

4.13 GEOLOGY, SOILS, AND SEISMICITY

Introduction

The analysis contained in this section is based upon a review of information regarding the regional geologic, soil, and seismic conditions of the proposed Corridor Plan and the Bay Meadows project as contained in the *1995 San Mateo General Plan*, a Geohazards and Geotechnical Feasibility Evaluation prepared by Lowney Associates in April 2003, and the Preliminary Geotechnical Investigation prepared by Treadwell and Rollo in October 2002.¹ Copies of the April 2003 Lowney Associates report are available for public review at the City of San Mateo Planning Division.

Throughout this section, references to the Corridor Plan Area include the Bay Meadows project site unless otherwise noted. The setting discussion prepared for the Corridor Plan Area would also be applicable to the regional and local vicinity conditions of the Bay Meadows project site. Discussion of impacts and corresponding mitigation measures are, however, provided separately for each project.

For the purposes of this EIR, all project site elevations are based on San Mateo Datum equivalent to mean sea level -2.36 + 100 feet.

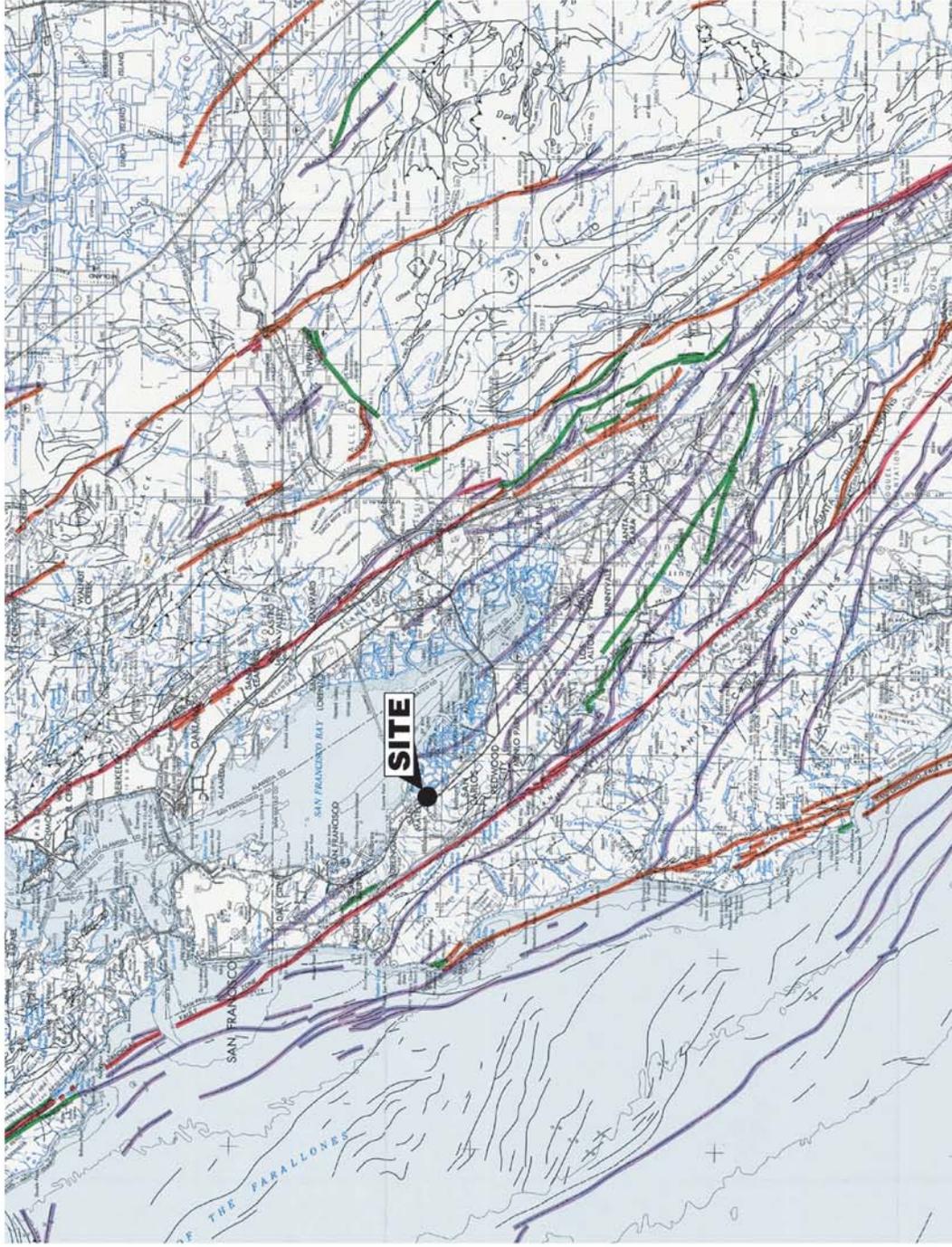
Existing Conditions

Regional Geology

The San Francisco Peninsula is a relatively narrow band of rock at the north end of the Santa Cruz Mountains separating the Pacific Ocean from San Francisco Bay. It represents one mountain range in a series of northwesterly-aligned mountains forming the Coast Ranges geomorphic province of California that stretches from the Oregon border on the north nearly to Point Conception on the south. In the San Francisco Bay area, most of the Coast Ranges have developed on a basement of tectonically mixed Cretaceous- and Jurassic-age (70- to 200-million years old) rocks of the Franciscan Complex. These basement rocks are capped locally by younger sedimentary and volcanic rocks. Most of the Coast Ranges are covered by younger surficial deposits that reflect geologic conditions for about the last million years.

In San Mateo County, the lithologic associations are divided into several assemblages of fault-bounded blocks that contain unique stratigraphic sequences. The major fault in the region is the San Andreas Fault, located approximately 3.5 miles southwest of the project area (see Figure 4.13-1 for a regional fault map). Lateral and vertical movement on the many splays of the San Andreas Fault system and other secondary faults has produced the dominant northwest-oriented structural and topographic trend seen today throughout the Coast Ranges.

