4.7 Geology, Soils, and Seismicity

This section discusses whether any element of the Project would result in increased exposure of people, structures, and/or the surrounding environment to geologic and seismic hazards such as ground shaking, slope failure, and accelerated erosion. Active surface mining and associated stockpiling and processing activities have been occurring in the Project Area for the past several decades. As a result, a substantial amount of information has been developed on the mineralogy, strength and character of geologic units, the predominant orientation and abundance of geologic contacts and faults, and areas of existing slope instabilities. The conclusions in this section are based on independent review of Project-specific geological data, and analyses and findings that have been developed by the Applicant’s geotechnical consultants (Golder Associates, 2009; Golder Associates, 2011a; Terraphase Engineering, 2011).

As required under CEQA, the effects of the Project are analyzed in the existing environmental context, which is that of an active quarry that historically has experienced landslides in the excavated pit walls, and whose existing slopes have been determined to be marginally stable. One of the Project objectives is to correct the areas of instability that have developed as a result of ongoing quarry excavations and material stockpiling activities that have substantially altered the natural topography of the Project Area and steepened slopes beyond their natural condition. This section evaluates the impacts of the Project relative to baseline conditions, including whether its implementation would cause changes during and upon the completion of the proposed reclamation activities, which would adversely affect offsite properties, the public, or the natural environment related to geologic and seismic hazards.

4.7.1 Setting

4.7.1.1 Site Geology and Soils

The Quarry is located in the southeastern foothills of the Santa Cruz Mountains, which are underlain by a set of volcanic and sedimentary rocks of marine origin that have been displaced by hundreds of miles; altered under high heat and pressure (i.e., variably metamorphosed); and faulted, folded, and uplifted by tectonic forces over millions of years. In the Quarry vicinity, past movements along active and formerly-active fault lines have juxtaposed and chaotically mixed rock types of sharply contrasting origin and character. As a result, the rock layers underlying the site are highly variable in their lithology[1], orientation (bedding attitudes), and are frequently cross-cut by relict faults. This set of ancient volcanic and sedimentary rocks is regionally referred to as the “Franciscan Complex” but is locally subdivided into several different fault-bound rock masses, as described below. Among the many rocks underlying the site is cement-grade limestone, which represents the primary resource material that is extracted in the Project Area, although the Quarry also produces aggregate products (e.g., sand and gravel) from other rocks underlying the Project Area (see Section 4.12, *Mineral Resources*).

[1] The lithology of a rock unit is a description of its physical characteristics visible at outcrop, in hand or core samples or with low magnification microscopy, such as color, texture, grain size, or composition.

Topography

The topography in the surrounding area consists of moderately to steeply-sloped terrain with rounded ridges and deeply-incised drainages. Relief at the site ranges from about 2,000 feet above mean sea level (amsl) along the higher ridge crests to the west, to less than 500 feet amsl along the eastern portions of Permanente Creek. Natural slope angles in the vicinity are typically around 25 degrees (above horizontal), although natural slopes can locally be on the order of 40 degrees or greater where underlain by more competent rock, such as limestone.

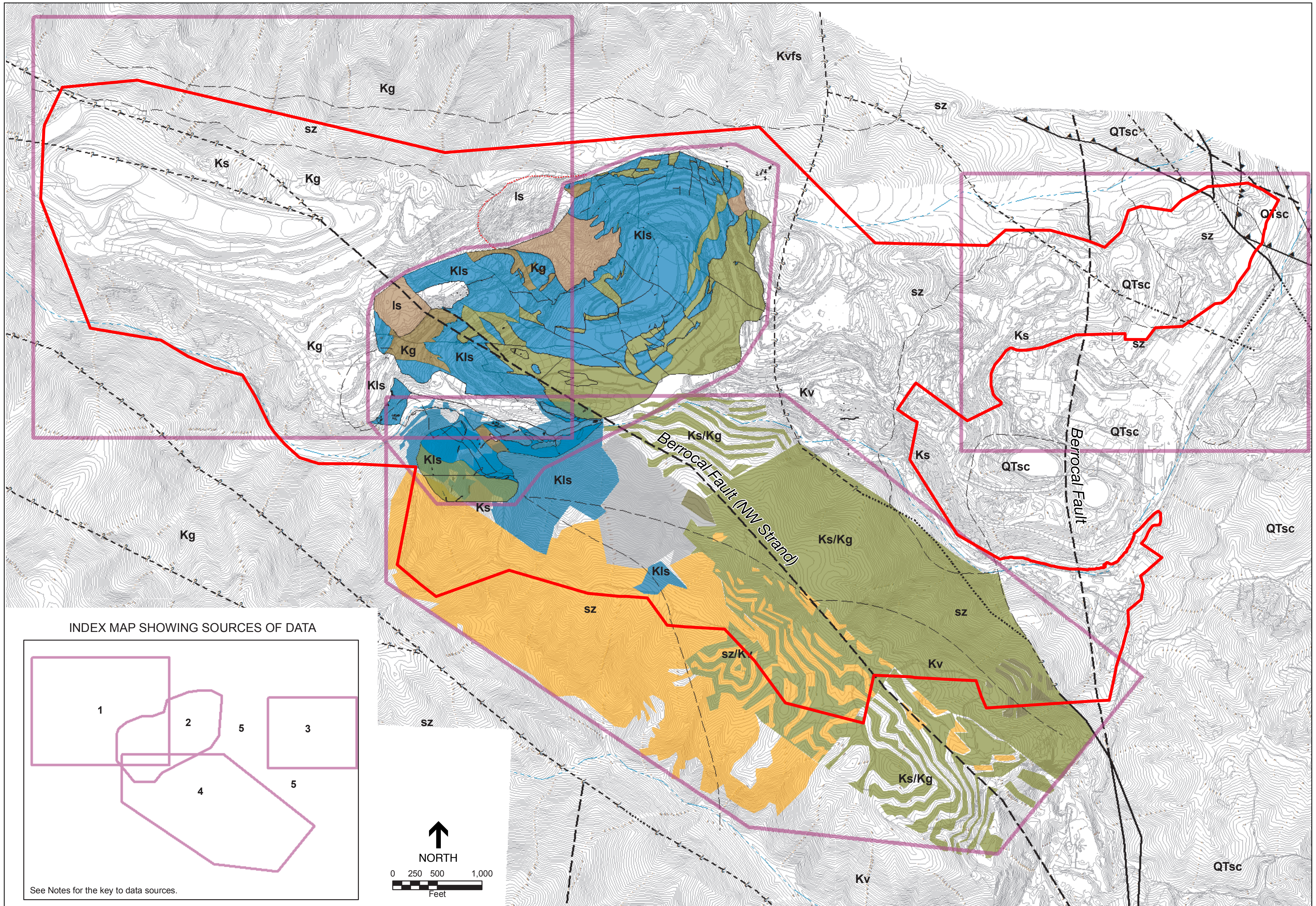
The Project Area has been modified by excavation and stockpiling activities over the course of several decades. In the Quarry pit, which ranges in elevation from about 720 feet amsl at the pit-bottom to 1,400 feet amsl at the crest of the northern wall, extensive benched excavations have substantially steepened the natural topography. Inter-bench slope angles (i.e., from bench face to bench face) vary based on the strength of the underlying rock, but are locally as high as 70 degrees over short distances. Where cuts have been made into weathered or less competent rock, such as greenstone, slope angles typically range from 26 to 34 degrees. Regularly-spaced benches in the quarry walls provide access to the pit-bottom, provide a catchment surface for soil or rock falls, and reduce the overall slope angle. Where quarry walls have been left idle for a long period of time, or where slope failure has occurred, the benches are muted (smoothed-out) by the accumulation of rock or soil debris. In the EMSA, non-saleable or recoverable overburden material has been stockpiled in repeated series of lifts, resulting in similarly benched topography that has elevated the surface by as much as 300 feet in some areas. Overburden material is end-dumped from haul trucks, slowly building up the land surface with slope faces at angles that average about 35 degrees. At nearly 2,000 feet amsl, the top of the WMSA, which is comprised of overburden material, is one of the most elevated areas on the site.

Bedrock Geology

As described above, the primary bedrock unit underlying the Quarry is the Franciscan Complex; however, sandstone, conglomerate, siltstone, and claystone of the geologically younger Santa Clara Formation also occur on the eastern end of the site. These two bedrock units and the various lithologies within the Franciscan Complex are shown in **Figure 4.7-1**, and further described below. Italicized symbols below indicate how the rock units are symbolized in Figure 4.7-1.

The Permanente Terrain of the Franciscan Complex

The Franciscan Complex underlying the site is part of the Permanente Terrain of Jurassic-Cretaceous age (65 to 200 million years old). The limestone and altered basalt layers within the Franciscan reach a minimum subsurface thickness of approximately 1,100 feet and are moderately inclined to the southeast. Specific lithologies found in the Project Area include greywacke sandstone (*Ks*), altered basalt / greenstone (*Kg*), limestone (*Kls*), chert (*Kch*), and localized areas that have been sheared (i.e., ground up or pulverized) to the point that no predominant lithology is discernable (*sz/Kv*). Near the ground surface, many of these rocks



LEGEND

- Geologic contact, certain
- Geologic contact, approximate
- Geologic contact, concealed
- Landslide

Rock Type (Surpac Model):

- Fault breccia/metabasalt (sz/Kv)
- Graywacke (Ks)
- Graywacke/greenstone (Ks/Kg)
- Greenstone (Kg)
- Greenstone/metabasalt (Kg)
- Limestone (Kls)

Rock Type (Fouria, simplified):

- Landslide (ls)
- Greenstone; all types
- Limestone; all types
- Metabasalts
- Alteration

NOTES

1) Modified after Rogers, T.H. and Armstrong, C.F., CDMG Preliminary Report 17 (1973) and Fouria, J. Geology of the Pemanente Limestone and Agrregate Quarry (2004).
2) Fouria, J. Geology of the Pemanente Limestone and Agrregate Quarry (2004).
3) Modified after Rogers, T.H. and Armstrong, C.F (1973).
4) Gemcom SURPAC results of geologic model.
5) Modified after Rogers, T.H. and Armstrong, C.F (1973).

REFERENCES

Topography (2007, 2008, 2009 composite; Chang Consultants (2010).

Spatial Reference:
NAD 1983 StatePlane California III FIPS 0403 Feet

SOURCE: Golder Associates, 2011

Figure 4.7-1
Geology of the Project Area

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(particularly the greenstones) are deeply weathered[2] and support fairly thick, clay-rich soils. In eastern portions of the site, the sheared Franciscan rocks are overlain by sandstone, gravels, and siltstone of the much younger Santa Clara Formation (described below).

Santa Clara Formation

The Santa Clara Formation was formed by prehistoric stream deposits composed of loose to slightly consolidated conglomerate, sandstone, siltstone, and claystone. The age of the Santa Clara Formation is uncertain but is estimated to be from the late Tertiary period to the Pleistocene epoch (i.e., somewhere between 10 thousand and 1.5 million years old). The Santa Clara Formation has been uplifted during recent geologic time to its present position due to faulting and tectonics along the San Andreas Fault system. The Santa Clara Formation lies directly upon the eroded surface of the Franciscan Complex bedrock within the central and eastern portions of the EMSA. The boundary between the two rock units represents a gap of millions of years in the geologic record.

Surficial Deposits

Much of the Project Area is covered at the ground surface by fills, stockpiles of aggregate product, overburden material, colluvium, and surface soils. In places where the land surface is undisturbed, bedrock geology is typically obscured by a mantle of native soil or colluvium, although there are localized outcrops and man-made exposures of the bedrock. Surficial materials are briefly described below.

Overburden Material

The main types of materials extracted and processed at the Quarry are low-quality limestone, high-quality limestone (available mostly at lower elevations), and overburden suitable for use as aggregate. Any overburden that was not recovered or saleable has been placed in the EMSA and/or the WMSA, within the Project Area. Generally, the overburden material consists of coarse stone fragments lacking cohesion (such as greenstone, greywacke, chert, and sedimentary rocks of the Santa Clara Formation). Other materials placed in the storage areas include fine-grained soils (silts and clays) that were produced during the washing of aggregate material, and which are estimated to represent a minor fraction of the material stored in the EMSA and WMSA.

Alluvium

This includes modern unconsolidated alluvial deposits along the active stream channel of Permanente Creek. These deposits are comprised of a mixture of cobbles, gravels, sand, silt and clay. Deposits range from a few inches thick in the upper reaches of the watershed where erosion has cut the channel down into bedrock, to tens of feet thick where the channel widens and deepens as it approaches the flatter terrain of the Santa Clara Valley (Golder Associates, 2011a). The Permanente Creek watershed encompasses a large portion of the Project Area, therefore

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2 Weathering is the breaking down of Earth's rocks, soils and minerals through direct contact with the planet's atmosphere. Weathering occurs in situ, or "with no movement," and thus should not be confused with erosion, which involves the movement of rocks and minerals by agents such as water, ice, wind and gravity.

much of the alluvial sediment that occupies the creek channel was eroded from disturbed ground and waste rock slopes within the mined area.

Colluvium

Colluvium refers to soil material such as rock fragments, silt, clay and detritus that accumulates at the base of slopes by the slow and continual down-slope movement, either due to gravity or surface runoff. Colluvium exists throughout the site on natural slopes including areas underlying the existing older overburden fills in the WMSA, and in the areas of current and proposed overburden fills in the EMSA. In general, the natural slopes in the region are overlain with approximately 1 to 2-feet of soil and colluvium, which thicken to several feet or more in natural swales and transitional areas between steep hill slopes and valley floors. Where past exploratory activities encountered colluvial materials, they consisted of a mixture of sand, gravel and clay, with rock fragments up to 3-inches in diameter (Golder Associates, 2011a). In some locations, particularly near constructed access roads and areas of overburden storage, the colluvium includes soil and rock that has been loosened, reworked, and/or moved as a result of current and former mining operations in the Project Area.

