4.5 **GEOLOGY AND SOILS**

This section provides information on geologic and seismic conditions and their associated hazards, and known soil and paleontologic resources that occur or could occur within the Park, and could be impacted by Program Actions of the Project. This section also includes specific information on those resources and potential impacts to those resources. Section 4.0, provides a description of DPR’s analytical methodology that is applied to each resource category, including Geology and Soils, from a Program and Area-specific perspective.

4.5.1 **EXISTING CONDITIONS**

Section 4.0 provides a regional overview of the Park’s existing conditions. A brief reiteration of regional features affecting the geologic resources at the Park is included below.

4.5.1.1 **Methods**

Baseline geologic conditions were established for the Project through a review of documents, including published technical maps and reports, consultant investigation reports prepared for Newmont and DPR, and archive documents at DPR, interpretation of stereoscopic aerial photographs (from 1941, 1947, 1962, 1971, 1997, and 2004), reconnaissance-level geologic mapping, data evaluation, and reporting.

4.5.1.2 **Regional Setting**

The Park is located in the western part of the Sierra Nevada physiographic province of California. This province comprises a wide and high mountain range, extending approximately 400 miles from the Cascade Range in northern California to the Mojave Desert in southern California (see Figure 4.5-1, Physiographic Provinces of California). The mountain range is not symmetric, but is tilted gently (2 degrees) toward the west resulting in the highest elevations located along the eastern margin. The eastern margin is defined by a very steep escarpment that marks the boundary to the Basin and Range geomorphic province to the east. To the west, the range slopes westward to eventually be covered by sedimentary rocks that comprise the Great Valley physiographic province.

The physiography of the Sierra Nevada mountain range generally reflects the west tilting of the range, and relative subsidence of the Great Valley during the modern tectonic regime that began about 4 to 4.5 million years ago. The mountain range rises gradually from 500 feet at the eastern margin of the Great Valley to greater than 8,000 feet, and locally greater than 14,000 feet, at the range crest. Former glaciers eroded the uplands extensively at elevations above about 5,000 feet and higher, forming typical U-shaped valleys separated by relatively narrow divides. The slopes below the area of
intense glaciations (generally below 5,000 feet) are characterized by relatively broad, west-sloping ridges and deep canyons carved by the major rivers, including the North Fork American, Bear, and South Fork Yuba Rivers that generally flow in a west-southwest direction. West of the glaciated regions, the larger west-flowing rivers and streams carved deep canyons below the Tertiary-age (about the last 65 million years) depositional surfaces and through volcanic deposits into the bedrock core of the Sierra Nevada rocks. Broad divides of low relief mark the degraded volcanic depositional surface that separate the river valleys.

4.5.1.3 Geologic History and Tectonic Setting

Geologic History and Tectonic Setting

The western slope of the Sierra Nevada is characterized by north- to northwest-trending belts or terranes of metamorphic rocks that pre-date the Sierra Nevada batholith. The western region is referred to as the Western Sierra Nevada Metamorphic Belt (WSNMB) by various investigators (Clark 1964). The geology of the WSNMB is complex because of the juxtaposition of multiple accreted terranes, which are fault-bounded blocks of former ocean floor sediment and volcanic rock that have been added to the western margin of the North America continent over hundreds of millions of years. Several periods of deformation that occurred at different time intervals from approximately 200 to 150 million years ago are recorded in these rocks.

The oldest rocks in the region are Paleozoic terranes that were initially deposited as volcanic island arcs near what was then the western margin of North America (Schweichert et al. 1999). The most significant remnant of the Paleozoic terranes is a group of meta-sedimentary and meta-volcanic rocks known as the Shoo Fly Complex. Continental accretion continued into the Mesozoic, as additional volcanic and sedimentary rocks were added to the North American landmass. Although some plutonic intrusions are dated to the same general time period as the older metamorphic rocks, the main Sierra Nevada batholith was emplaced after the terranes were accreted during what is called the “Nevadan orogeny.” The Nevadan orogeny was a major mountain-building episode that resulted in the emplacement of the widespread plutonic rocks of the Sierra Nevada batholith. The plutonic rocks, which consist of granite, quartz monzonite, granodiorite, quartz diorite, and gabbro, are seen throughout the eastern and higher parts of the Sierra Nevada mountain range. Chen and Tilton (1982) estimate the primary plutons of the Sierra Nevada batholith to be between 80 and 120 million years old.
During the late Mesozoic and early Tertiary periods, the Sierra Nevada experienced a long period of subaerial exposure and associated erosion and weathering. During this time period, metamorphic and plutonic rocks were deeply eroded, thus partly exposing gold veins in the foothills. The period (40 to 50 million years ago) is marked by the Eocene “auriferous gravels,” which were deposited by westerly flowing drainages over a deeply weathered surface. Later in the Tertiary (4 to 14 million years ago), subduction along the continental margin was reactivated, leading to volcanic activity. Deposits from the volcanism, including the Mehrten Formation volcanic flows and volcaniclastic sediments, covered extensive portions of the Sierran surface, including the Eocene gravels. Even later, during the Quaternary, glaciers covered the high regions of the mountain range, carving deep canyons and deposited glacial till and moraines. Drainages in the western foothills were eroded, re-exposing Tertiary gravels, and leaving Mehrten Formation volcanic deposits on upland areas.

**Rocks of Western Nevada County**

Various investigators subdivide the terranes of Western Nevada County into different units. In general, from oldest on the east to younger on the west, the metamorphic terranes include the following:

1. Paleozoic Shoo Fly Complex, consisting of metasedimentary and metavolcanic rocks located east of the Melones fault zone (equivalent to “Eastern Belt” of Day and Bickford, 2004);
2. Feather River peridotite terrane, which consists of ultramafic serpentine rock and metamorphic rocks near and along the Melones fault zone, lying between the Goodyears Creek and Downieville faults, and separates the Shoo Fly Complex from terranes to the west;
3. Calaveras terrane, consisting of Paleozoic and Triassic metasedimentary melange rocks west of the Melones fault, generally east of the Dogwood Peak-Gillis Hill faults, and accreted within earlier Mesozoic subduction complexes; and
4. Foothills terrane, consisting of Jurassic and older volcanic, plutonic, sedimentary, and ultramafic rocks west of the Melones and Big Bend-Wolf Creek faults, including the accreted terranes known as the Smartville Complex and Central Belt (includes Slate Creek Complex and Lake Combie Complex).

The Park is located within the “Western Metamorphic Belt” of the Foothills terrane, a fault-bounded block which includes all pre-batholithic rocks lying west of the Calaveras terrane, as defined in this area by the Gillis Hill fault.
Principal rock types include mafic volcanic lavas, breccias and tuffs, mudflows and turbidites, gabbroic to dioritic plutonic rocks, and various metamorphic assemblages.

**Grass Valley Gold Mining District**

During and following the continental collision process, the accreted rocks were metamorphosed and hydrothermally altered, leading to the mineralization that formed the gold-bearing deposits. The original gold veins were formed during the metamorphism of the former ocean floor sediments. The gold probably formed originally near volcanic vents on the deep ocean floor. The gold was mobilized and concentrated in veins after the ocean floor sediments were accreted to the continental landmass, and metamorphosed during emplacement of the plutonic rocks.

The Empire Mine and other mines in the Park are part of the Grass Valley Gold Mining District that is centered around the City of Grass Valley, and is bounded on the north by Nevada City and on the west by the Rough-and-Ready gold-mining districts. Geology of the central part of the Grass Valley Gold Mining District is characterized by the Grass Valley pluton, which is an elongated north-trending body of Mesozoic granodiorite that intrudes the older metamorphic rocks. The pluton is about 5 miles long and up to 2 miles wide (Clark 1970). Metadiabase and metadiabase porphyry (“porphyrites”) are located east and west of the pluton, and amphibolite schist, serpentine, gabbro and diorite, and slate are located to the northeast. Overlying part of the district to the east and northwest are Tertiary gravel beds, which are in turn overlain by Mehrten Formation andesite.

The Grass Valley pluton is itself cut by various dike rocks. According to Clark (1970), the Grass Valley district is the most heavily mineralized and richest gold district in California, with a number of productive veins. Veins are mineralized fillings of fractures in the bedrock. Lode (underground) mining of gold-bearing quartz veins in the Grass Valley area began with the discovery of gold quartz at Gold Hill in 1850.

The Grass Valley veins fall into two major groups: 1) those of the granodiorite-greenstone area, which have gentle dips; and 2) those of the serpentine-amphibolite area, with steep dips (Figure 4.5-3, Geologic Map of Project Area). Veins of the granodiorite area (including the Empire, Pennsylvania, Osborne Hill, Work Your Own Digs (W.Y.O.D), Omaha, and Allison Ranch veins) strike north...
and dip gently east or west. In the serpentine-amphibolite area (including the Idaho-Maryland, Brunswick, and Union Hill mines), the veins strike northwest, and most dip steeply southwest. Individual mines each follow a specific mineralized vein; in some of the larger mines, more than one mineable vein was encountered. Each vein follows a generally consistent trend, but typically is disrupted by fault displacement, shattering, segmentation, variability in thickness of quartz filling, and other irregularities. Veins of the Grass Valley district are generally small (typically 1 to 2 feet in thickness), but notably persistent and with many veins concentrated in a small area. The main Empire (Ophir) vein is a persistent and continuous zone that was mined along strike for over 5,000 feet and down dip for 7,000 feet (Johnston 1940).

Gold ores of the Empire and surrounding mines typically are a ribbon quartz vein, containing disseminated free gold and between 1% to 5% of sulfide minerals (known as “sulphurets”), including pyrite, galena, sphalerite, chalcopyrite, and arsenopyrite. Sulfides also contained gold that was recovered through chlorination. From 90% to 95% of the gold was recovered as free gold, and the remaining 5% to 10% was recovered in the finer concentrates after processing.

**Faults and Seismicity**

The Grass Valley region lies within a region of relatively low seismic activity, referred to as the Sierran microplate by recent researchers (Sawyer et al. 1993). The Sierran microplate encompasses two physiographic provinces: the Great Valley in the west and the Sierra Nevada in the east. The microplate is a relatively rigid tectonic block that lies within the 1,000-km-wide zone of distributed deformation between the Pacific and North American plates (Argus and Gordon 1991). Motion of the Sierra microplate, with respect to surrounding provinces, is accommodated primarily by active deformation along its margins, which include: 1) the Sierra Nevada Frontal fault system on the east; 2) the Coast Range-Sierran Block boundary between the Great Valley and Coast Ranges on the west; 3) the Garlock fault zone that forms the southern margin of the Great Valley and Sierra Nevada; and 4) fault structures between the Great Valley and the Klamath Mountains to the north.

