G. GEOLOGY AND SOILS

The Geology and Soils section of the EIR was prepared by Fred J. Potthast, Registered Geotechnical and Civil Engineer, and Richard T. Gorman, Registered Geologist and Certified Engineering Geologist, both of Earth Systems Pacific. The geologic and soils information, conclusions, and impact assessment were based upon a site reconnaissance and review of reports provided by the applicant, as well as review of available published and unpublished geologic data, publications, and maps.

1. Existing Conditions

a. General Site Conditions

The southwest portion of the expansion area consists of undeveloped, rolling terrain, with topography varying from nearly level to slopes of about ten percent. Elevations range between approximately 200 and 270 feet at the south and north ends, respectively. Along the northwest side of the expansion area, a cut slope with a height of about 25 feet descends toward the disposal area, the last module of which has been excavated and lined. The northeast portion of the expansion area has been graded nearly level and is used for the compost operation. On the east side of the compost operation, a fill slope descends toward a drainage, which consists of a broad swale vegetated with grasses and shrubs.

The proposed Resource and Recovery Park (RRP) and Materials Recovery Facility (MRF) sites lie in the northeast portion of the expansion area. Table V.G.-1 illustrates the existing, proposed uses, and existing geologic conditions of these sites.

TABLE V.G.-1
Geologic Conditions of the Northeast Expansion Area

Project Component	Existing Use	Topographic/Geologic Conditions
RRP	Undeveloped knoll and unimproved graded area	Slopes up to 20%, adjacent to and east of natural drainage
MRF	MRF, graded flat and paved with asphalt or concrete	Flat, engineered soils
Compost Runoff Pond	Storage area for green waste	Graded flat, adjacent to, and west of natural drainage

The southeastern portion of the expansion area consists of undeveloped rolling terrain; it is separated from the rest of the expansion area by a 100-foot riparian corridor. The new entrance facility would be constructed at the south corner of the site; the access road associated with the new entrance would ascend along a slope southeast of the riparian corridor. An office and a scalehouse are planned southwest of the MRF and east of the riparian corridor. The new detention basin is planned along the south side of the landfill expansion area, between the riparian corridor and proposed Module 14 (refer to Figure III-3).

b. Local Geologic Formations

1) Bedrock Units

(a) Regional Geologic Setting

The Landfill lies within the Western Franciscan block of the Coast Range Geomorphic Province of California. The Coast Range Province is divided into three major crustal blocks: the Eastern Franciscan Block, the Salinian block, and the Western Franciscan block. The Western Franciscan block comprises Jurassic-Cretaceous metamorphic Franciscan bedrock overlain by Miocene-Pliocene and Pleistocene sedimentary rocks. The Western Franciscan block is separated from the Salinian block crystalline rocks by the Sur-Nacimiento Fault zone, located approximately nine miles northeast of the Landfill. Regional geologic conditions are depicted in Figure V.G.-1.

(b) Local Geologic Setting

The Landfill lies within the northwest-trending Edna Valley. Edna Valley is bounded to the northeast by the Santa Lucia Range and by the San Luis Range to the southwest. The Landfill is underlain by Tertiary sedimentary rocks of the Pismo and Monterey formations. According to Hall (1973), the site is underlain predominantly by the upper Miocene Edna (sandstone) member of the Pismo Formation, with lower to mid-Miocene Monterey Formation (diatomite) beneath the northeastern end of the site. Pismo Formation sandstone and Monterey Formation diatomite are typically massive to thickly bedded. Bedding dips about 40 degrees to the southwest at the north end of the site, and about 25 degrees to the southwest at the south end. These dipping beds represent the eastern flank of the south-plunging Pismo Syncline. A small area of Quaternary alluvial sediments is present near the south corner of the site; these sediments consist primarily of sand, silt, and clay.

(c) Geologic Units

Outcrops of the Edna (sandstone) member of the Pismo formation are exposed in the central and southwest regions of the Landfill. The sandstone is typically white to light grey, poorly graded, fine grained quartzose sandstone. This rock is soft, friable, and exhibits noticeable cohesion due to its clay and silt content. Hydrocarbon-bearing zones have been identified within both the Monterey formation and the Edna member sandstone, typically near the contact between the two units (Golder, 2007). Monterey formation diatomite, exposed in the northeast part of the site, is typically white, very fine grained, and becomes cohesive and plastic when wet. The Quaternary alluvium near the south corner of the site is derived primarily from the weathering of the Monterey and Pismo rock units; volcanic gravel issued from the Franciscan rock complex within the Santa Lucia Range in the vicinity of the Landfill is also found in the alluvial sediments. The geologic units at the Landfill are shown on Figure V.G.-2.

2) Surficial and Soil Units

The Soil Survey of San Luis Obispo County, California, Coastal Part prepared by the United States Department of Agriculture, Soil Conservation Service (1983), lists three soil types as being present at the expansion area, described below. These soils are also shown in Figure V.B.-1 within the Agricultural Resources section, Section V.B.

Insert Figure V.G.-1 – Regional Geologic Map

Back of V.G.-1

Insert Figure V.G.-2 – Local Geologic Map

Back of V.G.-2

(a) Arnold Loamy Sand

Arnold loamy sand is deep, somewhat excessively drained, moderately steep and steep soil formed in residual material weathered from soft sandstone. Typical surface layer is light brownish gray loamy sand about 33 inches thick. Permeability is rapid, and available water capacity is low or moderate. Surface runoff is rapid, and the hazard of water erosion is high or very high. Blowing soil hazard is high. Gully erosion is a hazard in wet years. Special engineering design considerations may be required due to soil blowing and water erosion hazards, steep slopes, depth to bedrock and sandy texture. These design considerations include minimum grading and plant cover.

(b) Lodo Clay Loam

Lodo clay loam is shallow, somewhat excessively drained, very steep soil formed in residual material weathered from sandstone. Typical surface layer is dark brown clay loam about 12 inches thick, underlain by fractured, hard sandstone. Permeability is moderate, and available water capacity is very low or low. Surface runoff is very rapid, and the hazard of water erosion is very high. This soil is subject to sheet and gully erosion and compaction due to the clay loam surface layer and steep slopes. Special engineering design considerations may be required due to steep slopes and shallow depth to rock. These design considerations include runoff and sediment control structures, minimum grading for roads and other grading, and plant cover.