Native Soils

The description of Project Area soils is based on a review of soil surveys prepared by the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS, 2011). Figure 4.2-2 (see Section 4.2, *Agricultural and Forest Resources*) shows and **Table 4.7-1** identifies the soils present in the Project Area, their areal extent, and summarizes some of their key physical and hydrological characteristics. As stated above, most of the native soils onsite have been highly disturbed by surface mining operations, cut and fill activity, or buried by overburden—approximately 54 percent of the Project Area is mapped by the soil survey as “mine/pit” (NRCS, 2011). However, the remainder of the Project Area remains free of large-scale disturbance and is underlain primarily by the Mouser-Maymen complex and similar soil units which consist of gravelly loams[3] and sandy clay loams along slope gradients ranging from 30 to 75 percent. The soils predominantly are derived from colluvium and weathered greenstone and range in depth to bedrock from 1 to 5-feet. The deepest soils generally are located along ridge tops, swales and valley floors, with the shallowest soils located along steep, planar slopes.

In addition to regional soil maps, the geotechnical report prepared by Golder Associates (2011a) describes material properties of foundation soils, which are the natural soil beneath overburden, within the Project Area. While the NRCS focuses on mapping and characterization of soils for agricultural and land management purposes at a regional-scale, the geotechnical report provides material properties for the purpose of site-specific slope stability evaluations. Foundation soils as sampled from geotechnical borings within the EMSA are characterized as “a sandy clay to clayey sand with gravel to a silty or clayey gravel with sand” (Golder Associates, 2011a).

3 Loam is soil composed of sand, silt, and clay in relatively even concentration (about 40-40-20 percent concentration respectively). The term is often qualified to indicate a relative abundance of one constituent over others (e.g., a “sandy loam” is a loam, but where sand is more abundant than silt and clay).

TABLE 4.7-1
SOIL UNITS WITHIN THE PROJECT AREA

Map Unit Symbol and Name	Percent of Project Area	Predominant Soil Texture / Parent Material	Drainage Class[a]	Hydrologic Group[b]	Surface Runoff[c]	Risk of Corrosion[d]	Shrink-Swell Behavior[e]
PkG, Pits, mine	54	Limestone/Greenstone bedrock units, and overburden stockpiles	Well Drained	--	Very High	--	--
520, Mouser-Maymen complex, 30 to 75 percent slopes	32	Gravelly Loam and Clay Loam / Slope alluvium derived from greenstone	Well Drained-Somewhat Excessively Drained	C-D	High-Very High	Low to Moderate	Low
560, Katykat-Mouser-Sanikara complex, 30 to 50 percent slopes	6	Gravelly Loam and Sandy Clay Loam / Weathered sandstone and mudstone	Well Drained	B-C-D	Medium-High-Very High	Low to Moderate	Low
569, Katykat-Sanikara complex, 8 to 30 percent slopes	5	Gravelly Loam and Gravelly Clay Loam / Colluvium and weathered sandstone	Well Drained	B-C-D	Low-Medium-High	Low to Moderate	Low
326, Airship-Minlum complex, 40 to 65 percent slopes	2	Very gravely sandy loam / Old, eroded slope alluvium	Well Drained-Somewhat Excessively Drained	A-C	Medium-High	Low to Moderate	Low
580, Maymen gravelly sandy clay loam, 30 to 50 percent slopes	1	Gravelly sandy clay loam / weathered greenstone, schist or sandstone	Somewhat Excessively Drained	D	Very High	Moderate	Low

[a] Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained.

b Hydrologic soil groups are used for estimating the runoff potential of soils on watersheds at the end of long-duration storms after a prior wetting and opportunity for swelling, and without the protective effect of vegetation. Soils are assigned to groups A through D in order of increasing runoff potential.

[c] Surface runoff refers to the loss of water from an area by flow over the land surface. Surface runoff classes are based on slope, climate, and vegetative cover. The concept indicates relative runoff for very specific conditions. It is assumed that the surface of the soil is bare and that the retention of surface water resulting from irregularities in the ground surface is minimal. The classes are negligible, very low, low, medium, high, and very high.

[d] Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. The risk of corrosion also is expressed as low, moderate, or high.

[e] Shrink-swell behavior is the quality of soil that determines its volume change with change in moisture content. The volume-change behavior of soils is influenced by the amount of moisture change and amount and kind of clay in the soil. Linear extensibility is used to determine the shrink-swell potential of soils. The shrinkswell potential is low if the soil has a linear extensibility of less than 3 percent; moderate if 3 to 6 percent; high if 6 to 9 percent; and very high if more than 9 percent.

NOTE: Dashes within classification columns indicate the classifications assigned to separate soil series within the map unit. Soil units covering less than 1 percent of the Project Area are not shown.

SOURCE: NRCS, 2011

4.7.1.2 Naturally Occurring Asbestos, Crystalline Silica, and Trace Metal Concentrations

Rock and soil often contain naturally-occurring constituents which can be hazardous to human health. Exposure to these substances is most often through inhalation of fugitive dust emitted during excavation and processing of minerals, and as a result of heavy equipment and vehicle operations on unpaved roads. Natural constituents in soil and rock also can be released into surface water resulting in water quality problems. This section presents existing data on levels of naturally occurring constituents in the rock and soil present in the Project Area, although potential impacts to human health and/or water quality are addressed in Section 4.9, *Hazards and Hazardous Materials*, Section 4.3, *Air Quality*, and Section 4.10, *Hydrology and Water Quality*.

Naturally Occurring Asbestos

Asbestos is a common name for a group of naturally-occurring fibrous silicate minerals that are made up of thin but strong, durable fibers. Asbestos is a known carcinogen and presents a public health hazard if it is present in the friable (easily crumbled) form that can be inhaled. Naturally-occurring asbestos (NOA) would most likely be encountered in Franciscan ultramafic rock[4] (primarily serpentinite[5]) or Franciscan mélange.[6] According to a review of site-specific data regarding the presence of asbestos, as further detailed below, NOA-bearing minerals have not been detected within quarried rocks.

The California Air Resources Board adopted the Asbestos Airborne Toxic Control Measure (ATCM) for quarrying and surface mining operations in November 2002. The ATCM applies to quarrying and surface mining operations that meet any one of the following criteria:

- Any portion of the area to be disturbed is located in a geographic area designated as an ultramafic rock unit or ultrabasic rock unit on maps published by the Department of Conservation.
- Any portion of the area to be disturbed has ultramafic rock, serpentine, or naturally occurring asbestos on the site as determined by the Air Pollution Control District or the owner or the owner/operator.
- After the start of operation, the local Air Pollution Control District or Air Quality Control District, a registered geologist, or the owner/operator discovers ultramafic rock, serpentine, or naturally occurring asbestos in the area to be disturbed.

The regional geological map generated by the Department of Conservation does not indicate that the Project site is located in a geographic area designated as an ultramafic[7] rock unit likely to

4 Ultramafic rocks are formed in high-temperature environments well below the surface of the earth.
5 Serpentine is a naturally-occurring group of minerals that can be formed when ultramafic rocks are metamorphosed during uplift to the earth’s surface. Serpentinite is a rock consisting of one or more serpentine minerals. This rock type is commonly associated with ultramafic rock along earthquake faults. Small amounts of chrysotile asbestos, a fibrous form of serpentine minerals, are common in serpentinite.
6 Mélange is a mixture of rock materials of differing sizes and types typically contained within a sheared matrix.
7 An igneous rock consisting dominantly of mafic minerals, containing less than 10 percent feldspar. Includes dunite, peridotite, amphibolite, and pyroxenite.

contain asbestos (CDMG, 2000). However, the Franciscan Complex is highly variable in its lithology and the map used to locate ultramafic rocks is a coarse scale geologic map that does not allow for precise location of various rock types. In 2007, the Applicant's consultant, Geocon Consultants, Inc., performed a review of geologic information to determine whether it is likely that NOA minerals are present at the site, including review of laboratory analytical reports for materials sampled from the Quarry between 1981 and 2007. Geocon found no evidence to indicate that NOA minerals were present at the site (Geocon Consultants, Inc., 2007). The California Air Resources Board concurred with that finding and determined that the site is not subject to the requirements of either the ATCM for surface applications or the ATCM for Construction, Grading, Quarrying, or Surface Mining Operations.

Given the geologic setting of this area, the potential for the Franciscan Complex to contain NOA, and the changes in mining areas since 2007, the County of Santa Clara conducted an independent investigation for the presence of asbestos to support this EIR. The survey included the collection and laboratory analysis for asbestos of representative rock samples from the active mining area. On September 24, 2010, ESA, under contract with the County of Santa Clara, collected nine rock/gravel samples representative of the onsite geologic materials (i.e., greywacke, greenstone, limestone, and fill materials) and submitted them for laboratory analysis. The analysis of asbestos was conducted in accordance with the California Air Resources Board (CARB) Method 435 (Determination of Asbestos Content in Serpentine Aggregate, adopted June 6, 1991) using Polarized-Light Microscopy (PLM). The nine rock/gravel samples were analyzed for asbestos content by two independent labs: Asbestos TEM located in Berkeley, California and Forensic Analytical Laboratories located in Hayward, California. Multiple preparations of each sample were then examined by both laboratories by PLM and a total of 400 points were counted per the CARB 435 method. In no case did either laboratory detect asbestos in any of the nine samples, confirming previously-made conclusions by the Applicant's consultant that NOA-bearing minerals have not been detected in Project Area rocks (Asbestos TEM Laboratories, Inc., 2010; Forensics Analytical Laboratories, 2010).

Crystalline Silica

Crystalline silica is a component of soil, sand, granite and many other common minerals, which was identified as a Toxic Air Contaminant by the Office of Environmental Health Hazard Assessment in February of 2005. Crystalline silica may become respirable size particles when workers chip, cut, drill or grind materials that contain it. If respirable silica dust enters the lungs, it causes the formation of scar tissue (silicosis) which can be disabling or even fatal, reducing the lungs ability to take in oxygen and increasing the susceptibility to lung infections like tuberculosis. Silicosis is also often a precursor to lung cancer. Estimates of crystalline silica percentages in the rocks present in the Quarry are presented in **Table 4.7-2**. These estimates are based on published geological literature, not on laboratory analysis.

Potential impacts related to human exposure to crystalline silica are discussed in Section 4.3, *Air Quality*.

TABLE 4.7-2
ESTIMATED CRYSTALLINE SILICA PERCENTAGES FOR THE ROCK-TYPES IN THE QUARRY

Rock Type	Reference Sample Location	Range (percent by weight) Crystalline Silica (SiO_2)	Maximum (Percent by weight) Crystalline Silica (SiO_2)
Limestone	Average of 8 bulk samples from Permanente Quarry; locations and sample dates not available	0.08 to 17.2	17.2
Greenstone	Angel Island SP	43.8 to 52.89	52.89
Greywacke	Pacheco Peak Quadrangle, Santa Clara County	58.51 to 67.1	67.1

SOURCE: CDMG, 1964

Trace Metal Concentrations

During the asbestos investigation described above, ESA also submitted nine samples for CAM-17 metals laboratory analysis. The results are presented in **Table 4.7-3**. Potential impacts related to exposure to trace metals as toxic air contaminants are discussed in Section 4.3, *Air Quality*. The potential for release of trace metals, primarily selenium, into surface or groundwater is discussed in Section 4.10, *Hydrology and Water Quality*.

TABLE 4.7-3
ESTIMATED TOTAL METALS CONTENT WITHIN ROCK SAMPLES

Inorganic Chemicals (mg/kg)	Reporting Limit	Sample ID									
		HLM-1	GS-1	GW-1	GS-3	WR-1	GS-2	LLM-1	RF-1	LLM-2	Maximum
Antimony	0.5	2.5	0.58	0.67	1.5	ND	ND	ND	ND	0.76	2.5
Arsenic	0.5	6.5	3.1	6.7	12	1.4	0.58	1.5	6	3.6	12
Barium	5.0	1700	510	320	320	910	1100	220	890	1700	1700
Beryllium	0.5			0.64	0.79	0.65	ND	ND	0.55	ND	0.79
Cadmium	0.25	3.5	0.46	ND	ND	0.27	ND	ND	ND	0.47	3.5
Total Chromium	0.5	50	2.7	39	29	84	72	180	120	26	180
Cobalt	0.5	4.9	3	19	20	25	30	38	21	27	38
Copper	0.5	49	11	57	54	67	110	35	45	25	110
Lead	0.5	3.6	1.9	16	20	1.7	0.6	1	7.5	3.1	20
Mercury	0.05	0.52	0.078	0.065	0.052	0.28	ND	ND	0.069	0.11	0.52
Molybdenum	0.5	11	ND	1.7	1.1	0.66	ND	ND	0.71	0.66	11
Nickel	0.5	64	15	66	51	80	67	270	140	71	270
Selenium	0.5	10	ND	ND	ND	ND	ND	ND	ND	ND	10
Silver	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
Thallium	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
Vanadium	0.5	170	24	51	50	130	190	81	79	40	190
Zinc	5.0	190	49	120	95	91	90	81	77	88	190

ND means not detected above the reporting limit/method detection limit
HLM: High-Grade Limestone
LLM: Low-Grade Limestone
GS: Greenstone
GW: Greywacke
WR: Waste Rock
RF: Rock Fill

SOURCE: McCampbell Analytical, Inc., October 04, 2010.

