3.1 Geology, Soils and Mineral Resources

This section of the Draft Final Environmental Impact Report (EIR) discusses the current geologic and soil conditions at the proposed Eagle Mountain Pumped Storage Project (Project) site and identifies the potential geologic and soil-related impacts based on the construction and operational activities associated with the Project. Mitigation measures (MMs) are provided in order to reduce significant impacts to less than significant, where applicable. Information for this section was obtained primarily from existing reports, public and agency contacts, and Project area reconnaissance.

3.1.1 Regulatory Settings

The following federal, state, and local laws and policies apply to the protection of geology and soils. The proposed Project will be constructed and operated in conformance with all applicable federal, state, and local laws, ordinances, regulations, and standards (LORS).

Portions of the Project site are located on private lands which are not subject to federal or state land management requirements. Other portions of the Project site are located on federal land which is managed by the Bureau of Land Management (BLM) and therefore subject to the geological resource LORS of the agency.

3.1.1.1 Federal

The Uniform Building Code (UBC) was developed by the International Conference of Building Officials and is used by most states, including California, as well as local jurisdictions to set basic standards for acceptable design of structures and facilities. The UBC provides information on criteria for seismic design, construction, and load-bearing capacity associated with various buildings and other structures and features. Additionally, the UBC identifies design and construction requirements for addressing and mitigating potential geologic hazards. New construction generally must meet the requirements of the most recent version of the UBC.

3.1.1.2 State

The Surface Mining and Reclamation Act (SMARA) of 1975 is administered by the California Department of Conservation, Office of Mine Reclamation. Under SMARA guidelines adopted by the State Mining and Geology Board, the State Geologist is required to classify specified areas into Mineral Resource Zones. Classification is the process of identifying lands containing significant mineral deposits, based solely upon geologic factors and without regard to present land use or ownership.

The State Alquist-Priolo Earthquake Fault Zoning Act (A-P Act) of 1972 was passed to mitigate the hazards associated with surface faults in California. Administered by the California State Department of Conservation, California Geological Survey, the A-P Act prevents construction of buildings used for human occupancy on active faults. Before a project can be permitted, a geologic investigation is performed to demonstrate that proposed buildings will not be constructed across active faults.

The 1990 Seismic Hazards Mapping Act and related regulations establish a statewide minimum public safety standard for mitigation of earthquake hazards. The purpose of this Act is to protect the public from the effects of strong ground shaking, liquefaction, landslides, or other ground failure as well as other hazards caused by earthquakes. The Act provides the minimum level of mitigation needed to reduce the risk of a building collapse. Under this Act, the approving agency can withhold permits until geologic investigations are conducted and mitigation measures are incorporated into building plans. In addition, the Act addresses not only seismically induced hazards but also expansive soils, settlement, and slope stability. The program and actions mandated by this Act closely resemble those of the A-P Act by requiring:

- The State Geologist to delineate various “seismic hazard zones”
- Cities, counties, and/or other local permitting authority to regulate certain development “projects” within these zones by withholding the development permits for a site until the geologic and soil conditions are investigated and appropriate mitigation measures (if required) are incorporated into development plans
- The State Mining and Geology Board to develop regulations, policies, and criteria in guiding cities and counties in their implementation of the law
- Sellers (and their agents) of real estate property within a mapped hazard zone to disclose that property lies within such a zone at the time of sale

The California Building Code (CBC) of 2010 specifies the acceptable design and construction requirements associated with various facilities or structures, and includes a series of standards that are used in project investigation, design, and construction (including grading and erosion control). The CBC specifies criteria for open excavation, seismic design, and load-bearing capacity directly related to construction in California. The CBC augments the UBC and provides information for specific changes to various sections within it. The seismic building requirements under the CBC are more stringent than the federal UBC.

The Seismic Hazards Mapping Act, PRC Section 2690–2699 identifies areas that are subject to the effects of strong ground shaking, such as liquefaction, landslides, tsunamis, and seiches.

3.1.1.3 Local

Riverside County General Plan 2000, Safety Element adopts the UBC of 1997, which provides design criteria for buildings and excavations. The UBC is superseded by the CBC of

2007. It requires mitigation measures for geologic hazards, including seismic shaking, surface rupture (adopts the A-P Act), liquefaction, unstable soils and slopes, and flooding.

3.1.2 Existing Conditions

The Project site is located in the northeast portion of the Eagle Mountains near the lower western edge of the Mojave Desert Physiographic Province of California, slightly east of the southern limits of the adjacent Transverse Ranges Physiographic Province (CGS, 2002). The Eagle Mountains are bounded on the northeast by the Coxcomb Mountains, the southeast by Chuckwalla Valley, and the north by Pinto Basin. To the south are the Orocopia Mountains (west) and the Chuckwalla Mountains (east). A broad valley containing Smoketree Wash forms the edge of the Eagle Mountains to the west. The Cottonwood Mountains are to the southwest of the Project area.

The major rock units in the region include Jurassic- to Cretaceous-age plutonic intrusive rocks and Paleozoic and Precambrian metamorphic and meta-sedimentary rocks (Jennings, 1967). At the Eagle Mountain site, the meta-sedimentary rocks generally trend northwest and are surrounded and underlain by intrusive granitic rocks. The meta-sedimentary rock units have been folded into a northwest-trending anticline, which continues into the north-central Eagle Mountains. Iron ore deposits are typically found along the northeast limb of this anticline. The iron ore deposits are comprised of magnetite and hematite with minor amounts of pyrite, which were formed by the replacement of carbonate meta-sedimentary rocks.

Localized outcrops of Tertiary-age volcanic rocks are found in the region, principally at the northern end of the Chuckwalla Valley. Younger Pleistocene-age basalt is present in the north-central portion of the Eagle Mountains. Deposits of Quaternary-age alluvium fill the Pinto Basin and Chuckwalla Valley, locally reaching depths of greater than 2,000 feet (Eagle Mountain Energy Company [EMEC], 1994). Alluvial deposits include both cobbles/gravels and finer grained units that form alluvial fans at the mouths of major drainages from the adjacent highlands.

Regional structural trends are reflected in the alignments of faults in and near the Eagle Mountain site. East-west trending faults are present at distances of approximately 5 miles, both to the north and south of the site, while northwest-trending faults are present along the eastern edge of the Eagle Mountains. The latter group of faults includes the Bald Eagle Canyon Fault Zone and several smaller faults that traverse the planned tunnel alignments. None of these faults have experienced Holocene deformation as indicated by the unbroken alluvial deposits that overlie them (EMEC, 1994).

The site is cut by a series of northeast-trending dikes. The dikes have near-vertical dips and lie at approximately right angles to the northwest-trending faults. Where exposed, dikes that cross the northwest-trending faults are not offset by the faults (EMEC, 1994). Range-front faulting has been recognized to the east of the Eagle Mountain site, along the eastern side of the Chuckwalla Valley parallel to the base of the Coxcomb Mountains. Vertical displacements along this fault zone may be up to several thousand feet, with the western side being displaced downward relative to the eastern side (EMEC, 1994). Range-front faults do not appear to be present along the eastern side of the Eagle Mountains.

3.1.2.1 Project Area Geology

Bedrock geologic units present at the site can be generally classified as either igneous or meta-sedimentary. The igneous rocks are principally comprised of Mesozoic-age quartz monzonite. The meta-sedimentary units include quartzites, meta-arkoses, and marbles formed by metamorphosis and/or hydrothermal-alteration or sandstones, conglomerates, arkoses, and carbonate rocks deposited in the Paleozoic or Precambrian age (Figure 3.1-1). In general, the younger igneous rocks intruded into the older meta-sedimentary rocks, leaving the meta-sediments as remnant roof pendants atop the plutonic rock. Areal near-surface exposures of the rock units in the Project area are shown on Figure 3.1-2.

3.1.2.2 Formational Rock Stratigraphy

3.1.2.2.1 *Meta-Sedimentary Rock Units*

The meta-sedimentary units dip to the northeast in the site area, with dips ranging from 30 to 60 degrees (EMEC, 1994). The meta-sedimentary units can be subdivided into six distinct units, which include three quartzite units, two marbles, and a schistose meta-arkose. These units, beginning with the oldest and proceeding to the youngest, are described by GeoSyntec Consultants (GeoSyntec, 1992, cited in EMEC, 1994) as follows:

Lower Quartzite: This unit consists of a vitreous white to light-gray quartzite that is very coarse-grained and massive with bedding obscured or obliterated. This quartzite is compositionally supermature, commonly consisting of 98 to 99 percent quartz. The thickness of the unit is 1,000 feet (300 m) or more.

Schistose Meta-arkose: This unit consists of a gray, medium-grained, meta-arkose with schistose structure. Iron oxide staining throughout the unit has locally produced reddish- and purplish-brown colors. The unit has high percentages of quartz, feldspar, sericite, and clay, with minor amounts of chlorite, biotite, apatite, and opaque minerals. The thickness of the unit ranges from 20 to 200 feet (6 to 60 m).

Lower Marble: This unit consists of marble that is white, very coarse-grained with ferriferous layers of hematite-dolomite. The unit thickness ranges from 20 to 200 feet (6 to 60 m). The minerals magnetite and hematite are abundant in the iron ore zone, and gangue minerals associated with the ore are mainly pyrite, actinolite, and tremolite. Other associated minerals include diopside, serpentine, calcite, gypsum, and garnet.

Middle Quartzite: This unit consists of quartzite that is green and dark gray, fine- to medium-grained, vitreous, and banded. Conglomerate containing pebbles and cobbles of quartz and quartzite occurs in layers and lenses up to 10 feet (3 m) thick that are interbedded with cross-bedded quartzite near the base of this rock unit. Hematite imparts a characteristic rusty-brown stain to weathered rock in this unit. The thickness of the unit ranges from 150 to 400 feet (45 to 120 m). Banded varieties of quartzite are also present primarily due to the presence of diopside.

Upper Marble: This unit consists of dolomite marble that is white to light-gray on fresh surfaces and grayish orange to buff on weathered surfaces. The rock is a very coarse-grained, recrystallized dolomitic marble with grains up to 1 cm across, and is thin- to thick-bedded to massive. The thickness of the unit ranges from 50 to 400 feet (15 to 120 m). An iron ore zone has formed within the unit as a function of hydrothermal replacement of host rocks. The metallic mineralization in the ore zone is magnetite and hematite. Gangue minerals associated with the ore are pyrite, actinolite, and tremolite.

Upper Quartzite: This unit consists of quartzite that is mottled gray and bluish gray, vitreous, fine-to coarse-grained, medium-bedded to massive with low-angle sets of tangential planar cross-laminations. This unit is compositionally mature, consisting of 95 percent or more quartz. The rock contains thin interbeds of meta-arkose and conglomeratic lenses comprised of pebbles and cobbles of quartzite. The thickness of the unit is several hundred feet.

3.1.2.2.2 *Igneous Rock Units*

Igneous rocks at the Eagle Mountain site include several varieties of granitic rocks including porphyritic quartz monzonite, diorite, monzonite porphyry, granodiorite, and granite (EMEC, 1994). These rock types are collectively referred to as "granitic rocks." In addition to the granitic rocks, two discrete sets of igneous dikes cut across the site. GeoSyntec (1992, cited in EMEC, 1994) described the igneous rocks units as follows:

Granitic Rocks: This generalized rock unit consist of subunits including, from youngest to oldest: (1) biotite monzonite that is coarse-grained and typically contains 25 to 35 percent quartz; (2) biotite monzonite that is coarse-grained and porphyritic with abundant quartz and alkali feldspar; (3) sphene-biotite-hornblende granodiorite that is medium-grained; (4) quartz-poor monzonite that is coarse-grained; and (5) hornblende-biotite, quartz-poor, monzonite that is coarse-grained and porphyritic. Some subunits exhibit gneissic banding.

Dikes: Two systems of dikes were mapped within the proposed Project site. One system consists of mafic dikes oriented in a general northwest-southeast direction. The other comprises light- to medium-gray andesite and andesite porphyry dikes that trend northeast-southwest. Andesite dikes in the Chuckwalla/Chocolate mountains, to the southeast of the proposed site, were dated at 25 to 29 million years (MY) old.

Age dating of the mafic dikes was completed as part of the fault investigations completed by Proctor (1993, cited in EMEC, 1994). Two samples were collected for radiometric dating. Results of these tests indicated ages of 124±3 MY and 234±6 MY (EMEC, 1994).

3.1.2.2.3 *Surficial Deposits*

Natural Alluvial Deposits. Surficial geology of the Eagle Mountain area is shown on Figure 3.1-2. Unconsolidated alluvial deposits are found in several locations within the site area. The alluvial deposits include sands, silts, gravels, and debris-flow deposits (EMEC, 1994). The most significant alluvial deposits are found on the eastern edge of the site area, where they form a laterally extensive alluvial fan that extends and thickens to the east into the Chuckwalla Valley. Some of these deposits are exposed in the east wall of the East Pit, in an area that would underlie the Lower Reservoir (EMEC, 1994). Elsewhere in the Project area, alluvial deposits are confined to laterally discontinuous, generally thin deposits along the bottoms of the canyons (EMEC, 1994).

Extensive investigations of the alluvial deposits were completed by the firm of GSi/Water (GeoSyntec, 1992, cited in EMEC, 1994). Investigations included analysis of aerial photography, surface mapping, trenching, geophysical surveys, and drilling. The following four alluvial units were identified:

<u>Unit I</u>: This unit is composed predominantly of flat elongate cobbles (85 percent), boulders (5 to 10 percent), and fines (silt and clay-size particles), sand, and gravel (±5 percent). This unit forms an extensive dark red-brown to nearly black desert pavement that is nearly devoid of vegetation.

