CHAPTER 5

GEOLOGY, SOILS, AND SEISMICITY

The geologic, soil and seismic impact evaluation of the proposed Bulk Materials Processing Center (BMPC) use permit amendment changes and related actions (Project) are addressed in this chapter. The geologic environment of the West Contra Costa County Sanitary Landfill (WCCSL) plays a major role in the design and construction of the improvements and in the analysis of issues in this chapter.

A. SETTING

1. Regional

The regional setting of the WCCSL area is discussed in this section. Discussion is included on the physiography, geology, faults, earthquakes, and soils.

a. Physiography. The San Francisco Bay estuary extends from the Golden Gate Bridge to the Sacramento - San Joaquin Delta and includes San Pablo, Richardson, and Suisun Bays. The shorelines of the estuary margins are characterized by low elevation marsh and tide lands that are dominated by marsh flats and meandering creek channels with few isolated areas of higher elevations. Prior to 1850, marshes covered an area of about 860 square miles. Since the Gold Rush era, most pre-existing marshes have been levied or filled; these activities have promoted the erosion of some of the existing marshes and have assisted in the creation of other new marshes by both accident and design. All but approximately an area of 33 square miles of these marshes have been levied or filled during the past 125 years. Concurrently, human activities have caused the delivery of enormous quantities of sediment to the bays, thereby contributing to the creation of nearly 29 square miles of marsh.[70]

b. Geology. The San Francisco Bay Area lies within the Coast Ranges geologic and physiographic province. This province is characterized by northwest-southeast trending valleys and intervening mountain ranges that are structurally controlled by faulting and folding, the result of the collision of the Farallon and North American Plates, which is recorded by rocks of the Franciscan Complex of Cretaceous and Jurassic age (100 to 65 million years old). The subsequent right lateral shearing occurred between the Pacific and North American Plates and is recorded by the younger (Tertiary, 60 to 3 million years old) sedimentary and volcanic rocks of the Berkeley and Oakland Hills and marks a transition to the strike slip faulting that characterizes the present day movement of the San Andreas fault system.

To the west of the San Andreas Fault System lies a less well defined surface feature at the boundary of the Coast Ranges and the Central Valley also associated with seismicity. The Coast

Ranges-Central Valley (CRCV) geomorphic boundary is formed by an active fold and thrust fault zone that generally does not break the surface.[85]

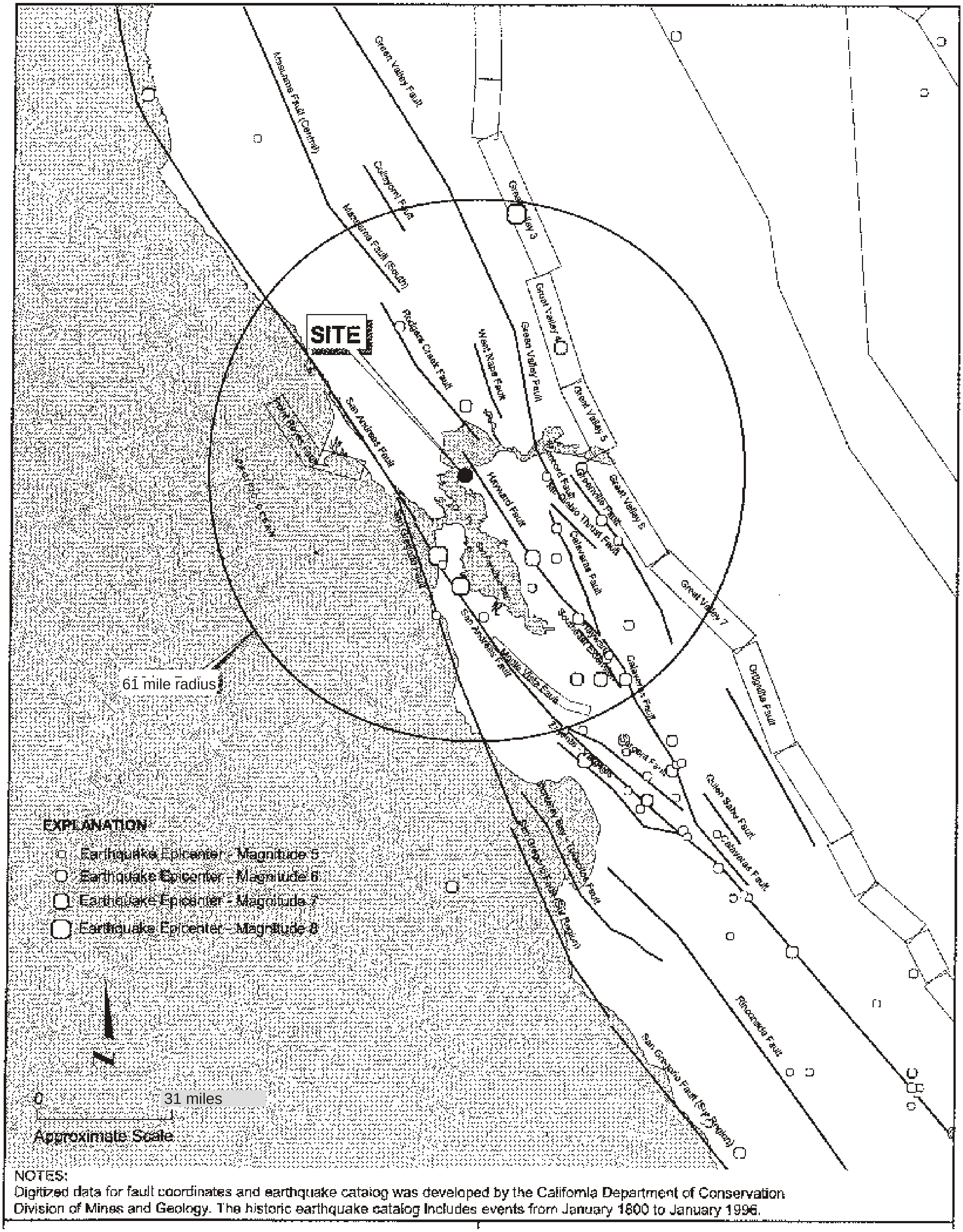
Although the bedrock record indicates a long history of deformation, the present day topography is controlled by movement of the San Andreas fault zone and abrupt changes in the climate. The geology of the San Francisco and San Pablo Bay margins is controlled by the interactions of the Quaternary (past 2 million years) climatological sea level fluctuations and the vertical tectonic deformation of the shorelines. This interaction of tectonics and sea level has controlled the advance and retreat of the Bay's shorelines resulting in their very distinct sequence of sediments.

The Soil Survey of Contra Costa County (County) indicates the native soils in the vicinity of the WCCSL site are Reyes Silty Clay.[97] These soils are found in salt marsh environments affected by tides and are characterized by very poor drainage. Natural slopes are less than 1 percent and elevation is at or near sea level. Vegetation is pickelweed, saltgrass, and some sedges. These soils are always moist with a high water table and are subject to inundation by tides.

c. Faults. The WCCSL is located within the San Francisco Bay Area, which lies at the edge of a major plate tectonic boundary between the North American and Pacific Plates. This boundary is defined by the San Andreas fault zone. There are several known active faults in the vicinity of the project site. Active faults, as included in the Alquist Priolo Earthquake Fault Zones, are characterized by displacement of Holocene deposits (soil or rock less than 11,000 years old), evidence of fault creep and/or well defined seismic activity on traces of known faults.

The major active, strike-slip faults in the area are part of the San Andreas Fault System, which includes the San Andreas, Hayward, Greenville, Green Valley-Concord, and the Calaveras faults. These and other faults of the region are shown on Figure 5-1. For the active faults within a 61-mile radius, the distance from the central Class II Landfill area and estimated maximum Moment magnitude event, are summarized in Table 5-1.[74,91] Moment magnitude is an energy-based scale and provides a physically meaningful measure of the size of a faulting event. Moment magnitude is directly related to average slip and fault rupture area.

Seismicity. The WCCSL is located in one of the most seismically active regions in the nation. A listing of earthquakes of magnitude 5.0 and greater occurring since 1800 in the San Francisco Bay area are presented in Table 5-2.