4.7.1.3 Regional Faulting and Seismicity

This section characterizes the region's existing faults, describes historic earthquakes, estimates the likelihood of future earthquakes, and describes probable ground shaking effects. The primary sources of information for this section were publications prepared by United States Geological Survey (USGS), the California Geological Survey (CGS), hazard mapping tools provided by the Association of Bay Area Governments (ABAG), and site-specific information gathered by Golder Associates (2011a).

Earthquake Terminology and Concepts

Earthquake Mechanisms and Fault Activity

Faults are planar features within the earth's crust that have formed to release strain caused by the dynamic movements of the earth's major tectonic plates. An earthquake on a fault is produced when these strains overcome the inherent strength of the earth's crust, and the rock ruptures. The rupture causes seismic waves to propagate through the earth's crust, producing the ground shaking effect known as an earthquake. The rupture also causes variable amounts of slip along the fault, which may or may not be visible at the earth's surface.

Geologists commonly use the age of offset rocks as evidence of fault activity. The more recently earthquakes have caused displacement along a fault, the more "active" it is considered. To evaluate the likelihood that a particular fault will produce an earthquake in the near future, geologists examine the magnitude and frequency of recorded earthquakes and evidence of past displacements along the fault. An *active* fault is defined by the State of California as a fault that has had surface displacement within Holocene time (the last 11,000 years). A *potentially active* fault is defined as a fault that has shown evidence of surface displacement during the Quaternary (last 1.6 million years) (Hart, 2007). *Blind* faults do not show surface evidence of past earthquakes, even if they occurred in the recent past, as they do not reach the ground surface.

Earthquake Magnitude

When an earthquake occurs along a fault, its size can be determined by measuring the energy released during the event. A network of seismographs records the amplitude and frequency of the seismic waves that an earthquake generates. The Richter Magnitude (M) of an earthquake represents the highest amplitude measured by the seismograph at a distance of 100 kilometers from the epicenter. Richter magnitudes vary logarithmically with each whole number step representing a ten-fold increase in the amplitude of the recorded seismic waves and 32 times the amount of energy released. While Richter Magnitude was historically the primary measure of earthquake magnitude, seismologists now use Moment Magnitude as the preferred way to express the size of an earthquake. The Moment Magnitude scale (Mw) is related to the physical characteristics of a fault, including the rigidity of the rock, the size of fault rupture, and the style of movement or displacement across the fault. Although the formulae of the scales are different, they both contain a similar continuum of magnitude values, except that Mw can reliably measure larger earthquakes and do so from greater distances.

Peak Ground Acceleration

A common measure of ground motion at any particular site during an earthquake is the peak ground acceleration (PGA). The PGA for a given component of motion is the largest value of horizontal acceleration obtained from a seismograph. PGA is expressed as the percentage of the acceleration due to gravity (g), which is approximately 980 centimeters per second squared. In terms of automobile accelerations, one "g" of acceleration is equivalent to the motion of a car traveling 328 feet from rest in 4.5 seconds. For comparison purposes, the maximum PGA value recorded during the Loma Prieta earthquake was in the vicinity of the epicenter, near Santa Cruz, and was 0.64g. Unlike measures of magnitude, which provide a single measure of earthquake energy, PGA varies from place to place, and is dependent on the distance from the epicenter and the character of the underlying geology (e.g., hard bedrock, soft sediments, or artificial fills).

The Modified Mercalli Intensity Scale

The Modified Mercalli Intensity Scale (**Table 4.7-4**) assigns an intensity value based on the observed effects of ground shaking produced by an earthquake. Unlike measures of earthquake magnitude and PGA, the Modified Mercalli (MM) intensity scale is qualitative in nature, which means that it is based on actual observed effects rather than measured values. Similar to PGA, MM intensity values for an earthquake at any one place can vary depending on its magnitude, the distance from its epicenter, the focus its energy, and the type of geologic material. The MM values for intensity range from I (earthquake not felt) to XII (damage nearly total), and intensities ranging from IV to X could cause moderate to significant structural damage. Because the MM is a measure of ground shaking effects, intensity values can be related to a range of average PGA values, also shown in Table 4.7-4.

Seismic Context

The Project Area lies within a region of California that contains many active and potentially active faults and is considered an area of high seismic activity (**Figure 4.7-2**). The USGS, the California Geological Survey (CGS), and the Southern California Earthquake Center formed the 2007 Working Group on California Earthquake Probabilities to summarize the probability of one or more earthquakes of magnitude 6.7 or higher occurring in the state of California over the next 30 years. Accounting for the wide range of possible earthquake sources, it is estimated that the Bay Area as a whole has a 63 percent chance of experiencing an earthquake of magnitude 6.7 or higher before 2036 (USGS, 2008). According to the working group, the individual faults posing the greatest threat to the Bay Area are the Hayward-Rodger's Creek Fault and the San Andreas Fault. Other principal faults capable of producing significant earthquakes in the Bay Area include the Calaveras, Concord–Green Valley, Marsh Creek–Greenville, and the San Gregorio faults (see Figure 4.7-2).

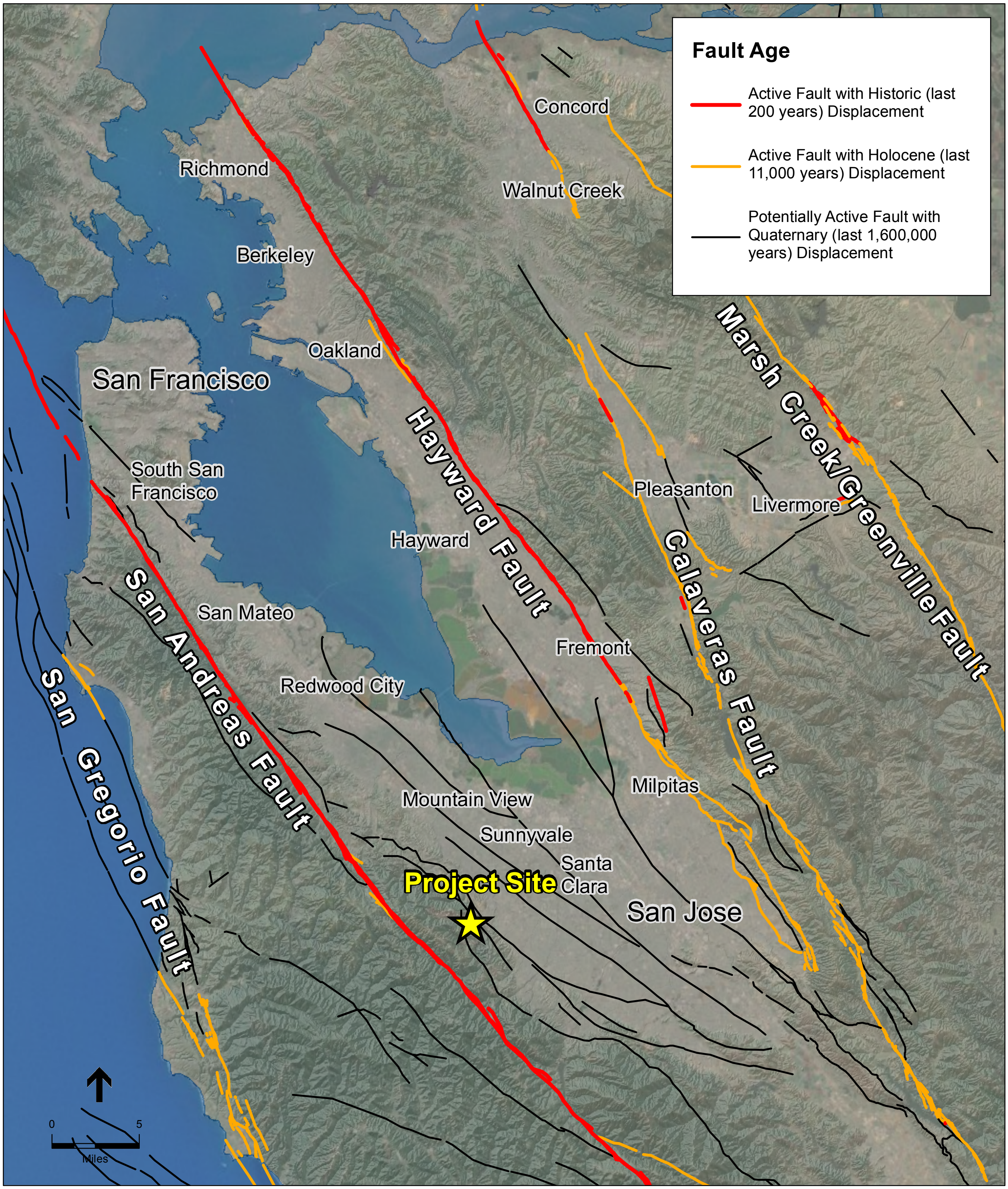
Table 4.7-5 lists active faults located within 30 miles of the Project Area, their distance and direction from the Project Area, their maximum moment magnitude earthquake, and the probability that they will generate a major earthquake.

TABLE 4.7-4
MODIFIED MERCALLI INTENSITY SCALE

Intensity Value	Intensity Description	Average Peak Ground Acceleration[a]
I	Not felt except by a very few persons under especially favorable circumstances.	< 0.0017 g
II	Felt only by a few persons at rest, especially on upper floors on buildings. Delicately suspended objects may swing.	0.0017-0.014 g
III	Felt noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly, vibration similar to a passing truck. Duration estimated.	0.0017-0.014 g
IV	During the day felt indoors by many, outdoors by few. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.	0.014–0.039g
V (Light)	Felt by nearly everyone, many awakened. Some dishes and windows broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles may be noticed. Pendulum clocks may stop.	0.035 – 0.092 g
VI (Moderate)	Felt by all, many frightened and run outdoors. Some heavy furniture moved; and fallen plaster or damaged chimneys. Damage slight.	0.092 – 0.18 g
VII (Strong)	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.	0.18 – 0.34 g
VIII (Very Strong)	Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed.	0.34 – 0.65 g
IX (Violent)	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.	0.65 – 1.24 g
X (Very Violent)	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from riverbanks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.	> 1.24 g
XI (Very Violent)	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.	> 1.24 g
XII (Very Violent)	Damage total. Practically all works of construction are damaged greatly or destroyed. Waves seen on ground surface. Lines of sight and level are distorted. Objects are thrown upward into the air.	> 1.24 g

[a] Value is expressed as a fraction of the acceleration due to gravity (g). Gravity (g) is 9.8 meters per second squared. 1.0 g of acceleration is a rate of increase in speed equivalent to a car traveling 328 feet from rest in 4.5 seconds.

SOURCE: ABAG, 2011



SOURCE: ESRI, 2011; USGS and CGS, 2006

Lehigh Permanente Quarry Reclamation Plan . 211742

Figure 4.7-2
Regional Fault Map

TABLE 4.7-5
FAULTS IN THE PROJECT SITE VICINITY

Fault	Minimum Distance and Direction from Project site	Most Recent Prehistoric Deformation[a]	Fault Classification	Historic Earthquakes > M 6.5[b]	Maximum Moment Magnitude Earthquake (Mw)[c]	Future Earthquake Probability[d]
Berrocal Fault	Onsite	Quaternary (<1,600,000 years)	Potentially Active	none	--	--
Monte Vista Fault	Onsite	Latest Quaternary (<15,000 years)	Potentially Active	none	6.7	--
San Andreas Fault (Peninsula Section)	2.8 miles southwest	Historic (<150 years)	Active	M 7.1, 1989 M 8.25, 1906 M 6.5, 1865 M 7.0, 1838	7.1	21%
Hayward Fault (Southern Section)	14.5 miles northeast	Historic (<150 years)	Active	M 6.8, 1868 M 6.75, 1838	6.7	31 %
San Gregorio Fault (San Gregorio Section)	16.5 miles southwest	Latest Quaternary (<15,000 years)	Active	None	7.2	6 %
Calaveras Fault (Central Section)	17.2 miles east-northeast	Historic (<150 years)	Active	M 6.5, 1911	6.2	7 %

[a] Defines one of the four time categories in which the most recent prehistoric surface-rupturing or surface-deforming earthquake occurred based on geologically recognizable evidence of faulting, folding, or liquefaction. The categories are (1) Historic (<150 years), (2) latest Quaternary (<15 ka), (3) late Quaternary (<130 ka), (4) late and middle Quaternary (<750 ka), and (5) Quaternary (<1.6 Ma). Note that earthquakes do not always produce recognizable evidence of surface rupture.
[b] From USGS and CGS, 2006. Historic earthquakes listed may have occurred along any portion of the fault (and not necessarily the fault section closest to the Project area).
[c] The Maximum Moment Magnitude Earthquake is derived from the joint California Division of Mines and Geology (CDMG) / USGS Probabilistic Seismic Hazard Assessment for the State of California (Peterson et al., 1996) and associated updates (Cao *et al*,. 2003)
[d] Probability of one or more earthquakes of magnitude 6.7 or greater from 2007 to 2036 provided by the USGS (2008). The Working Group estimates the probability of a “background” earthquake not from one of the seven major faults studied to be 9%.

SOURCES: USGS and CGS, 2006; USGS, 2008; Peterson et al., 1996.