¹ This section incorporates by reference all of the sources from these reports.



Geologic Time Scale	Years Before Present (Approx.)	Fault Symbol	Reactivity Movement on Land (Approx.)	DESCRIPTION
Quaternary	0	Red line	0-200	Displacement during historic time (e.g., San Andreas fault 1906), includes areas of known fault.
Quaternary	0-200	Orange line	0-200	Displacement during Holocene time?
Quaternary	0-200	Green line	0-200	Faults showing evidence of displacement during late Quaternary time. ^{3,4}
Quaternary	0-200	Purple line	0-200	Quaternary (undifferentiated) faults - most faults in this category show evidence of displacement during the last 2,000,000 years; possible exceptions are faults that displace rocks of undifferentiated Pleistocene age.
Pre-Quaternary	2,000,000	Black line	2,000,000	Faults showing evidence of no displacement during Quaternary time or faults without recognized Quaternary displacement.
Miocene	5,000,000	Black line	5,000,000	

1. Base map is a composite of part of the San Francisco 1:250,000 scale map (reference code 37 122-A1-TF-250-0, 1980) and the San Jose 1:250,000 scale map (reference code 37 120-A1-TF-250-00, 1969). For cartographic details, refer to these maps. Bathymetric information is not intended for navigational purposes.
 2. Transverse Mercator Projection 10,000-meter Universal Transvers Mercator grid, zone 10.
 3. Minor corrections and additions to culture by California Division of Mines and Geology 1987.
 4. From: Bortugno & others.
- Note: Some faults highlighted in purple are not considered active (Holocene Movement) by the State of California.

Source: Lowney Associates

FIGURE 4.13-1
Regional Fault Map - San Mateo, California

This trend reflects the boundary between two of the Earth's major tectonic plates: the North American plate to the east and the Pacific plate to the west. The San Andreas Fault system is about 40 miles wide in the Bay Area and extends from the San Gregorio fault at the coastline to the Coast Ranges-Central Valley blind thrust at the western edge of the Great Central Valley. The San Andreas Fault is the dominant structure in the system, nearly spanning the length of California, and capable of producing the highest magnitude earthquakes. Many other subparallel or branch faults within the San Andreas system are equally active and also capable of generating large earthquakes. Right-lateral movement dominates on these faults, but an increasingly large amount of thrust faulting resulting from compression across the system is now being identified (Lowney, 2003).

The site vicinity is situated within a broad, downwarped valley that extends from an area south of Hollister, to north of San Pablo Bay, and is located approximately one mile west of the San Francisco Bay. The structural depression containing the San Francisco Bay has subsided during the past five to eight million years, as indicated by various stream channel deposits now below sea level. The fills across portions of the project site are underlain by younger alluvial fan deposits consisting of unconsolidated fine sand, silt, and clayey silt. Information from a nearby off-site well indicates that the alluvial and bay mud sediments are underlain at a depth of about 80 feet by bedrock of the Franciscan assemblage (Lowney Associates, 1996). Bedrock and unconsolidated sediments in the San Francisco Bay region range from Jurassic (150 million years) to Holocene (10,000 years) in age.

Project Area Geology and Soils

Corridor Plan Area

The Corridor Plan Area is underlain by artificial fill of Historic age, alluvial fan and fluvial deposits of Holocene age, and minor basin deposits of Holocene and Pleistocene age. The alluvial fan and fluvial deposits are associated with the drainages from the hillsides. The only mapped bedrock units within the area consist of Franciscan chert and graywacke of Cretaceous-Jurassic age immediately south of Hillsdale Avenue and Laurel Creek, near the intersection with El Camino Real. The hills immediately to the southwest and south are underlain mostly by bedrock of the Franciscan assemblage, including sandstone, graywacke, and greenstone. The distribution of the various geologic units is depicted on Figure 4.11-1 in Section 4.11, Hazardous Materials.

As shown on Figure 4.11-1, artificial fill occupies a large portion of the northeastern and central eastern portions of the project area. The fill was placed since the late 1800s over the marshes of San Francisco Bay to create new land, and consists of heterogeneous mixtures of loose to very well consolidated gravel, sand, silt, clay, rock fragments, organic matter, and man-made debris. The thickness varies throughout the area, from generally thin along the western fill boundary to more than 30 feet in some places. This unit also includes artificial fill placed as highway embankments (e.g., Highways 92 and 101, and portions of El Camino Real). This artificial fill is generally engineered and therefore more homogeneous, compacted and firm. Fill placed before 1965 is nearly everywhere not compacted. The artificial fill is generally underlain by Holocene

Bay Mud, which overlies Holocene and Pleistocene alluvial and fluvial deposits. Test borings on the Bay Meadows project site indicate that Bay Mud is present on the eastern side of the site between the northern boundary of the Franklin Resources Corporate Center and the San Mateo Expo. Eight to 10 feet of artificial fill overlay 0 to 10 feet of Bay Mud in this eastern edge of the site (Treadwell and Rollo, 2002).

The Holocene alluvial fan and fluvial deposits consist mostly of medium dense to dense gravelly sand or sandy gravel that generally grades upward to sandy or silty clay. The Holocene basin deposits consist of silty clay and clay at the distal edges of alluvial fan deposits. The Pleistocene alluvial fan and fluvial deposits are similar, and can be distinguished from the younger deposits because they are generally at higher elevations, are more dissected by erosion, and have stronger soil development. Bedrock, most likely of the Franciscan assemblage, underlies the historic, Holocene, and Pleistocene deposits at depth.

