9

Geology and Soils

This chapter of the EIR evaluates the potential impacts of the Project related to geology and soils. This chapter also describes the existing geology and soil conditions in and near the Project Area, and evaluates the extent to which geology and soil conditions may affect development of the Master Plan Update as proposed.

Although some of the information in the Environmental Setting draws from the 2007 Master EIR (MEIR), 2012 Supplemental MEIR (SMEIR) and 2002 Britannia East Grand Project EIR, setting information has been updated for this EIR using current data from the following sources:

- the California Geological Survey,
- the Association of Bay Area Governments (ABAG) Resilience Program,
- the United States Geological Survey (USGS),
- the General Plan of the City of South San Francisco, and
- the City of South San Francisco East of 101 Area Plan

Environmental Setting

Geology

Regional Geology

The geology of the San Francisco Bay Area includes three geologic provinces: the Salinian block, the Franciscan complex and the Great Valley sequence. The Salinian block is west of the San Andreas Fault. It is composed primarily of granitic plutonic rocks, which are similar to those found in the Sierra Nevada and are believed to be rocks of the Sierra Nevada batholith that have been displaced along the San Andreas Fault. East of the San Andreas Fault, and bounded on the west by the Hayward Fault, is the Mesozoic Franciscan complex. Franciscan rocks represent pieces of former oceanic crust that have accreted to North America by subduction and collision. These rocks are primarily deep marine sandstone and shale. Chert, marble, serpentinite and limestone are also found in the assemblage. The rocks of the Franciscan complex are prone to landslides. East of the Hayward Fault is the Great Valley Sequence. In the San Francisco Bay Area, this sequence is mainly composed of Cretaceous and Tertiary marine sedimentary rocks. Like the Franciscan assemblage, the rocks of the Great Valley Sequence are also prone to landsliding.

Local Geology/Soil Types and Characteristics

The Project Area is on the western shore of San Francisco Bay on reclaimed Bay lands and adjacent uplands at the eastern base of San Bruno Mountain. Elevations range from 182 feet above mean sea level at the top of San Bruno Hill to approximately 0 feet mean sea level at the low-lying areas in the east. The lower portion of the Project Area was reclaimed from the waters of the San Francisco Bay in the mid- to late 1960s by using compacted materials derived primarily from excavations of bedrock, alluvial material, and Bay Mud lying directly beneath the reclaimed fill material.

In this area, the bedrock (Franciscan complex) consists primarily of sandstone and shale with clay, silt and sand overlying the bedrock surface. Previous soil borings have shown that shearing has obscured bedding relations in the sandstone, and much of the shale has been sheared to gouge-like materials. Geologic units in the Project Area (see **Figure 9-1**) include a mixture of intrusive igneous rock, Mesozoic and Franciscan bedrock, Quaternary sands, Upper and Lower Tertiary sandstones and mudstones, Franciscan mélange, serpentinite, and water-saturated muds and artificial fill at the Bay shoreline edges.

Seismicity

The City of South San Francisco is located in one of the most seismically active regions in the United States, with approximately 30 known faults in the Bay Area capable of generating earthquakes. Eleven of these faults are located within 40 miles of South San Francisco. The San Andreas Fault system, the general boundary between the northward moving Pacific Plate (west of the fault) and the southward moving North American Plate (east of the fault) is the dominant fault of the region and the state of California. The fault system movement is distributed across a complex system of generally strike-slip, right lateral parallel and subparallel faults including, but not limited to, the regional San Andreas, San Gregorio, Hayward, Rogers Creek and Calaveras faults. As shown in **Figure 9-2**, the Peninsula segment of the San Andreas Fault at approximately 7 kilometers (km) to the southwest, and the Seal Cove Segment of the San Gregorio Fault, at approximately 14 km to the west-southwest, are the two closest to the Project Area. While branches of the Hillside Fault have also been mapped a very short distance southwest of the Project Area, there is no evidence that this fault has been active within geologically recent time.

Based on criteria established by the California Geological Survey (CGS), faults may be categorized as active, potentially active or inactive. Active faults, such as the San Andreas and San Gregorio, are those that show evidence of displacement within the last 11,000 years; historically active faults are those that have shown evidence of displacement during the last 200 years; potentially active faults are those that show evidence of displacement during the last 1.6 million years. Faults showing no evidence of displacement within the last 1.6 million years, such as the Hillside Fault, are considered inactive.

Historic and Future Seismicity

The severity of an earthquake generally is expressed in two ways: magnitude and intensity. The energy released, as measured on the Moment Magnitude (M_W) scale, represents the "size" of an earthquake. The Richter Magnitude (M_L) scale has been replaced in most modern building codes by the M_W scale because the M_W scale provides information that is more useful to design engineers. The intensity of an earthquake is measured by the Modified Mercalli Intensity (MMI) scale, which emphasizes the current seismic environment at a particular site and measures ground-shaking severity according to damage done to structures, changes in the earth surface, and personal accounts. Historically, seismicity for the Bay Area is associated with the strike-slip faults of the San Andreas Fault system. Fifteen earthquakes of a moment magnitude (M_W) 6.0 or greater have occurred in the Bay Area in historic times, the most recent being the 6.0 South Napa earthquake in 2014 along the West Napa Fault. With a maximum MMI of VIII (Severe), it was the largest Bay Area earthquake since the 1989 Loma Prieta earthquake.

The Loma Prieta earthquake on October 17, 1989, was the most significant earthquake since the Great San Francisco Earthquake of 1906. This M_W 6.9 earthquake occurred on the southern Santa Cruz segment of the San Andreas Fault. The cities of Los Gatos, Watsonville and Santa Cruz were hit hard with damage, as were San Francisco and Oakland. Shaking was felt throughout the Bay Area. Damage to major transportation facilities included the collapse of the I-880 Cypress structure (with the loss of 63 lives), liquefaction and settlement damage to port facilities in Oakland and the runway apron at Oakland International Airport, and temporary closure of the Oakland–Bay Bridge. As in the 1906 earthquake, the worst damage from shaking occurred at structures on unconsolidated or saturated soils.