Local Faults

The primary active fault in the vicinity of the Project Area is the northwest-trending San Andreas Fault, located approximately 2 miles southwest of the Project Area (Figure 4.7-2). The San Andreas Fault juxtaposes the Mindego Hill assemblage[8] on the southwest against the Woodside assemblage (which includes the bedrock units underlying the Project Area), on the northeast. The San Andreas Fault is a right-lateral strike-slip[9] fault with an estimated displacement of 35 km over the last 8 million years (CGS, 2002). The San Andreas Fault includes many individual fault strands in a zone that ranges in width from several hundred to more than 1,000 feet. The

8 An assemblage is a group of rocks that are closely related on a regional and/or stratigraphic basis. Neighboring assemblages contain grouped bedrock units that differ in terms of their depositional and deformational history.
9 Rocks on either side of a strike-slip fault move parallel to the fault’s trace (i.e., side-by-side). When movement along a strike-slip fault is right-lateral, displacement along the fault is such that, in plan view, the side opposite the observer appears displaced to the right.

San Andreas Fault has experienced several large earthquakes in historic time, including the Great 1906 San Francisco Earthquake (Mw 7.9) and the 1989 Loma Prieta Earthquake (Mw 6.9). The USGS estimates a 21 percent chance that the San Andreas Fault could generate a Mw 6.7 earthquake or greater before 2036 (USGS, 2008).

The Sargent-Berrocal Fault Zone (SBFZ), part of the Santa Cruz Mountains front-range thrust fault[10] system, parallels the San Andreas to the east and forms the eastern-most structural boundary to the Permanente Terrain. The SBFZ consists of two northwest-trending, sub-parallel faults: the northeastern-most Monta Vista Fault Zone and the southwestern-most Berrocal Fault Zone (Golder Associates, 2011a). These faults intersect the central and eastern portions of the Project Area and are responsible for the uplift and juxtaposition of the young Santa Clara Formation against the ancient rocks of the Franciscan Complex. These faults are not considered one of the principal active faults in the Bay Area; however, they are classified by the CGS as potentially active. The Monta Vista Fault Zone traverses the eastern edge of the EMSA in a northwesterly direction, and a strand of the Berrocal Fault Zone lies beneath the Cement Plant area to the south of the EMSA, and extends west-northwest through the southern portion of the Quarry pit (Golder Associates, 2011a; USGS and CGS, 2006). The information below—derived from the U.S. Geological Survey fault and fold database—indicates that the two faults are closely related, that the Monte Vista-Shannon Fault Zone is possibly active, and provides further information on the characteristics of each onsite fault (USGS, 2000a; USGS, 2000b).

Monte Vista-Shannon Fault Zone

The Monte Vista-Shannon Fault Zone is a potentially active fault. This fault forms a part of what some seismologists have referred to as the Southwestern Santa Clara Valley thrust belt, which is located generally along the foothills of the northeastern Santa Cruz Mountains. The Monte Vista-Shannon fault zone is commonly associated with the Berrocal fault zone (described below). The Monte Vista-Shannon Fault Zone offsets sediment of the Santa Clara Formation. In addition, it is possible that the Monte Vista-Shannon fault is “active” because there is evidence to suggest that young Holocene (last 11,000 years) gravels of Permanente Creek are also offset along the fault line. Unlike many of the faults in the Bay Area, which are strike-slip faults, the Monte Vista-Shannon Fault is primarily a reverse-slip fault, meaning rocks one side of the fault are thrust over the other, rather than slipping side-by-side past each other. Minor ground deformations documented after the 1989 Loma Prieta Earthquake in urbanized areas were coincident with the general trend and location of the Monte Vista-Shannon fault zone and air-photo lineaments. The locations of these ground movements provide evidence that the fault may experience such minor “sympathetic” movements associated with future large earthquakes that originate on the San Andreas Fault.

10 A thrust fault differs from a strike-slip fault in that movement along the fault is primarily in the vertical direction, whereby rather than slipping side-by-side, rocks on either side are pushed into and up against one another (although a thrust fault can still exhibit horizontal displacement).

Berrocal Fault Zone

The Berrocal Fault is classified "potentially active" and also forms a part of the Southwestern Santa Clara Valley thrust belt. The Berrocal fault zone offsets sediment of the Santa Clara Formation and probably deforms late Pleistocene river and alluvial fan deposits. The fault is similar to the Monte Vista-Shannon Fault described above, except that there is no evidence indicating possible Holocene (last 11,000 years) displacements. Also similar to the Monte Vista-Shannon Fault, minor ground deformations in the urbanized areas associated with the 1989 Loma Prieta Earthquake were coincident with the general trend and location of Berrocal fault zone. As discussed further below, some of the slope failures observed in the Project Area are probably associated with zones of weakness and sheared rock located along strands of the Berrocal Fault.

4.7.1.4 Geologic Hazards

This section discusses the various hazards and/or adverse conditions that are associated with the geologic setting of the site.

Slope Failure

A slope failure is a mass of rock, soil, and debris displaced down a slope under the influence of gravity by sliding, flowing, or falling. Several factors can affect the susceptibility of a slope to failure, including: 1) steepness of the slope, 2)strength and bulk density of the soil or bedrock, 3) width, orientation and pervasiveness of bedrock fractures, faults, or bedding planes, 4) prevailing groundwater conditions, and 5) type and distribution of vegetation. Those features, among others, are important factors that determine the predisposition of a sloped surface to fail, while external processes such as exceptionally heavy rainfall, earthquakes, or human disturbances (e.g., quarrying, road cuts, and large-scale vegetation removal) may trigger a new or reactivate an existing slope failure. As further described below, the Quarry pit has experienced multiple slope failures along the western, northern, and northeastern walls. The Applicant's geotechnical consultants have conducted numerous studies of these slope failures over the past decades. The results and conclusions of these studies, including an independent peer review of geologic information conducted by Terraphase Engineering Inc. (2011) to support the technical analysis in this EIR, are summarized herein.

Measures of Slope Stability

The factors that contribute to slope movements include those that decrease the resistance to the force of gravity on the slope materials and those factors that increase the stresses on the slope. The degree to which a slope will remain stable is expressed by the "*factor of safety,*" (FOS) which is calculated by dividing the forces that resist movement (the shearing strength available along a potential slide surface) by the shearing stresses that tend to produce failure along a surface. When a calculated FOS value is less than 1, conditions that make a slope susceptible to failure have exceeded those that tend to hold it in place. In order to adequately calculate the FOS, geotechnical engineers and engineering geologists can accurately characterize the topography, underlying material strengths, and planes of weakness within a slope using investigative methods such as geologic and topographical mapping, drilling and logging, collecting samples, and laboratory testing. Based on professional judgment and conservative assumptions, geotechnical engineers identify a hypothetical failure plane (which determines the size, length and mode of failure being modeled) within a slope and perform a FOS calculation to determine its degree of stability. A computer program is typically used to conduct hundreds of iterations to search for the “critical” failure surface that results in the lowest FOS. Slope stability analyses that have been conducted for various locations in the Project Area are further discussed under Impact 4.7-1.

Regional Landslide Hazard Mapping

Several large, ancient landslides (defined here to be landslides that originated thousands to tens of thousands of years ago) have been mapped by various investigators in various areas of the 3,510-acre site, and throughout the broader foothills region. Those landslides are generally described as “possible old landslides”, are considered to be early Holocene age (last 11,000 years) or possibly late-Pleistocene age (11,000 to 800,000 years ago) features, and are identified on the basis of geomorphic features such as eroded scarps and irregular topography. Boundaries of ancient landslides are generally subtle and poorly defined as there is typically little to no evidence of modern activity (Golder Associates, 2011a). Along the south flank of Permanente Creek, two large ancient landslides have been tentatively identified by various investigators based on large-scale topographic features (such as muted topography and convex slopes) that commonly indicate the presence of such a landslide (Golder Associates, 2011a).

Large-scale, regionally-mapped landslides are located outside of the Project Area. Accordingly, regional-scale mapping by the USGS has mapped the majority of the Project Area as having “few landslides” (USGS, 1997). This mapping category means that the area contains few, if any, large mapped landslides, but could locally contain scattered small landslides. Portions of the area south of Permanente Creek, other areas south of Permanente Creek, and an area north of the Quarry pit are mapped as “mostly landslides”, which consists of buffers around mapped landslides or groups of mapped landslides (USGS, 1997). That regional-scale mapping does not take into consideration landslides that have developed on the man-made slopes located within the Quarry pit.

Quarry Pit Slides

Information provided by Terraphase Engineers (2011) on the three main areas of instability within the Quarry pit is summarized below.

Main (1987) Slide. The Main Slide (1987) in the Quarry pit has a slope length of about 750 feet in the central section of the northwest wall, and extends vertically over heights between 500 to 700 feet, from approximate elevation 1,050 feet to the ridge crest (see Figure 4.7-1). The slide developed in a greenstone rock mass that was partially excavated during development of the quarry and extends into the area of the 2H:1V[11] slope that forms the upper northwest wall of the pit. The reference to “1987” reflects the year when the first very large slope movements occurred. However, slope instability and smaller slope movements were evident before 1987, and the slide remains active currently, with a calculated FOS against sliding of about 1.0. Instability has been limited to

11 These slopes are expressed as the ratio of the horizontal distance to the vertical rise. For reference, 1H: 1V represents a slope angle of 45 degrees, or a gradient of 100 percent. The slope inclination of 2H: 1V is equivalent to a slope angle of about 27 degrees, and a slope gradient of 50 percent.

slumping and surficial movement since early 1999 when a significant amount of material was removed from the upper portions of the slide mass.

The Main Slide occurred mainly along the contact between the greenstone and underlying limestone and is believed to have been triggered when the thickness of limestone at the toe of the slide was reduced due to quarrying and was no longer strong enough buttress the mass of greenstone situated above it. As indicated previously, a strand of the Berrocal fault passes through the southwest corner of the Quarry pit. Consequently, sheared rock within the fault zone could be a contributing factor to the failure.

Scenic Easement Slide (2001). The “Scenic Easement Slide” occurred near the crest of the north slope of the Quarry pit in January of 2001. The slide is named the Scenic Easement Slide because the slope movements encroached into the scenic easement defined by the County of Santa Clara that exists along the ridge top above the Quarry pit (see footnote 5 in the Project Description for more detail). The slide contained approximately 175,000 tons of rock material weathered from greenstone. The slide extended between elevations 1,340 and 1,500 feet mean sea level. Golder Associates (2011a) estimates the landslide to be up to 400 feet wide and approximately 90 to 100 feet high. Golder Associates (2011a) interprets the Scenic Easement Slide to be a rotational slide in the upper weathered greenstone. The toe of the slide is generally coincident with the contact between the greenstone and limestone and the slide is laterally bounded by stronger limestone to the east and west. Golder’s slope stability analysis of the Scenic Easement Slide indicates a FOS of around 1.0, which is consistent with a recently failed slope.

Mid-Peninsula Slide (2001). The Mid-Peninsula landslide occurred along the top of the Quarry pit’s east wall during very heavy rainfall in the winter of 2001. The upper limits of the slide encroached upon the southeast portion of the Mid-Peninsula Regional Open Space District’s Rancho San Antonio Preserve (MPROSP). Golder Associates (2011a) characterized the Mid-Peninsula Slide as a narrow wedge-shaped slide within highly weathered greenstone bounded by faults and better-quality/ higher shear strength bedrock on either side of the slide. Golder’s geologic cross-sections and overview photograph indicate that the failure is apparently within sheared matrix rock between blocks. Golder’s slope stability analysis of the Mid-Peninsula Slide indicates a FOS of around 1.0 which is consistent with a recently failed slope. The slide is marginally stable and vulnerable to continuing deterioration of the headscarp by erosion and seismically-induced slumping.

Permanent Creek Restoration Area (PCRA)

The PCRA encompasses seven areas along the Permanente Creek corridor and the slopes above and to the north of the creek which have experienced both pre- and post-SMARA mining related disturbances. Aerial photo evidence reveals that over time, a substantial amount of mining-related overburden and/or road fills have traveled downslope, and in some places, have reached the active floodplain of Permanente Creek (Golder Associates, 2011b). These disturbances are related to past mining-related operations and activities on the Lehigh property, such as 1) improper or incidental end-dumping or side-casting of overburden material, 2) shallow slumping of overburden along the south side of the WMSA or within road fills, as well as 3) efforts to remediate erosion and overburden slumping in PCRA Subarea 1, which itself required construction of a new access road that has been subject to shallow failures in Subarea 2. PCRA Subareas 1 and 2 have been subject cleanup and abatement order issued in July 1999 by the San Francisco Bay Regional Water Quality Control Board (RWQCB), which required the Applicant to install sediment and erosion control measures such as slope armoring, rip-rap, and other best management practices. Past geotechnical investigations performed by Golder Associates (2009, 2010, 2011a) have shown that along sloped surfaces composed of overburden material, the most probable mode of failure consists of shallow translational slides or shallow soil slumps. Unlike the EMSA, WMSA, or the Quarry pit, the slopes on the north side of Permanente Creek within the PCRA have no benches to catch runaway material.

The County identified several other areas of concern regarding slope stability within the PCRA. In Subarea 5, a series of small erosion gullies and/or shallow slumps are located downgradient of the access road to sedimentation Pond 4. The County also identified an area of possible landsliding in 1995 ortho-photos of the area. According to Golder Associates (2011b), the ortho-photo reveals evidence of a relatively steep sideslope below the existing quarry haul road which is covered in sidecast overburden material which has locally covered native vegetation. The overburden material shows an arcuate “headscarp” which are characteristic of end-dumped or side-cast material at the angle-of-repose[12] with apparent flow of the material down the slope. At the break-in-slope at the toe of the hillside, the ortho-photo revealed what appears to be a lobe of overburden material, or landslide debris, that has cascaded over a former access road and onto the flood plain below the road and the debris extends to the flow line of the Creek (Golder Associates, 2011b).