A minor amount of deformation also occurs within the Sierran microplate, based on a low level of seismicity in the region. Over the past 150 years, only 13 earthquakes greater than magnitude five (M>5), and no events larger than magnitude six (M>6), have occurred between the Sierran crest to the northeast and the San Andreas fault system to the southwest. The seismicity patterns of magnitude three and larger earthquakes show most of the seismic activity concentrated east of the Sierran crest along a southeast trend that coincides with the Sierra Nevada Frontal fault system. The Quaternary-age faults of the Sierra
Nevada Frontal fault system have evidence of Quaternary, east-down normal and/or dextral faulting.

As depicted on Figure 4.5-4, Regional Seismicity Map, the largest earthquakes occurring within about 50 miles of the Park are the 1909 events near Downieville, the magnitude 5.7, 1975 Oroville earthquake, and the 1888 Plumas county earthquake. These three earthquakes are described briefly below:

- **April 29, 1888** – This earthquake, with an estimated magnitude of 5.9, was located approximately in Plumas County, about 39 miles (62 kilometers) northeast of the Park. The strongest shaking was located in the Mohawk Valley area, so it is assumed that the earthquake (and several strong aftershocks) was generated by the Mohawk Valley fault zone. The 1888 event was the strongest earthquake felt by the people in the Grass Valley region in recorded history. Tops of chimneys were knocked down in Grass Valley and rockslides were reported in the Downieville area (Stover and Coffman 1993).

- **March 3 and June 23, 1909** – These two earthquakes occurred near Downieville. According to Toppozada, et al. (2000), the first earthquake (estimated local Richter magnitude 5.0) could have been a foreshock of the second earthquake (estimated magnitude 5.9). The larger earthquake was felt most strongly in the area southeast of Downieville, and minor damage (plaster, chimneys) was reported in Sacramento and Sparks, Nevada (Stover and Coffman 1993).

- **August 1, 1975** – The Oroville earthquake was a magnitude 5.7 event, which is the largest instrumentally-recorded earthquake within 50 miles of the Park. The earthquake is associated with the reactivation of a part of the Mesozoic-age Foothills fault system, and resulted in surface rupture of the Cleveland fault. The earthquake is also associated with the first historic surface fault rupture in the Sierra Nevada foothills. The main shock was felt throughout northern California and western Nevada. Aftershocks were felt throughout Butte County. Structural damage included cracked chimneys, broken windows, and cracked plaster in the Oroville area (Stover and Coffman 1993).

The geologic structures that dominate the Sierra Nevada are the Foothills fault system on the west, and the active Sierra Nevada Frontal fault zone on the east. The Foothills fault system comprises two fault zones, the Bear Mountains fault zone on the west and the Melones fault zone on the east. Both fault zones contain numerous, individual faults strands and segments. Some of the individual faults in the northwest-trending Bear Mountains and Melones fault zones have been reactivated in late Cenozoic time (last 5 million years), but they
have a very low average slip-rate (typically less than 0.01 mm/year). In contrast, the faults of the Sierra Nevada Frontal fault system, located more than 40 miles (65 kilometers) to the northeast, have higher average slip rates (typically about 1 mm/year).

Regional Faulting

The faults of the Foothills fault system are all remnants of ancient fault zones associated with Mesozoic deformation of the western Sierra Nevada. Most of the faults do not offset Tertiary units, and therefore are not considered to be active by the state of California. However, some segments of the Foothills fault system are presumed to be active in Quaternary time (about the last 2 to 5 million years) because they deform Tertiary units, which are generally the youngest units available for analysis of fault activity. In general, the reactivated faults display indications of normal movement with a small component of right-lateral strike-slip movement. The Cleveland Hills fault is known to be active because of ongoing seismic activity and the coseismic rupture that occurred in association with the 1975 Oroville earthquake.

The Foothills fault system includes several faults in western and central Nevada County, including, from west to east, the Swain Ravine fault zone, the Wolf Creek-Grass Valley fault zone, the Gillis Hills fault zone, and the Melones fault zone (see Figure 4.5-5, Regional Fault Map). Of these faults, two have been identified as having possible late Quaternary activity (within the past 2 million years). The primary fault trends are described below:

- **The Swain Ravine Fault** – Part of a western trend of the Bear Mountains fault zone that includes, from southeast to northwest, the Deadman, Spenceville, Prairie Creek, and then to the Cleveland Hills fault in the Oroville area. The northern portion of the Swain Ravine fault is identified as having possible late Quaternary activity due to its close association with the Cleveland Hills fault and Oroville earthquake (Jennings 1994). The late Quaternary portion of the Swain Ravine fault is located about 24 miles northwest of the Park.

- **The Wolf Creek Fault** – Another part of the Bear Mountains fault zone, but with a more northerly trend from Auburn toward Grass Valley, where it aligns with the Grass Valley fault (which includes several fault splays in the Grass Valley area), and then with the Big Bend-Wolf Creek fault zone north of the Middle Fork Yuba River. A short, approximately 3-mile segment of the Wolf Creek fault has been identified as having possible late Quaternary activity. The
Wolf Creek fault follows Wolf Creek through Grass Valley, and passes within 2 miles of the Park. The potentially active segment is located about 8 miles southwest from the Park.

- **The Gillis Hill Fault** – A north-south trending zone located between the Wolf Creek and Melones fault zones in west-central Nevada County.

- **The Weimar Fault Zone** – A group of faults that appears to extend from the southern part of the Gillis Hill fault zone northwestward to the Grass Valley fault zone in the Grass Valley area. The Weimar fault has been identified as one of the major ore-bearing block boundaries at the Idaho-Maryland Mine, north of the Empire Mine (GeoSolutions 2008).

- **The Melones Fault** – The Melones fault zone follows a northerly trend from the South Fork American River, passing through Alta and Downieville, and then possibly connecting with the northwest-trending Mohawk Valley fault zone at the Middle Fork Feather River.

**Seismic Shaking**

Maximum magnitudes for potential seismic sources (faults) have been estimated by the California Geological Survey (CGS 2003). For the Foothill fault system, the closest active fault is the Cleveland Hills fault ($M_{\text{max}} = 6.5$ at 25 miles). For the Sierra Nevada Frontal fault system, the closest and most significant sources are the Mohawk Valley fault zone ($M_{\text{max}} = 7.3$ at 42 miles) and the Truckee-West Tahoe-Dollar Point fault zone ($M_{\text{max}} = 7.0$ at 50 miles).

The estimated peak ground acceleration (PGA) for the Park, based on probabilistic methods used by the CGS (CGS 2007) and U. S. Geological Survey (USGS 2002), range from 0.1 to 0.2g. The values represent the ground shaking with a 10% probability of exceedance in 50 years which is the same as a 475-year return period. PGA values of 0.22 to 0.25g are estimated for at a 2,475-year return period. Ground motions with a 2,475-year return period are the basis of seismic design in the 2007 California Building Code (CBC). These PGA values for these return periods are considered to be relatively low compared with much of California.
4.5 Geology and Soils

Surface Fault Rupture

While numerous faults have been mapped within the Park, no late Quaternary faults (potentially active or active faults) are known. Therefore, the potential for surface fault rupture associated with coseismic rupture within the Park is low.

4.5.1.4 Site Topography and Geology

Topography of Empire Mine SHP

The Park is situated in hilly terrain that is drained by Wolf Creek, which flows southerly toward the Bear River, and is located west of the Park. The Park is characterized by rolling hills and intervening drainages, at elevations between approximately 2,500 and 3,000 feet above mean sea level (msl). Figure 2.0-4a and 2.0-4b provide an aerial photograph and topography of the Park. Ridges occur in the northern, east-central, and southern portions of the Park, and a relatively low drainage area is located at the southwest corner of the Park. The upland areas of the Park include:

- Union Hill – Located north of SR 174, is a west-trending ridge reaching an elevation of almost 2,900 feet at the eastern edge of the Park;
- Ophir Hill Ridge – Trends northwesterly approximately parallel to SR 174, has a maximum elevation of approximately 2,800 feet; and
- Osborne Hill Ridge – Trends northerly from south of the Park boundary, and has an elevation of almost 3,000 feet at the southeast corner.

The Project area is drained by two tributary drainages of Wolf Creek, including:

- South Fork Wolf Creek – Flows westerly along the northern base of Union Hill (and north margin of the Park); and
- Little Wolf Creek – Flows to the north along the east side of Osborne Hill (and east of the Park), and then takes an abrupt westward change across the south-central portion of the Park where it converges with smaller drainages at the southwestern corner.

Additional ephemeral drainages include:

- The Woodpecker Ravine – A northwest-directed channel in the northwest portion of the Park, along the south side of SR 174. Woodpecker Ravine also includes drainage from the Magenta Drain Tunnel portal);
4.5 Geology and Soils

- **Unnamed Drainage (formerly "Mary's Ravine")** – A drainage that extends southwesterly from the central mine workings into the Sand Dam and Little Wolf Creek in the southwestern corner of the Park; and
- **The Stacy Lane Drainage Ravine** – Flows southwesterly from the Pennsylvania Mine into Little Wolf Creek just west and downstream from the western Park boundary.

The natural topography has been modified locally by earthwork associated with past mining activity and more recent grading for Park facilities such as roads and trails. Past mining activity involved excavations of shafts, adits and tunnels, construction of roads, structures, and pipelines, placement of mine waste rock on the ground surface, and hydraulic deposition of processed mill tailings in drainages and impoundments. Post-mining activities included dismantling of structures, excavation and removal of selected waste rock materials, and construction or improvement of trails, roads and parking areas.

**Geologic Units and Ages**

Early investigators recognized two groups of rocks in the Sierra Nevada foothills. They separated the older, complexly deformed rocks from the overlying, much younger and less deformed rocks (e.g. Lindgren 1896). The older group of rocks was called the “Bedrock Series,” and consists of the Paleozoic and Mesozoic metamorphic terranes and plutonic rocks. The younger group of rocks, called the “Superjacent Series,” includes beds of Tertiary-age gravel (conglomerate) and lava flows. These rocks were deposited on top of the older rocks after a period of intense faulting, metamorphism, and granitic intrusion. The ancestral (pre-Tertiary deposition) Sierra Nevada range was exposed and deeply eroded during the early Tertiary. The Superjacent Series rocks are only slightly deformed when compared to the strong deformation of the Bedrock Series. In the vicinity of Grass Valley, the Superjacent Series includes minor amounts of Eocene-age “auriferous gravels” and the Miocene-age Mehrten Formation as ridge-capping deposits (see Figure 4.5-3).