(c) Pismo Loamy Sand

Pismo loamy sand is shallow, somewhat excessively drained, strongly sloping, and moderately steep soil formed on foothills and mountains. This soil is formed in residual material weathered from sandstone. Typical surface layer is light brownish gray, medium acid loamy sand about 19 inches thick. Soft fractured sandstone occurs at a depth of about 19 inches. Permeability of this soil is rapid, and the available water capacity is very low. Surface runoff is medium or rapid, and the hazard of water erosion is moderate to high. The hazard of gully erosion is high in wet years. Special engineering design considerations may be required due to steep slopes, shallow rock, high sand content, and erosion hazard. These design considerations include runoff and sediment control structures, minimum grading for roads and other grading, and plant cover.

(d) Boring Log Data

Field exploration of the expansion area was conducted by Golder Associates (January, 2007) during drilling for five new groundwater monitoring wells, two temporary observation wells, and an exploratory boring. The wells and borings were part of a hydrogeologic characterization of the proposed expansion area. Surficial soil typically described as silty sand occurred to depths between 1.5 and six feet in four of the five groundwater monitoring wells. Pismo formation Edna member sandstone was logged below the surface soil in these locations, variously described as sandstone, silty sandstone, and sandy siltstone; the sand-sized fraction was typically logged as very fine to fine-grained. Edna member sandstone was logged for the total depth explored in two locations. Total depth of exploration in these locations ranged between 29 and 101 feet. A hydrocarbon-bearing zone of the Edna member sandstone (bituminous sandstone) was reported in one of the monitoring wells between approximately 25 and 50 feet below ground surface.

In the south region of the Landfill, borings drilled in the area of Quaternary alluvium revealed soil cover of two to four feet above Edna member sandstone (Golder, 2007). The alluvium is likely to be deeper along the thread of the drainage, but is anticipated to be less than ten feet thick, based upon field observations.

Borings were drilled at the location of the existing MRF in 1996 by Earth Systems Consultants Northern California. In those borings, sandstone was encountered at depths ranging from two to 12 feet, and was overlain by silty clayey sand.

3) Surface and Groundwater Conditions

Drainage of the Landfill site is primarily by overland flow that concentrates into drainage channels that flow southwest, south, and southeast towards Canada Verde Creek. Canada Verde Creek discharges into Pismo Creek to the west. In the southeast region of the site, a shallow, incised drainage swale lies within the designated 100-foot riparian corridor.

Groundwater was encountered by Golder Associates in the groundwater monitoring wells and temporary observation wells (Golder, 2007). Groundwater elevations on May 30, 2006, ranged between about 185 feet at the south corner of the site to 200 feet at the northern corner. At the northern corner of the Landfill, the groundwater elevation increased to about 300 feet. It should be recognized that groundwater levels may vary seasonally and from year to year, based primarily upon rainfall quantities. Rainfall during the 2005-2006 season at the San Luis Obispo Airport rain gauge was approximately 27 inches, which is five inches higher than the average at that location (refer to Appendix G).

Groundwater flow may occur both down the dip of the strata, laterally along the strike, and through permeable layers (ERCE, 1991). It may also flow through fractures in the rock, and at the soil/rock interface. The general direction of groundwater flow beneath the expansion area is to the south, consistent with the rest of the Landfill; however, in a portion of the expansion area, a depression in the groundwater elevation causes the flow to be to the north and east. This is believed to be the result of groundwater extraction from two supply wells located near the area of monitoring. A more thorough discussion of groundwater conditions at the Landfill can be found in Section V.K., Water Resources.

4) Faulting

The California Geological Survey evaluates faults based upon demonstrated activity and potential for future activity. Historically active faults have exhibited earthquake activity during historic time (within approximately the last 200 years). Active faults exhibit geologic evidence of movement in Holocene time (approximately the last 11,000 years). Potentially active faults have geologic evidence of Pleistocene Era movement (approximately the last 2,000,000 years). Significant faults within 65 miles of the Landfill are shown on Table V.G.-1, and discussed below.

(a) Indian Knob Fault

The Indian Knob Fault is located approximately 500 feet northeast of the Landfill and is nearly vertical, or dipping slightly to the west. This fault has been mapped as the contact between the Miocene-age Monterey formation and the Miocene-Pliocene age Pismo formation. It eventually intersects with the West Huasna fault southeast of the site. Studies have indicated that the Indian Knob fault has not experienced movement since late Quaternary time (300,000 to 500,000 years ago), and no evidence has been found of Holocene movement (ERCE, 1991; Jennings, 1975; PG&E, 1988). Exploratory fault trenches excavated by EMCON (ERCE, 1991) revealed the trace of the fault crossing the Landfill, but no evidence of movement within Quaternary deposits was observed. Consequently, this fault is not considered to be an active fault.

(b) Los Osos Fault

The Los Osos fault zone is a west-northwest-trending reverse fault that extends predominantly along the northeastern margin of the San Luis Range in San Luis Obispo County. The fault zone, which has an overall length of about 35 miles, is divided into four segments. The most westerly segment of the fault is the Estero Bay segment, which lies mostly offshore. The Irish Hills segment, the only active fault segment, starts in the vicinity of Los Osos and extends to just past San Luis Obispo Creek. A two-mile length of the Irish Hills segment, west of Laguna Lake and near the westerly limit of the City of San Luis Obispo, is considered to be active (Treiman, 1989) and is designated as an Alquist-Priolo Earthquake Fault Zone (Hart, 1997, revised). The other two segments of the Los Osos fault are the Lopez Reservoir segment and the Newsome Ridge segment, both located southeast of the Irish Hills segment, east of San Luis Obispo Creek. The Lopez Reservoir fault segment is the closest segment to the Landfill, located approximately one-half mile northeast. The active Irish Hills fault segment is approximately nine miles northwest. According to the San Luis Obispo County General Plan Safety Element (the Safety Element), the Los Osos fault has the potential to generate an earthquake with a maximum moment magnitude (M_w) of 6.75.