<u>Unit II</u>: This unit is similar to Unit I, but has more fines, sand, and gravel (15 percent) with some desert pavement. This unit is reddish-brown and supports low-lying desert shrubs.

<u>Unit III</u>: This unit contains greater percentages of sand and fines than Units I or II. The clasts are typically more angular in shape. This unit has little or no desert pavement and supports moderately dense desert vegetation.

<u>Unit IV</u>: This unit is similar to Unit III, but is located in stream-bed channels and supports thicker floral growth, including shrubs and palo verde.

These units are irregularly layered on top of one another within the alluvial wedge east of the mountain front. Individual units are typically elongated in an east-west direction and reflect the location of the primary depositional channel at the time of deposition. The total thickness of the alluvial fan is on the order of a few tens of feet near the mountain front. It thickens steadily to the east, reaching a maximum thickness of more than 2,000 feet in the eastern part of the Chuckwalla Valley (EMEC, 1994).

Alluvial deposits in the western portion of the site are confined to the canyon bottoms (EMEC, 1994). These deposits are typically composed of sandy gravel, but may vary locally from sand and gravelly sand to gravel. These deposits are discontinuous and range in thickness from 0 to 50 feet. The thickest deposits are found near the mouths of canyons. Older alluvial deposits in the upper portions of the canyons may be locally cemented (EMEC, 1994).

An ancient alluvial fan is exposed near the base of the north wall in the East Pit of the Eagle Mountain Mine (EMEC, 1994). At the base of this feature, and interbedded with some of the soils characteristic of the upper portions of the fan, are a series of debris flows. In the east wall of the East Pit, debris flow deposits rest directly on bedrock (EMEC, 1994).

Mining By-Product Deposits. Mining by-products generated by the former Kaiser Mining Company operations were deposited in numerous areas near the site (Figure 3.1-3). These by-products include several distinctly different materials, including both bedrock and alluvial overburden, and tailings produced as a result of the mining and separation of iron ore bearing rock from host rock. The tailings include both fine and coarse varieties. The mining waste materials are described below:

Overburden: Overburden materials removed during mining operations were stockpiled at several locations in the site area. The largest piles of overburden are located on the eastern edge of the site, to the northeast of the East Pit, along the northern rim of the East Pit, adjacent to the former haul road about midway between the Central and East Pits, and to the southeast of the Central Pit. The total volume of overburden materials on-site is estimated to be in excess of 100 million cubic yards (EMEC, 1994). Grain-size testing on these materials indicated a locally variable mix of sands, gravels, cobbles, and boulders, with up to 26 percent silt and clay.

Fine Tailings: The hydraulically placed fine tailings were placed in six separate settling ponds to the southeast of the Central Pit. Total volume of these materials is estimated to potentially be over 19 million cubic yards (EMEC, 1994). Laboratory testing (GeoSyntec, 1992 cited in EMEC, 1994) indicated the fine tailings vary in composition, ranging from silty sand and sandy silt to clayey silt to silty clay. In general, soils with higher sand content are located near the slurry discharge point while finer grained soils are present in the distal portions of each pond. Based on available test results, the fine tailings are suitable for use as a reservoir liner or for construction of a low-permeability central core in embankments proposed for the Upper Reservoir site (EMEC, 1994).

<u>Coarse Tailings</u>: Coarse tailings were placed at several locations around the site, although the largest deposit lies immediately south of the East Pit. The total volume of coarse tailings in this stockpile is estimated to be about 50 million cubic yards (EMEC, 1994). A testing program for the coarse tailings (GeoSyntec, 1992 cited in EMEC, 1994) indicated the majority were classed as clean gravels or sandy gravels containing significant percentages of cobbles and boulders and few fines. Based on the available test data, the coarse tailings were judged to be suitable for use in embankment construction (EMEC, 1994).

3.1.2.2.4 *Geologic Structures*

Three steeply dipping, pre-Holocene faults have been mapped at the site. These faults were investigated in detail by Proctor (1993) and Shlemon (1993) and summarized for landfill siting studies by GeoSyntec (1993). The most prominent faults at the site are the Bald Eagle Canyon Fault, which trends northwest-southeast along Bald Eagle Canyon, and an unnamed parallel fault about 4,600 feet (1,400 m) to the west. The faults do not cut overlying Quaternary sediments, or, in the case of the latter fault, a cross-cutting andesite dike (EMEC, 1994).

Several bedrock joint systems have been mapped at the site (EMEC, 1994). The most prominent joint set trends northwest-southeast, parallel to the trend of the Bald Eagle Canyon Fault. A second joint set is oriented approximately perpendicular to the first, and trends northeast-southwest. Less-developed joint systems with east-west and north-south trends were also noted in the fault studies, as was a set of shallowly dipping joints of varying strike (EMEC, 1994).

3.1.2.3 Mineral Resources

3.1.2.3.1 *Ore Deposits and Mining History*

The Central Project Area, where the Project reservoirs and powerhouse will be located, occupies an ore mineral-rich zone of the Eagle Mountains. Iron is the most important ore found within both the primary minerals of this zone, which are magnetite and pyrite, and within the secondary minerals, hematite and geothite (DuBois and Brummett, 1968, cited in EMEC, 1994).

The Central Project Area occupies a portion of the inactive Eagle Mountain Mine. This mine facility began operations in 1948 to extract iron ore from these deposits. During the life of the mining operation, 940 million net tons of rock were mined from the pits. With the closure of Kaiser Steel Company’s Fontana, California steel mill, the Eagle Mountain Mine lost its principal market, forcing the mine’s closure as well (Mine Reclamation Corporation, 1997). Ore crushing and concentrating facilities were subsequently dismantled and the mining equipment sold. By 1986, most of the mine’s infrastructure had been abandoned (Kaiser and MRC, 1991, cited in EMEC, 1994). Investigations in 1990 (Kaiser, 1990, cited in EMEC, 1994) indicated that recoverable precious metals are not present in the Central Project Area.

The proposed Project would utilize two of the four inactive pits at the Eagle Mountain Mine site: the East Pit and the Central Pit. The two western-most of the four pits, the North and South Black Eagle Pits, are outside the proposed Central Project Area and would not be affected by construction and operation of the pumped storage facility, access roads, or transmission line.

Iron Ore Resources. Approximately 170 million short tons of iron ore reserves, considered economically recoverable at the time the mine was closed, remain on the entire Eagle Mountain Mine site (Mine Reclamation Corporation, 1997). Eagle Mountain iron ore reserves are magnetite mixed with pyrite, or magnetite and hematite with small amounts of pyrite. The grades of ore remaining on the site are not a salable, direct shipping ore grade, but would have to be crushed and concentrated to produce salable products (Mine Reclamation Corporation, 1997). Following suspension of mining operations, equipment and structures were removed from the mine site; consequently no means exists on-site to convert ore into a salable product (Mine Reclamation Corporation, 1997). Thus, a new concentration facility would need to be built if large-scale mining activity were to resume at Eagle Mountain (Kaiser and MRC, 1991, cited in EMEC, 1994).

The reserves located in the alluvial resource area in the East Pit are the best candidates for future iron ore mining at Eagle Mountain. Approximately 13 percent of the remaining open pit ore reserves are located in this area. These deposits contain low average iron content; the iron could be concentrated at a relatively inexpensive facility. However, iron ore mining at Eagle Mountain was completely dependent on the availability of rail transportation. The rail line has been inactive since 1986 (Mine Reclamation Corporation, 1997), and would require substantial reconstruction for reoperation.

The placer deposits are contained in a parcel in which the California State Lands Commission (CSLC) has a 100 percent reserved mineral interest (EMEC, 1994). The mineral extraction lease permit granted to Kaiser by the CSLC expired in 2002. Kaiser’s application to exchange the state’s reserved mineral interest at Eagle Mountain for a nearby mineral estate owned by Kaiser remains in abeyance (CSLC, 2007). Nonetheless, activation of placer mining would be complicated by the present lack of equipment or a mining infrastructure at Eagle Mountain (EMEC, 1994).

Rock and Aggregate Resources. There are over 165 million tons of stockpiled rock located on the portion of the Kaiser property known as the West End Property (Kaiser, 2012). The West End Property is a 927 acre parcel within the Eagle Mountain Mine site, located west, and outside of, the property that would be used for the landfill project. Much of the West End Property is also outside of the boundaries of the proposed Project. Other stockpiled rock resources are present on the eastern portion of the property.

Kaiser sells rock and aggregate from the mine site. The value of these sales has varied from year to year. However, the significant cost of shipping the rock by truck has prevented Kaiser from capitalizing on this asset (Kaiser, 2012).

3.1.2.4 Soil Resources

Soils potentially impacted by the proposed Project include those that would be affected by construction of the major Project facilities within the proposed generating facility area, those that would be traversed by the proposed Interconnection Transmission Line, and those crossed by the water supply corridor.

3.1.2.4.1 *Proposed Generating Facility Area*

Detailed soils mapping within this area had not been conducted until 1994. The soils map (Figure 3.1-3) produced by EMEC (1994) was based on soils mapping by the U.S. Soil Conservation Service (SCS) in the Desert Center area (Kim, 1993, cited in EMEC, 1994). A SCS soil survey for the Coachella Valley area (Knecht, 1980, cited in EMEC, 1994), and studies by EMEC including August 1993 field observations, interpretation of 1:24,000 scale topographic maps, and aerial photo interpretation.

The soils within the Project area have developed in a mid-latitude, low desert environment at elevations ranging from 1,000 to 2,800 feet above mean sea level (MSL). Slopes range from nearly level to extremely steep and include both north- and south-facing exposures as well as numerous intermediate aspects. Most of the Central Project Area is unvegetated as a result of past mining activities. Undisturbed areas support Sonoran Creasote Bush Scrub (Figure 3.5-1).

The referenced reports indicate the proposed generating facility area has been divided into five soil mapping units (EMEC, 1994), which are described below:

Typic Torripsamments, sandy, mixed, hyperthermic, 2 to 5 percent slopes: These soils are very deep, excessively drained, sand and loamy sand horizons formed in alluvial fan deposits at the foot of the Eagle Mountains. The water erosion hazard of these soils is moderate because of minimal vegetative protection.

Typic Torripsamments, sandy, mixed, hyperthermic, 5 to 15 percent slopes: These soils are deep, excessively drained, sand and loamy sand horizons formed in alluvium within the valley bottoms of the Eagle Mountains. The water erosion hazard of these soils is moderate because of minimal vegetative protection.

Lithic Torripsamments, sandy skeletal, mixed - Rock Outcrop complex, 15 to 75 percent slopes: In addition to rock outcrops, this complex includes shallow, excessively drained, very gravelly sand and very gravelly loamy sand. These soils have formed on mountain slopes in colluvial deposits derived from crystalline bedrock. The water erosion hazard of these soils is severe because of steep slopes and minimal vegetative protection.

Mine Dumps/Tailings: Soils in these areas consist of mixed cobbles and soil deposited by human activity. These deposits have not been stable long enough to develop characteristic soil profiles.

Mine Pits: The pit excavations are characterized by disturbed rock outcrops or a thin mantle of mixed soil, and cobbles deposited by human activities.

3.1.2.4.2 *Water Supply Corridor*

Current published regional SCS soils surveys in eastern Riverside County are limited to the Coachella Valley Area (Knecht, 1980, cited in EMEC, 1994), located tens of miles southwest of the Eagle Mountain site, and the Palo Verde Area (Elam, 1974), similar distances east of the site near Blythe. Therefore, detailed soil mapping of the water supply corridor in the western Chuckwalla Valley has not been performed. The few areas that were examined along the route by EMEC (1994) were typically characterized by irrigated agriculture. In their report, EMEC (1994) also used site-specific mapping in the Desert Center Area by Kim (1993, cited in EMEC, 1994) to provide a general picture of soils along the water pipeline corridor.

The proposed pipeline route follows a portion of Kaiser Road from the Central Project Area then enters an existing transmission line corridor as it extends into the alluvial basin of Chuckwalla Valley to the southeast (Figure 3.1-4). Soils found within the water supply corridor are typical of those developed in a mid-latitude, low desert alluvial environment with elevations ranging from 500 to 1,600 feet MSL. Kim (1993, cited in EMEC, 1994) described these soils as Carsitas gravelly loamy sand. The Carsitas series consists of excessively drained, very deep soils formed in alluvium from granitic parent material. These soils have low runoff, moderately rapid to rapid permeability. Vegetation is typically Sonoran Creosote Bush Scrub, with some Desert Dry Wash Woodland, and (currently inactive) irrigated farmland.

The proposed water supply corridor extends through a desert basin environment crossed by numerous washes (EMEC, 1994). The soils of this area are gravelly loamy sands with particle size decreasing with distance from the mountains. Kim (1993, cited in EMEC, 1994) suggests that the sandy surface horizon typically extends 5 to 6 feet in depth.

3.1.2.4.3 *Transmission Line Corridor*

The proposed transmission line corridor extends generally southward from the Central Project Area (*see* Figure 3.1-4). Beyond the southwest corner of the Eagle Mountain township, the alignment turns generally to the southeast while partially following an existing service road. After passing through the existing transmission corridor to the Metropolitan Water District of

Southern California's Eagle Mountain Pumping Plant, the proposed transmission alignment turns to the southwest to follow the service road as it rises and cuts through a narrow east-west trending granitic ridge. South of the ridgeline, the proposed alignment again veers to the south.