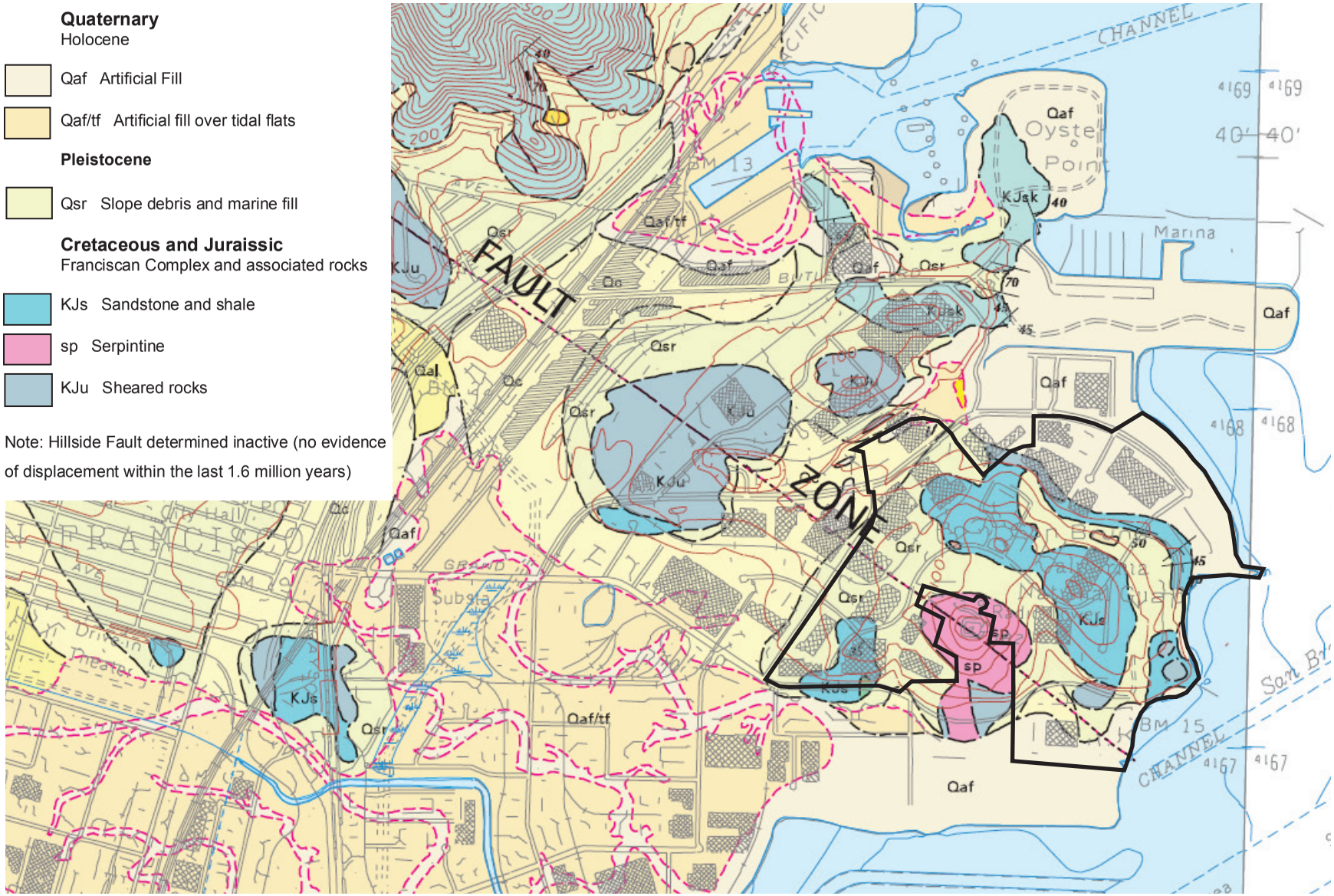
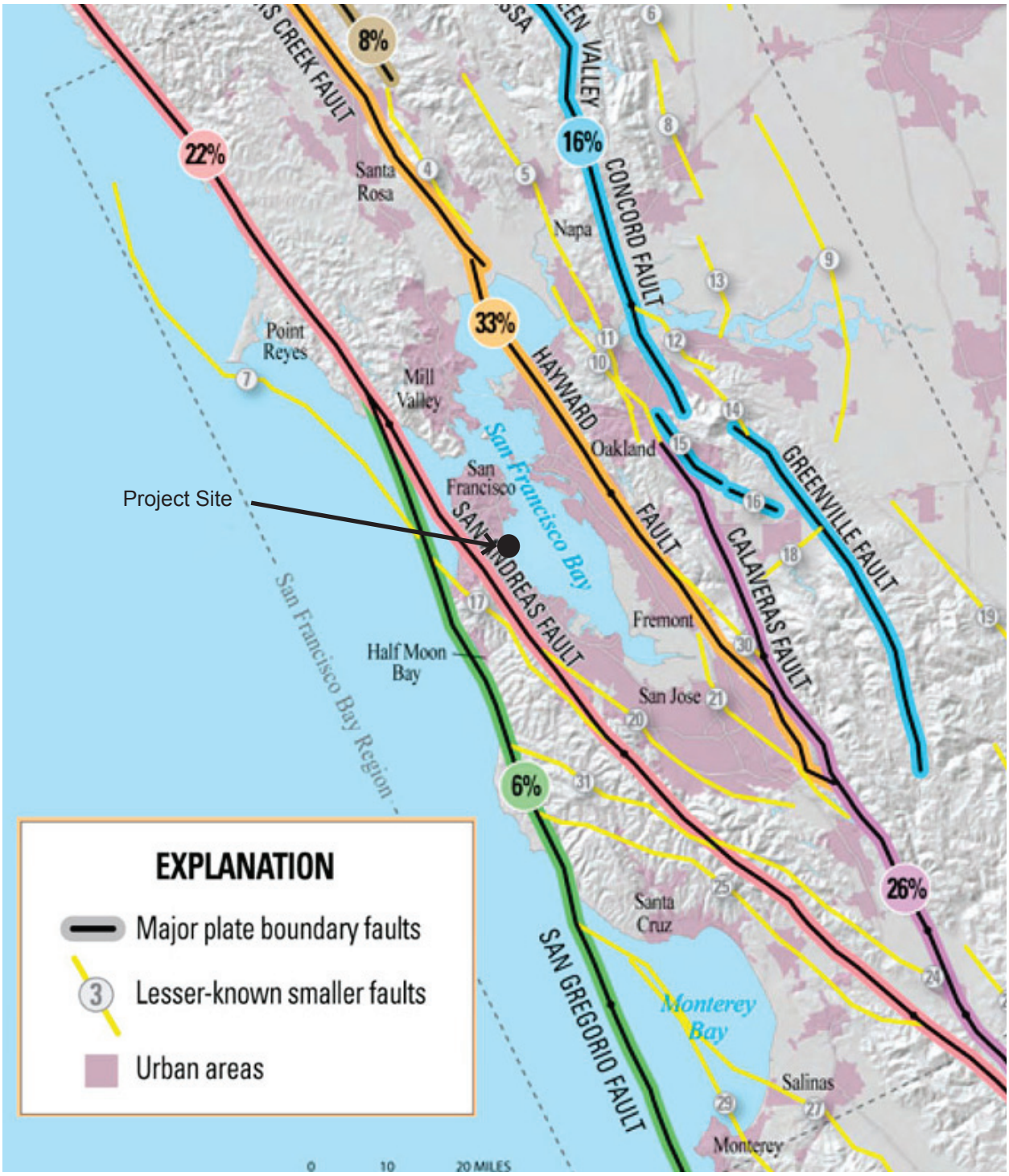


Figure 9-1
Geologic Units within the Project Area and Vicinity

Source: USGS, 1989



https://soundwaves.usgs.gov/2017/02/research.html

Figure 9-2
Regional Faulting

Source: USGS, 2017

In 2015, scientists with the USGS, CGS and the California Earthquake Authority published a new earthquake forecast model for California. The new model, referred to as the Third Uniform California Earthquake Rupture Forecast (UCERF3), provides estimates of the magnitude, location and likelihood of earthquake fault rupture throughout the state. [1] Overall, the results confirm previous findings, but include some significant changes because of model improvements. For example, compared to the previous forecast (UCERF2), the likelihood of moderate-sized earthquakes (magnitude 6.5 to 7.5) is lower, whereas that of larger events is higher. This is because of the inclusion of multi-fault ruptures, where earthquakes are no longer confined to separate, individual faults, but can occasionally rupture multiple faults simultaneously.