(c) West Huasna-Oceanic Fault

The West Huasna fault is located about four miles northeast of the Landfill, with a northwest-southeast trend. The activity along the West Huasna Fault is considered by the California Geologic Survey to be late Pleistocene age. The fault extends from about the Santa Maria River to San Luis Obispo, and joins the Oceanic and Cambria faults to the northwest. The Oceanic fault extends from San Luis Obispo to San Simeon and is approximately seven miles northwest of the Landfill. A significant earthquake occurred on the northwestern end of the Oceanic fault about seven miles northeast of San Simeon on December 22, 2003, with magnitude M_w 6.6. Although commonly referred to as the "San Simeon" earthquake, the source of this earthquake has been attributed to movement on the Oceanic Fault (PG&E, 2004), not the San Simeon Fault. Analysis by the USGS and the University of California at Berkeley indicates that the event had a thrust (reverse) faulting mechanism (Goel, 2004). The West Huasna-Oceanic Fault is considered capable of producing an M_w 6.5 earthquake.

(d) San Luis Range Fault System

The San Luis Range fault system comprises a series of west-northwest striking faults including, from south to north, the Santa Maria River Fault, the Wilmar Avenue Fault, the Oceano Fault, the San Luis Bay Fault, and the Olson Fault. The Santa Maria River Fault is approximately 16 miles south of the Landfill. The trend of this fault is inferred from oil well logs and geophysical records, and extends from south of Sisquoc in Santa Barbara County up to the Wilmar Avenue Fault in Nipomo. The Wilmar Avenue Fault extends from northern Nipomo to Pismo Beach, where it is exposed in the ocean bluff at the end of Wilmar Avenue. At this location, Pleistocene terrace deposits are displaced in the face of the bluff. The Wilmar Avenue Fault is approximately four miles southwest of the site. The Oceano Fault is a 12-mile long northwest-trending fault extending from the town of Nipomo to the offshore area of San Luis Bay. At its closest point, the Oceano fault is about six miles to the southwest of the site. Because of the thick dune sand and alluvial deposits within the Santa Maria Valley, the onshore trace of the fault is buried or obscured. The geometry of, and displacement across, the Oceano Fault are inferred from subsurface geophysical and well data. The San Luis Bay fault is generally a west-trending reverse fault that displaces and locally warps late Pleistocene marine terraces near the community of Avila Beach. The fault extends west into the offshore area between the coastline and the Hosgri fault, and to the southeast offshore of Avila Beach. The San Luis Bay does not directly connect with the Wilmar Avenue fault, but has similar geometry and structural features along the southwestern margin of the San Luis Range. The Olson Fault is located along the coastline about four miles northwest of Point San Luis and 12.5 miles west of the site. It is the northernmost fault along the southwestern margin of the San Luis Range. The fault is not exposed in any outcrop and has no geomorphic expression. Its presence along the coast is inferred on the basis of an offset of late Pleistocene marine terrace sequence (Lettis et al, 1994). The San Luis Range Fault System is considered to have a recurrence interval of about 6,000 years for a maximum M_w 7.0 earthquake (Peterson et. al, 1996).

(e) Hosgri-San Simeon Fault System

The Hosgri Fault-San Simeon fault system consists of two fault zones: the Hosgri fault zone, which consists of a series of faults off of the San Luis Obispo County coast, and the San Simeon fault zone, which comes onshore near the pier at San Simeon. A northwest-trending strike-slip fault, the San Simeon fault extends from offshore of Ragged Point to just offshore of San Simeon Point, where it joins the northern end of the Hosgri fault. From this point, the Hosgri fault extends to an ocean shelf two miles west of Point Buchon, and then trends toward the Point Sal area. The fault system is considered active by the United States Geologic Survey (USGS, 2004), based on Hall's claims of recent offset terrace deposits along San Simeon Cove, and also by a relocation of the 1927 "Lompoc Earthquake" onto the southern end of the Hosgri fault (Hall, 1975, 1976, 1977). At its closest point, the Hosgri-San Simeon Fault System lies approximately 14 miles southwest of the Landfill. It is considered capable of producing a maximum M_w earthquake of 7.3.

(f) Rinconada-East Huasna Fault

The East Huasna Fault is located approximately ten miles northeast of the Landfill. This fault extends north-northwest from Sisquoc in Santa Barbara County until it joins the Rinconada fault about 15 miles east of the city of San Luis Obispo. The East Huasna Fault is a nearly vertical or

steeply dipping reverse fault that displaces Quaternary deposits. The northern extension of the East Huasna Fault joins the Rinconada Fault, which projects north-northwest, eventually following the western edge of the Salinas Valley up to Monterey Bay. Although the California Geological Survey classifies the Rinconada Fault as exhibiting Quaternary movement, recent studies for the Santa Ysabel Ranch in Paso Robles and the Chicago Grade Landfill in Templeton have shown features that suggest Holocene movement (Lew Rosenberg, personal communication, 2008). No ground rupture has been mapped in Holocene time on the Rinconada fault, although there have been historical small to moderate earthquakes (<5.9 magnitude) that have been recorded in the vicinity of the fault. It is possible that the shock waves produced by these small earthquakes did not have enough energy to break the ground surface or cause any displacement within the surface materials. The Rinconada Fault is considered capable of generating a maximum M_w 7.3 earthquake.

(g) San Andreas Fault

The most seismically active fault in California is the San Andreas fault, which lies about 35 miles to the northeast of the Landfill. The San Andreas fault is the primary surface boundary between the Pacific and North American plates, and it is generally considered to be the most likely source for strong ground motion in the County of San Luis Obispo. There have been numerous historic earthquakes along the fault, and it is considered capable of producing a maximum M_w of 7.8.

Approximately 600 miles long, the San Andreas fault extends from the Gulf of California to the north coast of California just south of the town of Humboldt. The fault is a right-lateral strike-slip fault and, for classification purposes, is divided into several segments. Locally, the Cholame segment extends southeast from Cholame for about 40 miles, and joins the Carrizo segment, which extends another 90 miles to the southeast. The fault undergoes a major change in character between Parkfield and Cholame. North of Cholame, the fault moves more or less constantly in a process called creep, whereas the south end of the fault is locked, moving only in very large earthquakes. The last major earthquake on this part of the fault was the 1857 event, which is considered to have been a magnitude 8.0 or greater on the Richter scale. The Richter scale is an older and less accurate method to identify the energy released by powerful earthquakes. Engineers generally use the moment magnitude (Mw) referred to in the previous paragraph and in Table V.G.-2, when identifying potential earthquake-related design parameters. In the immediate vicinity of Parkfield, there is a 20-mile segment that is locked, generating an earthquake approximately every 20 years on average. Dated earthquakes on this segment are 1881, 1901, 1922, 1934, 1966 and 2004, and are usually in the magnitude 5.5 to 6.0 range, (Bakun, 1988). A 6.0 magnitude earthquake last occurred on this fault segment on September 28, 2004 (USGS, 2004).