Eocene “auriferous gravels” were deposited by westerly flowing rivers and streams over the eroded bedrock surface. Later, volcaniclastic sediments and flows of the Miocene Mehrten Formation were deposited over the Eocene and older rocks. Today, the Mehrten Formation deposits are only preserved as a cap to topographic ridges between the stream canyons. The rest of the Mehrten Formation has probably been eroded from the axes of modern rivers and streams.
Geologic Units in Project Area

Geologic units at the Park vary from relatively young surficial deposits of Quaternary age to basement rocks of the Paleozoic to Mesozoic-aged WSNMB and Cretaceous granitic intrusions. They also include Tertiary-aged gravel deposits and andesitic volcaniclastic units (e.g. lava flows, pyroclastic flows, ash beds and reworked volcanic sediments). The distribution of bedrock geologic units in the Project area is shown on Figure 4.5-3. Surficial deposits, including human-placed deposits, are shown on Figures 4.5-6a (Surficial Geologic Map – Union Hill Area), 4.5-6b (Surficial Geologic Map – Central Area), and 4.5-6c (Surficial Geologic Map – Osborne Hill Area). All geologic units from youngest to oldest are described below:

Quaternary Surficial Deposits

- **Mine Waste Rock (mw) and Mill Tailings (mt):** Human-placed deposits associated with historic mining operations have been placed at various locations in the Park since the 1850s. “Mine waste rock” includes rock material (primarily diabase and granodiorite) that was excavated from underground workings and loosely dumped or placed on the ground surface. The mine waste rock deposits include weathered rock from shallow excavations (and the shallow portions of deeper excavations), and coarse-grained ore and host rock from deeper excavations. “Mill tailings” are finer-grained materials (i.e., clay, silt and sand) resulting from ore processing operations, including stamp mill crushing and chemical treatments, which were usually hydraulically deposited as sediment-laden slurries. Figures 4.5-7a through 7f, Site Photographs, includes photographs of waste rock and tailings deposits at various locations in the Park.

- **Alluvium (Qa):** Quaternary-age stream channel deposits (Qa) are present in the South Fork Wolf Creek and Little Wolf Creek stream valleys, and in small tributary drainages. These deposits consist of varying percentages of gravel, sand, and silt with minor clay, and typically are several feet in thickness.

- **Colluvium (Qc):** Colluvium, consisting of thick (up to 10 feet) accumulations of slopewash, residual soil and deeply weathered bedrock that have moved downslope under the influence of gravity. Colluvium is present in many drainage swales and on the lower flanks of hillsides.
Tertiary Units ("Superjacent Series")

- **Mehrten Formation (Mm):** Volcanic-derived sediments, andesitic mudflows, volcanic breccias and minor lava flows (Miocene-Pliocene).

- **"Auriferous Gravels" (Tg):** Former river channel deposits dominated by sand, gravel, and cobbles derived from pre-Tertiary bedrock (Eocene, but could also include older and younger deposits). Auriferous gravels are not exposed in the Park, but locally underlie the base of the Mehrten Formation on Union Hill, where miners attempted to drift into the gravels.

Basement Rocks ("Bedrock Series")

- **Granitic intrusive rocks (KJg):** Plutonic rocks, including granodiorite and quartz diorite (Jurassic-Cretaceous);

- **Metavolcanic and metasedimentary rock (Jdb):** Metadiabase, porphyrite, schist and other hydrothermally altered metamorphic rock (Jurassic);

Distribution of Mine Waste Rock and Mill Tailings Deposits

Historic mining operations have resulted in the placement of mine waste and mill tailings at multiple locations throughout the Park. Potential mine waste and mill tailing locations were evaluated from review of historic mining records, compilation of locations and descriptions from previous studies (MFG 2008m, Selverston 2008), review of unpublished documents at DPR (DPR 2006, DPR 1983, DPR 1981), stereoscopic analysis of aerial photographs, and geologic field reconnaissance mapping conducted at a scale of 1 inch to 200 feet.

The locations of most mine waste rock sites were identified from two existing site studies conducted in 2008:

- **MFG (2008m):** provides locations and an inventory of historic mine and mill site features, both with and without observed waste rock or tailing materials. From research and compilation of historical documents, MFG identified a total of 137 potential historic mine or mill site features at the Park. Of these 137 sites, MFG’s field survey observed 28 sites with either mine waste or mill tailing materials, and another 28 sites without observed mine or mill materials.
Selverston performed a cultural resources inventory, evaluation study and developed a historic context for DPR (see Appendices F-1 and F-2 in this Draft PEIR). As part of that work, Selverston conducted a detailed field survey program using Global Positioning System (GPS) to establish locations of a variety of historic features that included mine waste rock and mill tailing sites. Selverston identified a much greater number of sites with potential mine waste rock and mill tailing materials than observed by MFG, including 140 waste dump locations, 9 mounds, 4 tailings areas, and 2 placer tailings (2008, 2009).

Surface features indicative of waste rock or tailings deposits tend to degrade over time, as the area becomes revegetated or even modified for other uses. Various degrees of resolution, disturbed ground, waste rock piles, and tailings ponds are, however, visible on stereoscopic aerial photography acquired during 1941, 1947, 1962, 1971, 1997, and 2004. The 1941, 1947, and 1962 photography depict conditions during or immediately following, active mine operations in the Park (see Figure 4.5-8, 1947 Aerial Photograph). Later aerial photography depicts subsequent ground changes associated with removal of certain mine materials, trail and road modifications, and an increase in vegetation cover.

Golder Associates performed field reconnaissance in December 2008 and January 2009 following the aerial photographic mapping of waste rock and tailings features described above. Golder Associates was able to directly observe and locate mine waste and mill tailing locations, most of which were also identified by Selverston (2009).

The largest and most extensive areas of mine waste deposits or mill tailings are associated with sites previously identified. At some Remediation Areas, the extents of the deposits are different than shown in earlier studies by MFG. The results of the geologic characterization are shown on Figures 4.5-6a through 4.5-6c. The most significant deposits are described below:

- **Red Dirt Pile (Remediation Completed):** The Red Dirt Pile was a stockpile of mill tailings. It is visible on aerial photography dated 1944, 1947, 1962, and 1971. A portion of the tailings estimated at 46,000 tons were removed between 1986 and 1989 to remediate environmental contaminants. The Red Dirt Pile is covered with a geosynthetic clay liner (GCL) installed over the entire surface of the regraded Red Dirt Pile and either a vegetated soil cover or asphalt and base coarse cover. The asphalt and base coarse cover portion of the Red Dirt Pile will serve as a future vehicle parking lot for
visitors to the Adit Project. Figure 4.5-8 shows the location of the Red Dirt Pile Area. Although the Red Dirt Pile was removed and remediated, the area around the former site appears to still contain minor amounts of waste milling tailings, that were anticipated, but determined to be of minor significance and will be addressed in future cleanup activities (RWQCB 2008).

- **Cyanide Plant (Remediation Area 2) and Conveyance Corridor and Adit Project (Remediation Area 3):** The Conveyance Corridor is a natural drainage ravine that was used to transport processed mill slurries from the Empire Mine Cyanide Plant to the Sand Dam located downstream from the plant. Review and interpretation of aerial photography, and field reconnaissance verification, indicate that fluvial deposits probably consisting of former mill slurries are present within the channel. Previous studies by MFG (2008a) indicate that the elevated concentrations of metals occur in surface deposits. Golder observed tailings deposits in the Conveyance Corridor to be 5 feet thick at several locations, and up to 10 feet thick at one location where an erosional gully exposes tailings over natural weathered bedrock (see Figures 4.5-7a through 4.5-7f, Site Photographs).

- **Sand Dam Area (Remediation Area 4):** The Sand Dam Area includes: 1) a rockfill embankment (dam), and 2) impounded tailings (reservoir basin). The embankment dam is situated across Little Wolf Creek, downstream from its confluence with the Conveyance Corridor channel and another ephemeral stream that drains southerly from east of the W.Y.O.D. Mine. The dam was constructed in the early 1900s with waste rock from the Pennsylvania Mine and possibly other mines (see Figure 4.5-7). An early earthfill and rockfill dam was raised in 1917-1918 to contain the tailings generated from the Cyanide Plant (MacBoyle 1919). Prior to the construction of the dams, tailings were sluiced down Little Wolf Creek, and deposited in stream channels downstream from the current Park boundary.

It is likely that the dam is a homogenous rockfill, which is typical for other embankment dams of similar age and type of construction. The embankment has a pronounced crest that extends above the mass fill which is aligned approximately north to south. The downstream embankment height is approximately 60 feet. The crest and upper embankment consists of cobbles, gravel and sand, and coarsens downward to large, angular rock in the lower portion of the embankment. The upstream embankment is visible for a
height of approximately 10 feet, but is mostly buried by the impounded tailings deposits. The geometry of the embankment suggests that fill placement started from the north end and progressed south and southwest across the Little Wolf Creek drainage, with the embankment becoming wider to the south, creating a maximum crest width of about 150 feet. The narrowest segment of the pronounced crest is near the south abutment, where the embankment crest narrows to about 12 feet (Golder 2007).

The existing outlet pipe structure was constructed in the 1980s, replacing an earlier metal culvert and wooden inlet (DPR 1983). The dam does not contain a spillway overflow structure; however, the crest above the outlet pipe is about 2 feet lower than the adjacent crest, providing for emergency overflow. Seasonal flow in the outlet channel has resulted in erosion of the toe of the embankment (north side of channel) and near-vertical scarp in the weathered rock on the south side of the channel (see Figures 4.5-7a through 4.5-7f).

The impounded materials consist of silt and sand, based on MFG’s reconnaissance observations, soil pits excavated by MFG (2009a) and borings completed by MFG (2009a). Comparison of current topography with pre-dam topography (Lindgren 1896) indicates that the tailings deposits fill the natural Little Wolf Creek channel in the impoundment area. MFG (2009a) encountered tailings deposits on the order of 30 to 45 feet in thickness in borings drilled along the periphery of the buried channel. Maximum thickness of approximately 50 feet probably occurs at the lowest point of the buried creek channel. Seepage has been observed at the base of the downstream embankment over a distance of 60 feet, and reportedly is a common occurrence after wet winters. Ponded water in the impoundment probably infiltrates the sandy tailings deposits and then flows downgradient through the coarse rockfill dam (Golder 2007)

- **Mine and Mill Sites (Remediation Area 5):** Mine and mill sites with associated waste or tailings deposits exist at various locations throughout the Park. The mine and mills sites have been grouped into three areas within Project boundaries:
  - **Union Hill Area:** Several areas of ground disturbance are visible on the aerial photography. A number of waste rock and tailings sites were also identified by Selverston (2008). Some placer drift mining occurred in the mid- to late-1800s on the north and
south side of Union Hill within the Park boundaries. The geology in this area is mapped as Mehrten Formation overlying older metamorphic bedrock. However, Lindgren (1896) and Johnston (1940) show an area of apparent man-made disturbance as “Placer Diggings.” They describe drift mines as localized deposits of auriferous gravels immediately under the base of the Mehrten Formation. Small pockets of Tertiary gravel are present in low spots on the pre-Mehrten topography. Field reconnaissance observations identified waste rock deposits consisting of Tertiary gravel on the north side of Union Hill (see Figures 4.5-7a through 4.5-7f). These unmapped Tertiary gravel deposits locally underlie the Mehrten Formation cap and were explored by early miners.