Two general soil map units have been mapped by the Soil Conservation Service (SCS), currently known as the Natural Resource Conservation Service (NRCS), within the project area. These include the Urban Land-Orthents Reclaimed units (which correspond to the Artificial fill materials shown in Figure 4.13-1) and the Urban Land-Orthents units (which correspond to the basin, alluvial fan and fluvial deposits shown in Figure 4.13-1) (Lowney, 2003). The Urban Land Orthents-Reclaimed consist of urban land, and very deep, nearly level, poorly drained and somewhat poorly drained soils on reclaimed tidal flats. This unit coincides mostly with the geologic unit of artificial fill overlying Bay Mud west of Highway 101. The Urban Land-Orthent soils consist mostly of urban land, and deep and very deep, nearly level and gently sloping, poorly drained to well drained soils on alluvial fans and similar deposits west of the previous unit (Lowney, 2003).

Bay Meadows

The underlying soils on the Bay Meadows project site are moderately to severely corrosive as determined by resistivity testing of the on-site soils (EDAW, 1996). Test borings on the site indicate it is blanketed by about 2 to 8 feet of clayey and sandy fill with gravel. Bay Mud was encountered below the fill along most of the eastern edge of the site in an area that ranges from about 300 to 800 feet in width (from north to south). The Bay Mud is medium stiff and appears to be desiccated. Borings indicate the Bay Mud is up to 10 feet thick. The fill and Bay Mud are generally underlain by alluvial deposits consisting of interbedded medium stiff to hard clay and medium dense to very dense sand (Treadwell and Rollo, 2002).

Topography

Corridor Plan Area

The project area is located mainly on the relatively flat valley floor skirting the northeastern flanks of the San Francisco Peninsula and partially occupies former marshes of San Francisco Bay. The project area slopes generally to the north and northeast from elevations of approximately 25 feet above sea level along the base of the hills on the western edge of the project area to approximately one or two feet above sea level in the vicinity of Highway 101 (Lowney, 2003). The average area elevation is approximately 10 feet above sea level. The hills of the Coast Ranges lying immediately southwest of the area rise to elevations of over 500 feet. The

project area is bisected by Laurel Creek, the major drainage extending from northwest to southeast, approximately parallel to Hillsdale Avenue (Lowney, 2003).

Bay Meadows

The racetrack area is graded and is occupied by a 90-foot tall grandstand, the racetrack and other ancillary facilities. Based on an aerial topographic survey, grades range from elevation 100 to 110 feet (datum unspecified) from east to west across the stable area (EDAW, 1996). The bottom of the detention ponds is below elevation 94 feet.

Seismicity

Regional Active Faults

The San Francisco Bay Area is recognized by geologists and seismologists as one of the most seismically active regions in the United States. The significant earthquakes that occur in the Bay Area are generally associated with crustal movement along well defined, active, fault zones of the San Andreas Fault system, which regionally trend in a northwesterly direction. The regional fault map illustrating known active faults relative to the project area (Figure 4.11-1) shows that the San Andreas Fault, which generated the great San Francisco earthquake of 1906, passes about 3.5 miles southwest of the project area. Two other major active faults in the area are the Hayward Fault, located approximately 15 miles northeast of the project area, and the Calaveras fault, located approximately 23 miles northeast of the project area.

Historical Earthquakes

Data from the U.S. Geological Survey Earthquake Data Base System and other historical sources indicate that between 1800 and December 1997, 80 known earthquakes of Richter Magnitude 5 or greater have occurred within 100 kilometers of the project area. Three earthquakes of Richter Magnitude 7 or greater have occurred during the same period, including the Loma Prieta Earthquake of 1989, centered about 42 miles from the project area (Lowney, 2003).

Future Earthquake Probabilities

Although research on earthquake prediction has greatly increased in recent years, seismologists cannot predict when or where an earthquake will occur. The U.S. Geological Survey's Working Group on California Earthquake Probabilities, referred to as WG99, determined that there is a 70 percent chance ($\pm 10\%$) of at least one magnitude 6.7 or greater earthquake striking the San Francisco Bay region by 2030 (Lowney, 2003). On April 22, 2003 the WG99 (which continues working as the WG02), updated their estimates on the probability of a magnitude 6.7 or greater earthquake between 2003 and 2032 to a 62% chance of such an earthquake anywhere in this region. Any major earthquake can cause damage throughout the region, as dramatically demonstrated when the 1989 Loma Prieta earthquake caused severe damage in Oakland and San Francisco, more than 50 miles from the fault rupture zone (Lowney Associates, 2003).

Geologic Hazards

Surface Fault Rupture

Surface expression of fault rupture is typically observed and is expected on or within proximity to the causative fault.² Surface rupture can severely damage buildings or result in collapse of the structure. The magnitude, sense, and nature of fault rupture can vary for different faults or even along different traces of the same fault. Fault rupture caused by a large earthquake on an active fault in the region could have potentially substantial adverse effects on a development if the fault crosses the project area. Thus, identifying such faults at a project site is required in California in accordance with the Alquist-Priolo Earthquake Fault Zoning Act. A regional fault map illustrating known active faults relative to the site is presented as Figure 4.11-1. As shown on this figure and on the geologic map of Figure 4.13-1, no known surface expression of active faults is known to exist within the project area (Lowney, 2003). The closest zoned active fault to the project area is the San Andreas, which passes approximately 3½ miles to the southwest. Primary fault rupture through the area, therefore, is not anticipated.

Groundshaking

The project area could be affected by strong groundshaking caused by a major earthquake during the next 30 years. This hazard is common to all development in the San Francisco Bay Area. Groundshaking may affect areas hundreds of miles distant from the earthquake's epicenter. Historic earthquakes have caused strong groundshaking and damage in the San Francisco Bay Area, the most recent being the 6.9 (moment magnitude) Loma Prieta earthquake in October 1989. The epicenter for this event was approximately 40 miles southeast of the project area; the earthquake caused strong groundshaking for about 20 seconds and resulted in varying degrees of structural damage throughout the Bay Area.