Continuing south, the alignment cuts across the west end of a second east-west trending rock ridge. On the south side of the ridge, the proposed transmission alignment continues on a southerly track for approximately 1 mile before turning east-southeast. From here the alignment continues to the connection with the regional grid at the northwest corner of Desert Center.

Specific areas of the transmission line corridor have not been mapped for soils type although limited soils mapping was performed by Kim (1993, cited in EMEC, 1994) in the Desert Center Area, typically east of the south end of the corridor. This information coupled with interpretations of topographic maps indicate that the soils within this area are similar to those along the water supply corridor, having developed in a mid-latitude, low desert environment at elevations ranging from 800 to 1,600 feet MSL. Slopes in the area range from nearly level to steep and include both north- and south-facing exposures as well as numerous intermediate aspects. Vegetation is Sonoran Creasote Bush Scrub and Desert Dry Wash Woodland (Figure 3.5-1).

Soils within the transmission line corridor that have developed primarily on valley fill alluvium are expected to belong to the Carsitas-Myoma-Carrizo association (EMEC, 1994). However, at the north end of the alignment, and across the two narrow bedrock ridges in the middle portion of the alignment, bedrock materials may be shallow. Because of the steeper surface gradient and shallower depth to bedrock, soil conditions in these areas may change to the Badland-Carsitas-Chuckwalla association (EMEC, 1994). General characteristics of these two soil associations are described in the following paragraphs:

> **Carsitas-Myoma-Carrizo Association:** These soils are somewhat excessively drained and excessively drained sands, fine sands, gravelly sands, cobbly sands, and stony sands. They are found on nearly level to moderately steep slopes, and have formed on alluvial fans and valley fill. These are deep soils (5 to 6 feet depth) with a moderate water erosion hazard.

> **Badland-Carsitas-Chuckwalla Association:** These soils are excessively drained fine sands, sands, gravelly sands, and cobbly sands. They are found on nearly level to steep slopes, and have formed on hill and mountainsides. These are shallow soils which are subject to severe water erosion on steeper slopes.

3.1.2.5 Earthquakes and Faults

Landfill siting studies completed by Kaiser and MRC (1991, cited in EMEC, 1994) and GeoSyntec (1996) included seismic hazard assessments to evaluate the potential for surface ground displacement from movement of active and potentially active faults, and for strong shaking from active faults, potentially active faults, and from non-specific area sources of seismicity. Active faults (Bryant, et al., 2007) are defined as faults along which seismically induced (tectonic) displacement has occurred in the past 11,000 years (the Holocene epoch). Potentially active faults are defined as faults along which tectonic displacement has occurred between 11,000 and 1.6 million years before present (the Pleistocene epoch). Inactive faults are defined as faults along which tectonic displacement has not occurred in the past 1.6 million years (since the beginning of the Quaternary period).

3.1.2.5.1 *Regional Faults*

There are numerous active and potentially active faults and fault zones located within 100 miles (161 km) of the site (Figure 3.1-5). Based on the Fault Activity Map of California (Jennings, 1994), the nearest active faults to the Eagle Mountain site are the Hot Springs Fault and the paralleling San Andreas Fault (Coachella segment), located about 30 miles (48 km) and 33 miles (53 km) southwest of the site, respectively.

The Alquist-Priolo Earthquake Zoning Act (Bryant, et al., 2007) establishes zones around "sufficiently active and well-defined" faults in California wherein site-specific fault location studies are required to mitigate fault surface rupture hazards prior to construction intended for human occupancy. The closest "zoned" faults to the Eagle Mountain site are the Hidden Springs Fault, located 29 miles (47 km) to the southwest, the aforementioned Hot Springs Fault, and the mid-east portion of the Pinto Mountain Fault, located 32.5 miles (52 km) to the northwest.

Potentially active faults from the late Quaternary are also frequently considered in a seismic hazard assessment since they can represent active faults that have a greater (more than 11,000 years) recurrence interval. In addition to the aforementioned faults, potentially active late Quaternary faults considered capable of generating significant seismic events include the Blue Cut Fault, with the nearest segment mapped about 4 miles (6 km) north of the site; the Salton Creek Fault, about 23.5 miles (38 km) to the southwest; and eastern segments of the Pinto Mountain Fault, located 30.5 miles (49 km) northwest of the site. In addition to these fault-specific sources, previous investigations of seismic exposure at the Eagle Mountain site (EMEC, 1994; GeoSyntec, 1996) considered non-specific area sources including the Southeast Transverse Ranges, the San Bernardino Mountains, the Eastern Mojave, the Sonoran, and the Salton seismo-tectonic zones. Table 3.1-1 identifies the faults and non-specific source zones considered in the previous seismic assessment by GeoSyntec. The table includes the closest distance from each source to the site, the length of each fault or area of each non-specific source zone, and the maximum event magnitude.

Table 3.1-1. Significant Seismic Sources Within 100 km of the Eagle Mountain Site

Fault or Fault Zone	Closest Distance Miles (km)	Length miles (km) or Area[1] miles² (km²)	Maximum Credible Earthquake[2] Magnitude (M max)	Recurrence Interval (years) M ≥ 4.5	Recurrence Interval (years) M ≥ (Mmax -0.50)	Maximum Credible Earthquake Peak Horizontal Acceleration[3] (g)
Blue Cut Fault	4 (6)	L – 52 (83)	7.5	39.5	12,500	0.48
Pinto Mountain Fault	28 (45)	L – 50 (80)	7.2	7.2	2,290	0.10
Southeast Transverse Ranges Zone	3 (5)[4]	A – 2,602 (6,737)	6.75	2.3	166	0.49
San Bernardino Mountains Zone	56 (90)	A – 832 (2,156)	7.0	6.2	778	0.03
Eastern Mojave Zone	7 (11)	A – 8,500 (22,008)	7.5	1.9	573	0.41
Sonoran Zone	14 (22)	A – 44,608 (115,487)	6.5	44.7	1,412	0.15
Salton Zone	34 (55)	A – 12,464 (32,269)	7.0	1.2	73.6	0.07
San Andreas Fault[5]						
- Coachella Valley Segment	33 (53)	L – 27 (69)	8.0	69.5	695	0.14
- San Bernardino Segment	40 (65)	L – 48 (125)	8.0	0.8	795	0.11

Notes: [1]L – length and A – area.
[2]Maximum Credible Earthquake (MC) is the "maximum earthquake that appears capable of occurring under the presently known tectonic framework" as defined by the California Geologic Survey. The MCE represents a seismic event more severe than the Maximum Probable Earthquake. The MCE is presented in this table as a means of indicating the relative differences in fault source characteristics.
[3]Using mean attenuation relationship of Sadigh as reported by Joyner and Boore (1988).
[4]Site is within S.E. transverse Range. Minimum site to source distance assumed to be five kilometers.
[5]Minimum magnitude equal to 6.5 for Coachella Valley Segment. Magnitude 8.0 maximum event assumes simultaneous rupture of Coachella Valley, San Bernardino, and Eastern Mojave Segments.

Source: EMEC, 1994

3.1.2.5.2 *Regional Seismicity*

The California Geological Survey provides a database of all known historical earthquakes of magnitude greater than 4.0 within the Project region for the period from 1769 to 2000 (CGS, 2001). Figure 3.1-6 is a plot of this earthquake activity in the Project region. The data shown in Figure 3.1-6 are only complete for the past 75 years, since establishment in 1932 of the Southern California Seismic Network jointly administered by the U.S. Geological Survey (USGS) and California Institute of Technology. Prior to 1932, only events large enough and close enough to be felt in populated areas were recorded. Locations of these events are inferred, based upon either observations of surface rupture or reports of observed shaking intensity.

Figure 3.1-6 shows the site on the eastern edge of a region of high historical seismicity in southern California. Most seismicity in this area is associated with the San Andreas Fault Zone (southwest and west of the site), the San Jacinto Fault Zone (south and west of the site), or the Brawley Fault Zone (south of the site). Some seismicity is associated with the Pinto Mountain Fault to the north of the site. Upon review of recorded seismicity in the region, and using the attenuation relationship developed by Sadigh as reported by Joyner and Boore, 1988, (cited in EMEC, 1994); GeoSyntec (1992 cited in EMEC, 1994) estimated that the strongest ground motion at the site from historical events was about 0.15g (1g = acceleration due to gravity), using mean attenuation rates, and 0.27g using mean plus one standard deviation.

Based on the distances to recognized regional seismic sources and a “random earthquake” of Magnitude 6.75 located 3 miles (5 km) from the Eagle Mountain site, deterministic calculations of potential ground motion at the site were performed (EMEC, 1994; GeoSyntec, 1996). The calculations, which used the attenuation relationship developed by Sadigh (Joyner and Boore, 1988, cited in EMEC, 1994), estimated the highest horizontal peak ground acceleration (PGA) of 0.49g that results from a moment magnitude (M_W) 6.75 random event in the Southeast Transverse Ranges (*see* Table 3.1-1). A similar PGA of 0.48g was estimated from a magnitude 7.5 event on the Blue Cut Fault (EMEC, 1994; GeoSyntec, 1996). Regional probabilistic studies on seismicity (Peterson et al., 2008) estimate that the site has a 2 percent probability of exceeding PGAs of between 0.35g and 0.46g in the next 50 years.

Several new peer-reviewed deterministic attenuation relationships, introduced in 1997, are in common use at this time. In addition, next generation attenuation (NGA) deterministic models were introduced in 2006-2007. The NGA relationships were extensively reviewed by regulatory agencies and the scientific community and were adopted by the USGS for use in their national ground-motion mapping (Peterson et al., 2008). However, many site investigators use the results from the 1997 relationships as a comparison to those from the NGA relationships in their estimates of seismic exposure.

For this investigation, the Applicant reviewed the fault parameters used in the previous site studies (EMEC, 1994; GeoSyntec, 1996) as presented in Table 3.1-1. Some of the information in Table 3.1-1 was updated based on more recent fault data, regulatory guidelines and professional judgment. In particular, the maximum considered earthquake for the Blue Cut Fault, which produces the highest estimated ground motions at the site, was considered overly conservative since the fault has no known Holocene movement and enechelon movement with adjacent faults was assumed in the GeoSyntec (1996) evaluations. In addition, the random event in the Southeast Transverse Ranges was reduced from M_W 6.75 to M_W 6.25 in keeping with the State Division of Safety of Dams (DSOD) guidelines (Fraser and Howard, 2002).

The revised fault information, as presented on Table 3.1-2, and newer attenuation relationships were used to update seismic exposure at the site using both the 1997 and NGA equations. The results of these analyses (Table 3.1-2) indicate that the highest seismic shaking at the site would again result from a maximum event on the Blue Cut Fault. The maximum earthquake of M_W 6.9 on the Blue Cut Fault yields a mean PGA of 0.46g with the 1997 relationships, and a mean PGA of 0.36g using the NGA equations. If the higher magnitude used by GeoSyntec (M_W 7.5) for the Blue Cut Fault is employed, the mean PGAs increase to 0.56g and 0.40g for the 1997 and NGA relationships, respectively.

The random earthquake in the Southeast Transverse Ranges also contributes a high mean PGA (0.48g) at the site with the 1997 attenuation relationships and 0.38g with the NGA formulas, but only if the GeoSyntec value of M_W 6.75 is used. Estimated potential ground motions from the random earthquake are reduced to a mean PGA of 0.15g for both the 1997 and NGA relationships when the preferred M_W 6.25 is used.

Probabilistic potential ground motions presented in Table 3.1-3 for the Eagle Mountain site are based on the California Geological Survey database (2007) and the USGS database (2002). The results indicate that for return periods of 100 and 475 years, PGAs of 0.10g and 0.19g, respectively, are estimated for the site.