- Central Area: The Central Area contains the largest mine workings in the Park, including the Empire, Orleans, W.Y.O.D., and Pennsylvania mines. These mines contain the most extensive waste rock and tailings deposits in the Park. Two large waste rock mounds, at Empire and Penn Mines, have been removed or redistributed since the mines were closed. It has been suggested that portions of the mounds were used as borrow sources for construction rock material in other areas of Nevada County. Only small and relatively thin remnants of the Empire Mine mound remain today, in the area east of the Red Dirt Pile and south of the historic structures. The large mound at the Pennsylvania Mine was either removed or redistributed to form the large graded pad that currently exists. Based on comparison of aerial photography and field reconnaissance, waste rock associated with the Orleans Mine has also been removed or redistributed since the 1940s.

- Osborne Hill Area: The Osborne Hill Area contains a large number of small and moderate sized mine workings. Because of their older age and relatively small size (many are less than 5 feet in height), many waste rock mounds could still remain unidentified and undocumented. In some areas, DPR or others have observed small pits and mounds that were too small to locate accurately. Consequently, Figures 4.5-6a through 4.5-6c outline several areas containing multiple small mine waste mounds and pits. Two of the larger mines in this area are the Prescott and Conlon. Records indicate both had mills and therefore could have residual tailings deposits in the drainages located downstream from these mines.

- Magenta Drain (Remediation Area 6): The Magenta Drain was constructed to drain ground water from the Empire Mine. Based on
information presented by MFG (2008n), the drain tunnel follows a gradient of approximately 0.7% for a distance of nearly 3,000 feet from the Empire Mine shaft to the portal located in Woodpecker Ravine. The drain tunnel flows past the Magenta Mine, which is located in Woodpecker Ravine, approximately 1,200 feet upstream from the tunnel portal.

According to Woodward Construction 1992, the Magenta drain tunnel intersects the Empire shaft at approximately 2,500 feet amsl (Woodward Construction 1992). The Magenta Drain tunnel drains the underground mine workings of the Empire Mine and originates at the 400-foot level of the Empire Mine decline (shaft).

A section of the drainage tunnel extending from the Empire Mine shaft was inspected in 1992 (Woodward Construction 1992). The inspected segment was determined to be in generally good shape, but was blocked at about 1,000 feet from the mine shaft due to collapse of the roof and side walls. In addition to flow from the Empire Mine shaft, the drainage tunnel apparently intercepts shallow ground water along portions of the length of the tunnel alignment, in particular, the last 1,000 feet where the tunnel lies beneath Woodpecker Ravine (Woodward Construction 1992). Subsurface drainage emanates from the tunnel portal and flows into a drainage ditch (Magenta Drain), and then into Woodpecker Ravine, under Race Street and Memorial Park, and to an underground storm water drain downstream from the Park. Water quality monitoring results of the drainage are discussed in Section 4.7, Hydrology and Water Quality.

- **Stacy Lane Pond Area (Remediation Area 7):** The Stacy Lane Pond Area includes: 1) a rockfill embankment, and 2) impounded tailings (reservoir basin). The upstream portion of the tailings is a topographic depression that serves as a basin for temporary storage of storm water runoff. The storage basin is approximately 1/3-acres, with 10- to 15-foot-high side banks. The storage capacity of the storage basin is approximately 3 to 4 acre-feet.

The rockfill dam was constructed from waste rock material and tailings from Pennsylvania Mine, and possibly from the W.Y.O.D. Mine. Remediation Area 7 is an approximate 2.8-acre tailings deposit with an embankment constructed from waste rock material. The embankment could also contain and tailings. The Stacy Lane Pond dam is approximately 25 to 30 feet in height. Two boreholes drilled by MFG (2009b) indicate that the tailings materials, consisting of sand, silt, and clay, were encountered to depths of 22
4.5 Geology and Soils

4.5 Geology and Soils

4.5.1.5 Paleontological Resources

Paleontological resources including fossil plants and animals, both vertebrate and invertebrate, not unlike archeological resources, are a non-renewable, limited and sensitive scientific and educational resource. Once found, the “significance” of a fossil can be determined after identification by a qualified paleontologist. Until then, the actual significance is not entirely known. For purposes of assessing the potential impacts of Project components on paleontological resources, it is important to recognize the important relationship between fossils and the geologic formations within which they might be preserved.

The presence of fossils is dependent on the rock type and age. The Society for Vertebrate Paleontology (SVP 1995) recommends using three categories for describing the paleontological potential of rock units or geologic formations: high or known potential, low potential and undetermined potential. The SVP (1995) defines these three categories as follows:

- **High potential** is used to describe a formation or rock unit in which vertebrate, significant invertebrate or significant suites of plant fossils have been recovered;
- **Low potential** is used to describe formations or rock units showing little to no recovery of nonrenewable paleontological resources; and
- **Undetermined potential** is used for rock units or formations in which little or no information is available.

Typically, these categories are established based on an initial review of literature and collections of paleontological resources in the target formations. Fossils are typically found in sedimentary rocks. In the Western Sierra Nevada Metamorphic Belt (WSNMB) in general, and in the Park specifically, the bedrock types are igneous plutonic rocks and metamorphic (including metavolcanic and metasedimentary) rocks. Igneous and volcanic rocks are formed from crystallization of molten magma, and do not contain fossils. Some of the metamorphic rocks currently found in the northern edge of the Park were originally deep-ocean sedimentary strata that likely contained fossils. However, fossils in the original sediments have mostly been destroyed by the metamorphic process, which included intense pressure and heat due to burial of the sediments, tectonic deformation, and hydrothermal alteration associated with plutonic intrusion.

Although not common, fossils have been found in Tertiary deposits in the Sierra Nevada. According to the University of California, Museum of Paleontology, 59 fossil localities have been identified in Nevada County (UCMP 2008). Most of those locations are in the Eocene-age Ione Formation, which is not present in the Park. One Mehrten
Formation fossil plant location was found at Burlington Ridge. Three locations were found in the Grass Valley area, including a recent (Quaternary) invertebrate fossil, and two plant locations from unknown formations. Based on the UCMP database, there is a low potential that a nonrenewable fossil location could exist in the younger (Tertiary) deposits on Union Hill. Bedrock formations in the remainder of the Park are not expected to yield any fossils.

### 4.5.1.6 Geologic Hazards

#### Surface Fault Rupture

While numerous faults have been mapped within the Park, no late Cenozoic faults (potentially active or active faults) are known. Therefore, the potential for surface fault rupture associated with coseismic rupture within the Park is low.

#### Seismic-Induced Effects

Seismic-induced effects include ground failure caused by earthquake shaking. In addition to slope failures, discussed in the subsection entitled “Landslides,” below, seismic ground failure can include liquefaction and lateral spreading, which can result in the temporary loss of foundation support for structures sited over potentially liquefiable sediments. The surface geology of the Park is dominated by bedrock units that are not prone to earthquake shaking induced deformation or failure. Furthermore, the Park lies in a region of low to moderate seismic activity and earthquake hazard, and could not experience sufficient earthquake ground shaking to cause liquefaction or significant subsidence.

Liquefaction is an earthquake-shaking effect that typically occurs in cohesionless and low plasticity, fine-grained soils during PGA over about 0.2g. Liquefaction occurs in saturated soils. Prior to an earthquake, the water pressure in the cohesionless, low plasticity soil is relatively low. However, earthquake shaking can cause the water pressure to increase to the point where the soil particles can readily move with respect to each other. The excess hydrostatic pressure generated during the earthquake shaking can result in the formation of sand boils and mud spouts, and/or seepage of water through ground cracks. Cohesionless and low plasticity, fine-grained soils within approximately 50 feet of the ground surface are most susceptible to liquefaction. Factors that influence the liquefaction potential of soils include:

- Grain size distribution (% sand and silt);
- Relative density (loose to medium dense);
- Degree of water saturation;
- Confining stresses (overburden) acting on the soils; and
• Characteristics of the causative earthquake, such as the intensity and duration of the ground shaking.

Based on the above criteria, the areas of the Park considered susceptible to liquefaction include the tailings deposits in Sand Dam and Stacy Lane Pond, and modern stream alluvium in South Fork Wolf Creek valley.

Lateral spreading is the result of liquefaction during earthquake shaking. Lateral spreads occur when the loss of strength of the liquefied layer causes primarily horizontal soil movement. When the lateral spread occurs near a steep change in the ground surface or free face (e.g., steep creek or river bank developed in alluvium), the lateral movement is usually toward the free face. Based on our review of topographic conditions, there are no unconfined alluvial or tailings deposits in the Project area with defined free faces of sufficient height and extent to develop lateral spreads.

Strong earthquake ground shaking can, under some circumstances, cause densification or compaction of loose to medium-dense granular soils. This densification can result in settlement of the ground surface and local differential settlement that could damage foundations and structures. Subsurface geotechnical investigations typically address the potential for seismically induced settlement on a site-specific basis.

The potential for seismically induced settlement to occur is controlled by the intensity and duration of ground shaking, and the relative density (the ratio between the in-place density and the maximum density) of the subsurface soils. In general, the materials that are susceptible to liquefaction could also be susceptible to seismically-induced settlement. Consequently, the tailings deposits in Sand Dam and Stacy Lane Pond Dam, and the alluvial sediments in South Fork Wolf Creek could be susceptible to seismically induced settlement.

**Subsidence**

Subsidence of the ground is caused by consolidation of loose or compressible soil materials, earthquake-induced shaking of weak, unconsolidated deposits, or collapse of subsurface openings, which could include tunnels, caves, or other underground excavations.