The composition of underlying soils in areas located relatively distant from faults can intensify groundshaking. The areas that experienced the worst structural damage due to the Loma Prieta earthquake were not those closest to the fault, but rather those with soils that magnified the effects of groundshaking. Areas that are underlain by bedrock tend to experience less groundshaking than those underlain by unconsolidated sediments such as artificial fill. Alluvial-type soils underlying the project site have a moderate to high potential of amplifying groundshaking during an earthquake (Lowney, 2003).

Groundshaking causes most damage during earthquakes. Unreinforced masonry buildings are those most likely to collapse within the City (EDAW, 1996). Tall and mid-rise buildings also have the potential for heavy damage or collapse during severe groundshaking. A major earthquake on the San Andreas or Hayward Fault, with an epicenter near the project area, could produce high levels of groundshaking.

² Fault rupture is displacement at the earth's surface resulting from fault movement associated with an earthquake.

Soil Erosion

Soil erosion is the process whereby soil materials are worn away and transported to another area either by wind or water. Rates of erosion can vary depending on the soil material and structure, placement and human activity. Soil containing high amounts of silt is often easily eroded while sandy soils are less susceptible. Excessive soil erosion can lead to damage of building foundations, roadways and stream embankments. The erosion potential for soils in the project area is variable because the soils have an erosion hazard ranging from none to moderate. Soils within the project area include mostly poorly drained silty clay loam along the northern portion of the area, and moderately drained sandy and gravelly loam on the southern portion of the area. Runoff is typically slow to medium. Correspondingly, the existing hazard of erosion is none to moderate (Lowney, 2003).

Expansive/Corrosive Soils

Shrink and swell movements occur in fine-grained sediments containing expansive clays. Soils containing high clay content often exhibit a moderate to high potential to expand when saturated, and contract when dried out. This shrink/swell movement can adversely affect building foundations, often causing them to crack or shift, with resulting damage to the buildings they support. The soils of the Holocene Bay Mud and basin deposits as well as the Pleistocene alluvial deposits found in the project area contain clay and therefore have the potential for shrink/swell movement. However, there are relatively minor economic losses from these conditions, and there are no risks to human life associated with the shrink/swell condition of clayey soils. Proper foundation engineering can usually overcome this problem.

Depending on their acidity and alkalinity, some soil can be highly corrosive and result in damage to buried concrete, steel pipes and electrical conduits. Soil compaction from surface loading (buildings and other structures) decrease the soil permeability and increase the corrosion potential. Soil testing was conducted on the Bay Meadows site to measure soil pH, electrical conductivity, and to determine the concentrations of chloride and sulfate ions in the fill and Bay Mud. Based on test results, the Bay Mud was classified as “severely corrosive” and the fill was classified as “corrosive.” The testing also indicated that the chloride ion concentrations in the Bay Mud are sufficient to attack concrete and reinforcing steel embedded in concrete mortar coating (Treadwell and Rollo, 2002).

Liquefaction

Liquefaction is the process by which water-saturated soil materials lose strength and become susceptible to failure during strong groundshaking in an earthquake. The shaking causes the pore-water pressure in the soil to increase, thus transforming the soil from a solid to a liquid. Liquefaction has been responsible for ground failures during almost all of California’s large earthquakes. Soils most susceptible to liquefaction are clean, loose, saturated, uniformly graded and fine-grained sands. The depth to groundwater also controls the potential for liquefaction in this area; the shallower the groundwater, the higher potential for liquefaction.

The California Seismic Hazards Mapping Act, passed in 1990, addressed non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides. The State of California is in the process of issuing Seismic Hazards Zones Maps on 7.5-minute topographic quadrangles that identify the areas susceptible to liquefaction and earthquake-induced landsliding. The Seismic Hazard Zones Map of the San Mateo quadrangle, in which the project area is located, has not been issued yet by the California Geological Survey (CGS), but the hazards have been addressed by the U. S. Geological Survey (Lowney, 2003).

The liquefaction susceptibility evaluated by the USGS is based on peak ground accelerations necessary to trigger liquefaction and estimated ground water levels for the geologic units. The USGS has concluded that about 50 percent of all historical occurrences of liquefaction in the San Francisco Bay Region, and about 80 percent of liquefaction occurrences resulting from the Loma Prieta earthquake were in deposits of artificial fill overlying Bay Mud deposits. Therefore, the area underlain by artificial fill and Bay Mud in the project area (generally the northeast and central-eastern portion of the project area) is generally considered to have a very high susceptibility to liquefaction. On the other hand, alluvial and fluvial fan deposits in the project area (the remainder of the project area) are considered to have low to moderate liquefaction susceptibility. See Figure 4.13-1 for a map indicating the soil type in the project area.

Although in the Bay Meadows project site the general high liquefaction susceptibility condition is found, site specific geotechnical studies conclude in general that the Bay Mud ranges from medium stiff to stiff and is desiccated, and the overlying artificial fill materials consist of medium dense to dense clayey sand in that area. These materials, even when saturated, have a low potential for liquefaction and lateral spreading (Lowney, 2003).

Settlement

Settlement is the drop in elevation of a ground surface caused by settling or compacting of soils under the weight of existing fill and any new fills or building loads. This settlement would generally be gradual and can continue beyond the life of a project's development. The amount of settlement is primarily influenced by the thickness of the Bay Mud, the site history, the thickness of the existing and proposed fills, and the layout and magnitude of any building loads. Differential settlement is uneven settlement, where one part of a structure settles more or at a different rate than another part. Differential settlement could be expected to occur in areas where building loads supported on fill vary substantially.

