the structure and based on standard engineering and construction practices. With adherence to these standard practices as applicable to the site-specific nature of the soils, potential impacts related to corrosive soils would be less than significant.

Impact GE-5 The proposed project would not have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal. (Less than Significant) ***[Criterion N.e]***

The proposed project would be connected to the existing City combined stormwater - wastewater disposal system serving the site. No septic tanks or alternative wastewater disposal systems are proposed. Impacts related to the adequate support of septic tanks would not occur.

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[56] W.W. Olive, A.F. Chleborad, C.W. Frahme, Julius Schlocker, R.R. Schneider, and R.L Shuster; 1989, United States Geological Survey publication: *Swelling Clays Map Of The Conterminous United States, Soils of California.*

[57] Treadwell & Rollo, 2008, op. cit., p. 2.

Impact GE-6 The proposed project would not substantially change the topography or any unique geologic or physical features of the site. (Less than Significant) *[Criterion N.f]*

The proposed project site is a 2.6-acre area located in a densely developed urban area in the Nob Hill neighborhood. The site vicinity was first developed in the late-1800s and at least two previous structures occupied the site prior to construction of the Fairmont Hotel in 1906. Currently, the site is fully occupied by the Fairmont Hotel complex with subgrade structures and underground utilities tunnels, which do not extend below the level of the subsurface basement. The proposed residential tower, mid-rise residential component and podium structure would replace the existing hotel tower and podium. No unique geologic features exist at the site. The proposed project would not substantially alter the topography or change any unique geological or physical features of the project area; therefore, this would be a less-than-significant impact.

CUMULATIVE IMPACTS

Geology impacts are generally localized and site specific and do not have cumulative effects with other projects. Cumulative future development in the project area would be subject to similar design review and safety measures as those for the proposed project. These measures would reduce the geologic effects of cumulative projects to less-than-significant levels. Therefore, the proposed project would have a less-than-significant impact related to geology, soils, and seismicity. The proposed project also would not contribute to any considerably cumulative impacts related to geology, soils, and seismicity.

MITIGATION AND IMPROVEMENT MEASURES

The proposed project would have a less-than-significant project-specific and cumulative effect related to geology, soils, and seismicity. No mitigation or improvement measures would be required.

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