Table 3.1-2. Fault Parameters and Established Ground Motions Eagle Mountain Project

FAULT PARAMETERS AND ESTIMATED GROUND MOTIONS
EAGLE MOUNTAIN PROJECT

								GEI Estimates	
FAULT	**M** **(low)**	**M** **(high)**	**M_w** **(used)**	**Type** **Length** **(km)**	**Slip** **(mm/yr)**	**Dist.** **(km)**	**GeoSyntec, 1996** **PGA[1]** **(g)** Mean	**1997** **PGA[2]** **(g)** Mean	**NGA** **PGA[3]** **(g)** Mean
Hot Springs	**--**	--	**6.6[4]**	R.L. S/S **19**	--	48.0	--	**0.07**	**0.06**
Hidden Springs	**--**	--	**6.6[4]**	uncertain **20**	--	47.0	--	**0.07**	**0.07**
Blue Cut (w/ rupture of parallel faults for GeoSyntec)	**6.8 [a]**	**6.9 [b]**	**6.90** *7.50*	L.L. S/S **30-83?** *83*	**1.0-2.5**	**6.0** *6.0*	*0.48*	**0.46** **0.56**	**0.36** **0.40**
Eastern Mojave Fault Zone[d] San Andreas Mojave segment for ECE	**7.7 [a]**	**8.3 [f]**	**7.50** *7.50*	uncertain **100-133** --	**19-25**	**11.0** *11.0*	*0.41*	**0.40** **0.40**	**0.30** **0.30**
SE Transverse Ranges (random event for GeoSyntec)	**6.0**	**6.5**	**6.25[g]** *6.75*	uncertain -- --	--	random *5.0*	*0.49*	**0.15** **0.48**	**0.15** **0.38**
San Andreas - Coachella[5] San Andreas - San Bernardino (3 segment rupture for GeoSyntec[6])	**6.8** **7.5**	**8.0** **8[e]**	**7.60** **7.70** *8.00*	R.L. S/S **600** **600** *194 + ?*	**20-30** **19-29**	**53.0** **65.0** *53.0*	*0.14*	**0.11** **0.09** **0.14**	**0.10** **0.08** **0.12**
Pinto Mountain[c]	**6.5**	**7.3[a]**	**7.00** *7.20*	L.L. S/S **73-90**	**1.0-5.0**	**45-49?** *45.0*	*0.10*	**0.09** **0.11**	**0.08** **0.09**
Salton Zone (Salton Creek Fault for GEI)	--	-- *7.4*	**6.75** *7.00*	L.L. (??) **18??**	--	**38.0** *55.0*	*0.07*	**0.10** **0.08**	**0.08** **0.06**
Sonoran Zone [random M?]	--	--	**6.50** *6.50*	-- --	--	**22.0** *22.0*	*0.15*	**0.15** **0.15**	**0.12** **0.12**
San Bernardino Mtns. Fault Zone[d]	--	--	**6.75** *7.00*	R.L. S/S **50??**	--	**90.0** *90.0*	*0.03*	**0.04** **0.04**	**0.03** **0.03**

ECE preferred estimates are in bold case ***GeoSyntec, 1996 estimates are italicized***

NOTES:

[1] PGA estimates for GeoSyntec (1996) used Sadigh 1988 equation
[2] Average of mean using Adamson and Silva (1997), Boore, et al (1997), and Sadigh, et al (1997) equations
[3] Average of mean using Campbell and Bozorgnia (2007), Chiou and Youngs (2006), and Idriss (2007) NGA equations
[4] Estimated from mapped length (Jennings, 1994) and Wells and Coppersmith (1994) length/magnitude relationship
[5] Includes Coachella and San Bernardino segments
[6] Previous magnitude .5 (GeoSyntec, 1996) assumed en-echelon rupture of the Blue Cut and all adjacent faults. This assumption may be overly conservative as the Blue Cut Fault is not documented as Holocene active.

REFERENCES:

[a] Wesnousky (1986)
[b] Anderson (1984)
[c] Petersen and Wesnousky (1994)
[d] WGCEP (1995)
[e] OSHPD (1995)
[f] Mualchin and Jones (1992)
[g] Fraser and Howard (2002)

Table 3.1-3. Probabilistic Seismic Hazard Analysis
(Based On Seismic Hazard Mapping Programs)

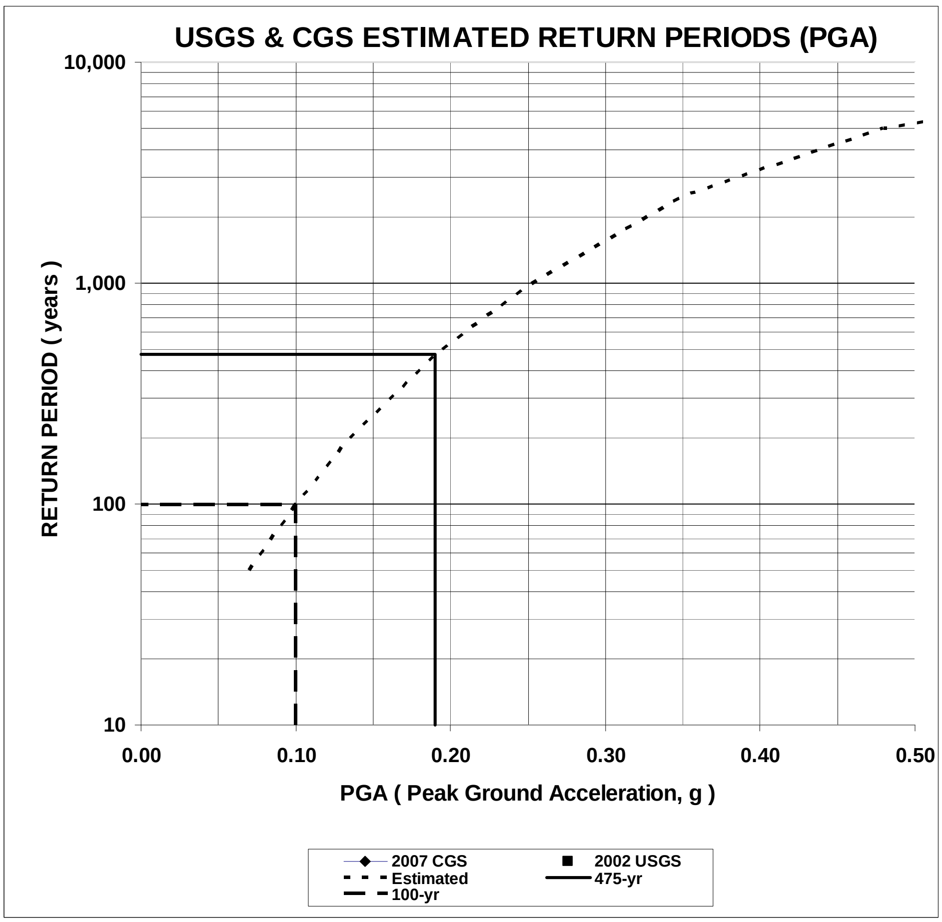
EAGLE MOUNTAIN SITE [SOFT ROCK CONDITIONS]

SITE COORDINATES	
LATITUDE:	33° 52' 12"
LONGITUDE:	115° 29' 38"

T (years)	DATABASE 2007 PGA (g)	DATABASE 2002 PGA (g)	ESTIMATED PGA (g)
50	--	--	0.07
100	--	--	0.10
200	--	--	0.14
475	**0.19**	**0.19**	0.19
975	--	--	0.25
2,475	--	**0.35**	0.35
5,000	--	--	0.48
10,000	--	--	0.75

2002: USGS database
2007: CGS - soft rock database
(both databases accessed 2008)

T = Return Period
PGA = Peak Ground Acceleration
g = acceleration due to gravity



USGS – U.S. Geological Survey
CGS – California Geological Survey

Note: Increase predictions by 30% for alluvium or soft soil site

3.1.2.5.3 *Local Faulting*

Field reconnaissance and review of remote sensing data (GeoSyntec, 1992, cited in EMEC, 1994) identified six major structural lineaments that trend across the site or are within 2,000 feet (600 m) of the proposed Eagle Mountain Landfill boundaries. Three of these were found to be bedrock faults (Fault A, Bald Eagle Canyon Fault, and East Pit Fault), two were determined to be intrusive dikes, and the last (Lineament B) resulted from differential erosion along prominent joints in the bedrock. These features were further investigated by Proctor (1993) and Shlemon (1993) to evaluate the activity or potential activity of the faults. The investigations included review of available geologic reports of the area, aerial photographs, high altitude infra-red imagery, gravimetric surveys, field mapping, trench excavating and logging, evaluation of local micro-seismicity, and soil-stratigraphic age dating.

The fault investigations indicated that the lineaments trend northwest across the site in a direction consistent with a pattern of regional faulting believed to have existed since Miocene time (approximately 5 to 22 million years ago). Analyses performed during the studies included evaluation of stereoscope air photos taken of the site during mining operations, which indicated no identifiable displacement of alluvium estimated to be at least 40,000 years old. Furthermore, evaluation of aerial photos taken prior to the start of mining operations, and field reconnaissance within the East Pit and the general site area, indicated that no displacement has occurred along faults at the site in the past 40,000 to 100,000 years.

In some areas of the site, shallow tailings or alluvial fan deposits cover the fault traces. Therefore, trenches were excavated through the overburden across Fault A and the Bald Eagle Canyon Fault. Exposures in the exploratory trenches also indicated unbroken alluvium, providing additional evidence that there had been no displacement along these faults at the site during Holocene or late Pleistocene time (GeoSyntec, 1993).

Site mapping indicated that cross-cutting dikes of volcanic rock, dated as 124 million years or more in age (GeoSyntec, 1993), are not offset by Fault A and the Bald Eagle Canyon Fault. This suggests that the most recent movement of these faults dates back to at least Mesozoic time. The relationship of the cross-cutting dikes to the East Pit Fault is less certain, but the fault is readily exposed in the walls of the East Pit beneath up to 270 feet (82 m) of unbroken alluvium, estimated to be more than 100,000 years in age (Proctor, 1993).

Additional northwest-southeast fault segments were mapped; one in the western end of the East Pit and another at western end of the proposed landfill footprint (GeoSyntec, 1993). Soil stratigraphic age dating of these features was hindered by lack of natural soil cover. However, GeoSyntec (1993, 1996) concluded that, due to the enechelon structure of the northwest-southeast system of site area faults, formation of all the northwest-trending faults at the site occurred within a similar geologic age and tectonic stress regime. Thus, these additional fault segments were also concluded to be at least pre-Holocene in age. However, if the northwest-trending faults are collectively considered to be of similar age and origin, significant displacement has not occurred on these faults since the formation of the dikes more than 100 million years ago. As such, these faults are considered inactive. Further details of the investigations for on-site faults, including information from the Proctor (1993) and Shlemon (1993) studies, are contained in GeoSyntec (1993, 1996).

3.1.3 Potential Environmental Impacts

3.1.3.1 Methodology

Preparation of this section is based on review of geologic maps, data, aerial photographs, and reports for the Project area. Extensive geologic investigations have been performed for the Eagle Mountain site. Mineralogical studies were conducted prior to and during operation of the iron ore mining activities at the site. In the early 1990s, comprehensive site investigations were performed during landfill permitting studies. The results of those investigations were summarized in the Eagle Mountain Pumped Storage Project Application for FERC License (EMEC, 1994), which was based largely on the *Report of Waste Discharge for the Eagle Mountain Landfill and Recycling Center* by GeoSyntec in 1992. Additional summary site investigations were performed by GeoSyntec in 1996.

3.1.3.2 Thresholds of Significance

The State Water Board concludes that the Project may have significant impacts on geology, soils, and mineral resource if the Project does any of the following:

(a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving: rupture of an earthquake fault, strong seismic ground shaking, seismic-related ground failure, liquefaction, or landslides

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

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

(d) Be located on expansive soils, as defined in Table 18-1-B of the UBC (1994), creating substantial risks to life or property

(e) Affect soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are unavailable for the disposal of waste water

(f) Cause inundation by seiche, tsunami, or mudflow

(g) Result in loss of available mineral resource that would be of value to the region and the residents of the state and/or

(h) Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan

Related to geologic considerations, the acid production potential of the site is addressed in Section 3.2 Surface Water, and reservoir seepage is addressed in Section 3.3 Groundwater.

3.1.3.3 Environmental Impact Assessment

3.1.3.3.1 *Earthquakes and Faults*

Studies for the landfill investigated those faults that trend towards or through the proposed landfill footprint. These include several northwest trending fault segments including the Bald Eagle Canyon Fault, the East Pit Fault, and Fault A. The East Pit Fault crosses through the East Pit, which is the proposed site for the Lower Reservoir of the proposed Project. The Bald Canyon Fault and Fault A extend through the broad area separating the proposed Upper (Central Pit) and Lower reservoirs. Reports by GeoSyntec (1996) and their consultants indicated that surface displacement has not occurred on these faults for at least 40,000 years and probably more than 100,000 years. Some of the faults were crossed by unbroken dikes estimated to be at least 100 million years old. This means that the faults are inactive as indicated by definitions as listed in Section 3.1.2.5, Earthquakes and Faults. As such, since they are not active faults, they are less susceptible to Reservoir Triggered Seismicity (RTS) (*see* Section 3.1.3.3.8).

GeoSyntec (1996) indicates that other northwest trending fault segments exist in the proposed landfill area, but activity on these was indeterminable due to lack of dateable features. However, they argue that the structure of the northwest trending faults indicates a common age and tectonic stress regime during their formation. Therefore, they conclude that the other northwest trending fault segments have the same general age as the Bald Canyon Fault, the East Pit Fault and Fault A.

Detailed mapping of the Upper Reservoir (Central Pit) (PRA Group, 1991) indicates that northwest trending fault segments, similar to those in the area of the proposed landfill, extend across the Upper Reservoir. Based on the GeoSyntec (1996) investigations for the landfill site, it could be concluded that the northwest trending fault segments crossing the Upper Reservoir have also not experienced displacement within the past 40,000 years or more. All faults in the general Eagle Mountain mining area, whether northwest trending or oriented in other directions (e.g., the Substation and Victory Pass faults), are indicated as not displaying Quaternary (last 1.6 million years) movement on the State Fault Map (Jennings, 1994).

The DSOD criterion for active faults (Fraser, 2001) is displacement within the last 35,000 years. Using this criterion, the on-site faults are considered to be inactive.

3.1.3.3.2 *Ground Subsidence*

Because of the density of the natural soil and rock formations at the reservoir sites, and the engineering characteristics of the proposed dam construction, ground subsidence is not a potential hazard associated with this Project. No abandoned or active mines in rock units susceptible to subsidence are known. Furthermore, soil deposits potentially susceptible to hydro-compaction subsidence are also not present in the immediate Project area (EMEC, 1994).

Information about subsidence risk in the Chuckwalla Groundwater Aquifer is found in Section 3.3 Groundwater.