TABLE V.G.-2
Significant Regional Faults

Fault	Closest Distance to Site (mi)[3]	Max. Moment Magnitude (M_w)[1]	Max. Credible Eq. (MCE)[2]	Est. Slip Rate (mm/yr)[1]	Recurrence Interval (years)	Fault Type[1]
Indian Knob (late Quarternary)	500ft[5]	n/a	n/a	n/a	n/a	n/a
San Luis Range (late Pleistocene)	4	7.0	n/a	0.2	6000	B
West Huasna – Oceanic (Oceanic segment-Historic)	4	6.5[4]	7.25	0.5[4]	n/a	B
Los Osos (Irish Hills segment-Holocene)	9	6.75	6.75	0.5	1925	B
Hosgri-San Simeon (Holocene)	14	7.3	7.5	2.5	646	B
Rinconada-East Huasna (Rinconada segment-Holocene)	10	7.3	7.5	1.00	1764	B
San Andreas (Cholame segment-Historic)	35	6.9	7.5	34.00	437	A
San Andreas (1857 rupture-Historic)	35	7.8	8.0	34.00	206	A
San Andreas (Parkfield segment-Historic)	42	6.7	7.5	34.00	25	A
San Andreas (Creeping segment-Historic)	56	6.2[5]	7.5	34.00	n/a	A

[1] Peterson & others, CDMG Open File Report 96-08, Appendix A.
[2] California Seismic Hazard Map, Caltrans 1996.
[3] Jennings, 1994
[4] Pacific Gas and Electric, 2004
[5] Hall, 1973
n/a – no data available.

c. Geologic Hazards

1) Landslide and Rockfall Hazard

The San Luis Obispo County General Plan Safety Element identifies the site as having predominantly low landslide potential, but as being bordered by areas of high landslide potential. The Safety Element states that a "low potential" designation applies to areas where slope gradients are less than 20 percent. A "high potential" designation applies to areas where slope gradients exceed 50 percent, or the slope gradients exceed 20 percent and are underlain by formations known to have a propensity for slope instability, creep, and landsliding. The Monterey formation, which underlies the northern portion of the site, is included in this category. The Safety Element states that the "moderate" designation applies to areas where slope gradients exceed 20 percent, but are underlain by formations characterized by poorly consolidated or weak rocks. The Pismo formation is included in this category. The central and southern regions of the Landfill are underlain predominantly by the upper Miocene Edna (sandstone) member of the Pismo Formation.

Insert Figure V.G.-3

Back of Figure V.G.-3

Most of the site is characterized by slopes that are less than 20 percent; steeper slopes exist only in areas that have been graded in the past. Where these steeper slopes exist, they are cut slopes that expose shallow bedrock, or are believed to be compacted structural fill slopes. A site reconnaissance was conducted by a Certified Engineering Geologist to observe the topography for indications of potential landslide and slope instability. No evidence of landslides or gross slope instability was observed at the site. The 1991 EIR for the first expansion of the Landfill indicated that minor landslides were identified in the southern region of what is now the existing Landfill, with a larger, more complex landslide deposit along the eastern boundary (ERCE, 1991). Based upon site reconnaissance, however, it appears that these areas have been graded during the previous landfill expansion as there is no remaining evidence of these previously existing landslides.

In view of the shallow depth to rock across most of the site and the absence of landslide features, and relatively shallow slopes, the potential for landslides to affect the site is considered low. There are no significant boulders on slopes that would create a potential for rockfall hazard.

2) Site Alteration and Slope Stability

Slope stability analyses were performed for the proposed expansion area by Shaw Environmental, Inc. (Shaw, 2007). The analyses were performed for both permanent waste slopes (global slope stability) as well as interim waste slopes within the modules (interim slope stability), under both static and seismic conditions. The most critical slopes for the interim and permanent waste slopes were identified, and analyses conducted to evaluate slope stability. Based upon the results of the interim slope stability analysis, a reduction of the maximum waste elevation for interim slopes from 413 feet to 340 feet was recommended, unless the geosynthetic clay liner (GCL) was encapsulated with a second geomembrane layer. It was also recommended that maximum interim waste sideslopes not exceed 3.5 horizontal to one vertical. Based upon the results of the global slope stability analysis, it was recommended that to limit permanent displacements to less than one foot under seismic conditions, the GCL at the toe area of the western and southern perimeters of the expansion area should be encapsulated with a second geomembrane layer for a distance of 200 feet from the toe of the slope; the GCL on the sideslope should also be encapsulated. Minimum shear strength criteria for liner systems to be used in conjunction with the encapsulated GCL were also provided.

3) Erosion

The erosion potential of soil is governed by the physical properties of the soil along with environmental factors such as rainfall, wind, topography, and vegetative cover. The Soil Survey of San Luis Obispo County (USSCS, 1983) identifies the soil types found at the site as having moderate to very high erosion potential. The highest erosion potential would be on slopes with steeper gradients, particularly during and following construction activities. Stockpiled soils would also be vulnerable to erosion.

4) Naturally Occurring Asbestos

Asbestos can occur naturally in certain rock formations, such as those that include serpentinite or ultramafic rock. The central and southwest regions of the site are underlain by upper Miocene Edna (sandstone), member of the Pismo Formation, with lower to mid-Miocene Monterey

Formation (diatomite) beneath the northeast end of the site, and a small area of Quaternary alluvial sediments in the south region. These geologic units are not asbestos-bearing. Consequently, the potential for naturally occurring asbestos to be encountered at the project site is very low.