Source: reference 74 and 91.

Figure 5-1 Map of Major Faults and Earthquake Epicenters in the San Francisco Bay Area

Table 5-1. Regional Faults and Seismicity

Fault	Approximate distance from WCCSL, miles	Direction from WCCSL	Maximum magnitude (maximum credible earthquake)
Hayward (Total)	2.6	Northeast	7.1
Hayward (North)	2.6	Northeast	6.6
Rodgers Creek	9	North	7.1
San Andreas (1906 Event)	15	Southwest	7.9
San Andreas (Peninsula)	15	Southwest	7.2
West Napa	15	Northeast	6.5
San Gregorio (North)	16	West	7.3
Hayward (South)	17	Southeast	6.9
Concord	17	East	6.5
Green Valley (South)	17	East	6.5
Mount Diablo Thrust	20	East	6.7
Calaveras (North)	21	East	7.0
Point Reyes	24	West	6.8
Greenville (North)	31	East	6.6
Green Valley (North)	25	Northeast	6.3
Great Valley – 6	27	East	6.7
Great Valley – 5	28	Northeast	6.5
Great Valley – 4	29	Northeast	6.6
Greenville (Central)	33	East	6.7
Hunting Creek – Berryessa	35	North	6.9
Monte Vista	37	South	6.8
Greenville (South)	44	Southeast	6.9
Hayward (Southeast Extension)	44	Southeast	6.4
Maacama (South)	44	North	6.9
Great Valley – 7	47	Southeast	6.7
Calaveras (Central)	48	Southeast	6.6
Great Valley – 3	48	North	6.8
Collayomi	57	North	6.5
San Andreas (Santa Cruz Mountains)	58	South	7.2

Source: References 74 and 91.

Table 5-2. Post-1800 Earthquakes with Magnitudes Larger than 5.0 in the Greater Bay Area

Date	Approximate distance from WCCSL, miles	Approximate magnitude
June 1, 1838	25	7.5
January 2, 1856	33	5.3
February 15, 1856	33	5.5
November 26, 1858	42	6.1
July 4, 1861	24	5.6
February 26, 1864	70	5.9
March 5, 1864	28	5.7
May 21, 1864	29	5.3
October 8, 1865	53	6.3
October 21, 1868	24	7.0
May 19, 1889	26	6.0
April 19, 1892	36	6.4
March 31, 1898	16	6.2
April 18, 1906	19	7.9
July 1, 1911	56	6.6
September 5, 1955	52	5.5
October 24, 1955	18	5.4
March 22, 1957	21	5.3
October 2, 1969	37	5.7
January 24, 1980	33	5.8
January 27, 1980	38	5.4
April 24, 1984	59	6.2
March 31, 1986	50	5.7
June 13, 1988	52	5.3
June 27, 1988	64	5.3
August 8, 1989	62	5.4
October 17, 1989	69	6.9

Source: reference 82.

Since 1800, four major earthquakes have been recorded on the San Andreas Fault as follows:

- In 1836, an earthquake with an estimated maximum intensity of VII on the Modified Mercalli (MM) scale occurred east of Monterey Bay on the San Andreas Fault. The estimated Moment magnitude (M_w) for this earthquake is about 6.3. [82]

- In 1838, an earthquake occurred with an estimated intensity of about VIII-IX (MM), corresponding to a M_w of about 7.5.

- The San Francisco earthquake of 1906 caused the most significant damage in the history of the Bay Area in terms of loss of lives and property damage. This earthquake created a surface rupture along the San Andreas Fault from Shelter Cove to San Juan Bautista approximately 250 miles in length and a maximum lateral displacement of 21 feet. It had a maximum intensity of XI (MM), an M_w of about 7.9 with an epicenter approximately 15 miles southwest of the WCCSL, and was felt 344 miles away in Oregon, Nevada, and Los Angeles.

- The most recent earthquake to affect the Bay Area was the Loma Prieta earthquake of October 17, 1989, in the Santa Cruz Mountains with a M_w of 6.9, approximately 69 miles south of the WCCSL.

The Vacaville-Winters earthquake of 1892 occurred on the CRCV boundary approximately 29 miles north of the WCCSL, and had an estimated magnitude of 6.8 (M_w).[75,83] Two after shocks were reported in 1892 of magnitudes 5.8 and 6.4 in the vicinity of Vacaville. Other activity on the CRCV includes a magnitude 6.3 event near Antioch, approximately 12 miles northeast of the site in 1889, and a magnitude 5.9 event in Paterson, approximately 45 miles southeast of the site in 1866.

In 1999, the Working Group on California Earthquake Probabilities (WGCEP) of the United States Geological Survey compiled the earthquake fault research for the San Francisco Bay Area in order to estimate the probability of fault segment rupture. They have estimated that the overall probability of a Richter magnitude 6.7 or greater earthquake occurring within the next 30 years is 70 percent. The highest probabilities are assigned to the San Francisco Peninsula segment of the San Andreas Fault and the northern Hayward/Rodgers Creek Faults (21 and 32 percent, respectively). The Calaveras Fault was assigned a probability of 18 percent, and the Greenville and Concord-Green Valley faults were each assigned probabilities of 6 percent.[91]

Ground Rupture. The WCCSL site is located in the tectonically active San Francisco Bay region where historic ground rupture associated with earthquakes has occurred on several active faults and/or faults subsidiary to the main active traces. These ground ruptures were extensively documented for the 1906 San Francisco Earthquake and for earthquakes since that time. However, several earthquakes that occurred during the early establishment of San Francisco Bay area are poorly documented.

Seismic Effects. Earthquakes have primary and secondary effects, which are important considerations in the evaluation of the proposed Project. Primary effects include fault creep, the slow accumulation of strain sometimes measurable at the ground surface, and rapid earthquake-induced fault rupture and strong ground shaking. In the case of the strike slip faults of the San Francisco Bay Area, fault rupture and creep affect a narrow, roughly linear area of the ground surface. Strong ground shaking is the result of large magnitude earthquakes and can be felt over wide areas extending for tens to several hundred miles from the epicentral region.

The secondary effects of earthquakes include vibrational damage to structures, liquefaction, landslides, fissuring, lurching and lateral spreading. The active faults in the region that are capable of producing the most significant ground shaking at the WCCSL site are the Hayward and San Andreas faults. EMCON/OWT (consultants for West County Landfill, Inc. [Applicant]) presented median peak ground accelerations (PGAs) for rock of 0.52g and 0.22g for maximum credible earthquake (MCE) events on the Hayward (M_w=7.1) and San Andreas Faults (M_w=7.9).[52]

Intense groundshaking during a large earthquake should be expected at the WCCSL site. The actual ground motions depend on the magnitude of the earthquake, the distance to the source, and the local soil conditions. For sites within a few miles of a fault rupture, the intensity of the ground shaking also depends on the direction of fault rupture relative to the site. These are discussed further in the next section.

Liquefaction is a “quicksand” condition that occurs when a loose, water-saturated sandy soil is subjected to dynamic loading that results in an increase of the pore water pressure and subsequent loss of shear strength and liquid behavior. The sandy soils most susceptible to liquefaction are situated at shallow (less than about 50 feet) depths. The temporary high pore water pressures sometimes result in sandy material being transported along horizontal or vertical conduits through the surficial soils as sand boils or volcanoes. The consequences of liquefaction include vertical and lateral deformation, and loss of bearing. Normally firm, but wet, ground materials take on the characteristics of liquids. Liquefaction-induced lateral deformation can occur on sloping ground and along embankment slopes. Liquefaction potential of a saturated granular soil is dependent on its relative density, fines content, earthquake magnitude, and the level of shaking. A discussion of liquefaction relative to the Class II landfill site is included in Section D of this chapter.

Maximum Credible Earthquakes. The MCE is the maximum earthquake magnitude that could occur under the presently known geologic framework. The probability of occurrence of that event is not considered. State regulations (California Code of Regulations, Title 27 [27 CCR]) require Class II Landfill facilities be designed to withstand the MCE without damage to the building foundations or to structures which contain leachate, surface drainage, extracted groundwater, or landfill gas (LFG). A summary of the MCE for nearby active faults is included in Table 5-1.