Abandoned mines are a common cause of ground subsidence, particularly in coal mines, where long-burning underground fires result in removal of material and roof collapse. The collapse of underground excavations in gold mining areas can be caused by fluid extraction (e.g., dewatering), decay of underground support systems, or removal of material without adequate support (e.g., mining). Caving or collapse of shallow mine workings can result in either slow or sudden subsidence at the ground surface.
The magnitude of ground subsidence, and whether any subsidence actually occurs, is dependent on the depth and size of the collapsed underground openings, as well as the geologic conditions such as rock strength, fracturing and faulting. In general, the potential for significant ground surface subsidence is greater for shallow collapses, and less for deeper collapses. Based on evaluations at the Idaho-Maryland Mine (located approximately ½-mile north of the Park), 70 feet is considered to be a conservative maximum depth of collapse that would result in ground surface subsidence (GeoSolutions 2008). GeoSolutions reported from their evaluation of the underground workings at the adjacent Idaho-Maryland mine that most of the existing drifts that are currently part of the underground workings are typically only about seven feet tall and six feet wide. Therefore, if caving were to occur in those excavations (for some unknown reason), the extent of upward caving would typically be not more than 70 feet before natural support is regained, assuming a final void space of 10% is achieved within the caved materials. Therefore, for these old mine workings located within deeper portions of the mine, the possibility of them generating a subsidence of earth materials at the ground surface is extremely low.

The majority of mine workings in the Park are very deep, and accordingly the potential for surface subsidence due to collapse is low. DPR records indicate that additional underground support was added to the upper part of the Empire Mine shaft to assure stability of the shaft. However, there could be other parts of the Park where the upper parts of underground shafts might be close enough to the surface to result in ground subsidence if they were to collapse underground. According to the Park Superintendent (Munson 2009), subsidence occurred over the downstream end of the Magenta Drain Tunnel approximately 10 years ago. The subsidence interrupted flow in the tunnel, and required construction of a new, bypass tunnel culvert to capture the flow. Subsidence related to underground collapse could have occurred in other areas in the Park. Selverston (2008b) mapped 11 features identified as “holes”, which are not associated with waste materials. Selverston suggests that these locations might be former ventilation openings or the result of caving-induced ground subsidence.

Subsidence caused by consolidation of loose or compressible materials is not likely to occur at the Park, except possibly during earthquake shaking (see subsection entitled “Seismic-Induced Effects”).
Landslides

Landslides are known to occur in the Sierra foothills, owing to the presence of weak and sheared geologic units, stream erosion, and steep topography. No active or inactive landslides have been identified in the Park. However, areas of relatively thick colluvium and residual soil occupy natural drainage swales and lower hillside areas. These types of materials normally experience slow downslope creep on slopes, which can impose lateral loads on fixed structures. In addition, steep colluvial swales could yield debris flows during periods of severe precipitation. Fractured, weathered rock is locally exposed in cut slopes. Fracturing and weathering of exposed rock can lead to the formation of loose blocks which can topple and fall from steep slopes such as road and trail cuts. The depth of movement of potential cut slope rock falls is generally less than 6 feet.

Other Geologic Hazards

Naturally occurring asbestos is associated with certain minerals that occur within serpentine and related ultrabasic rocks. Airborne asbestos, commonly associated with dust from disturbance of the naturally occurring asbestos minerals, is a health hazard. The Grass Valley Gold Mining District contains areas of ultrabasic rocks. However, no serpentine or serpentinite soils have been identified within the Park (Breedy and Brussard 2002); this hazard is considered negligible.

No other potential geologic hazards were identified for the Project.

4.5.1.7 Soil Resources

The Natural Resource Conservation Service (NRCS), formerly the U.S. Soil Conservation Service, publishes soil survey reports for nearly all regions of California, including Nevada County. These reports include detailed maps showing the distribution of soils in each particular area. The reports also include detailed qualitative and quantitative descriptions of soil characteristics including, but not limited to: color, texture, thickness, engineering properties, and the soil’s suitability for agricultural purposes. The soil distribution and characteristics for Nevada County in the Park’s vicinity were compiled to evaluate the impacts the Project might have on the soil resources of the area, as well as the impacts that the soils might have on the Project.

The most significant finding with regard to soils that could potentially impact the Project is that some of the soils at the Park are considered potentially corrosive. No soils in the Park were identified as highly expansive.
The most predominant soil types in the Park are the Sites loam and Placer diggings, with smaller areas covered by Cohasset loam, Musick sandy loam, Sierra sandy loam, and Sites very stony loam. The distribution of soils is depicted on Figure 4.5-9, Soils Located within the Park, and the soil types are described below:

- **Sites loam (SIB, SIC, SID):** Sites loam, which is the major soil type in the Central and Osborne Hill areas, is subdivided based on topography, and defined by the following slope gradients: 2% to 9% (SIB), 9% to 30% (SIC), and 15% to 50% (SID). Sites loam develops over weathered metamorphic rock, and has a high corrosion rating for uncoated steel and moderate shrink-swell potential.

- **Sites very stony loam (SmE):** Sites very stony loam (SmE) develops on slopes of 15% to 50%, and differs from the Sites loam soils in that it is coarse-grained, containing gravel and cobbles in a clayey matrix. SmE is mapped in the southwest portion of the area, downslope from the Daisy Hill Mine and trail. SmE soils develop over weathered metamorphic rock, and have a high corrosion rating for uncoated steel and moderate shrink-swell potential.

- **Placer diggings (Pr):** "Placer diggings" is the soil type associated with areas disturbed by mining surface operations, and includes mine waste rock, mill tailings, and general areas of surficial earthwork activity. Placer diggings soil is a mixture of various excavated and processed rock and ore, and has highly variable soil properties.

- **Cohasset loam (CmB):** The Cohasset loam is a loam to cobbly clay loam. It forms over Mehrten Formation andesitic conglomerate, and is present on the crest and upper slopes of Union Hill. It has a moderate corrosion rating for uncoated steel and moderate shrink-swell potential.

- **Musick sandy loam (MrC, MrE):** Soils of the northwestern portion of the area, between Empire Street and Highway 174 and west of the Pennsylvania Mine, are characterized as Musick sandy loam. Musick sandy loam is subdivided based on topography; MrC is on slopes with gradients of 5% to 15%, and MrE is on slopes with gradients of 15% to 50%. This soil develops from plutonic (granodiorite) bedrock, and has a moderate corrosion rating for uncoated steel and moderate shrink-swell potential.

- **Sierra sandy loam (SfD):** A small area of Sierra sandy loam is present on lower slope in the northwest corner of the Park. Sierra sandy loam develops over weathered plutonic (granite) rock, and has a moderate corrosion rating for uncoated steel and moderate shrink-swell potential.

### 4.5.2 REGULATORY SETTING

This section reviews the applicable regulations, rules, plans and industry standards that govern the geologic, seismic, soil, mineral and paleontological aspects of the Project. Geologic and soil resources and geologic hazards, including seismic hazards and geotechnical hazards, generally are governed by California state regulations. Similarly,
state regulations typically govern the management and protection of mineral and paleontological resources excepting such resources on lands under federal jurisdiction.

### 4.5.2.1 Federal

**Paleontological Resources**

Numerous federal regulations indirectly or directly regulate the disturbance, collection and preservation of paleontological resources. Federal regulations governing paleontological resources include the American Antiquities Act of 1906 and the National Environmental Policy Act of 1969. A brief description of these regulations is given below.

**American Antiquities Act**

The American Antiquities Act enacts criminal penalties for any act that will "appropriate, excavate, injure, or destroy any historic or prehistoric ruin or monument, or any object of antiquity, situated on lands owned or controlled by the Government of the United States, without the permission of the Secretary of the Department of the Government having jurisdiction over the lands on which said antiquities are situated." Additionally, the American Antiquities Act establishes rules for removal of "objects of antiquity." Paleontological resources are usually categorized as "objects of antiquity" under this Act.

**National Environmental Policy Act**

The National Environmental Policy Act (NEPA) does not directly regulate the disturbance or removal of paleontological resources; however, Section 101 (b) (4) of NEPA outlines one of the duties of the Act to "preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice." This section is considered to relate to paleontological resources.

### 4.5.2.2 State

**State Water Resources Control Board**

The SWRCB in California is the permitting authority for the NPDES Stormwater Program. The SWRCB implements the NPDES program following the federal rules, including the recent amendment exempting the oil and gas industry from the federal permit requirements. The State Water Resources Control Board (SWRCB) state-wide program is based on the federal program. The SWRCB
has jurisdiction over water quality for both surface and ground water and
routinely enforces SWRCB Resolution 68-16, commonly referred to as the non-
degradation policy either directly or through the State’s system of Regional Water
Quality Control Board’s (RWQCB). This resolution requires maintenance of
existing water quality within a specific surface water or groundwater system.

2007 California Building Code

The CBC (2007), implemented on January 1, 2008, is based on the 2006
International Building Code (IBC) but includes California-specific structural
seismic provisions. The CBC (Chapters 16 and 18) includes definitions of
seismic sources, site soil types and the procedure to calculate seismic forces on
structures. In addition, Chapter 33 contains provisions to protect adjacent
property during excavation and requires a 10-day advance written notice to
adjacent property owners.

Paleontological Resources

CEQA was established as a way to inform policy makers and the public
regarding projects which potentially affect the environment in a significant
manner and lessen such impacts by alternative and mitigation review. As part of
this process, projects determined to have a potential environmental impact must
prepare and submit to the lead agency and the public an Environmental Impact
Report. In this Project, the significance level of paleontological resources is
codified in Section 15064.5 “Determining the Significance of Impacts to
Archaeological and Historical Resources.” In particular, sub-Section 3(d) identifies
as significant locations one which “has yielded, or could be likely to yield,
information important in prehistory and history.”

California Public Resources Code

The California Public Resources Code (PRC) Section 5097.5 (a) of the California
Public Code Section states:

“No person shall knowingly and willfully excavate upon, or remove, destroy,
injure, or deface, any historic or prehistoric ruins, burial grounds, archaeological
or vertebrate paleontological site, including fossilized footprints, inscriptions
made by human agency, rock, art, or any other archaeological, paleontological or
historical feature, situated on public lands, except with the express permission of
the public agency having jurisdiction over the lands.”
Surface Fault Rupture and the Alquist-Priolo Earthquake Fault Zoning Act

Inspired by the damaging effects of the 1971 San Fernando Earthquake, California promulgated the Alquist-Priolo Special Studies Zone Act in 1972 (currently the Alquist-Priolo Earthquake Fault Zoning Act of 1972). This Act regulates the development and construction of buildings for human occupancy to avoid the hazard of surface fault rupture during earthquakes. CEQA makes reference to the act, and concludes that a project would have a significant impact on the environment if it will “Expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault.” The Alquist-Priolo Earthquake Fault Zone Act does not apply to the Project because no Alquist-Priolo Earthquake Fault Zones faults have been mapped within the Park.