Differential Compaction

If near-surface materials vary in composition either vertically or laterally, as they do in the project area, major earthquake shaking can cause non-uniform compaction, resulting in settlement of the materials and overlying facilities. This can also occur gradually over a long period of time. Differential compaction could be responsible for part of the cracking in the asphalt and concrete flatwork presently seen in many locations throughout the project area. Below the weak artificial fill that occurs throughout the project area is highly compressible and highly corrosive clay known as Bay Mud. Alluvial and fluvial deposits, basin deposits, and

bedrock also occur throughout the project area, and each of these materials has different strength characteristics. As such, some portions of the project area would be susceptible to differential compaction.

Lateral Spreading

Lateral spreading occurs as a response to earthquake-induced ground shaking, and is the movement of ground material toward a free face (i.e., a cliff or stream bank). Lateral spreading typically occurs as a form of horizontal displacement of relatively flat-lying material toward an open face such as an excavation, channel, or body of water. Generally in soils, this movement is due to failure along a weak plane and may often be associated with liquefaction. As cracks develop within the weakened material, blocks of soil displace laterally towards the open face. Cracking and lateral movement may gradually propagate away from the face as blocks continue to break free. Lateral spreading potential is highest in areas underlain by soft, saturated materials, especially where bordered by steep banks or adjacent hard ground. Lateral spreading is possible along the banks of water drainage courses that are not constrained in concrete channels and/or by other protective measures such as the 16th Avenue Channel, the 19th Avenue Channel and Laurel Creek, which all traverse the Corridor Plan Area. Because there are no steep banks or hard ground bordering the project area, there is a low potential for lateral spreading (Lowney, 2003).

Slope Instability

Based on a map showing slope stability during earthquakes in San Mateo County, the project area is shown to be within an area of very low susceptibility to landsliding due to seismically induced slope failure (Lowney, 2003). This is generally because the topographic slopes are very gentle throughout the area.

Regulatory Background

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act, signed into law December 1972, requires the delineation of zones along active, potentially active, and well-defined faults. The Corridor Plan Area does not contain a currently designated Alquist-Priolo Earthquake Fault Zone, known formerly as a Special Studies Zone (Lowney, 2003). The purpose of the Alquist-Priolo Earthquake Fault Zoning Act is to mitigate the hazard of surface faulting to structures for human occupancy and 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. This state law was a direct result of the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures.

No known surface expression of active faults is believed to exist within the project area (Lowney, 2003). The closest zoned active fault to the project area is the San Andreas, which passes approximately 3.5 miles to the southwest. Primary fault rupture through the project area, therefore, is not anticipated.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act enacted by the California legislature in 1990 was developed to protect the public from the effects of strong groundshaking, liquefaction, landslides, or other ground failure and other hazards caused by earthquakes. This Act requires the State Geologist to delineate various seismic hazard zones and requires cities, counties and other local permitting agencies to regulate certain development projects within these zones. Before a development permit is granted for a site within a seismic hazard zone, a geotechnical investigation of the site has to be conducted and appropriate mitigation measures incorporated into the project design.

The State of California is in the process of issuing Seismic Hazards Zones Maps on 7.5-minute topographic quadrangles that identify the areas susceptible to liquefaction and earthquake-induced landsliding. The Seismic Hazard Zones Map of the San Mateo quadrangle, where the project area is located, has not been issued yet by the California Geological Survey (CGS), but the hazards have been addressed by the U. S. Geological Survey (Lowney, 2003).

California Building Code

The California Building Code is another name for the body of regulations known as the California Code of Regulations (C.C.R.), Title 24, Part 2, which is a portion of the California Building Standards Code. Title 24 is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. Under State law, all building standards must be centralized in Title 24 or they are not enforceable.

Published by the International Conference on Building Officials, the Uniform Building Code is a widely adopted model building code in the United States. The California Building Code incorporates by reference the Uniform Building Code with necessary California amendments. About one-third of the text within the California Building Code has been tailored for California earthquake conditions.

City of San Mateo

The Safety Element of the *City of San Mateo General Plan* contains a Geologic and Seismic Hazards section, as required by State law (Government Code Section 65302). In addition to identifying and assessing known conditions and seismic hazards, the General Plan lays out one goal with four corresponding policies. Listed below are the goal and four policies that the City has adopted to reduce injury and damage from earthquakes.

Goal 1: Take steps to protect the community from unreasonable risk to life and property caused by seismic and geologic hazards.

Policy 1. Geologic Hazards. Require site specific geotechnical and engineering studies, subject to the review and approval of the City Engineer and Building Official, for development proposed on sites identified in Figure S-2 (of the General Plan) as having moderate or high potential for ground failure. Permit development in areas of potential geologic hazards only where it can be demonstrated that the project will not be endangered by, nor contribute to, the hazardous condition on the site or on adjacent properties.

Policy 2. Hillside Development Standards. Regulate hillside development consistent with the City's Site Development Code and Open Space/Conservation Policy 3.1.

Policy 3. Erosion Control. Require erosion control measures for all development sites where grading activities are occurring, including those having landslide deposits, past erosion problems, the potential for storm water quality impacts, or slopes of 15% or greater which are to be altered. Control measures shall retain natural topographic and physical features of the site if feasible.

Policy 4. Unreinforced Masonry Buildings. Establish and maintain a program which requires mandatory modifications of existing unreinforced masonry buildings identified as being potentially hazardous, and similar unsafe building conditions, to reduce the associated life safety hazards. The design of building modifications should be in keeping with character of existing architecture.

Impacts and Mitigation Measures

Significance Criteria

According to Appendix G of the *CEQA Guidelines*, the following effects would be considered significant if the project would expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

- fault rupture;
- strong seismic ground shaking;
- seismic ground failure, including liquefaction;
- landslides or mudflows;
- erosion or the loss of topsoil;
- on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse;
- expansive soils; or
- inadequate soils for supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available.