At the request of the County, Golder Associates (2011a, 2011b) evaluated the slope stability conditions within PCRA Subareas 1 and 2, which occur below the primary access road for the West Materials Storage Area (WMSA), as well as the stability and proposed remediation efforts within Subareas 5. Golder’s field observation of the road cut in Subarea 1 indicates that it appeared stable overall, although some evidence of erosion due to surface water runoff was observed. The results of Golder’s analyses indicate a minimum static FOS of 3.8 for the road cut (Golder Associates, 2011a). The relatively high static FOS indicates that the overall cut slope will remain stable under static conditions (Golder Associates, 2011a). Golder did not provide FOS calculations for Subarea 2 and 5, but provided their professional opinion as to the effectiveness of proposed remediation measures and the effect of proposed sedimentation ponds, as discussed below in Impact 4.7-1.

Erosion/Accelerated Erosion

Erosion is a natural process whereby soil and highly weathered rock materials are worn away and transported to another area, most commonly by water but also by wind. Natural rates of erosion can vary depending on slope, soil type, and vegetative cover (regional erosion rates are also dependant on tectonics and changes in relative sea level). Soils containing high amounts of silt

[12] When bulk granular materials are poured onto a horizontal surface, a conical pile will form. The internal angle between the surface of the pile and the horizontal surface is known as the angle of repose and is related to the density, surface area and shapes of the particles, and the coefficient of friction of the material.

and/or clay are typically easily eroded from moderate to steep slopes, while coarse-grained (sand and gravel) soils are generally less susceptible to erosion unless water flow velocities are high.

Soil erosion can become problematic when human disturbance creates steeper slopes and causes rapid soil loss and the development of erosional features (such as incised channels, rills and gullies) that undermine roads, buildings or utilities. Vegetation clearing and earth-moving reduces soil structure and cohesion, resulting in abnormally high rates of erosion, referred to as *accelerated erosion.* Rills, gullies, and excessive sediment transport can eventually damage building foundations and roadways, as well as clog or fill surface drainage facilities (siltation ponds, catchments and culverts). Erosion properties in the Project Area, including erosion hazard ratings and hydrologic groups are discussed in the preceding section on soils, and are presented in Table 4.7-1. Soils within the Project Area, especially where they have been compacted by haul roads and other land disturbances, are likely to generate high rates and volumes of runoff following long-duration storms (without the protection of vegetation). In addition to erosion on undisturbed soil, graded areas, coarse waste fill, and fine wastes can become eroded and contribute substantial volumes of sediment within the engineered drainages on the WMSA and EMSA. The overburden material, which is stockpiled on the site, has a low susceptibility to erosion because it is composed of coarse stone fragments that allow water to freely and rapidly infiltrate; however, the washing of limestone and aggregate produces a fine waste material that consists of unconsolidated, saturated silts and clays. Such fine waste soils are currently stored in places within the Project Area, and may be susceptible to accelerated erosion, and in places may rill or gully if unprotected and subjected to heavy winter rains.

4.7.1.5 Seismic Hazards

This section discusses the various hazards and/or adverse conditions that are associated with the seismic setting of the site.

Surface Fault Rupture

Seismically-induced surface fault rupture is defined as the rapid physical displacement of surface deposits in response to movement of the ground on one side of a fault relative to the other side, in conjunction with an earthquake. The magnitude, sense, and nature of fault rupture can vary for different faults or even along different strands of the same fault. Ground rupture is considered more likely along active faults.(Active faults within the vicinity of the Project Area are referenced in Figure 4.7-2 and Table 4.7-5.) The Project site is not within an Alquist-Priolo Fault Rupture Hazard Zone, as designated by the California Alquist-Priolo Earthquake Fault Zoning Act (CDMG, 2001); however, the surface traces of two potentially active faults have been mapped as passing through the Project Area, and these fault zones have been zoned by the County of Santa Clara as County Fault Rupture Hazard Zones (Ord. No. NS-1203.111, §1, 3-19-02; Santa Clara County, 2002). As discussed above, minor ground deformations were observed along the approximate trend of these fault lines accompanying the Loma Prieta Earthquake in 1989, suggesting that a small amount of “sympathetic” displacements may have occurred along these faults due to the earthquake on the San Andreas Fault. Cases such as these, where movement along a fault occurs in response to an earthquake centered on a different, but proximal fault line, are commonly referred to as "co-seismic" deformation.

Ground Shaking

As discussed above, a major earthquake is likely to produce strong ground shaking effects anywhere within the region at sometime during the next 30 years. Earthquakes on active or potentially active faults, depending on their magnitude and distance from the Project Area, could produce a wide range of ground shaking intensities in the Project Area. Historically, earthquakes have caused strong ground shaking and damage in the San Francisco Bay Area, the most recent being the moment magnitude 6.9 Loma Prieta earthquake in October 1989. The Loma Prieta earthquake is estimated to have caused strong (MMI-VII) shaking intensities at the site with the epicenter located approximately 16 miles to the southeast (ABAG, 2003a). The areas that experienced higher ground shaking intensities were those underlain by thick sequences of alluvium or colluvium on valley floors, which tend to amplify the longer wavelengths of ground shaking.

A future worst-case scenario for a regional earthquake in the vicinity of the Project Area would be a large seismic event originating on the Peninsula segment of the San Andreas Fault. It is estimated that a characteristic earthquake[13] (M 7.2) that the Peninsula segment of the San Andreas Fault would produce would result in very strong (MMI-VIII) ground shaking intensities, depending on the nature of the underlying soil (ABAG, 2003b). Representative intensity descriptions used to illustrate the extent of damage possible under various ground shaking intensities are provided in Table 4.7-4.

The primary tool that seismologists use to describe ground shaking hazard is a probabilistic seismic hazard assessment (PSHA). The PSHA for the State of California takes into consideration the range of possible earthquake sources (including such worse-case scenarios as described above) and estimates their characteristic magnitudes to generate a probability map for ground shaking. The PSHA maps depict values of peak ground acceleration (PGA) that have a 10 percent probability of being exceeded in 50 years. Use of this probability level allows engineers to design structures to withstand ground motions that have a 90 percent chance of not occurring in the next 50-years, making buildings safer than if they were merely designed for the most probable events. The PSHA indicates that at the Project site, there is a 10 percent chance of exceeding PGA values of 0.57g over the next 50 years (a 1 in 475 chance of occurring) (Golder Associates, 2011a). As indicated in Table 4.7-4, these PGAs are typical of a very strong ground shaking.

Liquefaction

Liquefaction is a transformation of soil from a solid to a liquefied state during which saturated soil temporarily looses strength resulting from the buildup of excess pore water pressure, especially during earthquake-induced cyclic loading caused by the arrivals of seismic waves. Soils that are susceptible to liquefaction include loose to medium dense sand and gravel, low-plasticity silt, and some low-plasticity clay deposits. Ground failure can occur when liquefaction occurs in layers of

[13] The concept of "characteristic" earthquakes means that we can anticipate, with reasonable certainty, the actual damaging earthquakes that will occur on a fault segment (Peterson et al., 1996).

sediment underlying a site. Soil liquefaction and associated ground failure can damage roads, pipelines, underground cables, and buildings with shallow foundations. Liquefaction can occur in areas characterized by water-saturated, cohesionless, granular materials at depths less than 40 feet. Soil that liquefies can manifest a number of failures, including lateral spreading, rapid settlement and flow slides. Mapping by the USGS has determined that the majority of the Project Area has a very low potential for liquefaction (USGS, 2006). The exception is the floor of the alluvial valley along Permanente Creek in the Project Area, which is mapped as having a high liquefaction susceptibility. There is no evidence that liquefaction effects occurred at the site following the Great 1906 Earthquake or the 1989 Loma Prieta Earthquake (USGS, 1978; USGS, 1998a).

Seismically-Induced Landslides

The type and occurrence of slope failure hazards have been discussed earlier in this chapter; however, landslides can also be a secondary effect of earthquakes and a major earthquake-induced hazard. The type and distribution of landslides that following the 1989 Loma Prieta earthquake indicates that the Santa Clara Formation and Franciscan Complex rocks (the same rocks that underlie the Project Area) produced very few landslides relative other rock types in the region (USGS, 1998b). Nevertheless, portions of the Project Area are mapped by the CGS as having the potential to produce landslides during an earthquake, mostly in areas that have steep topography (CGS, 2002).

4.7.1.6 Regulatory Setting

The following section provides a brief summary of the federal, state, and local regulations, goals and policies for quarry mining, mining safety and protection of natural resources from open pit mining operations and reclamation activities.

Mine Safety and Health Administration

The Mine Safety and Health Administration (MSHA), a division of the U.S. Department of Labor, administers the provisions of the Federal Mine Safety and Health Act of 1977. MSHA develops and enforces mandatory safety and health regulations pursuant to the Code of Federal Regulations (CFR) that apply to all surface and underground mines located in the U.S. through inspections, rigorous training, and providing educational programs for employers and employees in the mining industry. The ultimate purpose is to eliminate fatal accidents, reduce the frequency and severity of nonfatal accidents, minimize health hazards, and promote improved safety and health conditions in mines of the United States. Project operations would be regulated by MSHA, and periodic inspections would be performed under MSHA regulations to ensure maximum worker safety during implementation of the RPA. Mining operations are subject to periodic safety inspections by MSHA.

Surface Mining and Reclamation Act (SMARA)

SMARA was signed into law in 1975 and went into effect in 1976, and has been amended 24 times since its effective date. The intent of the Act is to: 1) assure reclamation of mined lands, 2) encourage production and conservation of minerals, and 3) create and maintain surface mining and reclamation policy (regulations).

One of the principal requirements of SMARA is the preparation of Reclamation Plan. This plan must be prepared by a mining applicant prior to initiation of mining activities. Reclamation plans must be approved by the SMARA lead agency (usually counties or cities) and the California Department of Conservation, Office of Mine Reclamation. Reclamation plans are subject to environmental review under CEQA. The County of Santa Clara is the SMARA lead agency for the Quarry and the CEQA lead agency for this Project.

SMARA (including the State Mining and Geology Board Reclamation Regulations) is flexible with respect to addressing geotechnical slope stability for both fill slopes and cut slopes. SMARA does not specify a minimum FOS required for slope stability. However, Title 14, Chapter 8, CCR Section 3704(f) requires that: “Cut slopes, including final highwalls and quarry faces, shall have a minimum slope stability factor of safety that is suitable for the proposed end use and conform with the surrounding topography and/or approved end use.” For fill slopes, Section 3704(d) states that “fill slopes shall be 2H:IV or flatter. Slopes steeper than 2H: IV must be supported by site-specific geologic and engineering analyses to indicate that the minimum FOS is suitable for the proposed end use.” More generally, Section 3704(e) states that at closure, all fill slopes, including permanent piles or dumps of mine waste and overburden, shall conform with the surrounding topography and/or approved end use. For the Quarry, the proposed end use is undeveloped open space.

California Building Code

The California Building Code (CBC) has been codified in the California Code of Regulations (CCR) as Title 24, Part 2. Title 24 is administered by the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. Under State law, all building standards must be centralized in Title 24 or they are not enforceable. The purpose of the CBC is to establish minimum standards to safeguard the public health, safety and general welfare through structural strength, means of egress facilities, and general stability by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of all building and structures within its jurisdiction. The 2010 edition of the CBC is based on the 2009 International Building Code (IBC) published by the International Code Conference. The 2010 CBC contains California amendments based on the American Society of Civil Engineers (ASCE) Minimum Design Standards 7-05. ASCE 7-05 provides requirements for general structural design and includes means for determining earthquake loads as well as other loads (such as wind loads) for inclusion into building codes. The provisions of the CBC apply to the construction, alteration, movement, replacement, and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures throughout California. While the Project does not include the construction of a building or structure, it would involve the demolition, removal and/or off-site transport of existing structures, including an equipment maintenance facility, office spaces, conveyors, crushers, screens, wash plants, scales, and other miscellaneous structures.

County of Santa Clara Ordinances, Local Plans, and Policies

County of Santa Clara Geologic Ordinance

The County's policies and standards pertaining to geologic hazards and associated investigation and mitigation standards are contained in Title C, Division C12, Chapter IV of the County of Santa Clara Ordinance Code. The geologic ordinance establishes minimum requirements for the geologic evaluation of land based on proposed land uses. It further establishes procedures to enforce these requirements, including rules and regulations for the development of land which is on or adjacent to known potentially hazardous areas, or which has the potential to create or increase the risk of geologic hazard. The provisions of the ordinance are also intended to ensure that the County fulfills its duties under state law regarding geologic hazards, including the Alquist-Priolo Earthquake Fault Zoning Act (surface fault rupture) and the Seismic Hazards Mapping Act (earthquake-induced landslides and liquefaction ground failure). The County Planning Office and/or the County Geologist reviews land development applications, building permit applications and land use proposals using maps showing the official County Geologic Hazard Zones, other maps and pertinent data, including, but not limited to previous investigations of the subject property, to determine if a geologic investigation is required. In addition, the ordinance sets forth minimum standards for the investigation and remediation of hazardous geologic conditions, and requires review and approval of geologic reports by the County Geologist.