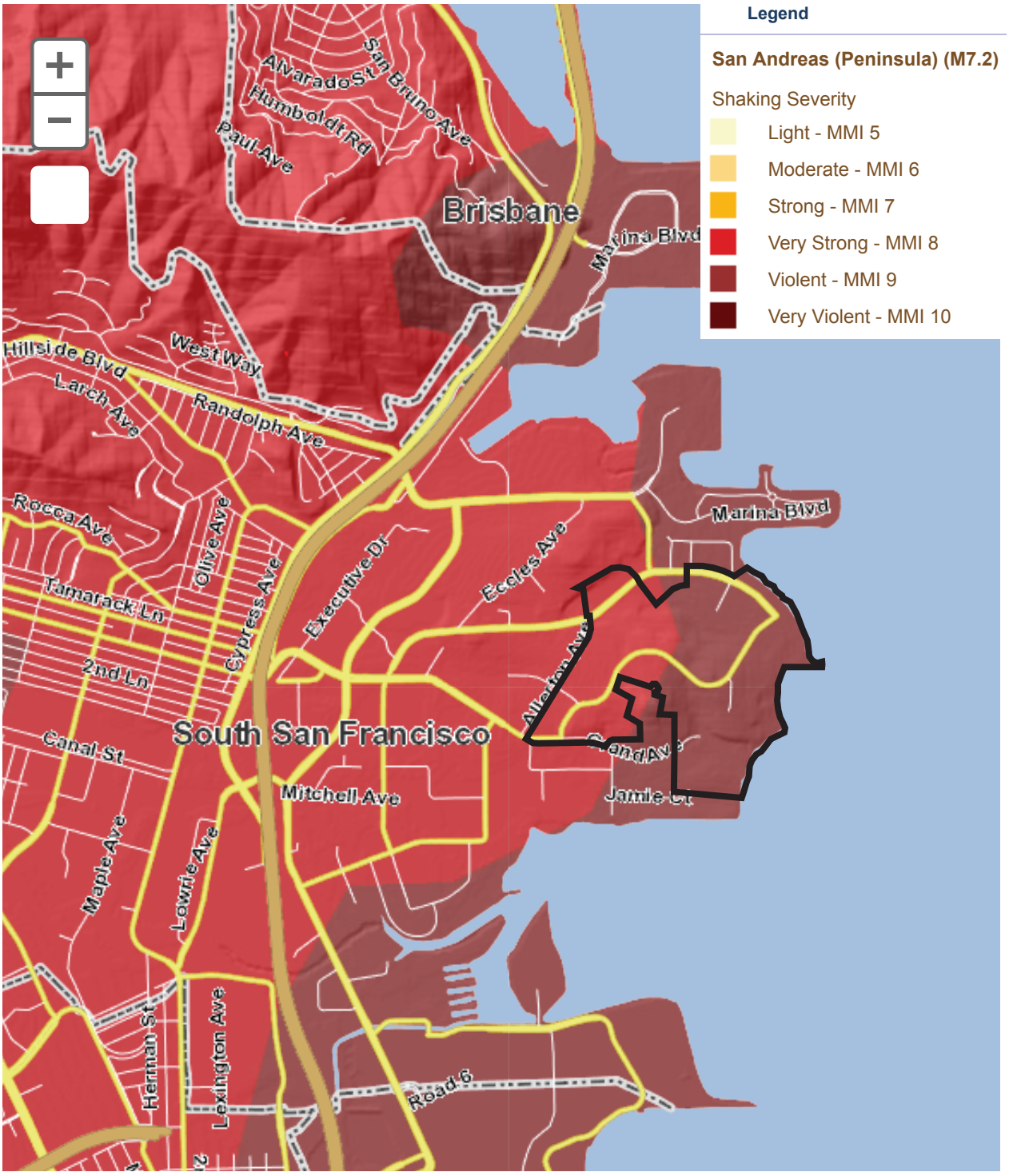
The faults in the region with the highest estimated probability of generating damaging earthquakes through year 2043 are the Hayward, Calaveras and San Andreas faults. In this 30-year period, the probability of an earthquake of magnitude 6.7 or larger occurring is 6.4 percent along the Northern San Andreas Fault (fewer than 5 miles from the Project Area at its closest point), 7.4 percent along the Calaveras Fault and 14.3 percent for the Hayward Fault.

Seismic Hazards

Groundshaking

The major cause of structural damage from earthquakes is groundshaking. The intensity of ground motion expected at a particular site depends on the magnitude of the earthquake, the distance of the site to the quake's epicenter, and the geology of the area between the epicenter and the site. Greater movement can be expected at sites on poorly consolidated materials, such as alluvium, or compressible materials such as Bay Mud or un-engineered fill. Sites near the causative fault or seismic events of extraordinary magnitude may also experience damage from groundshaking. ABAG has produced earthquake intensity maps (**Figure 9-3)** indicating that the scenario earthquake for the Peninsula Segment of the San Andreas Fault (M>7.2) would produce a "violent" shaking intensity at the eastern portion of the Project Area (based on the MMI scale). **Table 9.1** shows the shaking intensity of the most likely earthquake scenarios.

[1] USGS, UCERF3: A New Earthquake Forecast for California's Complex Fault System, March 2015. Accessed November 23, 2016, at http://pubs.usgs.gov/fs/2015/3009/pdf/fs2015-3009.pdf



http://gis.abag.ca.gov/website/Hazards/?hlyr=northSanAndreas

Figure 9-3
Seismic Shaking Severity

Source: ABAG Resilience Program, accessed 8-3-18

Table 9-1: Significant Earthquake Scenarios

Fault Name	Distance from Site (km)	Moment Magnitude (Mw)	Shaking Intensity (MMI)
San Andreas (All Northern Segments)	7	7.8	IX (Violent)
San Andreas (Peninsula Segment)	7	7.2	VIII – IX (Very Strong-Violent)*
San Gregorio	14	7.5	VIII (Very Strong)
Hayward (North & South)	24	7.0	VII (Strong)

* The level of severity is predicted at VIII west of a hypothetical line extending roughly due south from Gull Drive at Forbes Blvd, and at IX east of that line.