Methodology

This impact analysis focuses on potential effects to geologic resources and soils associated with seismic events around the Corridor Plan Area and Bay Meadows project site. The evaluation was conducted based on current information regarding the geologic, soil, and seismic characteristics of the project area, subsurface testing, project plans and applicable regulations and guidelines.

Evaluation of impacts and corresponding mitigation measures are provided separately for the Corridor Plan and the Bay Meadows project. Because the Corridor Plan Area includes the Bay Meadows project site, impacts and mitigation for the Corridor Plan would apply to the Bay Meadows site as well. However, impacts and mitigation measures described for the Bay Meadows project apply only to that independent project.



Corridor Plan Impacts and Mitigation Measures

This section provides an environmental evaluation of the potential impacts that could result with implementation of the Corridor Plan. The potential for geological, soils, and seismic impacts would be the same for both Corridor Plan development scenarios (Scenarios A and Z) and therefore, no distinction between the scenarios is made in this evaluation.

Seismic Impacts

Impact Geology-CP1: Implementation of the Corridor Plan (Scenarios A and Z) would increase the number of people that could be injured and the amount of property that could be damaged as a result of ground shaking associated with a seismic event. This would be a significant impact.

Active faults are located in the project site region. These faults could cause strong seismic ground shaking in the project area in the event they generate a large earthquake. Heavy damage would be expected from such earthquakes, especially in areas underlain by artificial fill and alluvial and fluvial deposits. Further, the Corridor Plan Area lies in zones designated as having a potential for “moderate,” “moderately high,” “high,” and “very high” ground shaking. Earthquakes originating on any of the nearby active fault zones would be expected to produce moderate to severe ground shaking at the site. The proposed project would result in additional homes and businesses, thus putting more people at risk of injury and property at risk of damage or loss due to earthquakes. This would be a significant impact.

Mitigation Measure Geology-CP1: The City shall require all applicants for projects in the Corridor Plan Area to implement seismic design standards of the current Uniform Building Code in effect at the time of project review.

Significance After Mitigation: Less than significant.

Impact Geology-CP2: Implementation of the Corridor Plan (Scenarios A and Z) would result in additional property that could be damaged and people that could be injured in the event of surface fault rupture. This would be a less than significant impact.

For the purposes of this EIR, rupture of a fault designated in the Alquist-Priolo Earthquake Fault Zoning Map would be considered significant. The project area does not contain a currently designated Alquist-Priolo Earthquake Fault Zone. Further, the closest zoned active fault to the project area is the San Andreas, which passes approximately 3.5 miles to the southwest of the project area. As such, fault rupture in the project area is not anticipated and the probability is low that the new development constructed in the Corridor Plan Area would be subjected to the hazards of surface fault rupture. Therefore, this would be a less-than-significant impact.

Mitigation Measure Geology-CP2: None required.

Impact Geology-CP3: Development associated with the Corridor Plan (Scenarios A and Z) would increase the number of people and structures exposed to potential adverse effects associated with seismically induced ground failure, including liquefaction and lateral spreading. This would be a significant impact.

The artificial fill in areas that are underlain by Bay Mud generally consist of medium dense to dense fine granular soils. In addition, ground water is generally considered to be at the top of the Bay Mud, meaning that the fill above the Bay Mud also can become saturated. As such, the artificial fill over the Bay Mud may have a high susceptibility to liquefaction during seismic shaking. Other portions of the project area not underlain by Bay Mud and fill would be less susceptible to liquefaction and related damage. Lateral spreading, often associated with liquefaction, is less likely because there are no steep banks or hard ground bordering the project area, but could still potentially be a hazard. This would be a potentially significant impact.

Mitigation Measure Geology-CP3: The City shall require all applicants for projects in the Corridor Plan Area to prepare a design-level geotechnical study for each project development before a grading permit is issued. The appropriate mitigation methods and extent of required mitigation would be determined at the time of project approval by the City based on the actual subsurface soils at the project location.

Significance After Mitigation: Less than significant.

Soils and Geotechnical Impacts

Impact Geology-CP4: Construction activities associated with the Corridor Plan (Scenarios A and Z) that would involve excavation and earthmoving could cause erosion or loss of topsoil, which could result in damage to buildings and infrastructure. This would be a potentially significant impact.

Construction activities would involve excavation, moving, filling, and the temporary stockpiling of soil. Earthwork associated with development construction could expose soils to erosion. Soils within the project area include mostly poorly drained silty clay loam and moderately drained sandy and gravelly loam. Soil containing high amounts of silt is often easily eroded while sandy soils are less susceptible. Some of the soils that exist within the Corridor Plan Area have a “moderate” erosion hazard. Excessive soil erosion can lead to damage of building foundations, roadways, and stream embankments. As such, this would be a potentially significant impact.

Mitigation Measure Geology-CP4: As determined appropriate by the City, the City shall require applicants for projects in the Corridor Plan Area to implement standard control measures for erosion prevention during construction, including those stipulated by permit regulations of the Urban Runoff Pollution Prevention Program and National Pollutant Discharge Elimination System as well as a Storm Water Pollution Prevention Plan. Typical erosion control features may include:

- **Protecting disturbed areas through minimization and duration of exposure. For example, by covering disturbed areas with rolled plastic sheeting or other like material;**
- **Controlling surface runoff (i.e. sand bags) and maintaining low runoff velocities;**

- Trapping sediment on-site; and
- Minimizing length and steepness of slopes.

Significance After Mitigation: Less than significant.

Impact Geology-CP5: Development associated with the Corridor Plan (Scenarios A and Z) would potentially be subject to damage from expansion of the near surface soils. This would be a potentially significant impact.