3.1.3.3.3 *Active and Inactive Mines*

The proposed Project would utilize two of the four main mining pits at the inactive Eagle Mountain Mine site: the East Pit and the Central Pit. The two western-most of the four main pits, the North and South Black Eagle Pits, are outside the proposed Central Project Area and would not be affected by construction and operation of the pumped storage facility, access roads, or transmission line.

Two mine adits are located adjacent to the Central Project Area. There are no current plans to use or otherwise disturb these features in conjunction with the proposed construction. The adits appeared to be stable at the time of previous evaluations (EMEC, 1994), although natural minor collapses are possible in the future.

The CSLC holds a 100 percent reserved mineral interest in a 467-acre parcel of land in the Eagle Mountain Mine area (Figure 3.1-7). The CSLC had issued a lease to Kaiser in 1978 covering 145 acres of the 467-acre parcel. The lease expired in 2002. Kaiser applied to exchange the state's reserved mineral interest on the entire 467-acre parcel of school lands for a partial interest in a nearby mineral estate owned by Kaiser. This application remains in abeyance pending resolution of legal challenges to the proposed land exchange between Kaiser and the BLM (CSLC, 2007).

If the proposed Project is approved and constructed, and the CSLC retained these mineral rights, the state's ability to mine this parcel would be impeded during the life of the Project. The portion of the CSLC land that would be inaccessible would be the placer deposits at the east end of the lower (East) pit. Geosyntec (1992) estimated 21.4 million short tons ore reserve in the East Pit – Alluvial resource area. This is approximately 6.3 percent of the estimated Eagle Mountain ore reserves.

At this time, no application has been filed with the Riverside County Planning Department to re-open iron ore mining at the Eagle Mountain site. Kaiser has expressed an interest in finding a third-party that would be interested in potentially acquiring iron ore and other mineral resources present on the Kaiser property. However, Kaiser's annual report for 2011 indicates that there is no assurance that they will be able to successfully consummate an Eagle Mountain iron ore mining transaction or opportunity (Kaiser, 2012). The actual amount, type and quality of the iron ore cannot be ultimately determined without further exploratory testing and not all of the ore reserves may be economically recoverable. In addition, certain permits and consents will likely be required prior to the resumption of large-scale extractive mining (Kaiser, 2012). A substantial portion of the Eagle Mountain Mine Site is subject to the lease and option with Mine Reclamation Corporation for the proposed Landfill project. Therefore, the area that could be available for large scale iron ore mining may be limited to those areas outside of the landfill area. Therefore, no plans have been developed to re-open the mine, and the resumption of large scale iron mining is not considered to be a 'probable future project'.

The proposed Project, if approved, would restrict mining within the project boundary during the period of the license. Aggregate mining could continue in the West End property (outside of the proposed Project boundary). In addition, iron ore mining could be resumed in areas outside of the project boundary.

3.1.3.3.4 *Soil Erosion*

Soil erosion impacts could occur during development of the Upper and Lower reservoirs, access roads, power line towers, water supply corridor, and surface facilities. After licensing, ECE would prepare and implement an erosion control plan (*see* Volume V, Appendix C, Section 12.2) as part of the detailed design. The erosion control plan describes the erosion and sediment control practices planned for implementation during construction of the Project, intended to minimize the erosion of soils in construction areas and prevent the transport of sediment into stormwater discharges away from the construction site.

Three main types of areas that would require erosion and sedimentation control measures based on their similar characteristics and anticipated impacts:

- Area Type 1 – represents the area of greatest potential risk of impact. This will include cleared and graded areas for minor cuts and fills (permanent roads, power cable conduit trench, interconnection switchyard at Desert Center, and transmission tower pads) and will have permanent structures, including roads, dams, piping, and tunnels remaining on-site after construction activities are finished.
- Area Type 2 – represents medium potential risk of impacts. This will include cleared and graded areas containing temporary soil stockpiles, equipment staging/laydown areas, temporary access roads, water supply pipeline corridor, and construction trailer/field office areas
- Area Type 3 – represents the lowest potential risk of impacts. This will include areas near the Upper and Lower reservoir used for temporary stockpiling and general low impact use activities

3.1.3.3.5 *Landslides and Mass Movements*

There are areas within the Central and East Pits that have potentially unstable slopes because mining has exposed adversely oriented fracture sets on the pit walls. Consequently, slope raveling and localized, surficial slope failures and/or rock falls should be expected on these slopes.

Programs for geologic mapping and scaling to prevent loose rock are incorporated in the Project Description. During site investigations, geologic mapping will be performed to identify conditions of the overburden and bedrock exposed in the mine pits (reservoir areas) that may affect the stability of existing slopes during reservoir level fluctuations. Mapping will identify the degree and orientation of jointing and fracturing, faulting, weathering, and the dimensions of the benches excavated during mining.

3.1.3.3.6 *Liquefaction*

Liquefaction can occur when loose, saturated granular soils are subjected to vibratory motion, such as those induced by earthquakes. The vibrations cause a rise in pore water pressure, which if high enough, can cause the soil to lose strength and behave as a fluid. Liquefaction can result in settlements, lateral spreading, and other disruptions at the ground surface.

Screening criteria for determination of liquefaction hazard (Southern California Earthquake Center, 1999) indicates that liquefaction assessments are not required at sites if the substratum has any of the following characteristics:

- The estimated maximum past, current, and future ground water levels are determined to be deeper than 50 feet below the existing or proposed final site grade.
- Bedrock or other lithified formational material that is considered non-liquefiable directly underlies the site.
- The granular soils underlying the site are all determined to be dense to very dense based on corrected Standard Penetration Test blow count or corrected cone penetration test data.
- The underlying soils have a clay content (particle size <0.005 millimeters) greater than 15 percent.

In addition, Youd and Perkins (1978) indicates that Pleistocene-age alluvial fan and plain sediments, such as those that are found on the eastern edge of the East Pit and at locations farther east and to the southeast, have in general a low potential for liquefaction based on their geologic maturity, which typically is an indication of higher material density.

A review of groundwater data at the site (*see* Figure 3.3-11) indicates that natural groundwater levels are typically at depths much greater than 50 feet below the surface in the Project area. The exception appears to be near the bottom of the East Pit, where the most recent data available (CH2M Hill, 1996) indicates natural groundwater levels lie about 20 feet below the lowest portions of the East Pit. Facilities constructed near or within the planned areas of reservoir inundation (e.g., inlet/outlet structures) in the East Pit (Lower Reservoir) and Central Pit (Upper Reservoir) will be founded on bedrock materials. Other East Pit-bottom construction could include a hardscape blanket as a seepage control measure on the Pleistocene-age alluvial sediments that form the east and southeast edges of the pit. In either case, the density of the foundational material will negate (bedrock) or greatly reduce (Pleistocene alluvium) the potential for liquefaction-induced settlements.

In recognition of the potential for seepage from the reservoirs to raise local groundwater levels, systems will be established to maintain groundwater at near pre-Project levels in areas influenced by reservoir seepage, as described in Section 3.3.3.3.8, Hydrocompaction Potential. Groundwater levels will be monitored as specified in MM GW-1, MM-GW-2, and MM GW-3 to ensure groundwater remains at near pre-Project levels. This coupled with the construction of Project facilities primarily on shallow bedrock, dense Pleistocene-age sediments, or properly engineered and compacted fill, will render the potential for liquefaction-induced settlements very low- to non-existent throughout the Project.

3.1.3.3.7 *Reservoir Triggered Seismicity (RTS)*

A comparison of site characteristics with those most commonly associated with RTS indicates that the potential for RTS at the Eagle Mountain site is very low. In addition, RTS is not known to cause an increase in the maximum credible earthquake. RTS is the activation of fault movement, and hence the production of earthquakes, by the impoundment or operation of a reservoir. This phenomenon is commonly referred to in the literature as Reservoir Induced Seismicity. However, because the crustal masses experiencing this phenomenon were likely only marginally stable to begin with, most experts consider the term “triggering” as more accurately describing increases in seismicity associated with reservoir impoundment.

From a worldwide perspective, only a small percentage of reservoirs impounded by large dams have triggered known seismic activity. It is generally accepted that reservoir filling will not cause damaging earthquakes in areas where they would not otherwise occur. Accordingly, the maximum credible earthquake for an area is not changed by reservoir filling, although the frequency of earthquakes may be increased, at least temporarily (Federal Emergency Management Agency, 2005).

General theory suggests that reservoir impoundment alters the stress regime within the crust of the earth by increasing shear stress due to the weight of the water, and reducing the shear strength by increasing pore-water pressure. While these changes appear insufficient to generate failure in unfractured rock, faulted rock under significant tectonic strain may be induced to slip by the compounding effects of reservoir impoundment (USCOLD, 1997). As such, zones of active faulting appear to be the most susceptible to RTS.

The mining pits selected to contain the Upper and Lower reservoirs were formed by the excavation of vast quantities of overburden and ore rock. The depth of excavation in the pit areas is estimated to range up to 290 feet in the Upper Reservoir and up to 480 feet in the Lower Reservoir. When the reservoirs are filled to maximum operation level, the deepest column of water will be about 255 feet in the Upper Reservoir and 377 feet in the Lower Reservoir. Considering that the weight of water is about two (2) (overburden) to two and a half (2.5) (ore rock) times less than that of the excavated material, the loads applied by the reservoirs at high-water will be substantially less than that originally imposed on the pit surfaces prior to mining. As such, the reservoir load may tend to restore some of the equilibrium lost through the site excavations rather than imposing potentially destabilizing stresses that could lead to earthquakes.

Because of the depth of the pit excavations, a dam with maximum height of 120-feet will be needed to contain the maximum water depth of about 377 feet at the Upper Reservoir. With 5 feet of freeboard, the maximum water thickness added to the pre-excavation land elevation by the impoundment of the reservoir will be about 115 feet (34.5 meters). Water storage (active and inactive) for both reservoirs combined is estimated at about 24,200 acre-feet (3×10^7 cubic meters).

A statistical examination of 234 reservoirs (with and without RTS) was performed by Baecher and Keeney (1982) to better understand site characteristics that correlate with RTS and to develop a model for predicting RTS from these characteristics. In their analysis, five attributes of reservoirs appear to correlate with RTS: depth, volume, stress state, presence of active faulting, and rock type. These attributes were chosen based solely on the ready availability of data (either site specific or regional) with the recognition that other attributes such as water level fluctuation and pore pressure changes may also be important in RTS. The model criteria define the attributes of shallow and small as less than 92 meters in depth and less than 12×10^8 cubic meters volume, respectively. Using this model, the proposed Upper and Lower reservoirs would be designated as shallow (assumes only the maximum depth of water above the original ground surface) and small in volume. In their study, Baecher and Keeney (1982) indicate that shallow, small reservoirs were not pursued further in their analyses since they would have a probability of RTS of "very near zero."

As indicated on Figure 3.1-6, macro-seismicity within 12 miles of the proposed reservoirs is rare with only one M4.0 to M4.99 event recorded about 3 miles south of the proposed reservoirs, possibly on the east-west trending Substation Fault. In consideration of the size of the proposed reservoirs coupled with the apparent lack of active faults in and near the areas of impoundment and the rarity of local seismicity, the potential of RTS at the site appears remote and should not prove a hindrance to site development. Responding to the question of whether certain geologic settings are more prone to RTS than others, USCOLD (1997) states: "Studies that have examined the geologic setting of RTS have not been able to provide any clear guidance that would justify abandonment of any reservoir site because of concerns about the seismic safety of the dam."

International Commission on Large Dams (ICOLD, 2008) recommends that an earthquake monitoring program be initiated at reservoir sites prior, during and after impoundment. This long-term monitoring is important as it provides the only conclusive evidence as to whether or not storage impoundment triggers earthquakes. Based on the recommendations of ICOLD (2008), and as required by the FERC and DSOD, an earthquake monitoring program will be established in advance of impoundment, and maintained during and after impoundment in the Project area. These recommendations (LORS) ensure placement of instruments[1] to monitor ground shaking at the dams and water intakes and in the powerhouse, as well as, ensuring assignment of various instruments to measure stresses and deflections of structures. Such features are designed to not only record for seismic events but as a measurement tool for the correlation of behavior within the project structures.

[1] The project would utilize several earthquake monitoring instruments, of which would be confirmed at the final engineering phase.

Environmental Impact Assessment Summary:

(a) *Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving: rupture of an earthquake fault, strong seismic ground shaking, seismic-related ground failure, liquefaction or landslides?* No. On-site faults have been evaluated and found to be inactive. Therefore, the risk of surface rupture at the site caused by faulting is very low (GeoSyntec, 1993, 1996); therefore, the potential for impact is less than significant. Liquefaction-induced settlement risk is very low to non-existent.

(b) *Would the project result in substantial soil erosion or the loss of topsoil?* No. The impact of potential soil erosion is minimized to the extent possible by limiting surface disturbance to only those areas necessary for construction. Storm water and dust control best management practices will be employed to minimize erosion, sedimentation and fugitive dust. Where natural topsoil occurs, it would be salvaged and stockpiled prior to construction, stabilized, and used during site restoration.

(c) *Would the project be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?* No. The Project is not located on a geologic unit or soil that is unstable or would become unstable as a result of the Project.