5) Subsidence

Subsidence is the sinking or settlement of the ground surface relative to the surrounding area, with little or no horizontal movement. Four types of land subsidence are known to occur in California. In descending order of significance, these are: 1) subsidence caused by aquifer system compaction related to the lowering of groundwater levels, generally due to pumping activities; 2) subsidence caused by hydrocompaction of soils above the groundwater table; 3) subsidence related to extraction of oil and gas deposits; and, 4) subsidence related to seismic activity.

Due to the shallow depth to rock in the areas where the proposed improvements are planned, the potential for subsidence to affect the expansion area is considered to be low.

6) Volcanic Eruption

The ancient volcanic peaks known as the Seven Sisters which stretch from south of San Luis Obispo to Morro Bay are the closest volcanic features to the proposed project, however they are inactive. The closest volcanic features that pose a threat in California are located in the Long Valley - Mono Lake area of California, over 205 miles to the northeast of the Landfill. The last known eruptions to have occurred in the Mono Lake area were between 250 and 600 years ago. Volcanic activity in the Mono Lake area has a potential to deposit ash for a distance of approximately 50 miles from the eruption (USGS, 1999).

Due to the distance of the Landfill from the closest source of volcanic hazard, the possibility of the site being adversely affected by volcanic eruption is insignificant.

7) Expansive Soils

Expansive soils tend to swell with seasonal increases in soil moisture and shrink during the dry season as soil moisture decreases. The volume changes that the soils undergo in this cyclical pattern can stress and damage structures if precautionary measures are not incorporated into design and construction. In the soils engineering report for the existing materials recovery project (Earth Systems Consultants, 1996), test results indicated a low expansion potential for the soil sampled, which was described as silty clayey sand. In the borings drilled by Golder Associates (Golder, 2007), the overburden soils were described as silty sands, which typically exhibit little, if any, expansiveness. There may be other localized areas of the site, however, where more expansive soils may be present.

8) Springs and Seeps

There is a moderate potential for springs and seeps to occur within the claystone and siltstone of the Monterey formation. Groundwater generally flows along fracture and bedding planes within this formation; water was encountered within the bedrock in several borings drilled by Golder (Golder, 2007). If these planes daylight out of a cut or natural slope face, groundwater can flow

out of the slope face as a spring or seep. The Pismo formation consists primarily of thickly bedded to massive sandstone and conglomerate. If these geologic units are highly weathered, surface water can percolate and be absorbed into the upper weathered horizons of the rock so it does not concentrate and form a spring or seep. Perched water conditions can occur along the surface of the bedrock if the sandstone or conglomerate is hard or cemented. Perched water can produce springs and seeps if a cut slope intersects the soil/rock interface.

The southwestern part of the expansion area consists of natural, low, rolling hill topography. This area is underlain by sandstone and conglomerate of the Pismo formation. The drainage swale in this area is shallow and incised. The depth to bedrock along the drainage appears shallow, less than five feet in most areas. The bedrock is overlain with a silty sand alluvium. Based upon subsurface investigation (Golder, 2007), groundwater is perched on top of the bedrock surface in this area.

9) Radon Gas

Radon is a naturally occurring, gaseous element formed by radioactive decay of radium atoms, and is associated with certain rock or soil units. When buildings are constructed above radon-bearing soil or rock, the gas can seep upward and gain entrance to the structure via cracks in concrete floors or walls, through floor drains, joints, bricks, or other conduits. Accumulation of radon gas within a structure can create significant health risks.

According to the Safety Element, geologic units that are characterized by high equivalent uranium concentrations are generally Mesozoic granitic rocks, Tertiary sedimentary rocks derived from Mesozoic granitic rocks, and Tertiary marine sedimentary rocks. The Monterey formation, a Tertiary marine sedimentary rock unit, is a potential source of radon (Churchill, 1997). Monterey formation is present in the northeast region of the site, where the RRP is planned.

d. Seismically Induced Hazards

1) Ground Shaking

The Landfill is located in a seismically active area, as is most of California. The Landfill has the potential of experiencing strong ground shaking from earthquakes on regional and/or local causative faults. There are several faults in the vicinity of the project site that are capable of producing strong ground motion, including the San Andreas fault, the Los Osos fault, the West Huasna-Oceanic fault, the San Luis Range fault system, the Hosgri-San Simeon fault system, and the Rinconada-East Huasna fault. During an earthquake along any of these faults, seismically-induced ground shaking would be expected to occur. The severity of the shaking would be influenced by the distance of the Landfill to the seismic source, the soil conditions, and the depth to groundwater.

2) Ground Surface Rupture Due to Faulting

Surface rupture is the displacement and cracking of the ground surface that occurs along a fault trace. Unlike seismically-induced ground shaking, which can affect a wide geographic area, surface rupture is confined to the area very near the fault. The Landfill is not located in an Alquist-Priolo State Earthquake Fault Zone and there are no mapped active faults adjacent to or

crossing the site. The closest known active fault to the site is the West Huasna-Oceanic fault, located about four miles to the northeast. Therefore, the potential for surface ground rupture to occur at the site is considered to be low.

3) Liquefaction and Lateral Spreading

Soil liquefaction is the loss of soil strength during a significant seismic event. Liquefaction potential is influenced by such factors as soil type, depth to groundwater, degree of seismic shaking, and density of the soil. It occurs most commonly in saturated, loose to medium-dense, fine to medium grained sands, and sandy silts. Common types of liquefaction-related ground failure include differential settlement and lateral spreading. In some cases, cracks in the ground surface occur, allowing mixtures of sand and water to be released at the surface in cone-shaped deposits known as "sand boils." Lightweight buried structures, such as pipelines, may float to the surface. Slopes may also become unstable during liquefaction, and level areas near descending slopes may move laterally toward the slope (as the slope becomes unstable) in a process called "lateral spreading." Lateral spreading is somewhat of a misnomer, as the soil movement may have a slight vertical component in addition to the larger lateral movement.

The Safety Element identifies the Landfill as lying within an area of low liquefaction potential. The 1991 EIR for the previous landfill expansion indicated that in areas underlain by the Monterey and Pismo formations, as is most of the current project site, the liquefaction potential is low to nonexistent (ERCE, 1991). The EIR stated that in the areas characterized by Quaternary alluvium, a moderate to high liquefaction potential could exist if groundwater was present. Quaternary alluvium is present in the south region of the site where the new entrance is planned; however, borings and field observations indicate that rock is present at shallow depths beneath the alluvium.