The soils of the Holocene Bay Mud and basin deposits as well as the Pleistocene alluvial deposits found in the project area contain clay and therefore have the potential for shrink/swell movement. This shrink/swell movement can adversely affect building foundations, often causing them to crack or shift, with resulting damage to the buildings they support. As such, residential and commercial structures constructed in the Corridor Plan Area on slab foundations would be exposed to potential structural impacts due to the presence of expansive soils. Additionally, some vertical movement of the exterior slabs, sidewalks, and pavement could result from volume changes in the surface soils during fluctuations in moisture content.

Mitigation Measure Geology-CP5: For projects in the Corridor Plan Area on sites underlain by soils of Holocene Bay Mud and basin deposits or of Pleistocene alluvial deposits, the City shall require that applicants prepare a design-level geotechnical study for each project development before a grading permit is issued. The study shall specifically address whether expansive soils are present in the development area and include measures to address these soils where they occur. Methods to address expansive soils include regrading areas with appropriate soils and adding special design features to foundations and other underground facilities. Measures included in the report will be implemented as appropriate, based on the specific soil conditions and the type of facility being constructed.

Significance After Mitigation: Less than significant.

Impact Geology-CP6: Development associated with the Corridor Plan (Scenarios A and Z) would be subject to potentially substantial damage from differential compaction and settlement of existing soil and fill materials. This would be a significant impact.

Portions of the site are underlain by highly compressible soil. Depending on the particular site's conditions, differential settlements on the order of 4 to 12 inches or greater, may be possible depending on the thickness of the compressible layer. As such, major groundshaking in the project area could potentially cause non-uniform compaction of the soil strata, resulting in differential ground surface movement. Such an event would increase the danger to people and structures.

Mitigation Measure Geology-CP6: The City shall require applicants for projects in the Corridor Plan Area to employ engineering methods to minimize the potential for damage from differential compaction by reworking the existing fills within areas of new construction on sites built upon

existing fill. This may include removing the compressible soil and replacing it with engineered fill, ground improvements, stiffer foundation elements (grid footings, mats), or deep foundations. Compressible soil and associated foundation considerations should be addressed during a design-level geotechnical study for specific projects.

Significance After Mitigation: Less than significant.

Impact Geology-CP7: The corrosiveness of project area soils could cause damage to buried concrete slabs and foundations and buried metal pipes during the operation of projects constructed as a result of implementation of the Corridor Plan (Scenarios A and Z). This would be a significant impact.

Results of soil testing on the Bay Meadows project site classified the Bay Mud as “severely corrosive” and the fill as “corrosive.” The testing also indicated that the chloride ion concentrations in the Bay Mud are sufficient to attack concrete and reinforcing steel embedded in concrete mortar coating. In addition to the Bay Meadows site, Bay Mud and fill are located in the northeastern and central eastern portions of the project area. Corrosive soil can affect underground structures and utilities. Because corrosive soils could cause failures to underground structures over the long term, this impact is considered significant.

Mitigation Measure Geology-CP7: The City shall require applicants for projects in the Corridor Plan Area to conduct a design-level geotechnical study for each project development before a grading permit is issued. The study shall specifically address corrosion potential and include measures to address corrosive soils where damage to underground facilities may occur. Potential methods include placing utilities in sandy fill materials or appropriately treated clayey fill materials. Treatment of clayey soils could include using lime, lime-cement, or other admixtures. If it is impractical to place utilities within less corrosive materials, the utilities would need to be composed of corrosion resistant material or protected with appropriate coatings. Appropriate measures identified in each geotechnical study shall be implemented during project construction.

Significance After Mitigation: Less than significant.



Bay Meadows Impacts and Mitigation Measures

Seismic Impacts

Impact Geology-BM1: The Bay Meadows project would increase the number of residences and businesses in an area susceptible to ground shaking associated with a seismic event. This would be a potentially significant impact.

Active faults are located in the project site region. These faults could cause strong seismic ground shaking on the project site in the event they generated a large earthquake. Heavy damage would be expected from such earthquakes, especially in areas underlain by artificial fill and alluvial and fluvial deposits. Further, the Bay Meadows project site lies in zones designated as having a potential for “high” and “very high” ground shaking. Earthquakes originating on any of the nearby active fault zones would be expected to produce

moderate to severe ground shaking at the site. The proposed project would result in additional homes and businesses, thus putting more people at risk of injury and property at risk of damage or loss due to earthquakes. This would be a significant impact.

Mitigation Measure Geology-BM1: The applicant shall implement the seismic design standards of the current Uniform Building Code in effect at the time of construction.

Significance After Mitigation: Less than significant.

Impact Geology-BM2: The Bay Meadows project would result in additional property that could be damaged and people that could be injured in the event of surface fault rupture. This would be a less than significant impact.

For the purposes of this EIR, rupture of a fault designated in the Alquist-Priolo Earthquake Fault Zoning Map would be considered significant. The project site does not contain a currently designated Alquist-Priolo Earthquake Fault Zone. Further, the closest zoned active fault to the project area is the San Andreas, which passes approximately 3.5 miles to the southwest. As such, fault rupture in the project area is not anticipated and the probability is low that the new development constructed on the Bay Meadows project site would be subjected to the hazards of surface fault rupture. Therefore, this would be a less-than-significant impact.

Mitigation Measure Geology-BM2: None required.

Impact Geology-BM3: The Bay Meadows project would increase the number of people and structures exposed to potential substantial adverse effects associated with seismically induced ground failure, including liquefaction and lateral spreading. This would be a significant impact.

The artificial fill in the portion of the project site underlain by Bay Mud generally consists of saturated sandy soil that is generally clayey and medium dense to dense. In addition, ground water is generally considered to be at the top of the Bay Mud. The density of the artificial fill over the Bay Mud is sufficiently high to categorize the risk of liquefaction as very low. Other portions of the project site not underlain by Bay Mud and fill also have a low susceptibility to liquefaction and related damage. Lateral spreading, often associated with liquefaction, is less likely because there are no steep banks or hard ground bordering the project area, but could still potentially be a hazard.