(d) *Would the project be located on expansive soils, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?* No. The site is characterized by Jurassic- to Cretaceous-age plutonic intrusive rocks and Paleozoic and Precambrian metamorphic and meta-sedimentary rocks (Jennings, 1967). At the Eagle Mountain site, the meta-sedimentary rocks are surrounded and underlain by intrusive granitic rocks. Iron ore deposits at the site are comprised of magnetite and hematite with minor amounts of pyrite, which were formed by the replacement of carbonate meta-sedimentary rocks. The most significant alluvial deposits are found on the eastern edge of the site area, where they form a laterally extensive alluvial fan that extends and thickens to the east into the Chuckwalla Valley. However, the proposed Project would not be built on soil. The reservoirs would occupy bare-rock mine pits and the tunnel would be constructed in granitic rock. The water pipeline would be constructed on sand fields and alluvium; however, the sands and soils in these areas are not expansive.

(e) *Would the project affect soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are unavailable for the disposal of waste water?* No. The waste system will be permitted, engineered, and constructed, and will not rely upon natural soils in or around the Project site.

(f) *Would the project result in loss of available mineral resources that would be of value to the region and the residents of the state?* No. A portion of CSLC mineral reserves, constituting a small percentage of the available iron ore on the site, would be inaccessible in the east end of the lower (East) pit during the 50-year life of the Project. However, there are no confirmed plans to reinitiate iron ore mining on the site. The mine owners intend to use portions of the mine as a regional landfill. Therefore, this impact would be *less than significant.*

The proposed Project would utilize two of the four main mining pits at the inactive Eagle Mountain Mine site: the East Pit and the Central Pit. The two western-most of the four main pits, the North and South Black Eagle Pits, are outside the proposed Central Project Area and would not be affected by construction and operation of the pumped storage facility, access roads, or transmission line. Mining of rock and aggregate could continue on lands outside of the project boundary. If, in the future, iron ore mining was proposed for the site, that could be initiated on lands outside of the project boundary.

(g) *Would the project result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?* No. Please *see* Response (f) above.

Impact 3.1-1 Earthquakes and Faults. On-site faults have been evaluated and found to be not active. Therefore, the risk of surface rupture at the site caused by faulting is very low (GeoSyntec, 1993, 1996); and therefore, this would be *less than significant* and no mitigation is required.

Impact 3.1-2 Ground Subsidence. Ground subsidence is not considered to be a potential hazard associated with this Project. This impact would be *less than significant* and no mitigation is required.

Information regarding subsidence risk in the Chuckwalla, Pinto, and Orocopia Groundwater Aquifers is found in Section 3.3 Groundwater.

Impact 3.1-3 Active and Inactive Mines. There are no current permitted plans to resume iron mining at the Project site. The owners of the mine site property intend to develop the mine site as a regional landfill and have not filed an application to re-open the mine site as an iron mine, although some small scale rock quarrying is ongoing. Ore reserves within the Project boundary, including a portion of CSLC mineral reserves, which constitutes a small percentage of the available iron ore on the site, will not be accessible for the life of the Project. Iron ore and other rock resources in the mine site outside the Project boundary will remain accessible for mining. This impact would be *less than significant* and no mitigation is required.

Impact 3.1-4 Soil Erosion. There will be potential increases in soil erosion resulting from construction of this Project. This impact is *potentially significant and subject to the mitigation program* (MM GEO-1). The effects of soil erosion would be minimized to the extent possible by limiting surface disturbance to only those areas necessary for construction. Where natural topsoil occurs, it would be salvaged and stockpiled prior to construction, and the soil piles would be stabilized. Following construction, all areas where natural topsoils were removed that are not occupied by permanent Project facilities would be re-graded, have the topsoils replaced, and be seeded with native vegetation to reduce erosion potential. Additional soil stabilization best management practices (BMPs) will be undertaken for effective temporary and final soil stabilization during construction. These measures would be required by storm water regulations, which require preparation and implementation of a Storm Water Pollution Prevention Plan.

Impact 3.1-5 Landslides and Mass Movements. Slope raveling and localized, surficial slope failures and/or rock falls are expected in areas where mining has exposed adversely oriented fracture sets on the pit walls. This impact is *potentially significant and subject to the mitigation program* (PDF GEO-1 and PDF GEO-2).

Impact 3.1-6 Liquefaction. The potential for liquefaction-induced settlements is very low to non-existent. This impact is *less than significant* and no mitigation is required.

Impact 3.1-7 Reservoir Triggered Seismicity. The potential of reservoir triggered seismicity at the site is remote; therefore this impact is *less than significant* and no mitigation is required.

3.1.4 Mitigation Program

The Project's effects would be addressed through project design features (PDFs) and mitigation measures (MMs). Project design features are design elements inherent to the project that reduce or eliminate potential impacts. Mitigation measures are provided to reduce impacts from the proposed Project to below a level of significance, where applicable. As appropriate, performance standards have been built into the mitigation program.

As described under Regulatory Settings, measures required by federal, state, or local laws, ordinances, regulations, and standards are frequently required independent of the California Environmental Quality Act review, yet also serve to offset or prevent certain impacts. The proposed Project will be constructed and operated in conformance with all applicable federal, state, and local LORS.

Project Design Features

PDF GEO-1 **Subsurface Investigations.** Detailed investigations to support final engineering will be conducted in two stages, as detailed in Section 12.1. These generally include:

Phase I Site Investigations: Based on available information and the current Project configuration, conduct a limited field program designed to confirm that basic Project feature locations are appropriate and to provide basic design parameters for the final layout of the Project features. Phase I Site Investigations will be initiated after licensing and receipt of site access, at the initiation of the Project engineering design phase. Field work will be completed within six months of the start of field investigations, and results filed with the State Water Board and FERC 12 months after the start of field investigations. Phase I field work is focused on the pumped physical facilities associated with the pumped storage project to provide the owner with additional information needed to confirm feasibility and Project cost.

Phase II Site Investigations: Using the results of the Phase I work, and based on any design refinements developed during pre-design engineering, conduct additional explorations that will support final design of the Project features and bids for construction of the Project. The Phase II program will also include field investigations and modeling to support detailed evaluation of potential seepage from the Project features (reservoirs and water conveyance tunnels). Seepage evaluations will include groundwater modeling to refine plans for seepage control, seepage recovery, and monitoring as required to avoid potential adverse impacts on the local groundwater regime and water quality, the Colorado River Aqueduct and the proposed landfill if and when it is implemented. It should be noted that the Phase II program may be implemented in a number of progressive steps. Geotechnical field programs during the design stage of implementation are usually implemented in a phased or step-wise manner with subsequent field work planned based on what is learned from the preceding field work.

The scopes of the Phase I and II programs are discussed in a technical memorandum found in Section 12.1.

PDF GEO-2. Geologic Mapping. During site investigations, geologic mapping will be performed by Project Engineers to identify conditions of the overburden and bedrock exposed in the mine pits (reservoir areas) that may affect the stability of existing slopes during reservoir level fluctuations. Mapping will identify the degree and orientation of jointing and fracturing, faulting, weathering, and the dimensions of the benches excavated during mining. The apparent stability of the cut slopes and benches will be assessed at this time.

Geologic mapping will begin during the Phase I Site Investigations (*See* Section 12.1 for details) and will continue during Phase II Site Investigations (*See* Section 12.1 for details).

During construction, areas within the pits that exhibit unstable slopes because of adverse fracture sets exposed in the pit walls will be scaled of loose rock and unstable blocks. Material scaled from the side slopes will be removed and disposed of outside the pit, or pushed downslope and buried in the bottom of the pit. Rock slopes within the East and Central pits that lie below an elevation of five feet above the maximum water level will be scaled of loose and unstable rock during construction. Existing cut slopes that lie above these elevations will not be modified unless there is evidence of potential failure areas that could impact Project facilities. Final Project design will be reviewed by the State Water Board and approved by the FERC.

Mitigation Measures

MM GEO-1. Erosion Control Plan. Erosion and sediment control measures for each area type, including proposed best management practices (BMPs), are listed in the Erosion Control Plan in Section 12.2. The Applicant shall limit impacts to soil erosion through implementation of an Erosion Control Plan limiting surface disturbance to only those areas necessary for construction as required by California Code of Regulations, title 23, section 122.26. Where natural topsoil occurs, it would be salvaged and stockpiled prior to construction, and the soil piles stabilized.

Following construction, all areas where natural topsoils were removed that are not occupied by permanent Project facilities would be re-graded, have the topsoils replaced, and be seeded with native vegetation to reduce erosion potential.

Erosion control measures will be maintained throughout the life of the Project.

At minimum, the Applicant shall use and implement the following BMPs for effective temporary and final soil stabilization during construction.

Preserving existing vegetation where required and when feasible to prevent or minimize erosion.

Once existing vegetation is cleared, construction will follow immediately behind to reduce unnecessary exposure of scarified soil to wind and water.

Sloping roadways and excavations away from washes will prevent or minimize erosion into washes. Where haul roads cross surface washes, the ground will be cleared of loose soil and pre-existing sediments, as necessary.

Installation of riprap at the washes to prevent or minimize erosion.

Small earthen embankments will be built within washes in order to slow or divert surface water to reduce erosion.

Silt fences will be installed when working around a wash to prevent sediment from entering washes during a rain storm and will be constructed as described in Attachment B of Section 12.2 (e.g., buried to a depth of at least 12 inches).

The Applicant will be required to preserve and protect existing vegetation not required, or otherwise authorized, to be removed. Vegetation will be protected from damage or injury caused by construction operations, personnel, or equipment by the use of temporary fencing, protective barriers, or other similar methods.

Water will be applied to disturbed soil areas of the Project site to control wind erosion and dust. Water applications will be monitored to prevent excessive runoff.

Sediment controls, structural measures that are intended to complement and enhance the soil stabilization (erosion control) measures, will be implemented.

Sediment controls are designed to intercept and filter out soil particles detached and transported by the force of water.

Prior to construction, a Stormwater Pollution Prevention Plan (SWPPP) will be prepared detailing BMPs that will be implemented at the site. The Applicant will comply with the General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities (Construction General Permit; Order No. 2009-0009-DWQ and amendments thereto; National Discharge Elimination System No. CAS000002).

Impact 3.1-1 Earthquakes and Faults. Mitigation program not required.

Impact 3.1-2 Ground Subsidence. Mitigation program not required. Information regarding subsidence risk in the Chuckwalla, Pinto, and Orocopia Groundwater Aquifers is found in Section 3.3 Groundwater.

Impact 3.1-3 Active and Inactive Mines. Mitigation program not required.

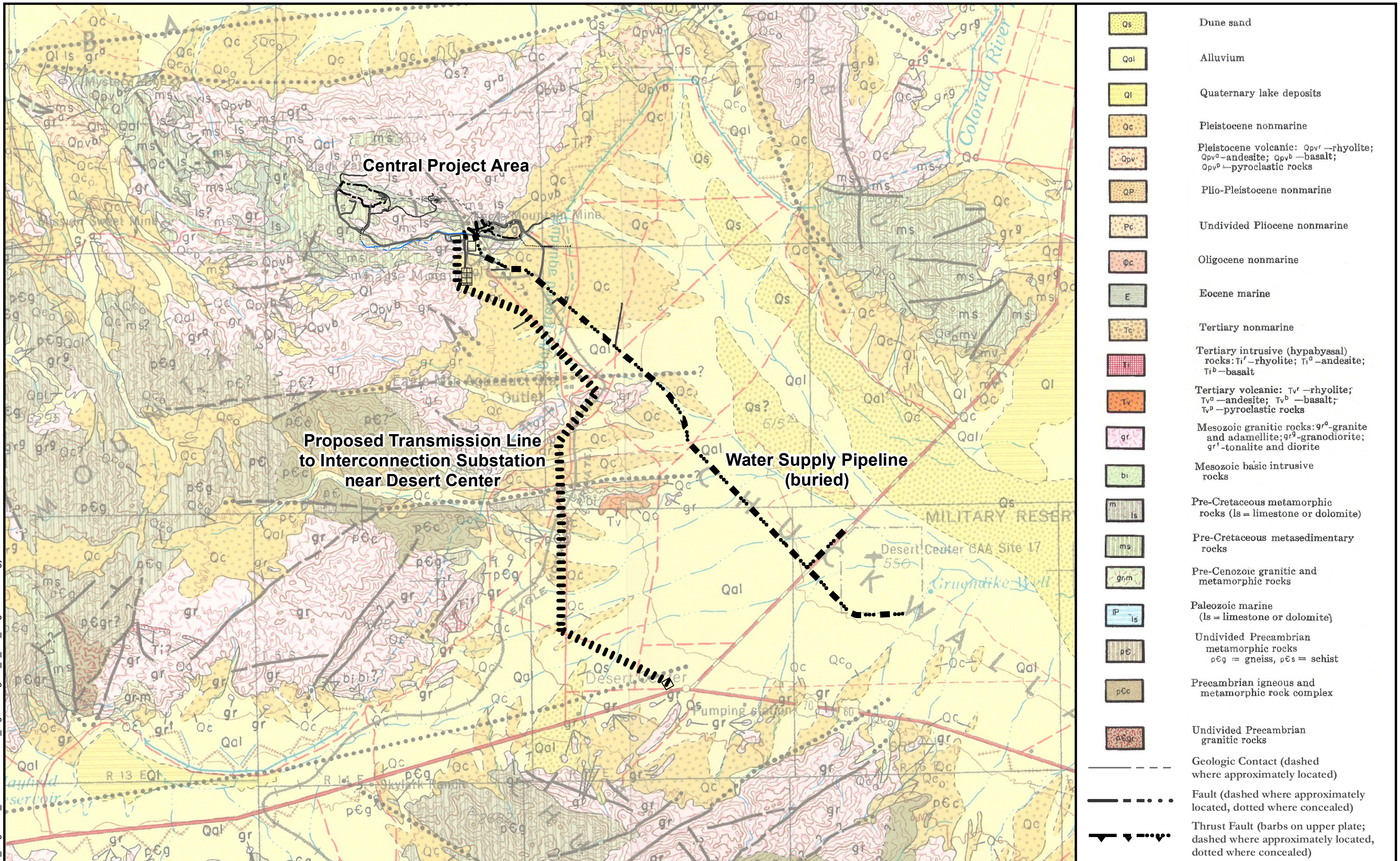
Impact 3.1-4 Soil Erosion. There will be some increases in soil erosion resulting from construction of the Project. Adherence to MM GEO-1 will reduce soil erosion impacts to a *less than significant* level.