4) Seismically-Induced Slope Failure

As discussed previously, slope stability analyses were performed for the proposed expansion area by Shaw Environmental, Inc. (Shaw, 2007). The analyses were performed for both permanent waste slopes (global slope stability) as well as interim waste slopes within the modules (interim slope stability) under both static and seismic conditions. Under seismic conditions, a potential for seismically-induced slope failure was found to exist and recommendations for mitigation were provided in the report.

At the rest of the Landfill, the potential for seismically-induced slope failure is considered low due to the presence of bedrock at relatively shallow depths.

5) Seismic Settlement Potential

Seismically-induced settlement of sufficient magnitude to cause structural damage is normally associated with poorly consolidated, predominantly sandy soils, or variable consolidation characteristics within the structure area. The soils compress when subjected to seismic shaking.

A potential for seismically-induced settlement of the filled landfill modules may exist. At the remainder of the Landfill, however, the potential for seismically-induced settlement is considered low due to the presence of shallow bedrock.

6) Tsunamis and Seiches

Vertical ground displacement due to submarine faulting occurring at great distance or just offshore from a site may cause hazardous tsunamis along the California coastline. According to the Safety Element, under "worst-case" conditions, tsunami run-up for the 100-year and 500-year events would be approximately elevation 24 and 39 feet above mean sea level, respectively. Due to the distance to the Pacific Ocean and the land elevation of the Landfill, there is no potential for a tsunami to affect the project.

A seiche is a single water wave that can be generated in a reservoir, pond, water-storage tank, or swimming pool as the result of long-period surface waves normally generated by strong local earthquakes or larger earthquakes at farther distances. Detention basins exist at the Landfill and the proposed project would include a new compost runoff pond and a new detention basin. In view of this, a potential for seiches exists.

2. Regulatory Setting

This subsection describes the local, state, and federal regulations that address development as it relates to geology and soils. These regulations are enforced at the local level during the permit process by the County of San Luis Obispo Planning and Building Department, and the Department of Public Works. For the proposed project, compliance with these regulations is considered by the County during review of grading permits and building permits for structures such as the new scalehouse.

a. Federal Policies and Regulations

There are no known federal policies or regulations relating to geologic hazards that are applicable.

b. State Policies and Regulations

1) Alquist-Priolo Earthquake Fault Zoning Act (1972)

Regulations that are applicable to geologic, seismic, and soil hazards may include Alquist-Priolo Earthquake Fault Zoning Act of 1972 and updates (AP, Public Resources Code, Section 2621, et. seq.), State-published Seismic Hazards maps, and provisions of the applicable edition of the California Building Code. There are no Earthquake Fault Zones established at or in the near the vicinity of the site, and procedures and regulations as recommended by the California Geological Survey for investigations conducted in such zones do not specifically apply.

2) California Building Code (2007)

Sections 17922 and 17951-17958.7 of the California Health and Safety Code requires cities and counties to adopt and enforce the current edition of the California Building Code (CBC). The County of San Luis Obispo enforces these provisions, and has elected to utilize Appendix Chapter 33 of the 2001 CBC with respect to grading regulations, rather than adopt Appendix J of the 2007 CBC. Sections of Volume 2 of the California Building Code specifically apply to select geologic hazards. Chapter 16 addresses requirements for seismic safety. Chapter 18 of the 2007 CBC regulates excavation, foundations, and retaining walls. Chapter 33 of the 2001

CBC contains specific requirements pertaining to site demolition, excavation, and construction. Appendix Chapter 33 addresses grading activities, including drainage and erosion control.

c. Local Policies and Regulations

1) Safety Element, San Luis Obispo County General Plan

The Safety Element, San Luis Obispo County General Plan, adopted by the County of San Luis Obispo Board of Supervisors December 14, 1999, Resolution 99-559, presents policies and implementation measures with respect to geologic and seismic hazards, with the objective of minimizing the potential for loss of life and property. The policies address hazards associated with seismicity, fault rupture, ground shaking, liquefaction and seismic settlement, slope instability, landslides, and coastal bluff erosion.

2) Land Use Ordinance, Chapter 22.52 Grading and Drainage

This chapter of the County's Land Use Ordinance establishes standards for the preparation of sites for development and construction activities, to protect the health, safety, and welfare of persons living on or near a project site by protecting against unwarranted or unsafe grading, or soil erosion resulting from grading; by defining appropriate circumstances for tree removal; by providing for adequate drainage and fire protection facilities; and by identifying appropriate standards for other aspects of site development.

3. Thresholds of Significance

For purposes of this EIR, the thresholds of significance for significant geology and soils impacts are based on Appendix G of the CEQA Guidelines and the County's Initial Study checklist. They include the following:

- Expose people or structures to potential substantial adverse effect, including the risk of loss, injury, or death involving:
    - Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault,
    - Strong seismic ground shaking,
    - Seismic-related ground failure, including liquefaction, or
    - Landslides.
- Result in substantial soil erosion or the loss of topsoil.
- Include structures located on expansive soils, as defined in Section 1802.3.2 of the California Building Code (2007), creating substantial risks to life or property.
- 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 an on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse.

4. Impact Assessment and Methodology

To assess the impacts of the proposed project with respect to geologic and soil conditions, a site reconnaissance was undertaken by Richard T. Gorman and Fred Potthast, a Certified Engineering Geologist and a Registered Geotechnical Engineer, respectively. The soil/geologic conditions were visually observed in the areas proposed for improvements, and available maps, geologic literature, aerial photographs, existing engineering reports, and the EIR (ERCE, 1991) for the previous Landfill expansion project were reviewed. Soils, geologic, and seismic hazards, as identified based upon the reports/literature reviews and the site reconnaissance, were assessed with respect to significance within the context of the CEQA Guidelines.

5. Project-specific Impacts and Mitigation Measures

a. Geologic and Soils Hazards

1) Asbestos

Due to the absence of site conditions that would create a significant potential for such occurrences, impacts related to landslide, rockfall, subsidence, volcanic eruption, and asbestos are considered insignificant and do not require any mitigation measures .