The Project Area intersects areas mapped by Santa Clara County as hazard zones for both landslides and fault rupture (Ord. No. NS-1203.111, §1, 3-19-02). No building, grading, or use permit approval would be required for the Project; however, in the event that the Applicant would pursue such a permit in the future, a slope stability evaluation may be required to be submitted to the County Geologist for review and approval based on the nature of the proposal. With respect to the RPA, the County has required the Applicant to submit geologic hazard evaluations of the slopes subject to SMARA requirements. These are further discussed in the discussion of impacts (Section 4.7.5).

County of Santa Clara Surface Mining and Reclamation Ordinance

The County of Santa Clara Surface Mining and Reclamation Ordinance was adopted in order to comply with and implement the provisions of SMARA by adopting procedures for reviewing, approving, and/or permitting surface mining operations, reclamation plans, and financial assurances in the unincorporated areas of the County. The ordinance sets forth the general procedural, operational, and reclamation requirements that must be complied with, where applicable, by surface mining and production operations in the County. The Ordinance contains requirements for the content of a reclamation plan, the review procedure and mining standards. The following lists applicable standards on setbacks and final slope gradients contained in the ordinance that would apply to the Project:

- **Cut slope setbacks:** Cut slopes shall be no closer than 25 feet distant from any adjoining property line, except where adjoining property is being mined; nor 50 feet to any right-of-way of any public street, or official plan line or future width line of a public road.

- **Ridgeline setbacks:** When surface mining occurs in a canyon area which abuts an urban area or the ridgeline is visible from the valley floor, the top of the uppermost cut area shall be as shown in an approved reclamation plan, or in the absence of an approved plan, not less than 50 feet from the top of the ridge existing prior to excavation.

- **Final Slope Gradient:** The designed steepness and proposed treatment of the mined lands' final slopes shall take into consideration the physical properties of the slope material, landscaping requirements, and other factors. The maximum stable slope angle might range from 90 degrees in a sound limestone, igneous rock, or similar hardrock to less than 20 degrees in highly expansive clay. In all cases, reclamation plans shall specify slope angle flatter than the critical gradient[14] for the type of material involved.

  - Dangerous contours shall be eliminated from the land surface of the excavated area. Mine shaft openings shall be filled or secured in some other satisfactory manner to eliminate dangerous conditions.

  - Whenever final slopes approach the critical gradient for the type of material involved, regulatory agencies shall require an engineering analysis of the slope stability. Special emphasis on slope stability and design will be necessary when public safety or adjoining property may be affected.

  - The Planning Commission, at the time of approval or modification of the plan, may, based on the maximum stable slope angle of the material involved, specify the slope of the reclaimed land surface, may require grading or back-filling, and may require the elimination of unnatural steps or benches where necessary to carry out the reclamation plan.

- **Erosion and Drainage:** Grading and revegetation shall be designed to both prevent excessive erosion and to convey surface runoff to natural drainage courses or interior basins designed for water storage. Lakes, ponds, streams, or other bodies of water may be created within an excavation only when created in accordance with the reclamation plan approved by the Commission after considering the recommendations of the County Health Department, Santa Clara Valley Water District and other affected agencies. Final surfaces shall be treated to prevent erosion unless otherwise specifically permitted by the Planning Commission.

The Project would be consistent with these plans and policies.

County of Santa Clara General Plan

The County of Santa Clara General Plan puts forward several strategies and associated policies with the goal of addressing natural geologic and seismic hazards for the general public (note that General Plan policies specifically associated with mining and resource extraction are described in Chapter 4.12, *Mineral Resources*). The General Plan policies related to natural hazards focus on reducing the threat of natural hazards for the general public and therefore are focused primarily on controlling the location and type of land uses permitted in hazardous areas and ensuring proposals adequately consider the presence of geologic and seismic hazards. Specific policies are provided below:

[14] The maximum stable inclination of an unsupported slope under the most adverse conditions that it will likely experience, as determined by current engineering technology.

***C-HS 28*:** Countywide strategies for reducing the threat of natural hazards to life and property should include:

a. Inventory hazards and monitor changing conditions.
b. Minimize the resident population within high hazard areas.
c. Design, locate and regulate development to avoid or withstand hazards.
d. Reduce the magnitude of the hazard, if feasible.
e. Provide public information regarding natural hazards.

C-HS 30: Local jurisdictions' urban development and land use policies should minimize the resident population within areas subject to high natural hazards in order to reduce

a. the overall risk to life and property; and
b. the cost to the general public of providing urban services and infrastructure to urban development.

C-HS 31: Cities should not expand Urban Service Areas into undeveloped areas of significant hazards.

C-HS 32: Areas of significant natural hazards shall be designated in the County's General Plan as Resource Conservation Areas with low development densities in order to minimize public exposure to avoidable risks.

R-RC 13: Sedimentation and erosion shall be minimized through controls over development, including grading, quarrying, vegetation removal, road and bridge construction, and other uses which pose such a threat to water quality.

R-HS 19: In areas of high potential for activation of landslides, there shall be no avoidable alteration of the land or hydrology which is likely to increase the hazard potential, including:

a. saturation due to drainage or septic systems;
b. removal of vegetative cover; and
c. steepening of slopes or undercutting the base of a slope.

R-HS 21: Proposals involving potential geologic or seismic hazards shall be referred to the County Geologist for review and recommendations.

The Project would be consistent with these plans and policies.

4.7.2 Baseline

The baseline for purposes of analyzing potential impacts related to geology and soils are the conditions as they existed in June 2007.

4.7.3 Significance Criteria

Consistent with County of Santa Clara Environmental Checklist and Appendix G of the CEQA Guidelines, the Project would have a significant impact if it would:

a) Expose people or structures to potential substantial adverse effects, including 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; and/or
- Landslides;

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

c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the Project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse;

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

e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater;

f) Cause substantial compaction or over-covering of soil either on-site or off-site; or

g) Cause substantial change in topography or unstable soil conditions from excavation, grading, or fill.

4.7.4 Discussion of Criteria with No Geology, Soils, and Seismicity Impacts

The Project would not have the potential to cause an impact in the following areas:

d) The Project would not be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code.

Expansive soils, or those soils with high expandable clay contents, can, over time, misalign some foundation structures or warp asphalt and concrete pavement. As shown in Table 4.7-1, the Project Area is underlain by soils with a low shrink-swell potential. Further, the final reclamation would result in the dismantling, removal, and offsite transport of all structures within the crusher/quarry office area and the rock plant. Thus, risks to life or property with respect to expansive soil, if present, would remain unchanged from baseline conditions for as long as existing structures remain on-site, and be eliminated following final reclamation. For this reason, the presence of expansive soil is not considered an issue for the Project and no related impact would result. This consideration is not discussed further.

e) The Project would not have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

The Project does not propose a new septic system or other wastewater disposal system. This issue is not discussed further.

4.7.5 Impacts and Mitigation Measures

Impact 4.7-1: Rock and soil slopes constructed as part of the proposed reclamation of the EMSA, Quarry pit, and WMSA could fail under static or seismic forces if not properly engineered and constructed. (*Less than Significant Impact with Mitigation Incorporated*)

Slope failure is a concern for its potential to undermine the success of reclamation efforts of the RPA, its potential for further impacts on scenic ridgelines and the Scenic Easement, and its potential to damage or destroy engineered drainage and erosion control features such as desiltation basins, drainage ditches, down drains, and/or silt fencing. As discussed in the setting, areas of slope instability within the Quarry pit have existed for years as a result of the fractured and sheared nature of the Franciscan Complex rock that is being excavated. As such, unstable slopes are a condition inherent in the baseline setting of the Project. As slope failures have developed, the quarry operator has studied rock strengths, discontinuities, and slope characteristics that have led to failures and adjusted its mining strategy accordingly to protect the safety of its workers and its ability to continue operating safely. The direct effects of slope failure would be limited to the Quarry property, and because the proposed end use is of undeveloped open space, the impact of slope failure is limited to its potential to compromise the long-term success of final reclamation and would not represent a potential risk to the public through off-site property damage, injury, or loss of life.

The primary result associated with implementation of all phases of the Project would be to lower the ultimate height of the WMSA while simultaneously raising the bottom of the Quarry pit. Approximately 60 million short tons of overburden obtained from a combination of continued mining in the Quarry pit and the excavation of the WMSA would be backfilled into the Quarry pit, thereby buttressing existing areas of instability, establishing positive drainage into Permanente Creek, and lowering slope heights and ultimate gradients within the WMSA. The areas of instability that would be buttressed include the Main Slide and to some extent the haul road “west area” slide. The overburden backfill would not buttress the Scenic Easement Slide or the Mid-Pen Slide because these are located close to the crest of the north and northeast walls of the Quarry. Following establishment of final contours, native vegetation and oak woodland habitats would be established consistent with the surrounding area, thereby resulting in improved stability conditions relative to baseline conditions. Because the baseline for this analysis is the conditions as they existed in June 2007, this analysis also considers the slope stability implications of material stockpiling within the EMSA, even though substantial material stockpiling already has occurred in accordance with geotechnical design specifications provided by Golder Associates (2009) (see discussion below). As the three phases of reclamation proceed, slope stability conditions within the Project Area incrementally will improve as past human alterations to the natural topography are partially corrected through lowering the height of the WMSA, raising the bottom of the Quarry pit, and ongoing revegetation efforts. Further, as reclamation proceeds, the workforce required at the Quarry either would stay the same or be reduced. Implementation of the Project, besides generally improving long-term slope stability conditions, also would result in lesser exposure of site workers to potentially unstable slopes.

Slope stability concerns for each of the areas within the Project Area are discussed below. Findings and conclusions presented below are based on site-specific geotechnical evaluations of slope stability for the Project performed by Golder Associates and independently peer reviewed for the County by Terraphase Engineering Inc. (2011). The findings regarding slope stability—and what factor of safety (FOS) constitutes an acceptable level of risk—reflect the professional judgment of registered geotechnical engineers. As the lead agency under SMARA, the County is ultimately responsible for determining the acceptable FOS both static and seismic conditions, because slope stability performance standards are contingent upon the proposed end use of reclaimed lands and the maximum level of risk the County is willing to accept (SMARA §3704(d)(f)).

East Materials Storage Area

Activities within the EMSA would be limited to reclamation Phase 1, and would achieve final contours and establish native vegetation and oak woodland habitats consistent with the surrounding area and topography, as shown in Figure 2-4. The EMSA is designed to accept total overburden placement of approximately 6.5 million tons (approximately 4.8 million cubic yards), and to provide overburden storage for the Quarry until approximately 2015. Much of the stockpiling activity has already occurred, and continued overburden stockpiling operations could result in slope failures if not conducted in accordance with accepted engineering practices. Small-scale soil slumps on inter-bench slopes typically would be confined by the lower bench, and would represent a maintenance issue rather than a significant impact on the safety of operations or the surrounding environment. However, larger-scale landslides comprising a significant portion of a fill slope (i.e., that would be large enough to consist of multiple benches and inter-bench slopes) could present direct impacts to the safety of Quarry workers, could damage Quarry equipment and structures, and could result in excessive sediment loads being delivered to Permanente Creek.

However, the design of the EMSA has been found to result in stable slopes, according to a geotechnical evaluation carried out by Golder Associates in 2009 and appended to the 2011 report. Golder Associates (2009) evaluated the stability of the final reclamation slopes within the EMSA as they would exist following reclamation Phase 1 by calculating the factor of safety (FOS). Golder Associates performed the slope stability analysis on the final reclamation slope configuration because slopes would be highest at the end of Phase 1 and the slope conditions would exist permanently after stockpiling activities cease. Golder Associates (2009) concluded that the static FOS for the EMSA would be approximately 1.7 when considering the potential for a large-scale landslide (i.e., a failure along the entire length of the slope), and 1.4 for the 2H:1V slopes in between adjacent benches. The static FOS for a large-scale landslide is greater than for inter-bench slopes because the presence of 25-foot wide benches spaced at 40-foot vertical intervals decreases the overall slope gradient to 2.5H:1V. The analysis of the reclaimed EMSA slopes performed by Golder Associates (2009) demonstrates that the proposed geometry would remain stable under static conditions. In its peer review of Golder's geotechnical investigations, Terraphase Engineering Inc. (2011) confirmed that the methods used by Golder Associates to perform the static FOS analysis is consistent with the state of practice of geotechnical engineers in northern California (refer to Section 4.7.1.4 for an explanation of FOS).

In addition, as part of its slope stability evaluation, Golder Associates (2009) considered the effect of washed fines (clays and silts generated during the washing of aggregates) on the stability of the EMSA. Washed fines would be placed in lifts within the coarse overburden material, and are estimated to comprise 6 to 9 percent of the total volume of material to be stored in the EMSA. Washed fines are a potential concern because they behave differently than coarse overburden material, may be subject to seismically-induced settlement under the weight of overlying material, and have different strength characteristics than the predominant coarse overburden material. As such, placement of washed fines must be performed carefully to avoid adverse impacts on the stability of the stockpile slopes. Golder Associates (2009) concluded that it is unlikely that the lifts of fine-grained material will influence the stability of stockpile slopes, provided washed fines are placed an adequate distance away from the final slope face and that they are dried before being covered with coarse overburden material.

Reclamation of the EMSA would include the addition of at minimum of 6 to 12 inches of growth medium for the proposed revegetation effort. The addition of this material on the surface of contoured slopes in the EMSA would have no bearing on slope stability. Potential impacts related to soil erosion are addressed under Impact 4.7-3. The implications of trace constituents, such as selenium, present within mining overburden are discussed in Section 4.10, *Hydrology and Water Quality*.