Impact 3.1-5 Landslides and Mass Movements. Slope raveling and localized, surficial slope failures and/or rock falls are expected in areas where mining has exposed adversely oriented fracture sets on the pit walls. Adherence to PDF GEO-1 and PDF GEO-2 will reduce landslide/mass movement impacts to a *less than significant* level.

Impact 3.1-6 Liquefaction. Mitigation program not required.

Impact 3.1-7 Reservoir Triggered Seismicity. Mitigation program not required.

No residual impacts to geology and soils would occur with Project implementation.



NOTE: Map area lies within the former U.S. Army California-Arizona Maneuver Area.
SOURCE: Geology from Jennings, 1967

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Eastern Riverside County, California

REGIONAL GEOLOGY

January 2013 Figure 3.1-1

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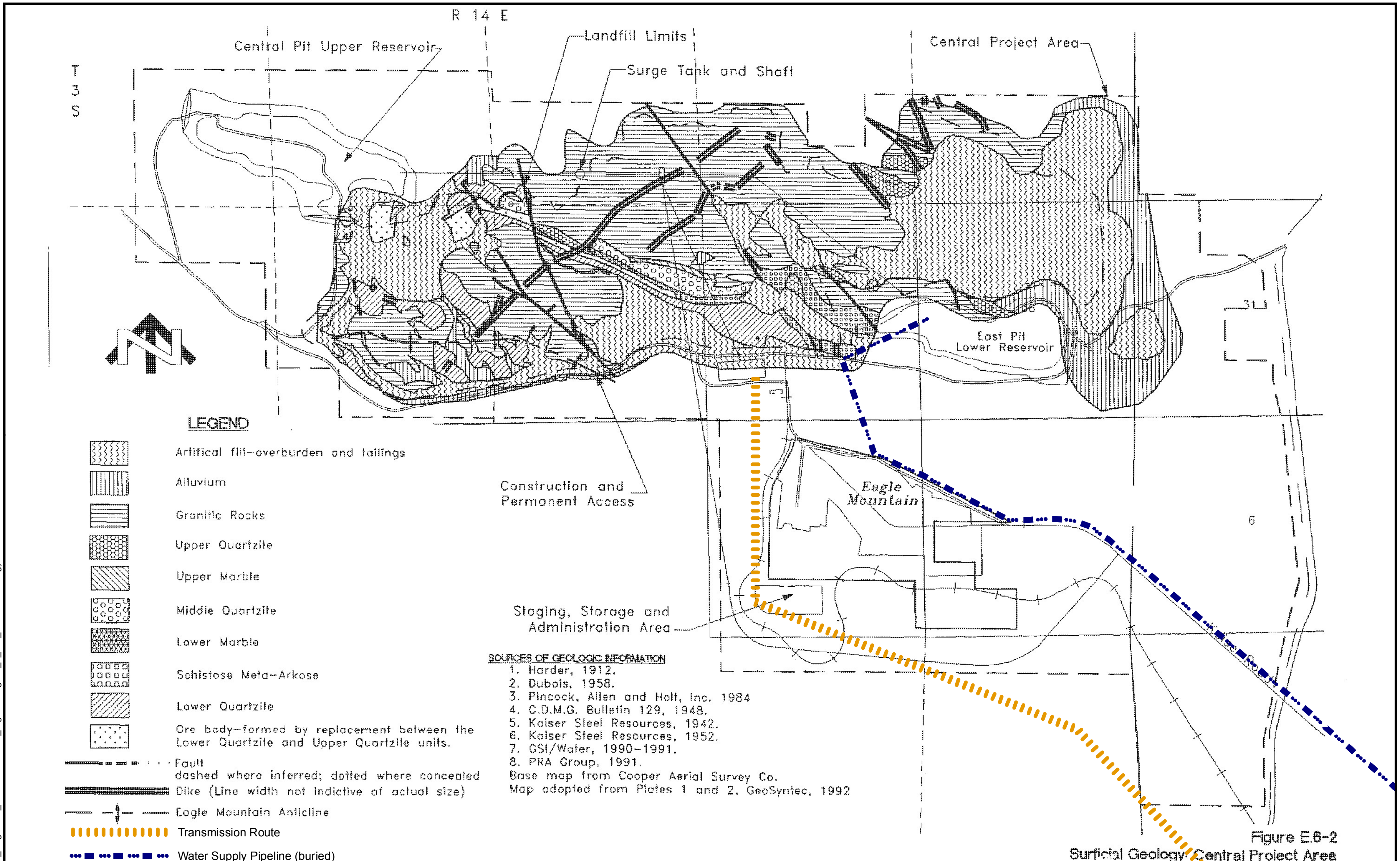

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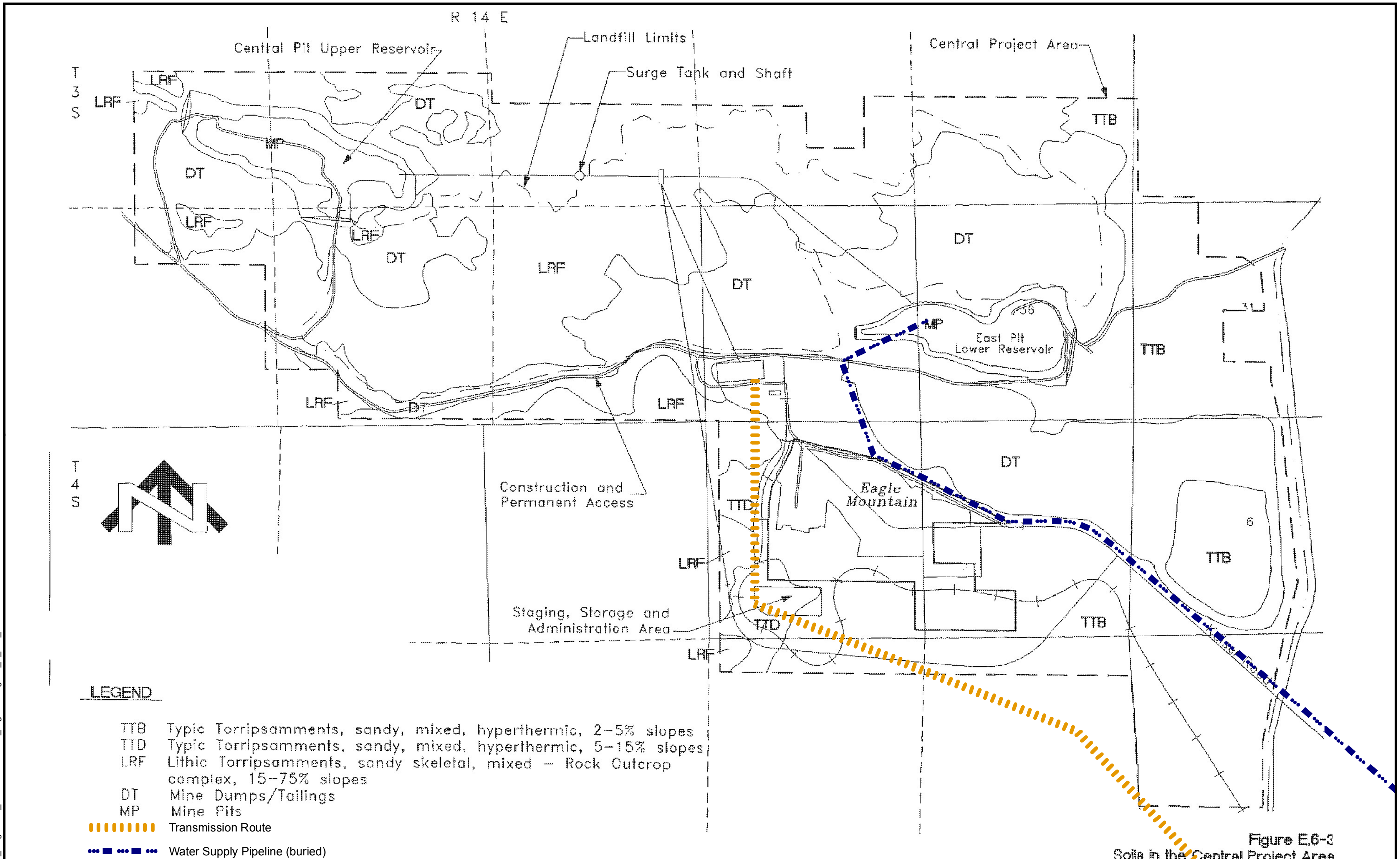
SURFICIAL GEOLOGY, CENTRAL PROJECT AREA

January 2013

Figure 3.1-2

25-Jan-2012 Z:\Projects\080472_EagleMtn_fromDenver\EIR_Figures\Figure_3_1-2_SurficialGeology.mxd SET



SOURCE: Map adapted from GeoSyntec, 1992

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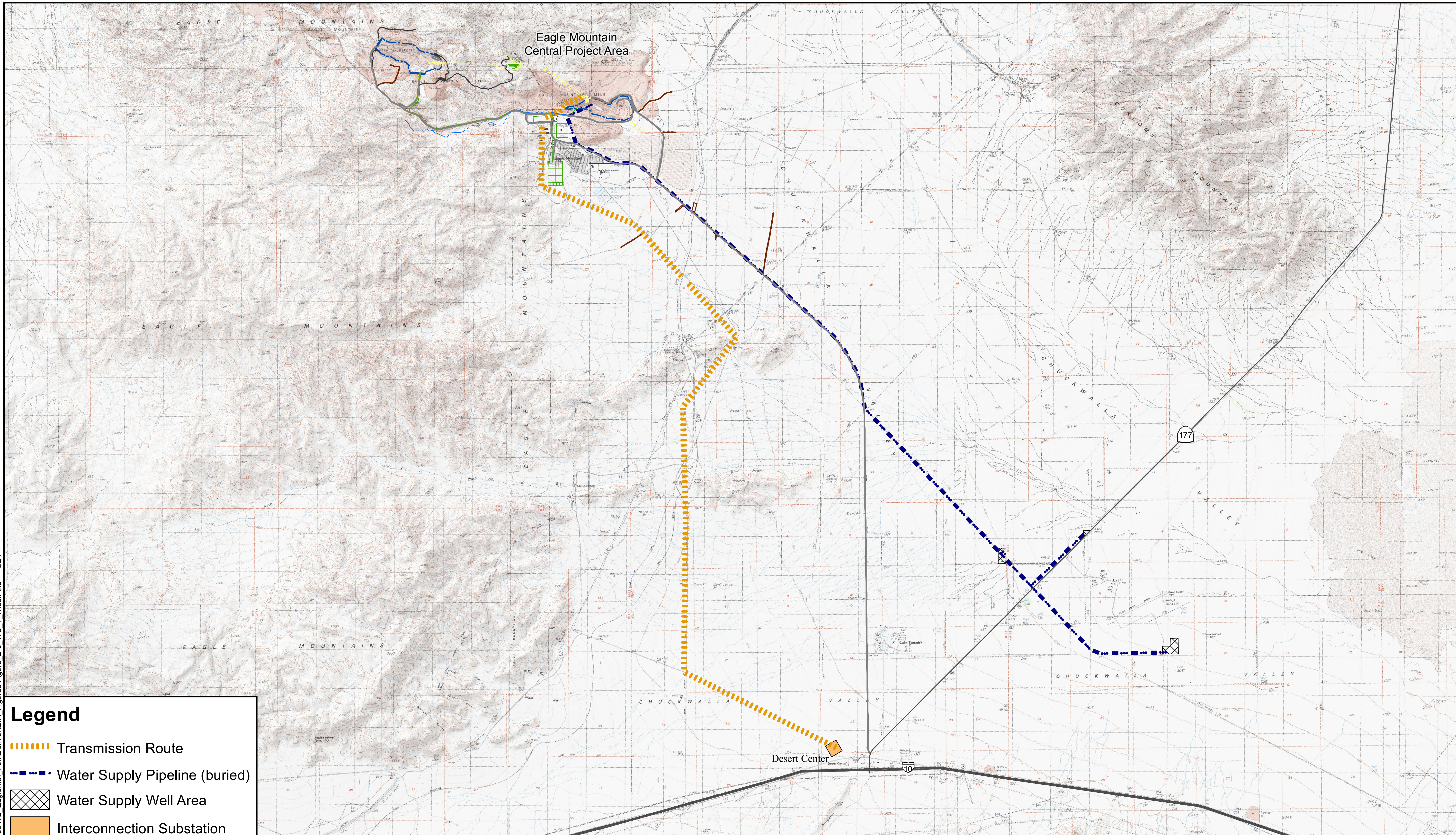
SURFICIAL SOILS
CENTRAL PROJECT AREA

January 2013 Figure 3.1-3

25-Jan-2012 Z:\Projects\080472_EagleMtn_fromDenver\EIR_Figures\Figure_3_1-3_SurficialSoils.mxd SET