2) Site Alteration and Slope Stability

The Landfill would encompass a total of 209 acres. The proposed expansion area is an 88-acre area southeast of the existing disposal area. Forty six acres of the expansion area are proposed for expansion of the disposal area. Seven new modules are planned. Their construction would proceed in a sequenced cut and fill operation. Excavation of a new module would begin while the previously excavated module is being filled. The excavated material would be stockpiled onsite in three designated locations for later use as cover and fill material. According to the project excavation plan**,** the expansion site would be excavated to a minimum elevation of about 205 feet (Shaw, June 2007). This would entail cuts of up to 65 feet at the north end. Interim and permanent fill slopes would be associated with the expansion; additional permanent fill slopes are planned along the edges of the expansion area. Per the excavation plan, the proposed maximum waste elevation of the completed Landfill expansion area would be approximately 440 feet.

Estimated earthwork quantities are approximately 3,572,200 cubic yards of fill, and 3,878,600 cubic yards of cut. These quantities are not equal for a number of reasons, including onsite topography and the project design. However completion of Module 8, which is currently being filled, will require an additional approximately 400,000 cubic yards of fill. With that additional fill requirement, plus the unknowns of final compaction, the precise sizes of stockpiles and drainage basins, it is likely that total cut and fill activities would approximately “balance” by the time the Landfill reaches full capacity and is ready for closure.

A potential for slope instability may exist where grading for the Landfill expansion would result in excavation into the existing fill along the northeastern side of the existing disposal area. Significant grading may also occur in conjunction with the construction of the RRP, construction of the compost runoff and detention basins, road construction, and the construction of the new entrance. Significant fill slopes would result when the spoils from the excavation are stockpiled

in the three designated stockpile areas for later use as cover material. Grading activities could result in slope instability due to the situation of fill over cut slopes, or if slope support is compromised, such as if material is removed from the base of slopes, slopes are oversteepened, runoff is allowed to flow in an uncontrolled manner over the faces of slopes, grading results in the introduction of subsurface water, fill is improperly placed over cut slopes, or if inappropriate fill materials are used. Drainage patterns can be disturbed, and concentration of runoff can occur if grading is performed in an improper manner.

GEO Impact 1 **Grading activities have the potential to result in unstable cut and fill slopes, a potentially significant impact.**

GEO/mm-1 **Prior to issuance of the grading permit**, the project Soils Engineer shall review the final grading plans for the Landfill expansion, the RRP, the compost runoff and detention basins, the stockpiles, the new access road, and the new entrance, to verify conformance with the 2007 California Building Code, Appendix Chapter 33 of the 2001 California Building Code, Title 19 of the County of San Luis Obispo Building and Construction Ordinance, and other applicable standards. Recommendations regarding gradients for temporary and permanent slopes, special consideration to areas of fill over cut, and the need for terraces in temporary slopes shall be provided as necessary. As applicable, plans shall be amended to include these provisions and shall be adhered to during all grading and construction activities.

Residual Impact With implementation of this measure, the impact would be mitigated to a *level of insignificance (Class II)*. No additional mitigation is required.

3) Erosion

The soils at the site have a moderate to very high erosion potential, which could be increased when the soils are exposed during grading activities. Stockpiled soils would also be vulnerable to erosion. The extent and severity of increased erosion potential is related to the type of soil, the velocity of concentrated runoff that may come into contact with unprotected soil, and the length of time during which unprotected soils are in contact with concentrated runoff. Generally, the steeper the slopes, the less cohesive the soils, and the longer the soils are unprotected and exposed to environmental elements, the greater the impact.

GEO Impact 2 **Proposed grading activities would result in exposed soils, including stockpiled soils that would be susceptible to the erosive effects of wind, rain, and surface runoff.**

GEO/mm-2 **Prior to issuance of the grading permit**, a sedimentation and erosion control plan shall be submitted for review and approval by the Departments of Planning and Building, and Public Works. The plan shall address erosion control during all phases of grading. Drainage shall discharge in a nonerosive manner away from improvements and, where slopes are present, away from the toes of the slopes. The applicant shall

also provide verification of continued compliance with NPDES requirements, and provide a copy of the approved SWPPP, as applicable.

Residual Impact With implementation of this measure, the impact would be mitigated to a *level of insignificance (Class II)*. No additional mitigation is required.

4) Expansive Soils

Expansive soils tend to swell, or expand, with seasonal increases in soil moisture, and shrink, or contract, as the soils become drier during the summer months. The expansion-contraction cycle can create a substantial risk to property, and can contribute to downslope creep of soils on slopes. Test results indicated a low expansion potential for soil sampled at the existing MRF, and in the borings drilled in other areas of the Landfill, the overburden soils were described as silty sands, which typically exhibit little, if any, expansiveness. There may be other localized areas of the Landfill, however, where more expansive soils may be present.

GEO Impact 3 **The surficial soils at the Landfill where buildings are proposed have the potential to be expansive.**

GEO/mm-3 **Prior to issuance of the grading permit or building permits for proposed structures,** the applicant shall submit a soils engineering report(s) prepared by a Soils Engineer. The report shall conform to Sections 1802.2 through 1802.6 (or other applicable sections) of the 2007 California Building Code, and Appendix Chapter 33 of the 2001 California Building Code, as adopted by the County of San Luis Obispo. The soils reports shall address expansion potential and, if determined to be warranted, provide appropriate recommendations for expansive soil mitigation. The recommendations presented in the soils engineering report shall be implemented during construction.

Residual Impact With implementation of this measure, the impact would be mitigated to a *level of insignificance (Class II)*. No additional mitigation is required.

5) Springs and Seeps

There is a moderate potential for springs and seeps to occur within the claystone and siltstone of the Monterey formation. Groundwater may flow along fracture and bedding planes within the bedrock, or as perched water along the surface of the bedrock. If a water-bearing layer within the bedrock or perched water flowing at the soil/rock interface daylights, either naturally or as a result of grading, springs or seeps could occur.

GEO Impact 4 **Grading activities would potentially encounter springs and seeps, which could affect erosion control efforts and drainage facilities.**

GEO/mm-4 **During construction**, the Soils Engineer shall observe grading operations, and any unusual subsurface conditions encountered during grading should be brought to his/her attention. Recommendations regarding mitigation

shall be provided by the Soils Engineer on an as-needed basis and implemented by the applicant. Such recommendations may include, but are not limited to, backdrains, intercept drains, or diversion ditches.