Source: ABAG, Resilience Program, 2016

Liquefaction

Loose sand and silt that is saturated with water can behave like a liquid when shaken by an earthquake. Earthquake waves cause water pressures to increase in the sediment and the sand grains to lose contact with each other, leading the sediment to lose strength. In the process, the soil acquires mobility sufficient to permit both the horizontal and vertical movements, if not confined. The soil can lose its ability to support structures, flow down even very gentle slopes and erupt to the ground surface to form sand boils. Many of these phenomena are accompanied by settlement of the ground surface—usually in uneven patterns that damage buildings, roads and pipelines. Soils most susceptible to liquefaction are loose, clean saturated, uniformly graded fine sands. Silty sands and clayey sands may also be susceptible to liquefaction during strong groundshaking, although to a lesser extent. Loose to medium dense sand layers can also be subjected to seismic compaction if they are above the water table.

In addition to the necessary soil conditions, the ground acceleration and duration of the earthquake must be of a sufficient level to initiate liquefaction. The ABAG Liquefaction Hazard Map (**Figure 9-4**) shows that the Project Area has a very high potential for liquefaction, specifically in the northeastern and southeastern areas of the site that consist of fill material overlying Bay Mud.

Seismically Induced Settlement

Settlement occurs in areas that are prone to different rates of ground surface sinking and densification (called differential compaction) and are underlain by sediments that differ laterally in composition or degree of existing compaction. Differential settlement can damage structures, pipelines, and other subsurface entities.

Strong groundshaking can cause soil settlement by vibrating sediment particles into more tightly compacted configurations, thereby reducing pore space. Unconsolidated, loosely packed alluvial deposits and sand are especially susceptible to this phenomenon. Poorly compacted artificial fills may experience seismically induced settlement.

Subsidence and Expansive and Collapsible Soils

Subsidence involves a sudden sinking or gradual settling and compaction of soil and other surface material with little or no horizontal motion. Expansive soils have a significant amount of clay particles that can give up water (shrink) or take on water (swell). The change in soil volume exerts stress on buildings and other loads placed on these soils. The presence of expansive soils is often associated with geologic units having marginal stability. Expansive soils can be dispersed widely, found in hillside areas as well as low-lying areas in alluvial basins. Soils testing to identify expansive characteristics and appropriate measures to address these characteristics are routinely required by grading and building codes.

accessd at: http://gis.abag.ca.gov/website/Hazards/?hlyr=liqSusceptibility

Figure 9-4
Liquefaction Susceptibility

Source: ABAG Resilience Program, accessed 8-3-18

Collapsible soils undergo a rearrangement of their grains, and a loss of cementation, resulting in substantial and rapid settlement under relatively low loads. Collapsible soils occur predominantly at the base of mountain ranges where Holocene-age alluvial fan and wash sediments have been deposited during rapid runoff events. Soils prone to collapse are commonly associated with artificial fill, wind-lain sands and silts, and alluvial fan and mudflow sediments deposited during flash floods. During an earthquake, even slight settlement of fill materials can lead to a differentially settled structure and significant repair costs. Differential settlement of structures can occur when heavily irrigated landscape areas are near a building foundation. Common problems associated with collapsible soils include tilting floors, cracking or separation in structures, sagging floors, and nonfunctional windows and doors.

The potential for subsidence and/or expansive and collapsible soils is considered high within the Project Area. This is due to the presence of significant amounts of artificial fill materials placed over soft Bay Mud, as well as the shallow water table (borings have indicated that the water table may be as shallow as 6 feet, with the potential of groundwater at near zero elevation at mean sea level).

Landsliding

Landslides are the downward sliding of a mass of earth and rock. Landsliding is a geological phenomenon that includes a wide range of ground movements, such as rock falls, deep failure of slopes, and shallow debris flows. Gravity acting on an over-steepened slope is the primary cause of landsliding. However, there are other contributing factors such as:

- erosion by rivers, glaciers, or ocean waves;
- rock and soil slopes that are weakened through saturation by snowmelt or heavy rains;
- volcanic eruptions that produce loose ash deposits, heavy rain, and/or debris flows;
- vibrations from machinery, traffic, blasting and even thunder; and
- excess weight from accumulation of rain or snow, stockpiling of rock or ore from waste piles, or from artificial structures

The strong ground motion that occurs during earthquakes is capable of inducing landslides, generally where unstable soil conditions already exist. When landslides occur, they deform and tilt the ground surface. The result can be destruction of foundations, offset of roads, and breaking of underground pipes within and along the margins of the landslide, as well as overriding of property and structures downslope.

Portions of the Project Area have slopes greater than 15 percent, underlain by weak bedrock. These areas will have a greater susceptibility to the risks associated with landsliding.

Soil Erosion

Soil erosion is the process by which soil particles are removed from a land surface by wind, water or gravity. Most natural erosion occurs at slow rates; however, the rate of erosion increases when land is cleared or altered and left in a disturbed condition. Site preparation activities associated with development can cause or accelerate erosion. Vegetation removal in previously landscaped areas could reduce soil cohesion, as well as the buffer provided by vegetation from wind, water and surface disturbance, which could render the exposed soils more susceptible to erosive forces.

Additionally, excavation or grading may result in erosion during construction activities, irrespective of whether hardscape previously existed at the construction site, because bare soils would be exposed and could be eroded by wind or water. The effects of erosion are intensified with an increase in slope (as water moves faster, it gains momentum to carry more debris), and the narrowing of runoff channels which increases the velocity of water). Surface improvements such as paved roads and buildings decrease the

potential for erosion. Once covered, soil is no longer exposed to the elements. The Project Area is developed with numerous buildings, hard pack, and paved parking lots with landscaping overfill material.

Regulatory Setting

State Regulations

Alquist-Priolo Earthquake Fault Zoning Act

The California Legislature passed the Alquist-Priolo Earthquake Fault Zoning Act in 1972 to mitigate the hazard of surface faulting to structures 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 addresses only the hazard of surface fault rupture, and does not address other earthquake hazards. Local agencies must regulate most development in fault zones established by the State Geologist. Before a project can be permitted in a designated Alquist-Priolo Earthquake Fault Zone, the city or county with jurisdiction must require a geologic investigation to demonstrate that proposed buildings would not be constructed across active or potentially active faults.

California Seismic Hazards Mapping Act

The California Seismic Hazards Mapping Act of 1990 (California Public Resources Code Sections 2690-2699.6) addresses seismic hazards other than surface rupture, such as liquefaction and seismically induced landslides. The Seismic Hazards Mapping Act specifies that the lead agency for a project may withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils.