Seismic Hazards Mapping Act

Prompted by damaging earthquakes in northern and southern California in the 1980s, the state adopted the Seismic Hazards Mapping Act in 1990. The purpose of the act is to protect public safety from the effects of strong ground shaking, liquefaction, landslides, or other ground failure, and other hazards caused by earthquakes. The act requires the State Geologist to delineate seismic hazard zones, which is currently an ongoing program. The act does not apply directly to the Project because seismic hazard zones have not yet been delineated in the Park. However, the act led to establishment of guidelines for evaluating seismic hazards (other than surface fault rupture). These guidelines (summarized in California Geological Survey Special Publication 117) provide industry-standards for evaluating and mitigating seismic hazards.

Surface Mining and Reclamation Act

The Surface Mining and Reclamation Act of 1975 (SMARA) requires the state of California to prepare an inventory and classify selected mineral resources within the State. Areas are classified into Mineral Resource Zones (MRZ) based on the occurrence and availability of mineral resources. The information is intended to inform local agencies regarding the planning and development of lands that contain significant mineral resources. The Mineral Land Classification of Nevada County, California was published as Special Report 164 by the California Geological Survey (formerly California Division of Mines and Geology) in 1990 (Loyd and Clinkenbeard 1990).

Most of the Park is classified as MRZ-2b(h-9), which is defined as areas underlain by significant inferred resources. The extreme northeastern corner of
the Park (lower northeast slope of Union Hill) is classified as both MRZ-2b(h-9) and MRZ-3b (CS)M, which is defined as areas underlain by bodies of metamorphic rock that could contain material suitable for use as crushed stone.

**California Division of Safety of Dams**

The Division of Dam Safety (DSOD) within the California Department of Water Resources has jurisdiction over dams of certain size and water impoundment area. The general criteria for DSOD jurisdiction is: 1) a minimum height of 6 feet and storage capacity greater than 15 acre-feet, or 2) a minimum dam height of 25 feet and storage capacity greater than 50 acre-feet. The tailings impoundment dams in the Park (Sand Dam and Stacy Lane Pond Dam) are not currently under DSOD jurisdiction because they do not impound significant reservoirs of water. However, the dams would become jurisdictional if future remediation is undertaken to increase water storage capacity (through removal of tailings or increase in dam heights), or otherwise alter the dams such that DSOD becomes concerned with safety issues (including removal).

**4.5.2.3 Local**

DPR is exempt from local regulations, including general plans, specific plans, and zoning ordinances, to the extent that such requirements conflict with DPR’s own General Plan for the Park (California Constitution Article XI Section 7). However, DPR must comply with the Park’s General Plan, as well as applicable state and federal rules and regulations governing historic buildings, structures, and districts and any local regulations applicable to impacts located outside the Park boundaries.

**4.5.3 THRESHOLDS OF SIGNIFICANCE**

The following thresholds have been prepared based on the State CEQA Guidelines (Appendix G) and Section 15065 of the State CEQA Guidelines. The Project would have a significant impact on geologic resources if it will:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving:
  - Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault;
  - Strong seismic ground shaking;
  - Seismic-related ground failure, including liquefaction; or
  - Landslides.
- Result in substantial soil erosion or the loss of topsoil;
• Location on a geologic unit or soil that is unstable, or that will become unstable as a result of the project, and/or will potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse;
• Location on expansive soil, as defined in Chapter 18 of the 2007 CBC, creating substantial risks to life or property; or
• Have soils incapable of adequately supporting the use of septic tanks or alternative waste disposal systems, where sewers are not available for the disposal of waste water.

CEQA (Appendix G of the CEQA Guidelines) also provides guidance for assessing the significance of potential environmental impacts relative to paleontologic and geologic resources. A project normally would have a significant effect on the environment if it will directly or indirectly:

• Destroy a unique paleontological resource or site or unique geologic feature.

4.5.4 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

4.5.4.1 Programmatic EIR Impact Assessment

To identify potentially significant impacts resulting from Program Actions, each proposed Program Action was assessed against the significance thresholds listed in Section 4.5.3. Table 4.0-1 summarizes the results of the impact analysis, and assesses reasonably foreseeable impacts that could occur to each of the identified environmental resources. The Program Actions are described in detail in Section 2.0 of the Draft PEIR. The discussion below lists each type of potential geologic, soil, paleontological, and other hazard impacts. This discussion provides an analysis of potential impacts from each Program Action, assesses the significance of each impact, and if necessary, identifies measures that would reduce impacts to a less than significant level. Table 4.5-1, Program EIR Geology and Soils Impacts Analysis, summarizes the Draft PEIR geology and soils impacts analysis. Effects assessed to be less than significant are described in Section 4.5.5.

This subsection provides a geologic impact analysis at a programmatic level. For an analysis of each of the Remediation Areas, see Section 4.5.3.
Impact 4.5-1:  Park Features Subject to Program Actions Could be Susceptible to Seismically-Induced Ground Failure

Seismically-induced ground failures including liquefaction, landsliding, and seismically induced ground settlements could potentially adversely impact Park features that could be subject to Program Actions. The following Project Actions could potentially be impacted by seismically-induced ground failure during implementation of Program Actions:

- Operation of heavy construction equipment;
- Transportation of contaminated soils leaving the Park and importation of clean fill material entering the Park;
- Mobilization and demobilization of heavy construction equipment to the Park;
- Demolition and/or removal of any structures, including temporary facilities;
- Importation of supplies and materials that could be used for remediation activities;
- Temporary and permanent fencing installation;
- Grading activities;
- Boring activities;
- Excavation activities;
- Blasting activities;
- Scarifying activities;
- Planting and seeding activities;
- Dredging and sediment removal;
- Stormwater BMP installation and maintenance activities;
- Physical contact with cultural and surface water resources;
- Removal of trees and other vegetation;
- Construction of ancillary structures, including utilities for either a temporary or permanent active water treatment facility;
- Construction and installation of permanent exclusion barriers;
- Construction and maintenance of access roads; and/or
- Monitoring activities.
### TABLE 4.5-1
#### PROGRAM EIR GEOLOGY AND SOILS IMPACTS ANALYSIS

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<thead>
<tr>
<th>Program Actions</th>
<th>Thresholds of Significance</th>
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<tbody>
<tr>
<td></td>
<td>Rupture of known earthquake fault</td>
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<tr>
<td>CHARACTERIZATION</td>
<td>NI</td>
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<td>Evaluation (e.g., bench/pilot testing)</td>
<td>NI</td>
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<tr>
<td>INTERIM OPTIONS</td>
<td>Fences</td>
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<td>Signs</td>
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<td>Installation of Zeolite Treatment Cells</td>
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<td>Installation of Straw Wattles</td>
<td>NI</td>
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<tr>
<td>Use of soil tackifiers/binding agents</td>
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</tr>
<tr>
<td>Construction of a temporary plant at Magenta Drain Area</td>
<td>NI</td>
</tr>
<tr>
<td>REMEDIATION OPTIONS</td>
<td>In-Situ Cover Establishment and Stabilization</td>
</tr>
<tr>
<td>Selective Removal and/or Replacement of Surface Materials</td>
<td>NI</td>
</tr>
<tr>
<td>Complete Removal and/or Replacement of Surface Materials</td>
<td>NI</td>
</tr>
<tr>
<td>Placement of Cover over Selected Areas</td>
<td>NI</td>
</tr>
<tr>
<td>Use of Institutional Controls to Prevent Access</td>
<td>NI</td>
</tr>
</tbody>
</table>
### 4.5 Geology and Soils

#### Thresholds of Significance

<table>
<thead>
<tr>
<th>Program Actions</th>
<th>Rupture of known earthquake fault</th>
<th>Strong seismic ground shaking</th>
<th>Seismic-related ground failure (including liquefaction)</th>
<th>Landslides</th>
<th>Substantial soil erosion or loss of topsoil</th>
<th>Location on unstable geologic unit or soil</th>
<th>Location on expansive soil</th>
<th>Soils incapable of supporting septic tanks or alternative waste disposal systems</th>
<th>Destroy a unique paleontological resource or site or unique geologic feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stormwater Collection and Diversion Structures</td>
<td>NI</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>NA</td>
<td>NI</td>
</tr>
<tr>
<td>Implement Active Treatment Measures</td>
<td>NI</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>NI</td>
<td>LS</td>
<td>NA</td>
<td>NA</td>
<td>NI</td>
</tr>
<tr>
<td>Implement Passive Treatment Measures</td>
<td>NI</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>NI</td>
<td>LS</td>
<td>NA</td>
<td>NA</td>
<td>NI</td>
</tr>
<tr>
<td>Other Water Treatment Measures</td>
<td>NI</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>NA</td>
<td>NI</td>
</tr>
<tr>
<td>Remediation of Structures</td>
<td>NI</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>NA</td>
<td>NI</td>
</tr>
<tr>
<td>Use of Engineering Controls to Prevent Access</td>
<td>NI</td>
<td>NI</td>
<td>NI</td>
<td>NI</td>
<td>NI</td>
<td>NI</td>
<td>NA</td>
<td>NA</td>
<td>NI</td>
</tr>
<tr>
<td>On-site Removal and/or Replacement of Material</td>
<td>NI</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>NA</td>
<td>NI</td>
</tr>
<tr>
<td>Maintenance and Enhancement of Existing Cover</td>
<td>NI</td>
<td>NI</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>NA</td>
<td>NI</td>
</tr>
</tbody>
</table>

**Notes:**
- PSU = Potentially Significant and Unavoidable
- PS = Potentially Significant Impact
- LS = Less than Significant Impact – with Project Specific and Standard Project Requirements
- LSM = Less than Significant Impact with Mitigation Incorporated
- NI = No Impact
- NA = Not Applicable
Historic earthquake records reveal that the Park is located within a region of low to moderate seismic activity and associated ground shaking. The estimated ground motions are not likely to produce significant damage, but they could induce localized ground failure under certain conditions. Hazards from seismically-induced localized ground failures of liquefaction and slope instability can result in settlement of the ground surface in ponded tailings areas, loss of foundation support, collapse of historic shafts, portals and other mine openings, and undermining and/or burial of trails on slopes by the downslope movement of soil and rock.

The most susceptible areas to seismically induced ground failure are old, partly collapsed or incompletely filled mine openings, ponded mill tailings, and steep slopes consisting of weak or unconsolidated rock and soil (including steep mine waste rock mounds). It is reasonably foreseeable that seismically induced ground failure could occur during implementation of Program Actions. It should be noted, however, that seismicity is part of the existing conditions at the Park and the Project would not change existing conditions regarding the susceptibility to seismically induced ground failure.

Per Standard Project Requirement GEO-1, A DPR-qualified personnel will inspect all structures (residences, adits, visitor center, etc) and features (trails, known mine openings, the Sand Dam, etc.) following a large earthquake (magnitude of 5.0 or greater within 50 miles of the Park), for damage, as soon as practical, and close any areas of the Park that are determined to pose a danger to Park users, volunteers, residents, and staff.