2. Project Site

More site-specific information on the geologic setting of the WCCSL site is presented in this section.

a. Geology. The WCCSL lies within a geologic province of the San Francisco Bay named the "Richmond Basin," bounded by the San Pablo and Hayward faults. Differential movement along these bounding faults has down dropped the area now occupied by the Bay and uplifted the blocks containing the Berkeley and Oakland Hills. This differential uplift probably occurred approximately 2 to 3 million years ago, during the early stages of movement on the Hayward fault. Interaction between the eroding sediments of the uplifting hills and fluctuating sea levels caused deposition of the multiple alluvial fans that coalesced to form the Bay marginal plain.[70,71] Bedrock "islands" that occur within this plain are the result of differential weathering caused by the rivers that intermittently flowed across the Bay floor during periods of lower sea level.

b. Subsurface Conditions. As discussed below, the geologic units at the WCCSL site are typical for the areas of the bay margin, and include fill material (including Landfill deposits), Younger Bay Mud, Old Bay Mud and other sediments, overlying Franciscan Bedrock. This section presents a synopsis of the site stratigraphy (the order and position of strata, a bed or formation of sedimentary rock). The primary significance of the site stratigraphy for the proposed height increase and other improvements relates to compression, consolidation and strength of the waste and Young Bay Mud, which can result in settlement and slope stability problems.

Numerous studies at the WCCSL have provided subsurface geotechnical and geologic data. The reported data include exploratory soil boring logs, well installation logs, and cone penetrometer test (CPT) soundings. CPTs are used to measure the relative stiffness of soil. Borings and CPTs were performed by various consultants, as referenced by Wahler (1994), and EMCON/OWT, Inc. (2003). The general stratigraphy beneath the Class II landfill, including the existing and proposed waste, is discussed below.[52]

Fill Material. The artificial fill materials at the Class II landfill primarily include municipal solid waste (including construction demolition debris and self-hauled waste), industrial waste, and sewage sludge. However, municipal solid waste (MSW) accounts for approximately 70 percent of the waste disposed. Clean soil is also present within the fill that was placed as intermediate and final cover layers. The landfill is presently permitted for fill placement up to elevation 110 feet mean sea level (msl) on side slopes, gradually sloping up to a topdeck elevation of 130 feet msl. The fill was originally placed directly over the Bay Mud around elevation 0 feet msl, but it has since settled downward. The base of the refuse is currently between about elevation 0 and –20 feet msl. Therefore, the thickness of fill/waste at the site ranges from zero at the landfill perimeter to about 150 to 160 feet near the central-west side of the landfill.

Refuse thickness at the former Soil Remediation Building, as reviewed by Woodward-Clyde Consultants in 1995, is on the order of 15 to 30 feet, corresponding to between about elevations 18 and –5 feet msl.[90] Since that time, a fill pad about 17 feet high reinforced with geogrid was placed over the refuse for construction of the building. Significant settlement of the ground surface occurred, resulting in an irregular ground surface and damage to the building floor slab.[78]

Refuse is not present at Area A as it is outside of the Class II landfill (Figure 3-1). Very little site-specific subsurface information is available for this location.

A perimeter berm of clean fill surrounds the Class II landfill site. The berm is on the order of 10 feet above adjacent grade. The bottom of the berm extends several feet below grade, as it has settled due to consolidation of the underlying compressible Bay Mud.

Young Bay Mud. Young Bay Mud underlies the artificial fill beneath the Class II landfill and is interbedded with sandy stream deposits. The Young Bay Mud (from here forth referred to as Bay Mud) consists of gray, soft and poorly consolidated, compressible, weak, organic-rich clayey silt to silty clay with moderate to high shrinkage potential. The age of the Bay Mud varies from approximately 9,600 years old to the most recent deposits which are still forming in the Bay.[70] The granular materials within the Bay Mud were deposited as streams flowed into standing water of San Pablo Bay. The sandy zones consist of fine silty sand to fine sand.

The maximum known thickness of the Bay Mud at the Class II landfill site is approximately 70 feet at the east and northeast sides. The thickness is approximately 60 feet under the northern and western parts, and it varies from 40 to 50 feet along the southern parts of the landfill. The Bay Mud is about 45 feet thick at the Soil Remediation Building location. The Bay Mud is generally interbedded with sand layers along the east, north, and western portions of the landfill. The sand layers were not observed along most of the southern side of the site. Sand layers up to 20 feet thick occur at depths greater than 100 feet below the site. Clean sands were primarily observed on the north side of the WCCSL site along San Pablo Creek.

Old Bay Mud, Sediments, and Bedrock. The Young Bay Mud at the site is underlain by a stiffer clay unit and other sediments. The clay unit likely corresponds to the unit known locally as Old Bay Mud or Old Bay Clay, however, there is some disagreement as to whether it is actually Old Bay Mud, or an older Holocene clay unit.[84] The Old Bay Mud extends from the bottom of the Young Bay Mud to an Elevation of about –135 feet msl, and varies from approximately 80 to 100 feet in thickness. It is primarily composed of clay and silty clay, and for the purpose of the settlement studies, is considered to be incompressible.

The Old Bay Mud is underlain by old consolidated sediments consisting of alternating sequences of estuarine and alluvial deposits. These sediments are heterogeneous sequences of silt, clay, and sand. The sediments are underlain by Franciscan bedrock at depths of about 150 to 300 feet below the original ground surface (approximately sea level); the actual bedrock depth at the Class II landfill is not well defined.

Groundwater. Groundwater levels within the landfill range from about elevation 0 feet msl at the edges of the landfill to about elevation 20 feet msl near the center of the landfill. The water within the landfill is composed of both natural groundwater and leachate from the MSW. Though desirable, an inward groundwater gradient toward the landfill has not yet been achieved because the Applicant has been unable to pump high volumes of leachate to the West County Wastewater District (WCWD) Treatment Plant due to concerns over elevated levels of chloride salts. As discussed in Chapter 6, Section D3, however, a separate Class II landfill leachate line to the WCWD sludge lagoons will be completed in late 2003. Class II leachate flows will then be routed directly to the City of Richmond Wastewater Treatment Plant. This will enable about 100,000 gallons per day of leachate to be pumped to the plant, thus greatly facilitating the establishment of an inward hydraulic gradient at the Class II landfill.

Leachate Containment Structures. The Bay Mud prevents the downward vertical migration of landfill leachate. Horizontal migration of leachate is prevented by a low-permeability vertical barriers, including a soil-attapulgite slurry wall separating the Class I and Class II landfills, and a Bay Mud barrier wall that surrounds the entire WCCSL site.

The soil-attapulgite slurry wall is 8 to 10 feet south of the former Soil Remediation Building site proposed for the location of the WRC. The wall was built in 1986 as a barrier between the Class I and Class II landfill sites. The slurry wall was constructed to be about 5 feet wide, with the bottom of the wall keyed into the Bay Mud at elevation –10 feet msl.[90]

The Bay Mud barrier wall was constructed in 1977-78 and surrounds the entire WCCSL site. Because subsequent investigations indicated the presence of sand channels beneath the mud barrier, sections of the original Bay Mud barrier were replaced by a soil-cement-bentonite barrier. The Bay Mud barrier and the soil-cement-bentonite barrier have hydraulic conductivities of 1×10^{-6} cm/s or less, a minimum thickness of 3 feet, and are keyed into the underlying Bay Mud at a minimum of 5 feet.[29] Hydraulic conductivities are a measure of a material's ability to transmit water. A lower conductivity value indicates the migration of liquids is substantially restricted.

Fault Occurrence. Active and potentially active faults that could have a significant impact on the Project facilities were previously discussed in Section A1.c of this chapter. However, another fault, the San Pablo Fault, has been mapped in the site vicinity based on bedrock outcrops and offshore features. This fault does not show any geomorphic features associated with Holocene surface displacements, has no seismicity associated with its trace and is not considered active or potentially active by the California Geological Survey geologists and is, therefore, not considered seismogenic.