California Building Code

The California Building Code (CBC) has been codified in the California Code of Regulations as Title 24, Part 2. Title 24 is administered by the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. Under State law, all building standards must be centralized in Title 24 or they are not enforceable. The purpose of the CBC is to establish minimum standards to safeguard the public health, safety and general welfare through structural strength, means of egress facilities, and general stability by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of all building and structures within its jurisdiction.

The 2016 CBC is based on the 2015 International Building Code published by the International Code Conference. In addition, the CBC contains necessary California amendments, which are based on reference standards obtained from various technical committees and organizations such as the American Society of Civil Engineers (ASCE), the American Institute of Steel Construction and the American Concrete Institute. ASCE Minimum Design Standards 7-05 provides requirements for general structural design and includes means for determining earthquake loads as well as other loads (flood, snow, wind, etc.) for inclusion into building codes. The provisions of the CBC apply to the construction, alteration, movement, replacement and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures throughout California.

The earthquake design requirements take into account the occupancy category of the structure, site class, soil classifications and various seismic coefficients that are used to determine a Seismic Design Category (SDC) for a project as described in Chapter 16 of the CBC. The SDC is a classification system that combines the occupancy categories with the level of expected ground motions at the site and ranges from SDC A (very small seismic vulnerability) to SDC E (very high seismic vulnerability and near a major fault) as well as SDC F (Hospitals, Police Stations Emergency control centers etc. in areas near major active faults). Design

specifications are then determined according to the SDC in accordance with Chapter 16 of the CBC, which provides earthquake loading specifications for every type of structure to resist the effects of earthquake motions in accordance with ASCE 7-05. Chapter 18 of the CBC covers the requirements of geotechnical investigations (Section 1803), excavation, grading, and fills (Section 1804), load bearing of soils (1805), as well as foundations (Section 1808), shallow foundations (Section 1809), and deep foundations (Section 1810). Chapter 18 also describes analysis of expansive soils and the determination of the depth to groundwater table. For SDC D, E and F, Chapter 18 requires analysis of slope instability, liquefaction and surface rupture attributable to faulting or lateral spreading, plus an evaluation of lateral pressures on basement and retaining walls, liquefaction and soil strength loss, and lateral movement or reduction in foundation soil-bearing capacity. It also addresses mitigation measures to be considered in structural design, which may include ground stabilization, selecting appropriate foundation type and depths, selecting appropriate structural systems to accommodate anticipated displacements, or any combination of these measures. The potential for liquefaction and soil strength loss must be evaluated for site-specific peak ground-acceleration magnitudes, and source characteristics consistent with the ground motions of the design earthquake.

California Code of Regulations Title 24 also includes the California Residential Code and California Green Building Standards Code, which have been adopted as separate documents (California Code of Regulations Title 24, Part 2.5 and 11, respectively).

Construction General Permit

The California Construction Stormwater Permit (Construction General Permit)[2], adopted by the State Water Resources Control Board, regulates construction activities that include clearing, grading, and excavation resulting in soil disturbance of at least one acre of total land area. The Construction General Permit authorizes the discharge of stormwater to surface waters from construction activities. It prohibits the discharge of materials other than stormwater and authorized non-stormwater discharges and all discharges that contain a hazardous substance in excess of reportable quantities established at 40 Code of Federal Regulations (CFR) 117.3 or 40 CFR 302.4, unless a separate National Pollutant Discharge Elimination System (NPDES) Permit has been issued to regulate those discharges.

The Construction General Permit requires that all developers of land where construction activities will occur over more than one acre do the following:

- Complete a Risk Assessment to determine pollution prevention requirements pursuant to the three Risk Levels established in the General Permit
- Eliminate or reduce non-stormwater discharges to storm sewer systems and other waters of the Nation
- Develop and implement a Stormwater Pollution Prevention Plan (SWPPP), which specifies Best Management Practices that will reduce pollution in stormwater discharges to the Best Available Technology Economically Achievable/Best Conventional Pollutant Control Technology standards
- Perform inspections and maintenance of all best management practices (BMPs)

Typical BMPs contained in SWPPPs are designed to minimize erosion during construction, stabilize construction areas, control sediment, control pollutants from construction materials and address post construction runoff quantity (volume) and quality (treatment). The SWPPP must also include a discussion of the program to inspect and maintain all BMPs.

[2] General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities, Order No. 2009-0009-DWQ, as amended by Order No. 2010-0014-DWQ, National Pollutant Discharge Elimination System No. CAS000002.

Local Regulations and Policies

City of South San Francisco Hazard Mitigation Plan

The City of South San Francisco adopted ABAG's Local Hazard Mitigation Plan as the Hazard Mitigation Plan (HMP) for the City by Resolution No. 65-2006, on August 16, 2006. The HMP has been designed to identify the areas where people or structures may have higher vulnerability to earthquakes, flood, wildland fires and other natural hazards. The HMP identifies policies and actions that may be implemented by the City to reduce the potential for loss of life and property damage in these areas, based on an analysis of the frequency of earthquakes, landslides, floods, and wildland fires in terms of frequency, intensity, location, history, and potential damage effects. The Plan also serves as a guide for decision-makers as they commit resources to reduce the effects of natural hazards.

City of South San Francisco General Plan

The Health and Safety Element of the City's General Plan includes a section on Geological and Seismic Hazards. This section identifies geotechnical and geologic impacts to the general City of South San Francisco area. The most recent General Plan update was completed in October 1999. The General Plan includes the requirement that new construction in South San Francisco must meet the requirements of the 1994 Uniform Building Code, and buildings of special occupancy are required by the State to meet more stringent design requirements.

City of South San Francisco Municipal Code

The CBC 2016 Edition, Vols. 1 and 2, including the California Building Standards, as modified by amendments, additions and deletions set forth in Chapter 15.08 of the South San Francisco Municipal Code, was adopted by reference as the building code of the City of South San Francisco.[3]

City of South San Francisco East of 101 Area Plan

In 1994, the City of South San Francisco developed the East of 101 Area Plan. The East of 101 Area Plan recognizes the unique character of the East of 101 Area, and seeks to guide and regulate development in a manner that protects and enhances the area's physical, economic and natural resources while also encouraging appropriate development. The East of 101 Area Plan Chapter 10, Geotechnical Safety Element sets forth specific guidelines with respect to site treatment and building design, and the unique geological hazards of the area. The East of 101 Area Plan Geotechnical Safety Element policies are as follows:

- **Policy GEO-1:** The City shall assess the need for geotechnical investigations on a project-by-project basis on sites in areas of fill shown in East of 101 Area Plan Figure 17, and shall require such investigations where needed.
- **Policy GEO-2:** Where fill remains under a proposed structure, project developers shall design and construct appropriate foundations.
- **Policy GE0-3:** Given the extensive use of the area for industrial and waste disposal purposes, investigation both by drilling and by examination of historic aerial photographs shall be conducted by project developers to determine if landfills exist under the project site prior to construction.
- **Policy GEO-4:** Project developers shall design developments on landfills and dump sites to deal safely with gas produced by the decomposition of the buried garbage. Inorganic soil capping over landfills

[3] City of South San Francisco Signature Report, November 14, 2016. Accessed at http://www.ssf.net/documentcenter/view/14621

shall be thick enough that excavation for repair of existing utilities or installation of additional utilities does not penetrate to buried garbage.