The anticipated seismic performances of potentially sensitive existing features (including mine openings, dams, tailings impoundments, steep slopes, etc.) are unknown. However, nothing identified in the Project involves the construction of new structures that would be susceptible to seismically induced ground failure (the water treatment plant would be constructed to modern standards). Therefore, with implementation of Project Requirement GEO-1, impacts related to seismically induced ground failure are less than significant. The potential impacts on specific Remediation Areas are assessed in the subsection entitled “Area-Specific Impact Assessment.”

**Level of Significance Before Mitigation:** Less than Significant

**Mitigation Measures:** None Required

**Impact 4.5-2:** Park Features Subject to Program Actions Could be Susceptible to Ground Subsidence Over Underground Excavations

Ground subsidence associated with collapse of shallow mine workings could potentially adversely impact Park features that could be subject to Program Actions. The following Project Actions could potentially be impacted by ground subsidence during implementation of Program Actions:
4.5 Geology and Soils

- Operation of heavy construction equipment;
- Transportation of contaminated soils leaving the Park and importation of clean fill material entering the Park;
- Mobilization and demobilization of heavy construction equipment to the Park;
- Demolition and/or removal of any structures, including temporary facilities;
- Importation of supplies and materials that could be used for remediation activities;
- Temporary and permanent fencing installation;
- Grading activities;
- Boring activities;
- Excavation activities;
- Blasting activities;
- Scarifying activities;
- Planting and seeding activities;
- Dredging and sediment removal;
- Stormwater BMP installation and maintenance activities;
- Physical contact with cultural and surface water resources;
- Removal of trees and other vegetation;
- Construction of ancillary structures, including utilities for either a temporary or permanent active water treatment facility;
- Construction and installation of permanent exclusion barriers;
- Construction and maintenance of access roads; and/or
- Monitoring activities.

The Park contains a large number of underground mine workings, most of which are considered to be too deep to impact the ground surface due to localized collapse. Mine shafts were generally constructed at 30% gradients, and thus rapidly (within approximately 100 feet) descend to depths beyond which ground subsidence is likely to occur due to collapse. In addition, very few portions of the Park are occupied by built structures. Mine drainage tunnels typically penetrate steep hillsides to intersect mines at depth; however they were constructed at low gradients (typically less than 2%). Consequently, some areas of the Park could overlie shallow mine workings that have a potential for collapse-related ground subsidence.

Per Specific Project Requirement GEO-2, a geotechnical examination of the proposed work area will be completed to evaluate the ground surface over known or suspected shallow mine workings to assess the potential of ground subsidence will occur as part of Project design and prior to ground disturbing activities.
Level of Significance Before Mitigation: Less than Significant

Mitigation Measures: None Required

Impact 4.5-3: Program Actions Could Have a Substantial Adverse Effect on Slope Hazards (Landslides and Erosion)

Slope hazards (landslides and erosion) could affect hillslope areas in the Park. No natural landslides have been identified; however, grading of steep slopes could lead to decreased slope stability and increased hillside erosion. The following Project Actions could result in increased susceptibility to slope hazards:

- Operation of heavy construction equipment;
- Transportation of contaminated soils leaving the Park and importation of clean fill material entering the Park;
- Mobilization and demobilization of heavy construction equipment to the Park;
- Demolition and/or removal of any structures, including temporary facilities;
- Importation of supplies and materials that could be used for remediation activities;
- Temporary and permanent fencing installation;
- Grading activities;
- Boring activities;
- Excavation activities;
- Blasting activities;
- Scarifying activities;
- Planting and seeding activities;
- Dredging and sediment removal;
- Stormwater BMP installation and maintenance activities;
- Physical contact with cultural and surface water resources;
- Removal of trees and other vegetation;
- Construction of ancillary structures, including utilities for either a temporary or permanent active water treatment facility;
- Construction and installation of permanent exclusion barriers;
- Construction and maintenance of access roads; and/or
- Monitoring activities.

As shown on Table 4.0-1, many of the Program Actions would utilize more than one of the Project Actions listed above. Per Standard Project Requirement HYDRO-1, the Project Proponents will implement BMPs to ensure that bare earth that becomes
exposed during the Project Actions does not erode during and immediately after storm events, and result in downslope sedimentation. In addition, the Project Proponents shall follow trail/road reconstruction standards as specified in the DPR Trails Handbook (DPR 1991) and use standard construction diagrams.

**Level of Significance Before Mitigation:** Less than Significant

**Mitigation Measures:** None Required

### 4.5.4.2 Area-Specific Impact Assessment

To identify potentially significant impacts resulting from the Project, each proposed Program Action was assessed for each Remediation Area using the significance thresholds listed in Section 4.1.3, Thresholds of Significance. Table 4.5-2, Area-Specific Geology Impacts Analysis, summarizes the Area-specific geologic impacts.

This section provides a geologic impact analysis of each of the Remediation Areas. For an analysis of impacts resulting from proposed Program Actions, see Section 4.5.3 (subsection entitled “Programmatic EIR Impact Assessment”).

<table>
<thead>
<tr>
<th>Remediation Areas</th>
<th>Rupture of known earthquake fault</th>
<th>Strong seismic ground shaking</th>
<th>Seismic-related ground failure (including liquefaction)</th>
<th>Landslides</th>
<th>Substantial soil erosion or loss of topsoil</th>
<th>Location on unstable geologic unit or soil</th>
<th>Location on expansive soil or soils incapable of supporting septic tanks or alternative waste disposal systems</th>
<th>Destroy a unique paleontological resource or site or unique geologic feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area 1: Mine Yard and Stamp Mill Area</td>
<td>NI</td>
<td>LS</td>
<td>LS</td>
<td>NI</td>
<td>LS</td>
<td>NI</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Area 2: Cyanide Plant Area</td>
<td>NI</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>NI</td>
<td>NA</td>
<td>NI</td>
</tr>
<tr>
<td>Area 3: Conveyance Corridor and Adit Project Area</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>NI</td>
<td>NA</td>
<td>NI</td>
</tr>
<tr>
<td>Area 4: Sand Dam Area</td>
<td>NI</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>NI</td>
<td>NA</td>
<td>NI</td>
</tr>
<tr>
<td>Area 5: Historic Mine and Mill Areas</td>
<td>NI</td>
<td>LS</td>
<td>NI</td>
<td>NI</td>
<td>LS</td>
<td>NI</td>
<td>NA</td>
<td>NI</td>
</tr>
<tr>
<td>Area 6:</td>
<td>NI</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>NI</td>
<td>NA</td>
<td>NI</td>
</tr>
</tbody>
</table>
### Thresholds of Significance

<table>
<thead>
<tr>
<th>Remediation Areas</th>
<th>Rupture of known earthquake fault</th>
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<th>Location on expansive soil</th>
<th>Soils incapable of supporting septic tanks or alternative waste disposal systems</th>
<th>Destroy a unique paleontological resource or site or unique geologic feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magenta Drain Area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Area 7:</strong> Stacy Lane Pond Area</td>
<td>NI</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>NI</td>
<td>NA</td>
<td>NI</td>
<td></td>
</tr>
<tr>
<td><strong>Area 8:</strong> Historic Grounds Area</td>
<td>NI</td>
<td>LS</td>
<td>NI</td>
<td>LS</td>
<td>LS</td>
<td>NL</td>
<td>NA</td>
<td>NI</td>
<td></td>
</tr>
<tr>
<td><strong>Area 9:</strong> Residences and Residences’ Yards Areas</td>
<td>NI</td>
<td>NI</td>
<td>NI</td>
<td>LS</td>
<td>LS</td>
<td>NL</td>
<td>NA</td>
<td>NI</td>
<td></td>
</tr>
<tr>
<td><strong>Area 10:</strong> Trails Areas</td>
<td>NI</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>LS</td>
<td>NL</td>
<td>NA</td>
<td>NI</td>
<td></td>
</tr>
</tbody>
</table>

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### Impact 4.5-4: Failure of Sand Dam Due to Tailings Liquefaction or Seismically Induced Settlement or Embankment Instability, Foundation Instability, or Erosion (Area 4)

The Sand Dam Area (Area 4) includes: 1) a rockfill embankment (dam), and 2) impounded tailings (reservoir basin). The rockfill embankment could be susceptible to seismic ground deformation during moderate to strong earthquake shaking, and possible slope or foundation failure in the absence of earthquake shaking. The tailings impoundment could be susceptible to seismic ground deformation involving liquefaction of the saturated tailings materials during moderate to strong earthquake shaking. Most of the suite of Program Actions would be considered for implementation at Area 4, including removal of all, or part of, tailings, and covering of tailings with a soil cover or engineered cap. The following Project Actions could result in increased susceptibility to embankment and tailings deformations:

- Operation of heavy construction equipment;
• Transportation of contaminated soils leaving the Park and importation of clean fill material entering the Park;
• Mobilization and demobilization of heavy construction equipment to the Park;
• Demolition and/or removal of any structures, including temporary facilities;
• Importation of supplies and materials that could be used for remediation activities;
• Temporary and permanent fencing installation;
• Grading activities;
• Boring activities;
• Excavation activities;
• Blasting activities;
• Scarifying activities;
• Planting and seeding activities;
• Dredging and sediment removal;
• Stormwater BMP installation and maintenance activities;
• Physical contact with cultural and surface water resources;
• Removal of trees and other vegetation;
• Construction of ancillary structures, including utilities for either a temporary or permanent active water treatment facility;
• Construction and installation of permanent exclusion barriers;
• Construction and maintenance of access roads; and/or
• Monitoring activities.

Based on preliminary site characterization and understanding of tailings materials, the tailings deposits are the types of materials that are susceptible to liquefaction and seismically induced ground settlement. The materials are sandy to silty, relatively loosely deposited, and at least partly saturated. However, the hazards from liquefaction and settlement of tailings deposits would likely not result in significant impacts, because the impoundment area does not support any structures, and is contained by the dam and adjacent hillslopes.

At this time, no structures are proposed for the tailings deposits. Therefore, no mitigation measures are required to reduce the hazard of liquefaction or other seismically induced settlement.

In 2007, Golder performed a preliminary embankment stability analysis of the Sand Dam. (Golder 2007). However, the stability of the Sand Dam has not been fully assessed. It should be noted, however, that seismicity is part of the existing conditions at the Park and the Project would not change existing conditions regarding the susceptibility to seismic failure. The dam embankments and foundation treatment likely
do not meet modern engineering standards based on the age and type of construction. In general, coarse rockfill embankments tend to have a greater degree of static stability due to their weight and free-draining capability that reduces the potential for the buildup of hydrostatic pressures within the dam. In addition, the dam has a wide crest for most of its length, which would help to mitigate any potential slope deformations on the embankment slopes. However, the foundation material, dam properties, and geometry have not been characterized, and thus the potential hazard cannot be quantified. Dams of similar age and type of construction are viewed as potentially deficient by DSOD.