B. REGULATORY AND PLANNING FRAMEWORK

There are State of California, County, and City of Richmond (City) policies and regulations that form the regulatory and planning framework for geology, soils, and seismicity. A discussion of these policies and regulations is provided in this section. Because a Class II landfill is a State of California designation, the California code supercedes the Federal code for this Project.

1. State and Regional

Applicable regulations from the 27 CCR and the Regional Water Quality Control Board (RWQCB) are summarized below.

a. California Code of Regulations (27 CCR):

- **§20240(d).** All engineered structures constituting any portion of a waste management unit shall have a foundation capable of providing support for the structures, capable of withstanding hydraulic pressure gradients to prevent failure due to settlement, compression, or uplift, and all effects of ground motions resulting from at least the MCE for Class II units.

- **§20250(b).** Landfills shall be immediately underlain with geologic materials with a hydraulic conductivity of not more than 1×10^{-6} cm/sec and are sufficiently thick to prevent vertical movement of fluid to waters of the state. Natural or artificial barriers shall be used to prevent lateral movement of fluid.

- **§20250(d).** New and expanded Class II units shall have a 200-foot setback from any known Holocene fault. [A Holocene-active fault has experienced movement within about the past 11,000 years.]

- **§20250(e).** New and existing Class II units can be located within areas of potential rapid geologic change only if the RWQCB finds the unit's containment structures can resist failure.
- **§20310(a).** Class II units shall be designed and constructed to prevent migration of wastes from the Unit to adjacent geologic materials, groundwater, or surface water.

- **§20310(d).** New and existing landfills shall be fitted with subsurface barriers, and shall have precipitation and drainage control facilities.

- **§20323.** Construction for all liner systems and final cover systems to be carried out in accordance with a CQA (Construction Quality Assurance) program. This article details the CQA requirements for reports, documentation, laboratory testing, field testing, earthen materials, and geosynthetic membranes.

- **§20330(b).** Clay liners for a Class II unit shall be a minimum of 2 feet thick (except synthetic liners).

- **§20360(b).** Cutoff walls meeting the requirements of this section are required at Class II units where there is potential for lateral movement of fluid, including waste or leachate, and the hydraulic conductivity of natural geologic materials is used for waste containment in lieu of a liner.

- **§20370(a).** Class II units shall be designed to withstand the maximum credible earthquake without damage to the foundation or to the structures which control leachate, surface drainage, or erosion, or gas.

- **§21090(a).** Final cover slopes shall not be steeper than a horizontal to vertical ratio of one and three quarters to one, and shall have a minimum of one 15-foot-wide bench for every 50 feet of vertical height. Other final cover requirements of this section must be met.

- **§21190.** Postclosure land uses must meet the requirements of this section (see Appendix 3A for the Applicant's Postclosure Development Performance Standard).

- **§21750(f)(5).** The discharger should provide a stability analysis, including a determination of the expected peak ground acceleration at the unit associated with the MCE (Class II units). An updated stability analysis (if the original analysis no longer reflects the conditions at the unit) shall be included as part of the final closure and post-closure maintenance plan. The stability analysis must meet the requirements of this section.

b. California Regional Water Quality Control Board. Additional requirements are set forth by the RWQCB in Order No. R2-2002-0066, Updated Waste Discharge Requirements for the WCCSL Class II Waste Management Facility.[29] This order states that in addition to the applicable provisions in 27 CCR and Division 7 of the California Water Code, additional specifications should apply. These specifications, with the same numerical designations as in the Order, are summarized below:

5. The structures that control leachate, surface drainage, erosion and gas should be constructed and maintained to withstand conditions generated during the maximum probable earthquake. [Title 27 supercedes this specification and requires the improvements to be designed to a higher level, consistent with the MCE.]

> **11.** A minimum of two surveyed permanent monuments should be provided near the landfill to determine the location and elevation of wastes, containment structures, and monitoring facilities.

Order No. R2-2002-0066 also requires the Applicant to comply with the following provisions, which are relevant to the analysis in this chapter:

1. December 1, 2002—Submittal of a technical report evaluating landfill stability, including a determination of whether unstable landfill conditions may result form filling until January 2006.[52]

2. March 1, 2003—Submittal of a technical report providing an independent peer review of the landfill slope stability evaluation. This peer review is ongoing.

3. May 1, 2003—Submittal of a technical report that provides responses to all comments and recommendations in the peer review.

4. September 1, 2003—Submittal of a technical report including a work plan and schedule of actions necessary to establish an inward hydraulic gradient at the Class II landfill.

5. 120 days prior to any material change in site operations or features—Submittal of a technical report describing any material changes in site development, redevelopment projects, site features, or site operations at the landfill, including a specification of design components necessary to maintain the integrity of the final cap and prevention of water quality impacts.

6. 30 days after initial notification—Notify the RWQCB of any flooding, ponding, settlement, equipment failure, slope failure, exposure of waste, or other changes in site conditions that could impair the integrity of the landfill cap, waste or leachate containment facilities, and/or drainage control structures and immediately make repairs. Within 30 days, a technical report shall be submitted documenting the corrective measures taken.

2. County/City of Richmond

The County General Plan, the City of Richmond (City) General Plan, and North Richmond Shoreline Specific Plan all contain goals, policies, and implementation measures relative to seismic and geologic hazards.[5,7,12] These measures are summarized in the Hazardous Waste Management

Facility (HWMF) EIR (State Clearinghouse No. 95063005), which is incorporated by reference pursuant to Section 15150 of the California Environmental Quality Act (CEQA) Guidelines. The local mechanism of complying with these measures is through the use permit process.

In summary, the General Plan goals, policies, and implementation measures relate to seismic and geologic hazards to the construction of new facilities. The goals emphasize the protection of human life, property, and mitigation of environmental damage. Policies and implementation measures address facility siting, the need for geologic reports and engineering studies as necessary, the use of safeguards during design and construction, and County/City review of development applications.

The Safety Element of the County General Plan includes maps that show the estimated damage susceptibility from seismic ground response, estimated liquefaction potential, and landslide hazard areas for the County. The WCCSL is located in Damage Susceptibility Zone 4, which is most susceptible for damage from seismic ground response.

Areas classified as Zone 4 are typically underlain by saturated unconsolidated deposits, such as Bay Mud, bay sand, and artificial fill. The site is shown as an area of generally high liquefaction potential. The Safety Element defines liquefaction as a specialized form of ground failure caused by earthquake ground motion. It is a “quicksand” condition occurring in water-saturated, unconsolidated, relatively clay-free sands and silts caused by hydraulic pressure (generated from earthquake ground shaking), which forces apart soil particles and creates a quicksand-like liquid suspension. In the process, normally firm, but wet, ground materials, take on the characteristic of liquids.

The Safety Element of the City General Plan includes maps that show relative ground response to seismic shaking, liquefaction potential, and landslide hazard areas for the City. The WCCSL site is located in Zone D, which can experience significant levels of shaking. Areas classified as Zone D are typically underlain by marine deposits of Bay Mud with possible inter-layering of sands and silts near the shoreline. The Bay Mud is underlain by alluvial deposits of sand, clay and gravel to depths in excess of 200 feet. The site is also shown to be located in areas where liquefaction potential is either present or possibly present.

C. SIGNIFICANCE CRITERIA

Appendix G of the CEQA Guidelines indicates a project will normally have a significant effect on geology and soils if it will:

- Expose people or structures to rupture of a known earthquake fault; strong seismic groundshaking; or seismic-related ground failure, including liquefaction; or landslides.

- Result in substantial soil erosion or the loss of topsoil.
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the Project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.
- Be located on expansive soil, creating substantial risks to life or property.

Significant impacts would also result if proposed improvements conflict with Title 27 or adopted County or City policies and regulations that relate to geology, soils, and seismicity. These regulations, discussed in Section B, require proper foundation support of the landfill, cutoff walls for lateral migration of leachate, design in accordance with the MCE, stability of slopes under static and dynamic conditions, and proper design of the final cover, appurtenant structures, and underground utilities.

D. IMPACTS AND MITIGATION MEASURES

This section includes a discussion of impacts associated with the proposed Project and associated improvements as they relate to geology, soils, and seismicity. Principal issues relate to settlement, liquefaction, slope stability, earthquake-associated ground shaking, and protection of the landfill cover.