- **Policy GEO-5:** If hazardous fill, such as garbage organics, is encountered it shall be appropriately disposed by a project developer during construction. This material shall not be used for either structural fill or grading fill. However, other uses may be possible, such as landscaping around vegetation if the fill has a high organic content. If no acceptable use is found on-site, the hazardous fill should be properly disposed off-site.
- **Policy GEO-6:** Where a landfill or dump occurs under a proposed structure, project developers shall design and construct appropriate foundations.
- **Policy GEO-7:** New slopes greater than 5 feet in height, either cut in native soils or rock, or created by placing fill material, shall be designed by a geotechnical engineer and should have an appropriate factor of safety under seismic loading. If additional load is to be placed at the top of the slope, or if extending a level area at the toe of the slope requires removal of part of the slope, the proposed configuration shall be checked for an adequate factor of safety by a geotechnical engineer.
- **Policy GEO-8:** The surface of fill slopes shall be compacted during construction to reduce the likelihood of surficial sloughing. The surface of cut or fill slopes shall also be protected from erosion due to precipitation or runoff by introducing a vegetative cover on the slope or by other means. Runoff from paved or other parts of the slope shall be directed away from the slope.
- **Policy GEO-9:** Steep hillside areas in excess of 30 percent grade shall be retained in their natural state. Development of hillside sites should follow existing contours to the greatest extent possible and grading should be kept to a minimum.
- **Policy GEO-10:** In fill areas mapped on Figure 17 (in East of 101 Area Plan,) a geotechnical investigation to determine the true nature of the subsurface materials and the possible effects of liquefaction shall be conducted by the project developer before development.[4]
- **Policy GEO-11:** Development shall be required to mitigate the risk associated with liquefaction.
- **Policy GEO-12:** Structural design of buildings and infrastructure shall be conducted according to the Uniform Building Code and appropriate local codes of practice, which specify procedures and details to reduce the effects of ground shaking on structures.
- **Policy GEO-13:** Development within the preliminary boundary of the Coyote Point hazard area, as depicted on Figure 15 of the East of 101 Area Plan, shall be reviewed by a geotechnical engineer. Fault trenching may be required on individual development sites where feasible and determined necessary by the engineer. No structure for human occupancy shall occur within 50 feet of identified active faults, unless a geotechnical investigation and report determine that no active branches of that fault underlie the surface

South San Francisco General Plan Health and Safety Element

The 1999 South San Francisco General Plan Health and Safety Element contains policies designed to minimize the risks associated with development in areas of seismic hazards. As such, the South San Francisco General Plan, Health and Safety Element, has set forth specific guidelines with respect to site treatment and building design and the unique geological hazards of the area. The South San Francisco General Plan, Health and Safety Element, policies are as follows:

[4] East of 101 Area Plan, Figure 17 shows that portions of the Project site have fill over Bay mud

- **Implementing Policy 8.1-1**: Do not permit special occupancy buildings, such as hospitals, schools and other structures that are important to protecting health and safety in the community, in areas identified in Figure 8-2 of the South San Francisco General Plan, Health and Safety Element.
- **Implementing Policy 8.1-2**: Steep hillside areas (i.e., slopes in excess of 30 percent grade) should be retained in their natural state. Development of hillside sites should follow existing contours to the greatest extent possible. Grading should be kept to a minimum.

Impacts and Mitigation Measures

Thresholds of Significance

Based on the CEQA Guidelines, the Project would have a significant environmental impact if it were to:

1. Directly or indirectly cause potential substantial adverse effects, including the 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 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)
    b) Strong seismic ground shaking
    c) Seismic-related ground failure, including liquefaction
    d) Landslides
2. Result in substantial soil erosion or the loss of topsoil.
3. Be located on a geologic unit or soil that is unstable, or that would become unstable because of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.
4. Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property.
5. 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.

Approach to the Analysis

The Master Plan Update identifies potential Opportunity Sites as locations where new development or redevelopment within the Genentech Campus is likely to occur. The majority of these potential Opportunity Sites are in the same or similar locations as were contemplated and analyzed in the previous EIRs, and certain Setting information regarding geologic conditions remain valid and applicable to this new analysis of the Project. The analysis of the Project presented below relies upon known geologic conditions that are present in the Project Area and as updated for this EIR. To the extent that new Opportunity Sites have been identified that present new or substantially more severe impacts related to geologic conditions, these are specifically identified and discussed below.

Seismic Hazards

Geology 1: With implementation of all applicable regulatory requirements, future development pursuant to the Project would not expose people and/or structures to potentially substantial adverse effects

resulting from strong seismic groundshaking and seismic-related ground failure. **(Less than Significant)**

The Project Area is not within an Alquist-Priolo Seismic Hazard Zone, and no known active or potentially active faults traverse the Genentech Campus. Branches of the Hillside Fault have been mapped as crossing the South Campus area, but this fault is considered inactive and not prone to earthquake-induced fault offset. Because ground rupture generally occurs only at the location of a fault, and no active faults are known to traverse the Project Area, new development pursuant to the Project is not subject to substantial risk of surface fault rupture.

The Project Area is in one of the most seismically active regions in the U.S. and could be subject to violent shaking under a scenario earthquake along the San Andreas Fault, and very strong shaking under a scenario earthquake along the Peninsula Segments of the San Andreas or on the San Gregorio Fault. Strong seismic ground shaking has the potential to induce seismic-related ground failure (e.g., liquefaction) and lateral spreading. According to ABAG Liquefaction Hazard Maps[5], the Project Area has a high potential for liquefaction, including areas of the Genentech Campus with fill material overlying Bay Mud.

These impacts would be less than significant because all new development will be required to comply with regulatory requirements that fully address seismic hazards, as described below.

Regulatory Requirements

All new development pursuant to the Project will be required to comply with all applicable regulatory requirements for seismic hazards, including but not limited to the following:

- California Seismic Hazards Mapping Act, which enables the City of South San Francisco to withhold development permits until geologic or soils investigations are conducted for specific sites, and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils
- California Building Code, which provides minimum standards for building design including but not limited to regulations governing seismically resistant construction (Chapter 16, Section 1613)
- City of South San Francisco Municipal Code - Chapter 15.08, which includes CBC standards as further modified by amendments, additions, and deletions adopted as the building code of the City of South San Francisco
- East of 101 Area Plan, Chapter 10, which sets forth policies and specific guidelines pertaining to site development and building design applicable to the unique geological hazards in the East of 101 Area, including the Project Area

Regulatory Requirement Geology 1 – Seismic Hazards: Pursuant to regulatory requirements, Genentech will be required to retain a certified licensed geotechnical engineer to prepare site-specific geotechnical studies for each new development project pursuant to the Project.