The reservoir basin contains a large volume of impounded tailings, and there is limited area remaining behind the dam for water storage, even during periods of maximum storm water runoff. The amount of storage in the Sand Dam is controlled by the difference in elevation between the crest of the San Dam and the surface of the tailings at the base of the dam which is approximately 10 feet. Because significant amounts of water are not contained behind the dam, downstream flooding is not likely to occur in the event of dam failure. However, if Sand Dam experienced large deformations, it might result in an uncontrolled release of the embankment material and saturated tailings deposits. In addition, upstream embankment instability or foundation failure could potentially result from removal of impounded tailings. These potential issues are part of the existing conditions at the Sand Dam Area. Program Actions would not exacerbate the existing conditions. Therefore, implementation of Program Actions would be a less than significant impact.

**Level of Significance Before Mitigation:** Less than Significant

**Mitigation Measures:** None Required

**Impact 4.5-5:** Grading of Mine Waste Rock and Mill Tailings Could Cause Substantial Adverse Effects from Erosion and Slope Hazards (Landslides) at the Historic Mine and Mill Sites (Area 5)

Mine waste rock mounds and mill tailings deposits are present at various locations in the Park. Some or all of these deposits could contain COC. The largest deposits have previously been identified and considered in Program Actions. Program Actions of the Remediation Areas are ongoing. Specific Remediation Options for Area 5 have not been identified. However remediation options that are likely to be implemented include the use of engineered controls to prevent access, in-situ covers, establishment and stabilization, selective removal and/or replacement, and/or placement of cover over selected areas. The following Project Actions could result in increased susceptibility to adverse effects from erosion and slope hazards:

- Operation of heavy construction equipment;
- Transportation of contaminated soils leaving the Park and importation of clean fill material entering the Park;
• Mobilization and demobilization of heavy construction equipment to the Park;
• Demolition and/or removal of any structures, including temporary facilities;
• Importation of supplies and materials that could be used for remediation activities;
• Temporary and permanent fencing installation;
• Grading activities;
• Boring activities;
• Excavation activities;
• Blasting activities;
• Scarifying activities;
• Planting and seeding activities;
• Dredging and sediment removal;
• Stormwater BMP installation and maintenance activities;
• Physical contact with cultural and surface water resources;
• Removal of trees and other vegetation;
• Construction of ancillary structures, including utilities for either a temporary or permanent active water treatment facility;
• Construction and installation of permanent exclusion barriers;
• Construction and maintenance of access roads; and/or
• Monitoring activities.

Mine waste rock deposits typically are mounds, ranging from small piles of rock to larger deposits up to approximately 30 feet in height (e.g., Conlon, Prescott, W.Y.O.D., Rowe), or graded slopes (e.g., Orleans, Pennsylvania). Mill tailings occupy low-lying areas, and are estimated to be up to approximately 50 feet deep in the Sand Dam impoundment. Excavation and removal of mill tailings that might create or expose slopes, or partial removal of portions of steep-sided waste rock slopes, could have an adverse impact on slope stability, if conducted without proper consideration of geotechnical conditions.

Grading and recontouring on slopes can lead to decreased slope stability and increased hillside erosion; no Standard Project Requirement specifically addresses the impacts of grading on slopes. However, DPR proposes to develop design drawings and specifications for specific road and trail segments and implement Standard Project Requirements (e.g., HYDRO-1) to ensure that bare earth that becomes exposed during the Program Actions does not erode during and immediately after storm events, and result in downslope sedimentation. In addition, DPR will follow trail/road reconstruction standards as specified in the DPR Trails Handbook (DPR 1991) and use standard construction diagrams which would reduce the potential for slope hazards such as landsliding and erosion.
Implementation of Standard Project Requirement HYDRO-1, along with DPR’s trail/road reconstruction standards, as specified in the DPR Trails Handbook (DPR 1991), and use of standard construction diagrams would reduce the potential for slope hazards such as landsliding and erosion. Consequently, grading-induced slope instability is considered to be a less than significant impact with implementation of Standard Project Requirements.

**Level of Significance Before Mitigation:** Less than Significant

**Mitigation Measures:** None Required

**Impact 4.5-6:** Ground Subsidence Over the Magenta Drain Tunnel Could Result in Potentially Significant Adverse Effects to the Magenta Drain (Area 6)

As discussed in Impact 4.5-2, the collapse of shallow mine workings is known to be a cause of ground surface subsidence in areas of abandoned underground mines. The Magenta Drain tunnel remains relatively shallow (less than 70 feet) for a longer distance than other tunnels because it is situated beneath a drainage ravine for approximately 800 feet, instead of immediately penetrating a steep hillside (see Figure 4.5-6a and 6b). The shallowest segment of the Magenta Drain tunnel underlies a housing area outside of Park boundaries.

Per Standard Project Requirement GEO-2, DPR-qualified personnel will inspect and evaluate the ground subsidence over known shallow mine workings, to assess the potential ground subsidence hazard associated with underground collapse of mine workings.

**Level of Significance Before Mitigation:** Less than Significant

**Mitigation Measures:** None required.

**Impact 4.5-7:** Program Actions Could Cause Failure of Stacy Lane Pond Dam Due to Embankment Instability, Foundation Instability, or Erosion in the Stacy Lane Pond Vicinity (Area 7)

The Stacy Lane Pond area includes: 1) a rockfill embankment (dam), and 2) impounded tailings. Both the dam and tailings at Area 7 could be susceptible to seismic ground deformation during moderate earthquake shaking, including liquefaction of the saturated tailings materials and slope deformation or failure of the dam embankment. The following Program Actions could have an impact in Remediation Area 7

- Operation of heavy construction equipment;
- Transportation of contaminated soils leaving the Park and importation of clean fill material entering the Park;
4.5 Geology and Soils

- Mobilization and demobilization of heavy construction equipment to the Park;
- Demolition and/or removal of any structures, including temporary facilities;
- Importation of supplies and materials that could be used for remediation activities;
- Temporary and permanent fencing installation;
- Grading activities;
- Boring activities;
- Excavation activities;
- Blasting activities;
- Scarifying activities;
- Planting and seeding activities;
- Dredging and sediment removal;
- Stormwater BMP installation and maintenance activities;
- Physical contact with cultural and surface water resources;
- Removal of trees and other vegetation;
- Construction of ancillary structures, including utilities for either a temporary or permanent active water treatment facility;
- Construction and installation of permanent exclusion barriers;
- Construction and maintenance of access roads; and/or
- Monitoring activities.

Impounded tailings deposits are the types of materials that are susceptible to liquefaction and seismically induced ground settlement. Earthquake shaking could result in failure of slopes along the perimeter of the basin, thus exposing the edge of the depression to ground failure. However, the hazards from slope instability, liquefaction and settlement of tailings deposits would likely not result in significant impacts, because the tailings area does not support any structures, and is generally contained by the dam and adjacent hillslopes.

Although Stacy Lane Pond is designed to capture storm water runoff, the basin capacity is less than 5 acre-feet. Consequently, significant downstream flooding would not occur in the event of dam failure, even during maximum water storage. However, if sudden failure of the dam were to occur, it might result in an uncontrolled release of the embankment material and saturated tailings deposits. These potential issues are part of the existing conditions at the Stacy Lane Pond Area. Program Actions would not exacerbate the existing conditions. Therefore, implementation of Program Actions would be a less than significant impact.

**Level of Significance Before Mitigation:** Less than Significant
Mitigation Measure: None Required

Impact 4.5-8: Program Actions Could Cause Substantial Adverse Effects from Erosion and Slope Hazards (Landslides) on, or Adjacent to, Trails (Area 10)

Mine waste rock mounds and mill tailings deposits are present at various locations in the Park, including under, or in near proximity to, existing and proposed trails. As described in Section 2.6.4, MFG characterized and evaluated the trails in 2006 and 2007. Based on the findings that COC are present along several trails or trail segments, several remediation options were proposed, including: 1) closure of certain trails that do not meet DPR trails guidelines; 2) upgrade or reconstruction of existing trails; and 3) construction of new trails (MFG 2008h). Grading and recontouring on slopes can lead to decreased slope stability and increased hillside erosion.

Remediation actions would involve the suite of Program Actions provided in Section 2.6.3, which include:

- In-situ covers establishment and stabilization;
- Selective removal and/or replacement of surface materials;
- Complete removal and/or replacement of surface materials;
- Placement of removed soils or materials within the Park;
- Placement of cover over selected areas;
- Maintenance and enhancement of existing cover;
- Use of Engineered Controls to prevent access;
- Use of institutional controls;
- Stormwater collection and diversion structures;
- Implement active treatment measures;
- Implement passive treatment measures;
- Other water management measures; and/or
- Remediation of structures.

Implementation of Standard Project Requirement HYDRO-1, along with DPR’s trail/road reconstruction standards, as specified in the DPR Trails Handbook (DPR 1991), and use of standard construction diagrams would reduce the potential for slope hazards such as landsliding and erosion. Consequently, grading-induced slope instability is considered to be a less than significant impact with implementation of this Standard Project Requirement.

Level of Significance Before Mitigation: Less than Significant

Mitigation Measures: None Required
4.5.5 EFFECTS CONSIDERED NO IMPACT OR LESS THAN SIGNIFICANT WITHOUT PROJECT REQUIREMENTS

The following describes environmental effects that were determined to be less than significant without Project Requirements or no impact; therefore, they are not discussed in detail in the Draft PEIR:

- **Rupture of Known Earthquake Fault:** No potentially active or active faults are mapped through the Park. Therefore, there is no impact from the hazard of surface fault rupture.
- **Development on Expansive Soil:** Highly expansive soils have not been identified in the Project area. Furthermore, the Project does not involve the construction of foundations or structures which could be damaged by expansive soils. Consequently, there is no impact due to expansive soils.
- **Soils Incapable of Adequately Supporting the Use of Septic Tanks or Alternative Waste Disposal Systems:** The Project does not involve the installation of septic systems or leach fields. Therefore, there is no impact associated with waste disposal.
- **Loss of Paleontologic Resources or Unique Geologic Features:** Geologic formations in the Park have a low potential for yielding fossils. There are no known paleontologic resources or unique geologic features that would be impacted by the Project. Consequently, loss of paleontological resources or unique geologic features is considered to be a less than significant impact.

4.5.6 FINDINGS

Implementation of Standard and Specific Project Requirements will ensure that Program Actions will result in less than significant impacts.