1. Impacts Considered not to be Significant

Significance criteria applicable to geology, soils, and seismicity are discussed in Section C. Criteria that are not applicable or are not considered significant include the following:

- Fault rupture – Fault rupture or surface rupture occurs in the immediate vicinity of an earthquake trace or fault line during a seismic event. There are no known or active earthquake faults located in the immediate vicinity of the WCCSL site, the nearest active fault is the Hayward Fault located approximately 2.6 miles from the WCCSL site.
- Expansive soil – Expansive soil is not known to exist at the site.
- Cover design – The proposed cover design incorporating a geosynthetic clay liner (GCL) is suitable from a geotechnical standpoint.

Issues related to erosion are discussed in Chapter 6, Water Resources. No geotechnical, soil, or seismic issues are associated with the Public Access Trail.

The regulations discussed in Section C require emphasis on seismic and geologic factors for siting, design, and construction projects. The Applicant and their consultants have performed detailed studies on seismic and geologic aspects during the initial and subsequent landfill planning process. Impacts that may be potentially significant have been identified and are discussed in the following sections.

2. Liquefaction

IMPACT 5-1 Liquefaction occurring in sandy soil below the landfill and/or associated structures could cause ground surface settlement and/or lateral spreading at the landfill sideslopes causing damage to the cover, environmental control systems and buildings. The impact is considered to be less than significant.

Liquefaction of loose saturated sandy soils during earthquakes is an important issue related to the proposed modifications at the site. Liquefaction is a phenomenon in which saturated (submerged), cohesionless soil can be subjected to a temporary loss of strength because of the build up of pore water pressure, especially during cyclic loadings such as those induced by earthquakes. Soil most susceptible to liquefaction is loose, clean, saturated, uniformly graded, fine-grained sand. Consequences of liquefaction include: sand boils, vertical settlement, lateral deformation or flow slides. The County General Plan (Section B.2) shows the site as being located in a "high liquefaction potential" area.[12]

Based on the results of previous analyses by the Applicant, it was concluded that most of the sand layers present at the site (primarily within the Bay Mud) are sufficiently dense, have sufficient clay content, and/or are overlain by a sufficient thickness of Bay Mud, such that the potential for liquefaction is low.[84] The greatest potential for liquefaction is on the north side of the Class II landfill adjacent to San Pablo Creek. Limited slumping or lateral spreading along the creek could occur. Wahler (1994) recommended the potential for liquefaction be accounted for in the design of improvements to the Class II containment barrier wall and the lining of San Pablo Creek.[84] EMCON evaluated the Wahler recommendations during the evaluation of the Class II site slurry wall performance reviews and the HWMF stability studies. Liquefaction potential was not re-evaluated by EMCON/OWT in their analysis regarding Class II landfill slope stabilization completed in January 2003, but recommended that past liquefaction analyses be updated. That work is scheduled to be completed in late 2003 and recommendations in the post-earthquake maintenance and repair plans.

The post-earthquake maintenance and response plan includes visual observations of the landfill cover and lateral containment areas immediately after a seismic event to determine, at the earliest possible time, if any damage has occurred to the landfill's containment structures. The repairs required in any given instance will depend upon the degree to which any damage to containment systems has occurred. The post-earthquake inspection plan must be of necessity flexible in this regard since it is not possible to predict what type of seismic event will occur and how long it will take to assess damage, if any. The same is true of repair plans. Once any damage was observed, the plan will require the expeditious repair of the area(s) in question.

Liquefaction-induced ground deformation could result in localized failure of the cover system, irregular cover settlement, and localized distress to the perimeter barrier wall. However, because the barrier wall is several feet wide, a complete breach of the slurry wall is not considered likely.

Control Measures Incorporated by Applicant:

a) The liquefaction analysis for the WCCSL would be updated in late 2003 and recommendations incorporated into post-earthquake maintenance and repair plans.

b) Following an earthquake, inspection of the landfill would be performed by the Site Engineer and necessary repairs made.

c) Under the seismic scenarios where the barrier wall is breached, an inward hydraulic gradient would be maintained prior to and throughout the repair.

The impacts of such movements on the cover and lateral containment system would be reduced to less than significant by adhering to the inspection, monitoring and repair plans.

EIR Recommendations:

MITIGATION MEASURE 5-1. None required.

3. Settlement

IMPACT 5-2. Settlement of the landfill under proposed refuse and cover fill loads could impact site grading and runoff. This impact is considered to be less than significant.

Settlement is an important issue for the proper operation of the Class II landfill and associated facilities during the active and post-closure periods. As discussed in Chapter 3, Section C1, the purpose of the landfill height increase is to remediate the excessive settlement that has occurred on the central plateau. Restoring the landfill by placing additional MSW subbase will allow the foundation layer, barrier layer, and top landfill cover surface to be placed at correct elevations and slope so that drainage can be properly managed. If not properly addressed during design, excessive total and differential settlements can occur, which may cause significant changes in the surficial slopes of the landfill.

Settlement can occur as a result of consolidation of the Bay Mud underlying the landfill, as well as degradation, decomposition, and compression of the waste within the landfill. The consequences of settlement-induced changes of the final design slopes include the reduction of the final grades to slopes less than the required 3 percent minimum slope gradient, creation of local low regions on the final cover that would allow ponding of surface water, and could result in potential cracking and failure of the cover system. Hence, adverse impacts associated with settlement and subsidence would be significant.

One of the Applicant's consultants, EMCON/OWT (2003), evaluated settlement of the landfill at the topdeck for a final elevation of 150 to 160 feet.[52] Settlements due the loads imposed by the placement of new waste and the final cover include: (1) compression of the waste materials (2) primary consolidation settlement of the Bay Mud, and (3) settlement due to secondary compression of the Bay Mud.

Total expected settlements are in the range of 20 to 25 feet. The expected settlement after 10 ears is about 10 feet at the perimeter and 20 feet at the center for a 150-foot final elevation (settlements for a final elevation of 160 feet appear to be similar). In the subsequent 20 years, 3 to 5 feet of additional settlement is expected. The impacts of these relatively large total and differential settlements will be to reduce the slopes of the closed final cover surfaces. Final design of topdeck slopes are 10 percent (at the time of final cover placement). Minimum topdeck slopes, after a 30-year post-closure period, are expected to be about 5 percent, though average slopes are expected to be at least 8 percent. Therefore, even under the worst predicted settlement, topdeck slopes should be steeper than the required 3 percent minimum slope gradient.

Control Measures Incorporated by Applicant:

a) A program of landfill inspection, maintenance, and repair will continue to be implemented consistent with State regulations and as detailed in the RDSI and Postclosure Plan. The program will maintain the final grading at the site to prevent ponding and minimize infiltration in accordance with State regulations and will include permanent monument installation and aerial photogrammetry to develop site topography and iso-settlement maps. Repair to the cover system, if necessary, may require the placement of additional fill.

Cover design and maintenance as proposed as part of the Project are sufficient to reduce settlement impacts to a less-than-significant level.

EIR Recommendations:

MITIGATION MEASURE 5-2. None required.

IMPACT 5-3. Settlement of the landfill under proposed refuse and cover fill loads could impact cover integrity. This impact is considered to be less than significant.

As discussed in Impact 5-2, the settlements along the perimeter of the landfill would be less than the settlements near the center of the landfill where the fill loads would be greater. Plans are to use a GCL in lieu of a compacted clay layer that has been approved and constructed over portions of the site. The differential settlement over the landfill cap can cause strain within the GCL. However, the GCL has an allowable strain of about 10 percent (compared to the one to two percent tensile strain that can cause cracking in compacted clay). According to the study by EMCON/OWT (January 2003), strains induced by differential settlements are less than one percent and should have no impact on the integrity of the final cover system.[52]

Control Measures Incorporated by Applicant: None.

EIR Recommendations:

MITIGATION MEASURE 5-3. None required.

IMPACT 5-4. The placement of stockpiles could cause additional landfill settlement. This impact is considered to be less than significant.