1. Required geotechnical studies shall include site-specific geotechnical recommendations demonstrating compliance with all applicable seismic-related geotechnical engineering standards.
2. Recommendations shall be incorporated into individual development project designs and construction, providing an acceptable level of protection against seismic-related hazards.

[5] Accessed July 25, 2017, at: http://gis.abag.ca.gov/website/Hazards/?hlyr=liqSusceptibility

Mitigation Measures

No mitigation measures are required.

Project compliance with the state and City's codes and policies, including those outlined in the East of 101 Area Plan and the California Building Code, and applicable provisions of the Seismic Hazards Mapping Act, would ensure potential impacts related to seismic hazards would be reduced to a less than significant level.

Landslides

Geology 2: With implementation of all applicable regulatory requirements, most future development pursuant to the Project would not expose people and structures to potentially substantial adverse effects resulting from landslides. Future development on steep hillside sites could pose increased risks of slope instability and landslide potential. **(Less than Significant with Mitigation)**

Several portions of the Project Area contain relatively steep slopes, and general construction activities such as excavation and grading may create new slopes. Improper loading of fill materials or excessive irrigation practices could induce slope instability or landsliding. New development may occur on Opportunity Sites identified for potential future development (particularly for new parking garages) that are located along the base of the existing steep hillsides that slope up to the Upper Campus (**Figure 9-5**). To accommodate these hillside structures, deep cuts into the hillside would likely need to be performed, cutting into existing slopes that exceed 30 percent grade. These types of cuts into the hillside could exacerbate slope failure and/or result in landslide conditions if not conducted in a safe manner and consistent with applicable excavation design and slope stability standards. Impacts related to the risk of landslides and slope instability on these identified hillside Opportunity Sites pursuant to the Project is considered potentially significant. Mitigation measures to specifically address these hillside Opportunity Sites are recommended, below.

Grading of hillside Opportunity Sites would be inconsistent with current East of 101 Area Plan Seismic Safety Element policies (specifically Policy Geo-9), and would not be fully consistent with General Plan Implementing Policy 8.1-2, which provide that "*Steep hillside areas (i.e., slopes in excess of 30 percent grade) should be retained in their natural state. Development of hillside sites should follow existing contours to the greatest extent possible. Grading should be kept to a minimum.*" Inconsistencies with these General Plan policies are further addressed in the Land Use chapter of this EIR (see Chapter 13: Land Use).

Figure 9-5
Potential Development Opportunities as Compared to Steeper Hillside Locations

Regulatory Requirements

All new development pursuant to the Project on non-steep Hillside Opportunity sites will be required to comply with applicable regulatory requirements for slope stability and landslide prevention. These requirements include, but are not limited to the California Seismic Hazards Mapping Act, which enables the City of South San Francisco to withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures are incorporated into plans to reduce hazards associated with seismically induced landslides and slope instability. All new development pursuant to the Project on non-step Hillside Opportunity Sites will also be required to adhere to policies of the East of 101 Area Plan Geotechnical Safety Element, which sets forth policies and specific guidelines pertaining to site development and building design applicable to the unique geological hazards in the East of 101 Area.

Regulatory Requirement Geology 2 – Landslide Hazards: Pursuant to regulatory requirements, Genentech will be required to retain a certified licensed geotechnical engineer to prepare site-specific geotechnical studies for each new development project pursuant to the Project.

1. Required geotechnical studies shall include site-specific geotechnical recommendations demonstrating compliance with all applicable excavation design and slope stability standards. The East of 101 Area Plan Geotechnical Safety Element policies (specifically Policy Geo-7 through Geo-9) are designed specifically to mitigate impacts associated with landsliding and unstable slope conditions.
2. Recommendations shall be incorporated into individual development project designs and construction, providing an acceptable level of protection against landslide hazards.

Continued adherence to the City's codes and policies would ensure the maximum practicable protection available to minimize the risks associated with landsliding for new development at those Opportunity Sites not located on steep hillsides. These codes and policies reduce potential impacts at non-hillside sites to a level of less than significant (see mitigation measures below pertaining to steep hillside slopes).

Mitigation Measures

To address the potential for significant impacts associated with development at hillside Opportunity Sites (sites with slopes of 30 percent or greater), the following additional mitigation measure is recommended:

Mitigation Measure Geology 2 - Geotechnical Requirements for Hillside Opportunity Sites: Site-specific geotechnical studies required for each new development at hillside Opportunity Sites (sites with slopes of 30 percent or greater) shall including site-specific geotechnical recommendations to address the stability of existing and proposed slopes, as well as the stability of all proposed excavations. These investigations and recommendations may include, but are not limited to the following:

a) A geologic evaluation of the bedding properties of the underlying bedrock to determine if joints or fractures may project out of the proposed excavation during construction

b) Recommendations for appropriate shoring systems to be used when making vertical cuts, including evaluation of the stability of the excavation as well as job-site safety considerations

c) Evaluation of the drainage and infiltration properties of the existing slope bank

d) Installation of horizontal drains to remove seepage

e) Construction of a buttress wall at the base of the slope to reduce the risk of damage in the case of an accidental slope failure

Resulting Level of Significance

Compliance with applicable state and local regulations, and implementation of site-specific mitigation measures to be implemented at steeply sloped hillside Opportunity Sites would minimize the risk of landslide and slope failure, and potential impacts would be reduced to a less than significant level. Inconsistencies with current East of 101 Area Plan and General Plan policies that require steep hillside areas in excess of 30 percent grade to be retained in their natural state and where grading should be kept to a minimum are further addressed in the Land Use chapter of this EIR (see Chapter 13: Land Use).

Differential Settlement and Unstable or Expansive Soils

Geology 3: With implementation of all applicable regulatory requirements, future development pursuant to the Project that may be located on a geologic unit or soil that is unstable or that could become unstable because of development, and future development that may be on expansive soil, will not create a substantial risk to life or property. **(Less than Significant)**

Soils conditions vary throughout the Project Area and include bedrock belonging to the Franciscan complex, alluvial material and Bay Mud. Because of these varying soil conditions, the potential for soil expansion also varies throughout the Project area. Areas of unsuitable soils (such as improperly compacted fill material) exist throughout the Project Area, particularly in the Lower Campus and South Campus where fill soils have previously been placed over wetlands and Bay Mud. Bay Mud is expected to settle significantly under new fill and building loads depending on the thickness of new fill, the thickness of existing fill and Bay Mud and the history of fill placement, among other factors.