The geotechnical design recommendations provided by Golder Associates (2009) are incorporated by reference in Appendix C of the RPA, are being implemented as part of the ongoing stockpiling activities within the EMSA, have been agreed to by the Applicant, and would be implemented as part of the Project. For reference, these measures are identified below:

(a) Foundation preparation should be completed prior to fill placement of the outer 50 feet beneath the EMSA fill. Foundation preparation should consist of over-excavation of outer 50 feet of topsoil, organic materials (trees, brush, grasses), fine-grained colluvium with a Plastic Index greater than 25, or other unsuitable soils until firm bedrock, granular soils, or clay soils with a Plastic Index less than 25 are exposed. If the exposed foundation surface is inclined at 5H: IV or steeper, the over-excavation distance from the outer slope should be extended from 50 feet to 100 feet. Furthermore, the fill placed on slopes of 5H: IV or steeper should be benched into the slope with individual bench heights of at least 2 feet and up to approximately 5 feet.

(b) A qualified California Professional Geologist, Certified Engineering Geologist, or a California Registered Civil Engineer with geotechnical experience should inspect the foundation preparation to ensure all unsuitable materials are removed prior to placement of the outer 50 to 100 feet of EMSA fill.

(c) If seepage or wet zones are observed in the foundation, suitable drainage provisions should be incorporated into the foundation prior to fill placement. Suitable drainage provisions include the placement of a blanket of free-draining sand or gravel over the seepage/wet zone in conjunction with a perforated, polyvinyl (PVC) or high-density polyethylene (HDPE) drain pipe that drains positively toward and daylights at the slope face. The sand or gravel drainage material should be fully covered with a minimum 8-oz/square yard, non-woven, geotextile filter to provide separation from the EMSA materials.

(d) The fine waste materials shall be placed in lifts not to exceed 8-feet, and offset a minimum of 30 feet from the final slope face. Each lift of fine waste should be allowed to dry before being covered by overburden material. Each lift shall be overlain by a minimum 25-foot thick lift of overburden.

(e) Any modification to the EMSA fill geometry including increases to the maximum overall slope inclination, maximum inter-bench slope inclination, slope height, or footprint shall require an additional or revised slope stability analysis.

The purpose of these measures is to ensure that the ground upon which overburden is placed is adequately prepared by removing soil that could destabilize the overburden material and by ensuring that groundwater seepage does not adversely affect the stability of the proposed EMSA slopes. Because Golder Associates has demonstrated that the final slope configuration of the EMSA would be stable, and because activities on the EMSA are being carried out in accordance with the geotechnical recommendations provided by Golder, the potential impact due to slope failure within the EMSA is less than significant.

Quarry Pit Reclamation

Reclamation activities within the Quarry pit would begin around year 2021 and would involve backfilling the final depth of the pit, which is planned to be at about 440 feet amsl, with approximately 60 million tons of overburden to a new base elevation of 990 feet amsl. Approximately 12 million short tons of this would be developed through continued mining in Phase 1, with the remaining 48 million short tons obtained from the excavation of the WSMA in Phase 2. In addition to raising the final elevation of the Quarry pit bottom, overburden would be placed at higher elevations against the existing walls to flatten slope angles. Fill slopes in the Quarry pit would not exceed 2.5H:1.0V overall from Quarry floor to rim, although inter-bench[15] slope angles would be 2H:1V. Cut slopes above elevation 990 feet on the northern and northeastern side of the final reclaimed Quarry would generally be left in place, except for targeted remediation grading to lay back landslide headscarps and remove landslide debris associated with the Scenic Easement and the Mid-Peninsula Slides. Inter-bench slopes in this area of the Quarry pit locally exceed 1H:2V in the competent limestone.

Slope stability analyses conducted by the Applicant’s geotechnical consultant (Golder Associates, 2011a), and peer reviewed for the County by Terraphase Engineering Inc (2011), concluded that slopes within the Quarry pit, as they would exist upon final reclamation, including both cut slopes and fill slopes, have an acceptable FOS under static conditions. Factor of safety calculations which are performed using gravity only as a downslope force are called “static” analyses, whereas FOS calculations which include ground shaking forces caused by earthquakes are called seismic, or “pseudo-static” analyses. The imposed force is assumed to be equal to the total weight

15 A line defined by the top-of-bench face to top-of-bench face, or crest-to-crest.

of the sliding mass multiplied by a seismic coefficient of acceleration of 0.15g. The seismic coefficient is based on a design earthquake of Mw 6.8-7.1, and a PGA of 0.57g. Golder's pseudo static analyses concluded that upon final reclamation, slopes within the Quarry pit would have a FOS above 1. Recognizing that factors of safety greater than 1.0 under a pseudo-static analysis do not necessarily indicate that the slopes will not move, Golder also assessed seismic deformations, which estimate the maximum slope movements that may be expected under the design earthquake. Golder found that seismic deformations would be generally less than one foot, which was considered to be an acceptable magnitude given the proposed end use of the quarry as undeveloped open space (Golder Associates, 2011a).

Table 4.7-6 summarizes the results of Golder's analyses by comparing existing conditions in the Quarry pit with the final reclamation slope along the three existing areas of instability within the Quarry pit, and along the final east and south walls. In all cases, the final reclamation results in an improvement in FOS values for static conditions. Under a design earthquake scenario (referred to as pseudo-static), estimated displacements along final reclamation slopes are equivalent or less than existing conditions, and minor in magnitude (i.e., less than 1 foot). Along cross section EW1 in the east wall, implementation of the Project would slightly reduce the seismic FOS; however, it would remain above the critical threshold of 1, and Golder concluded that the estimated displacements are acceptable considering the proposed end use of the quarry.

Slope stability analyses conducted by Golder Associates demonstrate that slopes within the Quarry pit would remain stable, and in nearly all cases, would result in improved stability conditions relative to baseline conditions. Therefore, the Project would cause no adverse impact related to slope failure within the Quarry pit.

West Materials Storage Area

The WMSA has reached maximum allowable fill elevations (elevations currently range from approximately 1,500 to 1,975 feet amsl), and would undergo re-grading to achieve final reclamation slopes and manage drainage from the Project Area. The overburden materials stockpiled in the WMSA would be excavated and placed in the Quarry pit. With implementation of the Project, final WMSA elevation and contours would be returned by grading generally to pre-mining contours.

The reclaimed slopes of the WMSA would be a maximum of 2.5H:1V, with most areas being significantly flatter. Golder Associates (2011a) determined the static FOS to vary slightly depending on the primary slopes evaluated; however, the minimum static FOS of 1.57 as determined for the south-facing slope, which Golder considered as representing the most delicate slope condition, exceeds the critical gradient, and thus is considered acceptable. The median seismically-induced displacement associated with the design earthquake is less than 12 inches, which also is considered acceptable (Golder Associates, 2011a). For these reasons, and because implementation of the Project would reduce slope heights and gradients relative to baseline conditions, the potential impact of the Project related to slope failure within the WMSA is less than significant.

TABLE 4.7-6
SUMMARY OF SLOPE STABILITY EVALUATIONS IN THE QUARRY PIT

Section[a]	Condition	Description	Calculated Factor of Safety and Estimated Displacement under a Design Earthquake
Main Slide (1987)			
Azimuth 120	Existing	Static	0.93
		Seismic: Pseudo-Static	NE
		Seismic: Displacement under design earthquake	NE
	Final RPA Slope	Static	1.44
		Seismic: Pseudo-Static	1.01
		Seismic: Displacement under design earthquake	7 inches (median)
Stability Section	Existing	Static	1.07
		Seismic: Pseudo-Static	NE
		Seismic: Displacement under design earthquake	NE
	Final RPA Slope	Static	1.53
		Seismic: Pseudo-Static	1.05
		Seismic: Displacement under design earthquake	6 Inches (median)
Scenic Easement Slide			
SE1	Existing	Static	1.05
		Seismic: Pseudo-Static	0.8
		Seismic: Displacement under design earthquake	2.5 to 10 feet
	Final RPA Slope	Static:	2.27
		Seismic: Pseudo-Static	1.57
		Seismic: Displacement under design earthquake	NE
Mid-Peninsula Slide			
MP1	Existing	Static	1.03
		Seismic: Pseudo-Static	0.84
		Seismic: Displacement under design earthquake	4 feet
	Final RPA Slope	Static:	1.36
		Seismic: Pseudo-Static	1.03
		Seismic: Displacement under design earthquake	6 inches (median)
MP2	Existing	Static:	1.24
		Seismic: Pseudo-Static	0.98
		Seismic: Displacement under design earthquake	9 inches (median)
	Final RPA Slope	Static:	1.32
		Seismic: Pseudo-Static	1.02
		Seismic: Displacement under design earthquake	6 inches (median)
East Wall			
EW1	Ultimate Slope Excavation Prior to reclamation	Static	1.36
		Seismic: Pseudo-Static	1.04
		Seismic: Displacement under design earthquake	6 inches (median)
	Final RPA Slope	Static:	1.48
		Seismic: Pseudo-Static	1.02
		Seismic: Displacement under design earthquake	6 inches (median)
EW2	Ultimate Slope Excavation Prior to reclamation	Static:	1.28
		Seismic: Pseudo-Static	0.97
		Seismic: Displacement under design earthquake	12 inches (median)
	Final RPA Slope	Static	1.41
		Seismic: Pseudo-Static	1.07
		Seismic: Displacement under design earthquake	5 inches (median)

TABLE 4.7-6 (Continued)
SUMMARY OF SLOPE STABILITY EVALUATIONS IN THE QUARRY PIT

Section*	Condition	Description	Calculated Factor of Safety and Estimated Displacement under a Design Earthquake
South Wall			
9A	Ultimate Slope Excavation Prior to reclamation	Static: Final Excavated South Wall, circular failure	1.7
		Final Excavated South Wall, failure along thrust fault	2.3
		Seismic: Displacement under design earthquake	NE
	Final RPA Slope (within backfill)	Static	1.46
		Seismic: Pseudo-Static	1.05
		Seismic: Displacement under design earthquake	6 inches (median)

[a] Cross sections used to calculate FOS values were chosen by Golder Associates based on the location of current areas of instability, and locations considered to be most representative of current and proposed conditions. The acronyms uniquely identify each of the cross sections, which are further detailed in Golder's geotechnical evaluations.

NE: Not Evaluated

SOURCE: Golder Associates, 2011a

Crusher/Quarry Office Area

The relocation of quarry equipment and buildings, including the primary and secondary crushing stations, two portable trailers used for office purposes, and maintenance areas would have no bearing on slope stability within the Project Area. Therefore this element of the Project would have no impact with respect to slope stability.

Surge Pile

Reclamation activities at the surge pile would involve removal of stockpiled materials and restoration of the area to approximate the natural (pre-surface mining) topography. Because this element of the Project would remove an overburden stockpile and generally restore preexisting topography, no impact would result related to slope stability.

Rock Plant

Reclamation activities at the rock plant would involve the dismantling, demolition, and transport off-site of all structures (including conveyors, crushers, screens, wash plants, scales, and miscellaneous structures) with the exception of the lower garage and scale house. These activities have no bearing on slope stability within the Project Area. Therefore, this element of the Project would have no impact with respect to slope stability.

South of Permanente Creek Restoration Area

The south of Permanente Creek restoration area previously was disturbed by exploratory drilling activities and would be reclaimed in accordance with the reclamation standards described in Section 2.8. This activity would not require the alteration of topography. Consequently, no impact would result related to slope stability issues.

Permanente Creek Restoration Area

The Permanente Creek Restoration Area (PCRA) contains mining disturbance that occurred both before and after SMARA's effective date of January 1, 1976. Subareas 1 and 2 of the PCRA have been subject to erosion control measures installed by the Applicant pursuant to a cleanup and abatement order issued in July 1999 by the San Francisco Bay Regional Water Quality Control Board (RWQCB). In response to the order, the Applicant installed sediment and erosion controls, including slope armoring, rip-rap, and other best management practices. Activities proposed under the RPA within the PCRA are aimed at further restoring and stabilizing various Subareas of the PCRA through revegetation (using a hydroseed slurry that would include a bonded fiber matrix, and if necessary, the use of winched sheepsfoot to hold seed mix in place), slope BMPs (e.g. use of fiber rolls, erosion blankets, slit fences and hand silt removal), repairs and installation of catch/sedimentation basins, the regrading (insloping) of access roads, and the removal of slide debris.

Upon final reclamation, conditions with respect to slope stability within the PCRA would be similar or improved as a result of the restoration efforts. The revegetation of the side slopes would generally aid in increasing the cohesion of near-surface materials through root growth and may therefore provide additional stability. The primary method of revegetation within the PCRA would be hydro seeding, which would promote the growth of grasses, herbs and shrubs. However, the most effective vegetation in providing a substantial increase in soil cohesion would be woody shrubs and trees, which have greater root penetration but would take a greater amount of time to establish naturally. Due to access difficulties, the steepness of the slopes within the PCRA, and the possibility that manual planting activities may themselves result in further downslope movements of overburden, plantings of trees and shrubs are not proposed for the PCRA treatment areas. While the ultimate effectiveness of reclamation efforts within the PCRA in improving slope stability is uncertain; relative to the baseline setting, final reclamation would result in similar or improved conditions with respect to slope stability. Therefore the impact with respect to slope stability following final reclamation would be less than significant.