Materials including concrete rubble, finished rock products, and wood waste could be stockpiled over the landfill and could cause settlement and differential settlement over the cap. The "Proposed WCL Report of Disposal Site Information Changes" allows for alternative daily cover (ADC) materials to be stockpiled near the landfill active face. In addition, ADC stockpile heights are limited to 20 feet for biosolids mixtures, 15 feet for Construction and Demolition (C&D) debris, and 30 feet for treated auto shredder waste.[69]

Control Measures Incorporated by Applicant:

a) Stockpiles would be located a minimum of 50 feet from the crest of 4:1 (horizontal:vertical) landfill sideslopes.

b) Stockpiles would have maximum slopes of 6:1 for heavier materials such as concrete rubble and 5:1 for lighter materials such as wood waste.

c) Maximum stockpile height would be 20 feet.

d) A stockpile plan would be approved by a registered professional engineer before any stockpiling takes place.

The proposed control measures would reduce the impact to a less-than-significant level.

EIR Recommendations:

MITIGATION MEASURE 5-4. None required.

IMPACT 5-5. Settlement of the landfill under existing and/or proposed fill loads could impact the existing and proposed structures supported on the landfill. This impact is considered potentially significant.

New facilities constructed at the proposed site (former Soil Remediation Building) may experience settlement as a result of consolidation of the underlying Bay Mud, as well as compression of the waste, if they are located over the waste fill(s). Structures could experience differential settlement across the building footprint, and between the building and exterior grades. Underground utilities connecting to the buildings could experience breakage if they are not properly designed.

The former Soil Remediation Building is constructed over a portion of the Class II landfill (Figure 5-2). Because of previous fill placement in the area and resulting differential settlement, the east end of the building is about 1.3 feet lower than west end, and the north side is about 1.6 feet lower than the east end. The sag is approximately 3 feet below the finish floor at the west end.[79] Before this building can be converted to the proposed WRC, portions of the building may need renovation prior to occupancy. From a future settlement standpoint, the Soil Remediation Building is located on a closed area of the Class II landfill,

where about 95 percent of decomposition of the refuse has already occurred.[13] Therefore, future settlement and soil stability would not constitute a significant impact.

Control Measures Incorporated by Applicant:

a) Adjustable height building columns and footers would be used for proposed building facilities.

Figure 5-2 Settlement of the Former Soil Remediaton Building. This building would be rehabilitated and expanded for the proposed WRC. It is located on fill which has experienced substantial differential settlement since it was constructed in 1996.

EIR Recommendations:

MITIGATION MEASURE 5-5

a) Geotechnical studies would be performed for each proposed/renovated site structure to be located on waste fill that evaluate impacts of landfill settlement on building performance, as well as additional settlement, if any, caused by new structures, and recommendations included in construction plans and specifications.

b) Flexible utility connections, if determined to be necessary by the geotechnical studies, would be used in areas of waste fill to reduce damage to utilities resulting from differential settlement between buildings and the surrounding ground.

c) Settlement of buildings located on waste fill would be addressed in the WCCSL Post-Closure Plan with monitoring and repairs as needed.

Implementation of these measures would reduce settlement impacts to renovation of existing and proposed new structures on the landfill to a less-than-significant level.

IMPACT 5-6. Settlement of the landfill under new refuse and cover fill loads could impact lateral containment structures. This impact is considered potentially significant.

The proposed WRC site is within about 8 to 10 feet of the soil-attapulgite slurry wall separating the Class I and Class II landfills. An additional barrier wall (Bay Mud and soil-cement-bentonite) surrounds the entire WCCSL. Large settlements could cause ground deformations, which may impact the integrity of the hydraulic barrier properties of these walls. However, the magnitudes of the expected settlements are not likely to be large enough to breach the walls.

Control Measures Incorporated by Applicant: None.

EIR Recommendations:

MITIGATION MEASURE 5-6

a) If new fill is placed for renovation of the proposed WRC site, additional geotechnical studies would be performed by the Applicant to evaluate settlement, slope stability, and potential impacts on the integrity of the soil-attapulgite slurry wall with recommendations included in construction plans and specifications.

b) Monitoring would be performed consistent with the recommendations of Mitigation Measure 5-6(a) to evaluate the condition of the soil-attapulgite slurry wall and appropriate repairs made as necessary.

Implementation of these measures would reduce settlement impacts to lateral containment structures to a less-than-significant level.

4. Slope Stability under Static and Dynamic Conditions

Static stability is a measure of the ability of a natural or made slope and its foundation to withstand movements due to imposed loads. Stability is expressed in terms of a “factor-of-safety” (F.S.). An F.S. is the ratio of strength of the resisting material divided by the imposed loads due to gravity and any external forces, if present. An F.S. of less than one represents a condition where the imposed loads are greater than the resisting forces, which will result in deformation, while an F.S. greater than one indicates that the resisting forces are larger than the imposed loads. Typically, a factor-of-safety of 1.5 or greater is considered to provide adequate margin of safety against a slope failure in a static condition.

Dynamic stability is the ability of slopes to withstand the loads imposed during an earthquake event. There are two primary impacts that could affect the foundation or cover of the Class II landfill during a seismic loading condition: (1) deformation of the foundation soils due to liquefaction, and (2) deformation of the foundation materials due to shear failure. Liquefaction was discussed in Section D2 of this chapter and is not a likely mechanism for causing significant deformation over the majority of the site during earthquake loading. Dynamic slope deformation due to shear failure has been evaluated by EMCON/OWT.[52] Typically, the result of such an analysis is an estimate of the amount of deformation a particular slope will undergo as a result of an earthquake shaking. The level of acceptable deformation is generally considered to be the amount of deformation that can occur without affecting the cover and other environmental control systems.

Global Landfill Stability. EMCON/OWT, Inc. (January 2003) performed slope stability analyses to evaluate the stability of the Class II Landfill.[52] This analysis was conducted pursuant to RWQCB Order No. R2-2001-0066 and the peer review of the analysis as required by the Order is ongoing. The results of this ongoing process with the RWQCB may further refine the preliminary conclusions summarized below as well as the control measures that may be required by the RWQCB due to the results of the analysis.

The slope stability analyses were performed using the two-dimensional limit equilibrium computer program PCSTABL. Three cross sections designated 1-1, 2-2, and 3-3 were used to analyze the global stability that took into account critical locations with respect to various loading conditions. The locations of the cross sections are shown on Figure 5-3. The Bay Mud at the southern perimeter of the site (cross section 3-3) appears to have single drainage (i.e. it can only drain upward into the waste), and is therefore likely partially consolidated, while on the northern and western slopes (cross sections 1-1 and 2-2) the Bay Mud has double-drainage boundary conditions, resulting in a faster rate of consolidation. However, filling history suggests fill placement at the northern boundary was more recent than in the south, and the slope configuration on the north and west sides is more critical. On the southeastern slope (cross section 3-3), the existing waste slope is the steepest, the Bay Mud has single-drainage, and the time of consolidation is shorter than on the south side. EMCON/OWT concludes the south slope cross section (1-1) represents the worst critical slope for end-of-filling conditions.

Previous and new borings, laboratory data, and historic plots of waste profiles were used to evaluate the degree of consolidation of the Bay Mud, which is related to the strength. The static slope stability analysis was performed for the end-of-filling conditions corresponding to the Bay Mud strength in the year 2002 for a maximum waste elevation of 160 feet. The static slope stability analysis was performed assuming both circular and sliding block-type failure surfaces. For all cases evaluated, the factor of safety is greater than the acceptable value of 1.5, except at cross-section 3-3 for a circular failure mode. For this analysis, the factor of safety was 1.46, however, if 3-dimensional effects are considered (the location is in a valley), EMCON/OWT concludes the factor of safety would be higher than 1.5.