New development in these areas pursuant to the Project has the potential to result in damage to building foundations, which may compromise the stability of the overlying structure, as well as to create future liquefaction, subsidence or collapse problems leading to building settlement and utility line disruption. These impacts would be less than significant because all new development will be required to comply with regulatory requirements that fully address soils-related hazards.

Regulatory Requirements

All new development pursuant to the Project will be required to comply with all applicable regulatory requirements to address soils constraints, including but not limited to the following:

- California Seismic Hazards Mapping Act, which enables the City of South San Francisco to withhold development permits until geologic or soils investigations are conducted for specific sites, and mitigation measures are incorporated into plans to reduce hazards associated with seismically unstable soils
- California Building Code, Chapters 18A and 23 (or Uniform Building Code for Zone 4), which addresses building foundations and structural support requirements, subject to structural peer review
- City of South San Francisco Municipal Code - Chapter 15.08, which includes CBC standards as further modified by amendments, additions and deletions adopted as the Building Code of the City of South San Francisco
- East of 101 Area Plan, Chapter 10: Geotechnical Safety Element, which sets forth policies and specific guidelines pertaining to site development and building design applicable to soils conditions that exist in the East of 101 Area

Regulatory Requirement Geology 3 – Soils Hazards: Pursuant to regulatory requirements, Genentech will be required to retain a certified licensed geotechnical engineer to prepare site-specific geotechnical studies for each new development project pursuant to the Project.

1. Geotechnical studies shall include site-specific geotechnical recommendations demonstrating compliance with all applicable soils-related building design requirements.
2. Site-specific recommendations may include design features (such as expansion joints, mounting foundations on concrete piles), or replacing existing soils on a project site with stable fill material such that structures can withstand soils expansion. Building pad substrates may also be applicable on soils subject to expansive potential, and weak soils may require re-engineering specifically for stability. Soil treatment programs (replacement, grouting, compaction, drainage control, etc.) may be included in excavation and construction plans, and/or piling supports that conform to implementation criteria described in the CBC, Chapters 16, 18, and A33 may need to be designed and implemented.
3. All recommendations shall be incorporated into individual development project designs and construction, providing an acceptable level of protection against soils-related hazards.

Compliance with these regulations and project-specific recommendations (as applicable) will ensure that individual development project designs and construction of foundations and structures provide adequate protection against soils-related hazards as defined in the CBC, Uniform Building Code, and the East of 101 Area Plan Geotechnical Safety Element.

Mitigation Measures

No mitigation measures are required.

Adherence to the City's Codes and policies, including any project-specific recommendations to demonstrate full compliance, would ensure the maximum practicable protection available for soils hazards, and would result in a less than significant impact.

Substantial Soil Erosion or Loss of Topsoil

Geology 4: With implementation of all applicable regulatory requirements, future development pursuant to the Project would not result in substantial soil erosion or the loss of topsoil. (**Less than Significant**)

New development pursuant to the Project could potentially generate soil erosion, primarily from site preparation activities for new development. Vegetation removal in landscaped areas could reduce soil cohesion and remove buffers from wind, water and surface disturbance, potentially rendering exposed soils susceptible to erosive forces. Excavation or grading for any subterranean buildings or parking structures may result in erosion during construction activities as bare soils become exposed. Construction-period earth-disturbing activities would be temporary, and erosion effects would depend largely on the areas excavated, the quantity of excavation and the length of time soils are subject to conditions that would be affected by erosion processes.

Substantial erosion is unlikely to occur on an operational basis, and is not considered significant.

Regulatory Requirements

Regulatory Requirement Geology 4 – Grading Regulations: Pursuant to regulatory requirements, Genentech will be required to retain a certified licensed geotechnical engineer to prepare site-specific geotechnical studies for each new development project pursuant to the Master Plan Update. Geotechnical studies shall include site-specific geotechnical recommendations demonstrating compliance with all applicable erosion control requirements, including but not limited to the following:

1. California Building Code, Chapter 18 (which regulates excavation activities and the construction

of foundations and retaining walls) and Chapter 33 (which regulates grading activities, including drainage and erosion control)

2. Bay Area Air Quality Management District Rules regarding fugitive dust, which would stabilize soils and prevent erosion through the reduction of dust generation by up to 85 percent
3. All new qualifying construction projects pursuant to the Master Plan Update will be required to comply with Provision C.6 of the Municipal Regional Permit (MRP), including filing a Notice of Intent for permit coverage under the Construction General Permit, and preparation of a Stormwater Pollution Prevention Plan (SWPPP) that demonstrates compliance with the City's Grading Ordinances and other local requirements (see further details in Regulatory Requirement Hydro 1A in the Hydrology chapter of this EIR)
4. The evaluation of potential erosion of steeper slopes is also required as part of new development design in accordance with East of 101 Area Plan Geotechnical Safety Element policies. These policy requirements specify that slopes be graded and compacted during construction to reduce the likelihood of surface slumping or erosion, and that vegetative cover be applied to protect the slope from soil erosion.

All regulatory requirements will be incorporated into individual development project's construction activities to ensure that erosion is controlled to the maximum extent feasible. Adherence to these codes and regulatory requirements would result in a less than significant erosion impact.

Mitigation Measures

No mitigation measures are required.

The Project is required to comply with City and state codes, regulations and policies, including those outlined in the East of 101 Area Plan and the California Building Code, as well as the applicable NPDES General Construction Permit requirements for construction activities, which would ensure potential impacts related to erosion would be reduced to a less than significant level.

Septic Tanks

Geology 5: Future development pursuant to the Project would be served by the existing municipal sewer system. No septic tanks or alternate waste disposal systems are proposed for development. (**No Impact**)

Sewage and wastewater generated within the Project Area is collected through the City's sewer system and is disposed of and treated at the South San Francisco/San Bruno Water Quality Control Plant. The sanitary sewer system has an interconnecting network of gravity sewers, force mains, and pump stations, which function together to bring wastewater from the Genentech Campus to the South San Francisco/San Bruno Water Quality Control Plant. Existing infrastructure is located throughout the Project Area, and any new development would connect to or expand the existing wastewater lines. No septic tanks or alternative wastewater systems are proposed, and there would be no impact.

Cumulative Geologic Effects

The geographic context for the analysis of impacts resulting from geologic hazards is generally site-specific rather than cumulative in nature. Each development site has a different set of geologic considerations that would be subject to specific site development and construction standards. As such, the potential for cumulative geologic impacts to occur is limited.

All cumulative development is required to be constructed in conformance with the provisions of applicable federal, State, county and city laws and ordinances, including but limited to the California Building Code, the

East of 101 Area Plan Geotechnical Safety Element, and City building codes. With adherence to all relevant plans, codes and regulations pertaining to building design and construction, cumulative development would provide adequate levels of safety, cumulative geologic impacts would be less than significant and the Project would not present a cumulatively considerable contribution to cumulative geologic impacts.