Mitigation Measure Geology-BM3: The applicant shall conduct detailed geotechnical investigations for each of the structures proposed at the site. Subsurface conditions should be explored and laboratory tests conducted on selected soil samples to establish strength parameters for foundation design and perimeter slope stability. Based on recommendations developed for foundation support for each component of project construction, the applicant shall design building foundations to resist the potential differential movements and employ ground improvement techniques such as over-excavation and recompaction, pressure grouting and soil mixing.

Where determined necessary by the City, the applicant shall also employ engineering methods to minimize the potential for damage from liquefaction by reworking the existing fills within areas of new construction. The existing fills would be removed and reworked where buildings are supported on the fill materials. The depth and extent of fill removal will vary depending primarily on the nature of the structural loads of each proposed building. The removed fill shall later be used as new fill provided it is compacted to engineering standards. The actual extent of fill removal shall be determined in the field by the project Geotechnical Engineer prior to construction.

Significance After Mitigation: Less than significant.

Soils and Geotechnical Impacts

Impact Geology-BM4: Construction activities that would involve excavation and earthmoving could cause erosion or loss of topsoil, which could result in damage to buildings and infrastructure. This would be a potentially significant impact.

Construction activities would involve excavation, moving, filling, and the temporary stockpiling of soil. Earthwork associated with project construction could expose soils to erosion. Test borings on the site indicate it is blanketed by about two to eight feet of clayey and sandy fill with gravel. Bay Mud was encountered below the fill along most of the eastern edge of the site in an area that ranges from about 300 to 800 feet in width (from north to south). Some of the soils that exist within the Corridor Plan Area have a “moderate” erosion hazard. Excessive soil erosion can lead to damage of building foundations, roadways, and stream embankments.

Mitigation Measure Geology-BM4: The project sponsor shall implement standard control measures for erosion prevention during construction, including those stipulated by permit regulations of the Urban Runoff Pollution Prevention Program and National Pollutant Discharge Elimination System as well as a Storm Water Pollution Prevention Plan (SWPPP). Typical erosion control features may include:

- **Protecting disturbed areas through minimization and duration of exposure. For example, by covering disturbed areas with rolled plastic sheeting or other like material;**
- **Controlling surface runoff (i.e. sand bags) and maintaining low runoff velocities;**
- **Trapping sediment on-site; and**
- **Minimizing length and steepness of slopes.**

Significance After Mitigation: Less than significant.

Impact Geology-BM5: Construction of the Bay Meadows project would potentially be subject to damage from expansion of the near surface soils. This would be a potentially significant impact.

The soils of the Holocene Bay Mud and basin deposits found on the project site contain clay and therefore have the potential for shrink/swell movement. This shrink/swell movement can adversely affect building foundations, often causing them to crack or shift, with resulting damage to the buildings they support. As such, residential and commercial structures supported on slab foundations would be exposed to potential structural impacts due to the presence of expansive soils. Additionally, some vertical movement of the exterior slabs, sidewalks, and pavement would result from volume changes in the surface soils during fluctuations in moisture content.

Mitigation Measure Geology-BM5: The project sponsor shall engineer project buildings to minimize risks posed by expansive soils to a less than significant level. Engineering methods available to designers include: soil treatment, mat foundations, pile foundations, and removal of expansive soil. Selection of the specific mitigation would be dependent on factors specific to the proposed building and the soils on which it would be located. A determination that appropriate engineering has been conducted would occur as part of the San Mateo Building Department’s building permit process, which would require the project sponsor to submit site-specific soil and geotechnical reports as a condition of approval.

Significance After Mitigation: Less than significant.

Impact Geology-BM6: Development as part of the Bay Meadows project would be subject to potentially substantial damage from differential compaction and settlement of existing soil and fill materials. This would be a significant impact.

Portions of the site are underlain by highly compressible soil. By utilizing varying combinations of soil improvements and foundation designs (i.e., soil treatment, mat foundations, pile foundations, and removal of expansive soil), differential settlements would be on the order of one-half inch.

Mitigation Measure Geology-BM6: Prior to issuance of a grading permit, the City shall require the project sponsor to employ engineering methods to minimize the potential for damage from differential compaction by reworking the existing fills within areas of new construction. This may include removing the compressible soil and replacing it with engineered fill, ground improvements, stiffer foundation elements (grid footings, mats), or deep foundations. Compressible soil and associated foundation considerations should be addressed during a design-level geotechnical study for specific building projects.

Significance After Mitigation: Less than significant.

Impact Geology-BM7: The corrosiveness of on-site soils could cause damage to buried concrete slabs and foundations and buried metal pipes during the operation of the Bay Meadows project. This would be a significant impact.

Results of soil testing on the Bay Meadows project site classified the Bay Mud as “severely corrosive” and the fill as “corrosive.” The testing also indicated that the chloride ion concentrations in the Bay Mud are

sufficient to attack concrete and reinforcing steel embedded in concrete mortar coating. Corrosive soil can affect underground structures and utilities. Because corrosive soils could cause failures to underground structures over the long term, this impact is considered significant.

Mitigation Measure Geology-BM7: Utilities shall be placed in sandy fill materials or appropriately treated clayey fill materials. Treatment of clayey soils could include using lime, lime-cement, or other admixtures. If it is impractical to place utilities within less corrosive materials, the utilities would need to be composed of corrosion resistant material or protected with appropriate coatings. A corrosion specialist should be consulted for the design and construction of utilities, and other structures as necessary.

Significance After Mitigation: Less than significant.

REFERENCES

EDAW, *Bay Meadows Specific Plan and Route 101/Hillsdale Boulevard Interchange Modifications Project, Draft Environmental Impact Report*, October 1996.

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