Pseudo-static slope stability analyses were performed to evaluate the yield acceleration of the failure surfaces during an earthquake. These analyses included a strength increase in Bay Mud due to the rapid nature of loading during an earthquake. 27 CCR requires that Class II landfills be designed to withstand ground motions from the MCE. An average horizontal equivalent acceleration (HEA) for the critical failure mass associated with the yield acceleration was computed for each of seven acceleration-time histories. Associated displacements were then estimated using a Newmark (1964) type dynamic slope deformation analysis. The coupled analyses performed by Professor Jonathan Bray, a consultant to EMCON/OWT, resulted in average seismic displacements of about 1 to 3 feet for MCEs on the Hayward and San Andreas faults. The largest displacements occurred at cross-section 1-1. However, for cases where degraded material properties were used, seismic deformations exceeded 5 feet for five of the seven analyzed cases. The largest computed deformation was 25 feet for the synthetic input earthquake motion simulating the 1906 San Andreas event.

Cover Stability. Stability of the cover under both static and dynamic conditions was also evaluated by EMCON/OWT (January 2003) as related to maintaining slopes.[52] Information provided by EPA Subtitle D (incorporated by CCR) was used to establish F.S. criteria for cover design. Slope stability analyses were then performed using an infinite slope method and a peak ground acceleration (PGA) of 0.5g. The maximum required slopes to meet the F.S. criteria based on the analyses are summarized below:

- The minimum required F.S. for the static condition, without including seepage forces, is 1.5; analyses show a 4:1 (horizontal:vertical) slope (25 percent) is sufficient to meet the criteria.
- The minimum required static F.S. for the static condition, including full seepage forces, is 1.0; analyses show a 5:1 slope (20 percent) is sufficient to meet the criteria.

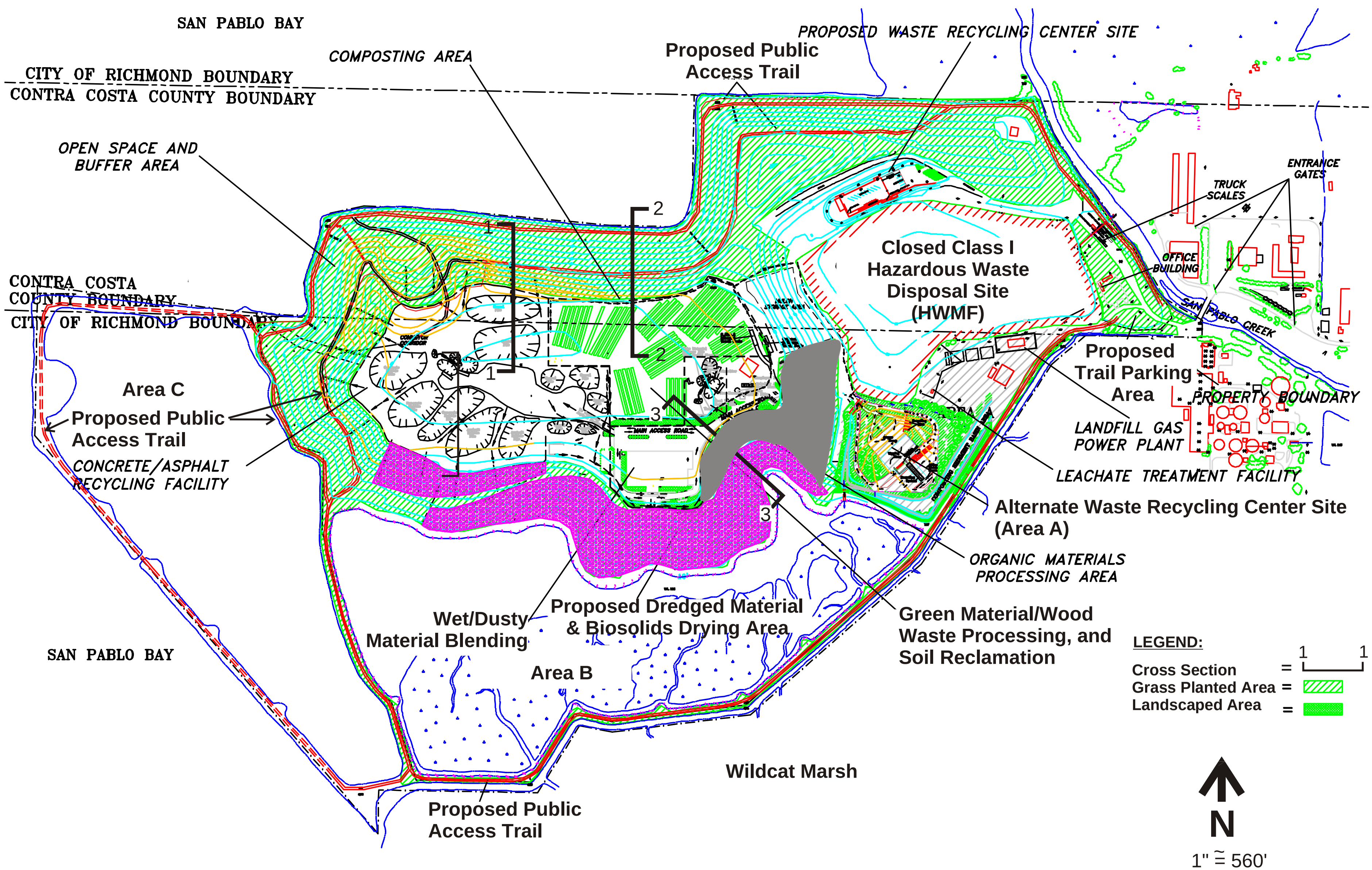


Figure 5-3 Location of Slope Stability Cross Sections

Source: WCL, February 2003

- The maximum allowable cover displacement during an earthquake is one foot; analyses indicate this criteria can be met using a 7:1 slope (14 percent), or flatter.

Therefore, a proposed topdeck slope of 10:1 (10 percent) or flatter will meet both the static and seismic slope stability criteria. The predicted post-settlement slope of 5 percent also meets the cover stability and drainage criteria.

IMPACT 5-7. The placement of new fill could cause a static slope or cover failure that could damage the landfill cap and environmental control systems. This impact is considered to be less than significant.

The analyses performed by EMCON/OWT for the cover and general landfill indicate the factors of safety are sufficient to resist sliding of the cover or failure of the landfill in a static condition. Therefore, impacts associated with the static stability are not significant and no mitigation measures are required.

Control Measures Incorporated by Applicant: None.

EIR Recommendations:

MITIGATION MEASURE 5-7. None required.

IMPACT 5-8. The combination of new fill placement and seismic shaking could cause slope deformations, which could damage the landfill cap and environmental control systems. This impact is considered potentially significant.

EMCON/OWT has concluded the probability of an MCE event occurring on the Hayward Fault or San Andreas Fault is low, which is in general agreement with the 30-year probabilities presented in the USGS Group (1999) discussed earlier. The analyses performed indicate lateral slope displacements on the landfill cover could be on the order of 12 inches, while displacements of the landfill sideslopes could be as much as 25 feet (see discussion above).[52] This landfill slope deformation would likely result in damage to the landfill cap and GCL, irregular surface and related drainage issues, and potential distress to the containment structures (Figure 5-4). As discussed under Impact 5-1, a post-earthquake maintenance and repair plan would be implemented by the Applicant. If the barrier wall is breached under seismic conditions, an inward hydraulic gradient would be maintained to control off-site migration of leachate or waste prior to and throughout the repair. Due to the relatively low permeability of the subsurface materials, it is unlikely large-scale, off-site migration of leachate or waste would occur.

Control Measures Incorporated by Applicant:

a) Following an earthquake, an inspection program would be implemented to evaluate the extent of cracking of the cover materials, damage to LFG collection system, damage to leachate collection and pumping systems, global landfill sliding, and cracking of the barrier wall. Appropriate repairs would be made pursuant to RWQCB Order No. R2-2002-0066.

b) Under the seismic scenarios where the barrier wall is breached, an inward hydraulic gradient would be maintained prior to and throughout the repair (see Control Measure 5.1(c)).

c) A slope remediation study would be performed, or a long-term slope maintenance program would be developed to address the consequence and possible repairs resulting from large seismically-induced permanent slope displacements.

d) As recommended in the EMCON/OWT, Inc. slope stability report, a probabilistic analysis of the permanent displacements would be performed to be used in developing a detailed earthquake response plan. The response plan would provide details on procedures to be followed for inspection of the site following major earthquakes, and on the slope maintenance requirement that may be triggered by significant displacements.