Residual Impact With implementation of this measure, the impact would be mitigated to a *level of insignificance (Class II)*. No additional mitigation is required.

6) Radon Gas Exposure

Radon is a colorless, odorless gas that occurs naturally in some soil and rock formations. When buildings are constructed above radon-bearing soil or rock, the gas can seep upward and gain entrance to the structure via cracks in concrete floors or walls, through floor drains, joints, bricks, or other conduits. Accumulation of radon gas within a structure can create significant health risks. The Monterey formation, a Tertiary marine sedimentary rock unit, is a potential source of radon (Churchill, 1997). Monterey formation is present in the northwest region of the expansion area, where the RRP is planned.

GEO Impact 5 **Habitable buildings sited over Monterey formation materials may be subjected to radon gas.**

GEO/mm-5 **Prior to issuance of construction permits for habitable structures founded on fill materials derived from Monterey formation bedrock**, radon gas testing shall be conducted by a certified professional. The results shall be submitted to the County Department of Planning and Building. In the event that radon gas is determined to be present, buildings shall be designed and constructed in accordance with Environmental Protection Agency (EPA) guidelines for minimizing impacts associated with radon gas exposure.

Residual Impact EPA guidelines for minimizing radon gas impacts include preparing an Operations and Maintenance Plan, which would specify how often follow-up testing should occur. This follow-up testing would ensure that radon gas impacts would be reduced in the long-term. With implementation of this measure, the impact would be mitigated to a *level of insignificance (Class II)*. No additional mitigation is required.

b. Seismic Hazards

1) Fault Rupture,

As the site is not located in an Earthquake Fault Zone and there is no evidence of active faulting, the potential impacts from fault rupture are considered insignificant, and no mitigation is required.

2) Ground Shaking

The site is located in a region traditionally characterized by moderate to high seismic activity, which could result in damage to structures and other improvements due to ground shaking.

GEO Impact 6 **Buildings and other improvements may be subjected to strong ground shaking and associated damage due to seismic activity.**

GEO/mm-6 **Prior to issuance of the grading or building permits for proposed structures**, the applicant shall submit a soils engineering report(s) prepared by a Soils Engineer. The report shall conform to Sections 1802.2 through 1802.6 (or other applicable sections) of the 2007 California Building Code, and Appendix Chapter 33 of the 2001 California Building Code, as adopted by the County of San Luis Obispo. The report shall provide seismic parameters for use in design. Plans for structures that shall be designed in accordance with the seismic parameters presented in the soils engineering report and the applicable sections of the California Building Code.

Residual Impact With implementation of these existing requirements, the impact would be mitigated to a *level of insignificance (Class II)*. No additional mitigation is required.

3) Seismically-Induced Slope Failure

While most of the landfill is underlain by shallow rock that would not be prone to seismically-induced slope failure, there is a potential for seismically-induced slope failure to occur in the stockpile slopes and in slopes surrounding the basins. A slope stability analysis was performed for the permanent waste slopes and the interim waste slopes within the modules. A slope stability analysis was not performed for the stockpile slopes or the surrounding drainage basins.

GEO Impact 7 **Seismically-induced slope failure has the potential to impact the permanent and interim waste slopes within the modules.**

GEO/mm-7 Plans for landfill expansion modules shall be in accordance with the recommendations presented by Shaw Environmental, Inc (Shaw, 2007). These recommendations include, but are not limited to:

- Maximum waste elevation for interim slopes shall be 340 feet unless the geosynthetic clay liner (GCL) is encapsulated with a second geomembrane layer.
- Maximum interim waste sideslopes shall not exceed 3.5 horizontal to one vertical.
- Encapsulating the toe area of the western and southern perimeters of the expansion area with a second geomembrane layer for a distance of 200 feet from the toe of the slope; the GCL on the sideslope should also be encapsulated.

GEO Impact 8 **Seismically-induced slope failure has the potential to impact the stockpile slopes and the slopes surrounding the basins.**

GEO/mm-8 **Prior to issuance of the Notice to Proceed**, the applicant shall submit a report(s) of slope stability analysis addressing the stockpile slopes and basins. The recommendations of the report shall be implemented during construction. The report shall include, but not be limited to, a numerical slope stability analysis under seismic conditions and, for the ponds, under the conditions that would be present in the event of seepage from the ponds; and specific recommendations for stabilization, including but not limited to, decreasing slope angles, decreasing slope heights, utilization of retention systems, and slope reinforcement.

Residual Impact With implementation of this measure, the impact would be mitigated to a *level of insignificance (Class II)*. No additional mitigation is required.

4) Seismically-Induced Settlement

While most of the Landfill is underlain by shallow rock that would not be prone to seismically-induced settlement, there is a potential for seismically-induced settlement of the filled modules.

GEO Impact 9 **Seismically-induced settlement has the potential to impact the landfill expansion modules.**

Implement GEO/mm-7.

Residual Impact With implementation of this measure, the impact would be mitigated to a *level of insignificance (Class II)*. No additional mitigation is required.

5) Seiches

A seiche is a single water wave that can be generated in a reservoir, pond, water-storage tank, or swimming pool as the result of long-period surface waves normally generated by strong local earthquakes or larger earthquakes at farther distances.

GEO Impact 10 **The proposed compost runoff pond, the new detention basin, and existing basins may be impacted by seiches.**

GEO/mm-9 New basins shall be designed with sufficient freeboard to accommodate the seiche waves, or in such a manner that overtopping of basins can occur without damage to downslope areas due to flooding or erosion. The assessment should be conducted by a qualified civil engineer.

Residual Impact With implementation of this measure, the impact would be mitigated to a *level of insignificance (Class II)*. No additional mitigation is required.

6. Cumulative Impacts

Additional development, including the proposed project, would increase the number of people and structures exposed to a variety of geologic and soils hazards within the county. Potential impacts related to geologic, soils, and seismic hazards are all site-specific, and mitigation measures are applied to each project to minimize the potential for significant geologic impacts. All development projects are required to comply with State and local regulations regarding grading and construction; therefore, cumulative impacts are *less than significant (Class III).*

This page intentionally left blank.