Interim activities associated with PCRA improvements, however, have the potential to incidentally result in further slumping or shallow sliding of overburden materials. The design and reclamation methods proposed within the PCRA have minimized or avoided slope disturbances through the choice of revegetation methods and BMPs that largely do not require use of heavy machinery or voluminous grading. However, activities such as regrading of access roads (Subarea 1), removal of slide debris using an excavator (Subarea 5), and installation of sedimentation basins (Subareas 1, 2 and 6) have the potential to cause the further downslope roll-back or shallow slumping of overburden material. Such slope movements would likely be relatively minor in magnitude; however, due to their potential to reach Permanente Creek and cause further degradation of water quality, such activities could potentially result in a temporary, albeit significant impact.

The effectiveness of proposed methods in the RPA (e.g., silt fencing) to prevent roll back of material and to capture shallow slides is uncertain. Therefore, Mitigation Measure 4.7-1 directs the applicant to employ grading methods that avoid, where possible, shallow slumping of overburden material, and to install, where necessary, barriers to catch any downslope movements of overburden. These measures would effectively reduce the potential impact of slope movements on Permanente Creek to a less-than-significant level.

> **Mitigation Measure 4.7-1: Avoidance and containment of shallow slumps and/or fall-back of overburden material.** In all areas requiring the use of excavators for grading within the PCRA (e.g., access road in-sloping, installation/repair of sedimentation basins, and removal of slide debris), the Applicant and/or its contractor shall begin excavations from the top of slope and proceed downward. The Applicant and/or its contractor shall not undercut sloped materials unless no other option is feasible (e.g., excessively sloped or otherwise inaccessible terrain). In all areas of the PCRA where excavations would occur in sloped materials, the Applicant and/or its contractor shall install barriers immediately downslope of the activity. Downslope barriers shall be designed and installed in a manner that would be adequate to prevent overburden and/or native materials from falling, sloughing or sliding further downslope, or into Permanente Creek. Such measures may consist of temporary interlocking soldier piles, wooden shoring systems, wire mesh or other containment measures(s), and the Applicant and/or its contractor shall not be permitted to conduct excavation or grading activities downgradient of the barrier, or prior to its installation. The ultimate location, design and installation method of such measures shall be prepared and certified, or reviewed and approved by a California State registered civil engineer.

Impact after Mitigation: The implementation of this mitigation measures would avoid or contain shallow slumps and fall-back of overburden material. As a result, Impact 4.7-1 would be mitigated to a less-than-significant level.

Summary

The analysis of each individual area addressed in the Project Area generally shows an improvement in slope stability conditions across the Project Area. The EMSA, which is the only Project element that increases slope heights and gradients relative to baseline conditions, has been designed adequately to avoid unstable slope conditions. Within the Quarry pit, marginally stable and unstable baseline conditions would be improved substantially with implementation of the Project.Within the PCRA, intermin reclamation activities have the potential to cause sloughing or sliding of overburden further downslope; however, Mitigation Measure 4.7-1 would reduce the potential to a less-than-significant level. As a whole, implementation of the Project would have a less-than-significant impact with mitigation.

Impact 4.7-2: In the event of a major earthquake in the region, seismic ground shaking could result in injury to site workers, damage to Quarry equipment and structures, or trigger slope failures. In addition, a large earthquake on the San Andreas Fault could result in minor ground deformation along traces of the Berrocal or Monte Vista Fault Zones. (*Less than Significant Impact*)

As discussed in the Setting, the Project site has a 10 percent chance of exceeding PGA values of 0.57g over the next 50 years. This would correspond to very strong (VIII) Modified Mercalli Intensities. At these intensities, the earthquake would be felt in the Project Area and could cause damage to, or toppling of unsecured Quarry equipment. Due to the substantial quantity of coarse waste material and washed fines on the site, minor ground displacements and secondary ground shaking effects could occur. In addition, there is a possibility that a large earthquake on the San Andreas Fault could trigger co-seismic deformation along the Berrocal and Monte Vista-Shannon Faults which cross, or nearly cross, portions of the Project Area. Because no structures for human occupancy are proposed in the Project Area, and because the Project would not involve an increase in the baseline number of onsite workers, the Project would have a less-than-significant impact with respect to exposure of people and structures to substantial risks of loss, injury or death from an earthquake. However, because an earthquake could result in ground deformations within overburden materials, and could possibly induce landslides, the impact could be considered significant because it would present potential risks to the safety of Quarry personnel, damage to Quarry equipment and structures, and lead to excessive sediment loads within Permanente Creek. Both co-seismic ground deformation and seismically induced slope failure are discussed below.

Fault Rupture

No active faults pass through the Project Area; thus, adverse impacts from fault rupture are unlikely. However, as discussed above, the two potentially active faults that pass through the Project Area are mapped by the County of Santa Clara as fault rupture hazard zones. These faults are not considered likely sources of earthquakes large enough to produce appreciable ground rupture; however, minor co-seismic ground deformation coincident with the approximate traces of both faults was documented accompanying the Loma Prieta Earthquake. This provides anecdotal evidence that future earthquakes on the more active San Andreas Fault may cause small amounts of offset or deformation along the Berrocal or Monte Vista-Shannon Faults. If ground deformation occurred along one of the faults within the Quarry property, the movement would be minor, and would not likely be evident on the surface; at worst this would cause localized sloughing or raveling of material, which would likely be contained by the system of benches in the Project Area (Terraphase Engineering Inc, 2011). The potential for fault rupture within the Project Area is minor (in terms of both probability and magnitude) and would not present risk of injury or harm to the public or offsite property. For these reasons, the impact from fault rupture to the Project is less than significant.

Seismically-Induced Slope Failures

The potential impact from seismically-induced slope failure is similar or the same as that discussed in Impact 4.7-1, only this section discusses the effect of a large regional earthquake on the stability of the final reclamation slopes. In order to assess the effects of an earthquake on final reclamation slopes, Golder Associates (2009, 2011) performed pseudo-static analyses, which assumes that an earthquake imparts a force to the soil mass in the direction of the potential failure. The seismic FOS computed for the EMSA ranged from 1.12 to 1.16 for a large-scale landslide (multi-bench failure), and 1.01 to 1.02 for the 2H: 1V slopes in-between benches (Golder Associates, 2009). The seismic FOS computed for subarea 1 of the PCRA was 3. The seismic FOS values computed for the Quarry pit are shown in Table 4.7-6. For all seismic FOS calculations, the imposed force is assumed to be equal to the total weight of the sliding mass multiplied by a seismic coefficient of acceleration of 0.15g. The seismic coefficient is based on a design earthquake of Mw 6.8-7.1, and a PGA of 0.57g. The analysis computed the seismic FOS for the proposed fill slopes along the cross sections that were considered the most critical in terms of slope length and volume of rock. While the seismic FOS for the final reclamation slopes are greater than 1 in all cases, in some cases, the FOS values were less than the recommended threshold value of 1.15 using only pseudo-static analysis. Because the pseudo-static analysis yielded certain FOS values as being below the threshold of 1.15, additional analyses were then performed to estimate possible slope deformation that could result from the design earthquake, yielding permanent ground displacements of less than 7 inches or less compared to as much as 10 feet under existing conditions. These displacements are small, and would be confined by the bench system along the fill slopes. While the Project may expose new fill slopes to earthquake induced movements, the geotechnical evaluation has shown that such movements would be minor. For these reasons, and for similar reasons described in Impact 4.7-1, the RPA would ensure that potential impacts due to earthquake-induced slope failures are less than significant.

Impact 4.7.3: Earthmoving and other ground disturbance associated with the phased reclamation of the site could temporarily promote accelerated erosion and soil loss. (*Less than Significant Impact*)

The impact of the Project on erosion and soil loss with respect to hydrologic conditions and water quality is discussed in Section 4.10, *Hydrology and Water Quality*. This impact focuses on the potential for accelerated erosion (such as sheet wash, rilling, rutting, and in more extreme cases, gullying, sloughing, or sliding of incised gully sidewalls) to undermine haul roads, or cause damage to other structures. Accelerated erosion typically occurs on bare, unprotected slopes during the wet season, particularly in response to prolonged, intense storms. As discussed in the setting, the susceptibility of a surface to erosion depends largely on the soil condition present. Coarse overburden material is unlikely to undergo significant erosion because of its ability to freely and rapidly drain excess water. However, stockpiles of washed fines, fill slopes along haul roads, or unprotected soil cover could potentially be subject to accelerated erosion. Following successful reclamation of the Project Area, erosion and soil loss would be approximately similar to natural pre-mining conditions.

However, the interim phases of reclamation could leave certain surfaces temporarily subject to accelerated erosion. As discussed in Section 2.7.9.5 of the Project Description, temporary erosion control measures would be installed within the Project Area as described in the drainage report, the SWPPP, and the revegetation plan. The drainage report concludes the project would be designed consistent with the State Water Resources Control Board (SWRCB) and the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) guidelines regarding design and water quality flow rates, and would meet SMARA's reclamation standards for erosion and sediment control (14 Cal. Code Regs §3706). A monitoring program would be instituted to observe and classify the condition of surface soils in the Project Area and remedial measures, such as reseeding, re-grading, and installation of silt fences, would be implemented based on the severity and extent of erosional features observed (See Table 2.6 and Table 2.7 in the Project

Description). Further, drainage ditches, swales and desiltation basins would serve to capture excess sediment, will be maintained and cleared as needed, and will be sufficient to convey the 10- and 20-year storms, and safely release 100-year flows.

Standard procedures and implementation of the measures described above would prevent or remediate accelerated and damaging erosion within the Project Area. With respect to excessive sediment load being carried by stormwater flows, numerous controls, as described in Section 4.10, *Hydrology and Water Quality,* would be designed and implemented in a manner that reduces the potential impact to less than significant. As such, the impact with respect to erosion and soil loss would be less than significant.

4.7.6 Alternatives

4.7.6.1 Alternative 1: Complete Backfill Alternative

Impacts to geology and soils under Alternative 1 would be similar to those described under the analysis of the proposed Project, except that overburden materials stored in the EMSA would be backfilled into the Quarry pit upon the conclusion of mineral extraction activities. The analysis of impacts and significance conclusions presented for all areas of the Project other than the EMSA and the Quarry pit would remain the same. Significance conclusions for geology and soils within the EMSA and the Quarry pit would be similar, although the impacts related to slope stability would be reduced in intensity because the Quarry pit's lowest areas would be further raised, thereby providing additional support to quarry walls. Under the proposed Project, design slopes along the EMSA were found to have adequate slope stability; however, Alternative 1 would remove these slopes altogether, thereby eliminating any potential for the mining-related fill slopes to fail or otherwise become unstable. The relocation of overburden stored in the EMSA to the Quarry pit would also further reduce potential impacts related to erosion and soil loss because the total area underlain by mining-related overburden would be reduced under Alternative 1. Compared to the proposed Project, Alternative 1 would reduce the potential for and intensity of impacts related to geology and soils, but not to a level that would be substantial enough to change the overall CEQA significance determinations.

4.7.6.2 Alternative 2: Central Materials Storage Area Alternative

Impacts to geology and soils under Alternative 2 would be similar to those described under the analysis of the Project, except that reclamation of the eastern and central portions of the EMSA (as it exists as of reclamation plan amendment approval) would begin immediately, and overburden generated by continued mining in the Quarry pit would be stored west of the EMSA in the CMSA. Under Alternative 2, the eastern edge of the CMSA overlaps with the flat pad at the west end of the EMSA. Under the proposed Project, the impact of the EMSA alone due to the potential for failure of fill slopes was determined to be less than significant because the proposed slope geometry was determined to be stable. The use of the CMSA under Alternative 2 would result in an additional height of overburden material being placed on top of the western end of the EMSA while avoiding overburden placement in the eastern and central portions of the EMSA. For slope stability, there would be some beneficial effects related to avoidance of overburden placement and an earlier commencement of reclamation activities within the eastern and central portions of the EMSA; however, the location of the CMSA higher up on the ridge could further increase the potential for fill failures due to the combined length and height of the resulting slope.

For these reasons, the applicant's geotechnical consultant conducted a combined EMSA/CMSA study which provided a geotechnical evaluation and design recommendations to address the potential combined impacts related to slope instability (Golder Associates, 2010). The study updated the slope stability evaluations performed on the EMSA alone to include the additional placement of overburden within the combined EMSA/CMSA area. The assessment concluded that the static factor of safety (FOS) for global stability (crest of slope to toe of slope) would exceed 1.6; and the static FOS for interbench slopes would be 1.4. Considering the effects of a design earthquake, seismically-induced displacements were estimated to average 6-inches or less in the overburden rock fill (Golder Associates, 2010). Compared to the proposed Project, Alternative 2 results in similar or slightly greater impacts with respect to geology and soils, since the changed location of the overburden storage is higher in elevation and estimated static FOS values were slightly lesser and seismically-induced displacements slightly increased relative to the proposed Project. Compared to the proposed Project, Alternative 2 would slightly increase the potential for and intensity of impacts related to geology and soils, but not to a level that would be substantial enough to change the overall CEQA significance determinations.

4.7.6.3 No Project Alternative

From a geology and soils perspective, the No Project Alternative would result in a greater potential for significant impacts relative to the proposed Project. While reclamation activities would ultimately be required and completed, and as required under SMARA, slope stability impacts would eventually be remediated, the No Project Alternative would delay both the start and the completion of reclamation activities by approximately 12 and 7 years, respectively. Baseline conditions associated with geology and soils are unacceptable from both an erosion and slope stability perspective, as evidenced by the marginal factors or safety present in the Quarry pit, and the Orders to Comply/ NOVs issued by the County in 2006 and 2008. As such, because such conditions are likely exist for a greater period of time under the No Project Alternative, impacts related to geology and soils would be greater than those under the proposed Project.

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