EIR Recommendations:

MITIGATION MEASURE 5-8:

a) A plan for inspection and as-needed repair of the GCL following an earthquake would be added to the Postclosure Plan.

Implementation of this mitigation measure would reduce impacts associated with slope deformations to a less-than-significant level.

IMPACT 5-9. Slope deformations or slope failure at the proposed WRC site could impact the soil-attapulgite slurry wall. This impact is considered potentially significant.

The stability of the fill pad at the former Soil Remediation Building and related effects on the soil-attapulgite slurry wall separating the Class I and Class II Landfills were evaluated by Woodward-Clyde Consultants in 1995.[90] The building design uses geogrid reinforcement within the fill pad and a downslope berm. The expected lateral deformation of the pad during a seismic event would be limited to 3 to 4 inches. This level of displacement is not likely to significantly impact the 5-foot-wide slurry wall.

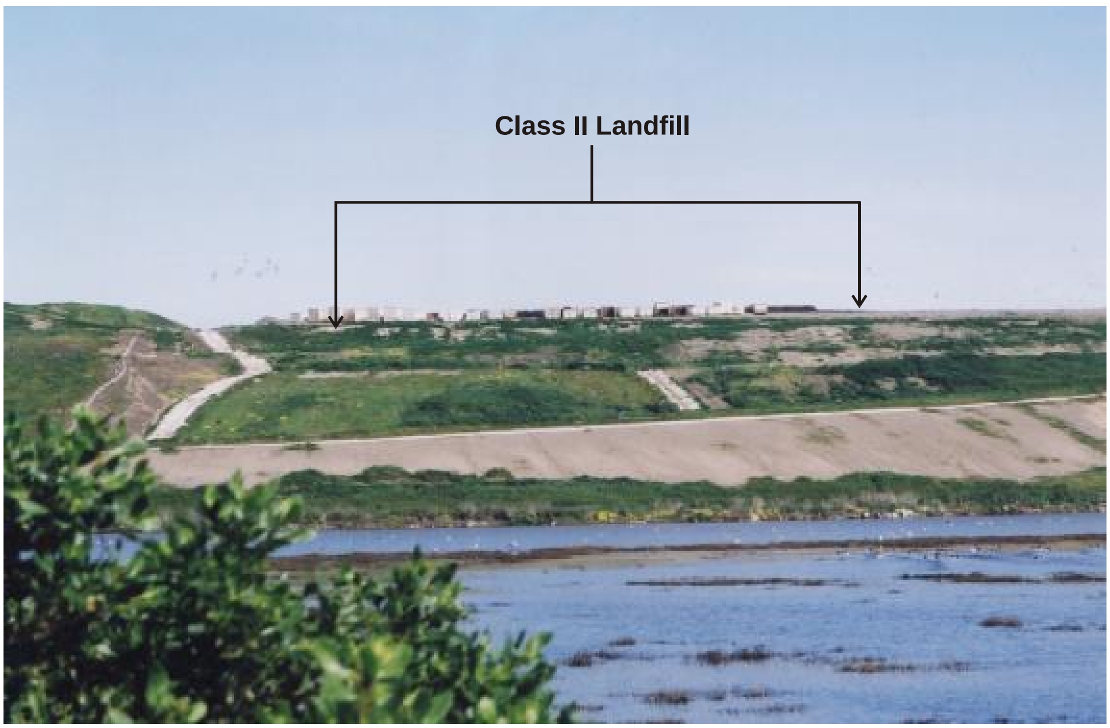


Figure 5-4 Landfill Seismic Displacements. The Southern area of the Class II landfill shown here is less stable than other areas under certain seismic conditions. A detailed earthquake response plan will be developed by the Applicant (Control Measure 5.7 (d))

However, localized repair of the soil-attapulgite slurry wall (and the cover system) may be required.

Control Measures Incorporated by Applicant:

a) The inspection, monitoring and repair plans outlined in the Post-Closure Maintenance Plan would be followed.

b) Following a significant earthquake (magnitude 6.5 or greater) the site would be inspected to evaluate the performance of the environmental control systems related to the Class I Landfill. Slurry wall deformations in excess of 1 foot would require notification to the State Department of Toxic Substances Control (DTSC) and RWQCB within 14 days and repairs made pursuant to their recommendations.

EIR Recommendations:

MITIGATION MEASURE 5-9:

a) If new fill will be placed for renovation of the proposed WRC site, additional studies would be performed to evaluate potential settlement, slope stability, and movement of the soil-attapulgite slurry wall and recommendations would be incorporated into construction plans and specifications (see Mitigation Measure 5.6(a)).

Implementation of these measures would reduce seismic shaking impacts to a less-than-significant level.

5. Seismic Shaking of Building Structures and Associated Improvements

IMPACT 5-10. Ground shaking during an earthquake could affect building structures and associated improvements. This impact is considered potentially significant.

An earthquake on a nearby fault would cause ground shaking at the landfill site. If new structures are not designed to resist earthquake ground motions, damage could be sustained. Ground shaking with respect to liquefaction and slope stability were discussed in previous sections.

Control Measures Incorporated by Applicant:

a) New buildings would be designed to meet the 1997 Uniform Building Code (UBC) Seismic Zone Factor 4 standards, and constructed in accordance with all applicable building codes and regulations.

EIR Recommendations:

MITIGATION MEASURE 5-10:

a) To ensure proper structural design, a geotechnical report would be prepared for all new buildings to be located on waste fill with recommendations incorporated into construction plans and specifications (see Mitigation Measure 5-5(a)). The geotechnical report would discuss the potential for differential ground surface settlement and the need for flexible utility connections (see Mitigation Measure 5.5(b)).

Implementation of these measures would reduce seismic shaking impacts to buildings and site improvements to a less-than-significant level.

6. Cover Protection

IMPACT 5-11. The construction and operation of new buildings and facilities, as well as construction of the cap itself, could cause damage to the landfill cover (cap). This impact is considered to be less than significant.

The cover, and in particular the GCL, must not sustain damage during construction or post-closure activities to allow it to function properly. The GCL could be damaged during placement due to puncture by underlying materials or the cover soil, or by ripping. The landfill cap would be overlain by an additional 3 feet of protective soil in post-closure operations areas. At the former Soil Remediation Building, a regulatory-compliant landfill cover system was installed before construction of the building. A 60-mil high density polyethylene (HDPE) (plastic) liner provides a barrier between the soil underlying the building foundation and the landfill cap.

Control Measures Incorporated by Applicant:

a) During construction, the subgrade would be prepared properly to create a smooth surface and proper construction and quality assurance monitoring would be conducted consistent with the requirements of the Postclosure Plan.

b) If the cover (including the GCL) is damaged during construction or post-closure activities, it would be repaired or replaced.

Implementation of these measures would reduce impacts to the landfill cap to less-than-significant levels. Other control measures to assure the integrity of the final landfill cap are discussed in Chapter 6, Water Resources (Control Measures 6-2 (a, b, c).

EIR Recommendations:

MITIGATION MEASURE 5-11: None required.

7. Impacts of Mitigation Measures

None of the mitigation measures discussed above will have any significant adverse impacts.

E. CUMULATIVE IMPACTS

The proposed Project would not have any geologic, soil, or seismic impacts that cannot be mitigated to less-than-significant levels. The Applicant must comply with State requirements as well as the recommendations in this EIR to ensure the geologic compatibility of the proposed Project and the WCCSL site. Similarly, all future development projects discussed in Chapter 4, Section A3(b) would be subject to the requirements of the CEQA and State and local agency requirements in regard to the identification and protection against geologic, soil, and seismic hazards. For most projects, soil studies are required through the building permit process in order to mitigate impacts from soil problems such as liquefaction, unstable soils, and soils with a large degree of shrink/swell. Mitigation measures for potential impacts from such problem soils include proper foundation construction and soil anchors. All buildings and other facilities must be constructed to meet specified earthquake requirements contained in the Uniform Building Code. As a result, there are no cumulative geologic, soil, or seismic impacts that would result from the proposed Project and other cumulative projects in the area.