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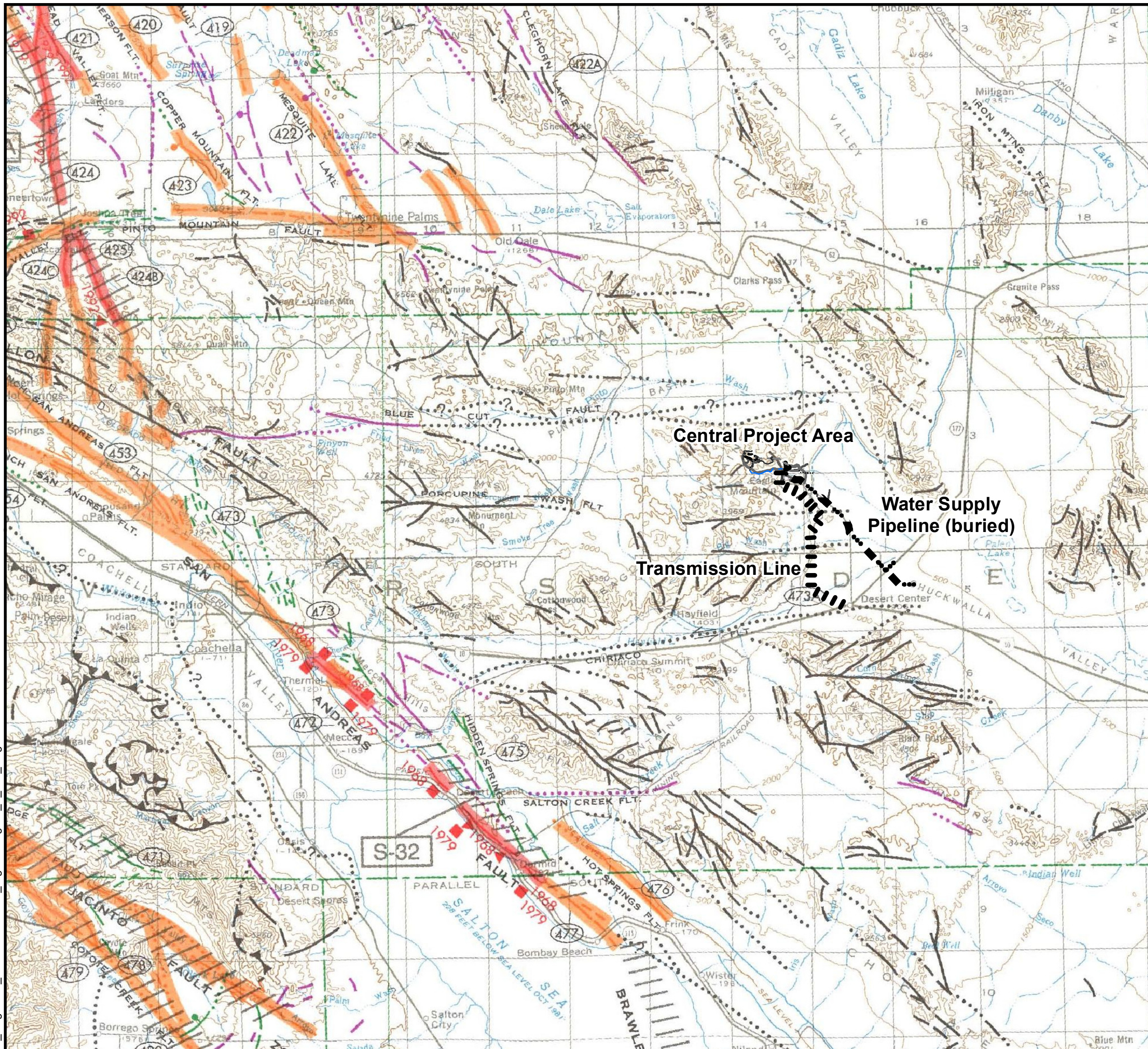
PROPOSED UTILITY SERVICE LINE ALIGNMENTS

January 2013

Figure 3.1-4

19-Jan_2012 Z:\Projects\080472_EagleMtn_fromDenver\EIR_Figures\Figure_2-3_WS_T_lines.mxd SET



Fault with Historic (last 200 years) displacement. Pink band added to emphasize location of Historic fault displacement.

Holocene fault displacement (during past 10,000 years) without historic record. Pale orange band added to emphasize location of Holocene fault displacement.

Late Quaternary fault displacement (during the past 700,000 years).

Quaternary fault (displacement within past 1.6 million years).

Pre-Quaternary fault (last displacement older than 1.6 million years) or fault without recognized Quaternary displacement.

Fault segment associated with a significant linear trend of accurately located earthquake epicenters (Magnitude 0.2 or greater).

Fault - solid where well defined; dashed where inferred; dotted where concealed; queried where uncertain. Bar and ball on downthrown side. Arrow indicates direction of dip.

Low angle fault - barbs on upper plate; dashed where inferred; dotted where concealed.

SOURCE: Faults from Jennings, 1994

0 10 20 Miles

N

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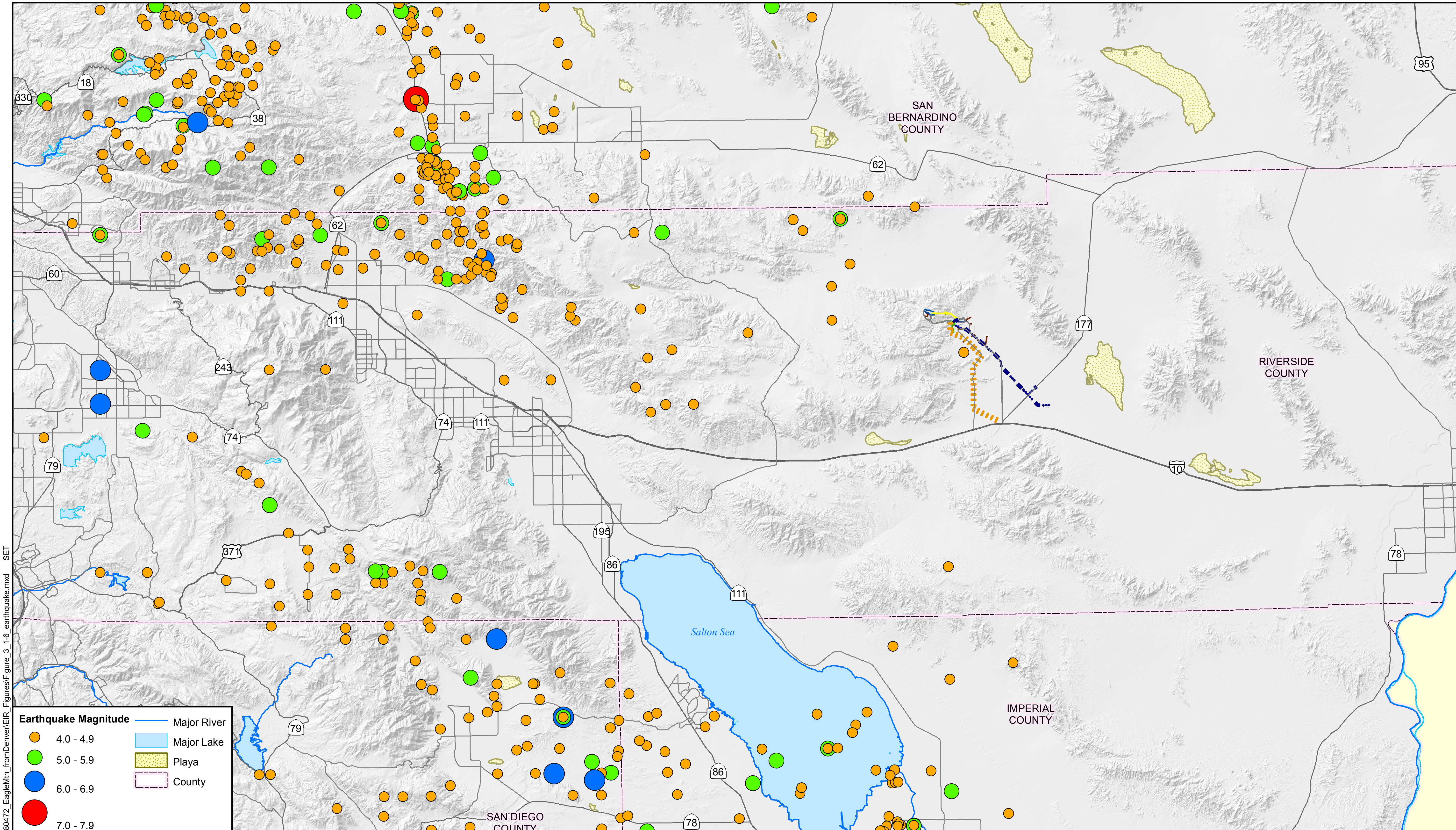
REGIONAL FAULTS

January 2013 Figure 3.1-5

25-Jan-2012 Z7\Projects\080472_EagleMtn_fromDenver\EIR_Figures\Figure_3_1-5_RegionalFaults.mxd SET



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REGIONAL EARTHQUAKES MAGNITUDE 4.0 AND LARGER

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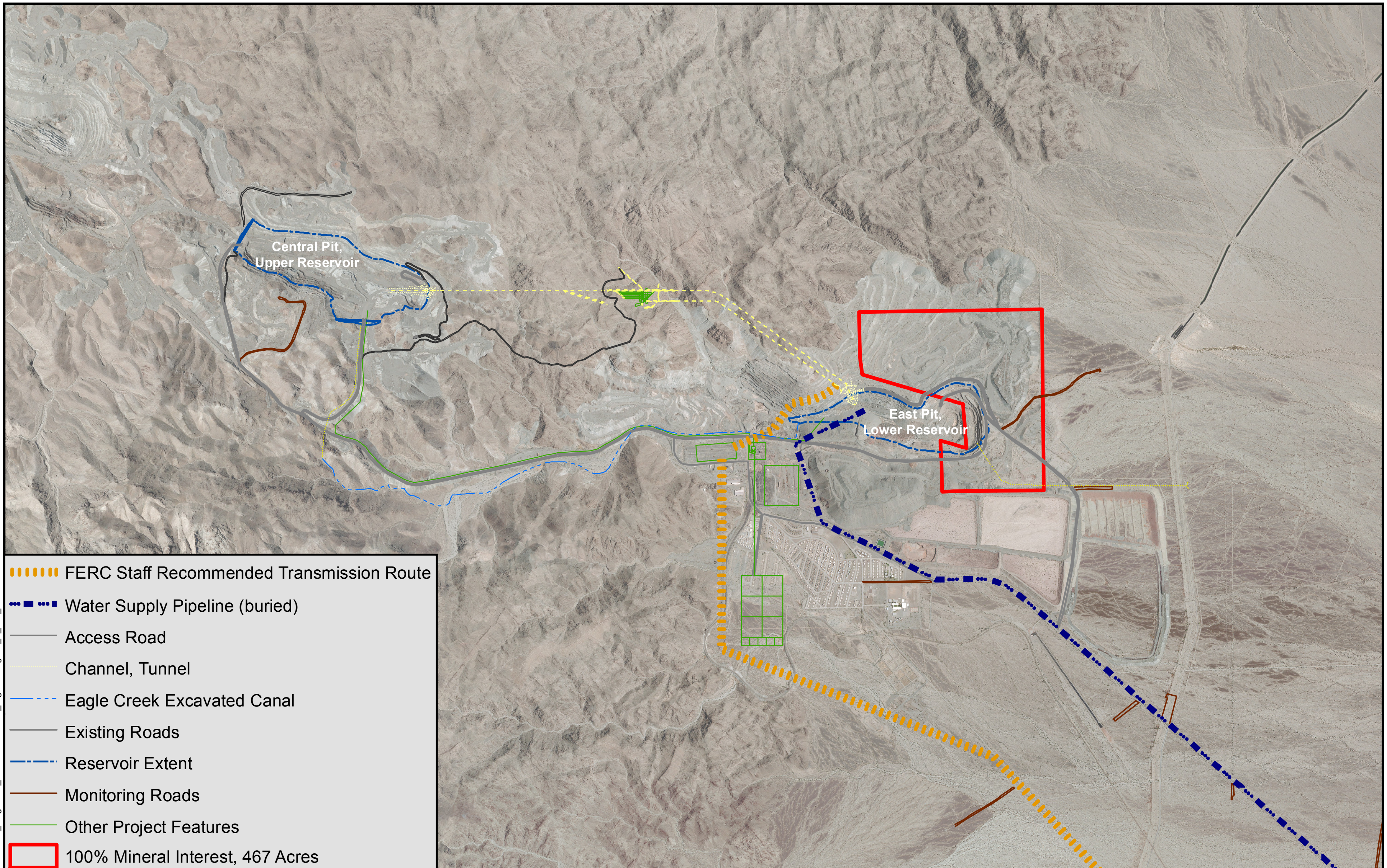
Figure 3.1-6

25-Jan-2012 Z:\Projects\080472_EagleMtn_fromDenver\EIR_Figures\Figure_3_1-6_earthquake.mxd SET



SOURCE: USDA FSA Aerial Photography Field Office:
County image mosaic for Riverside, CA (2010).

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Eastern Riverside County, California

California Water Boards
State Water Resources Control Board
Regional Water Quality Control Boards

STATE LANDS COMMISSION MINERAL INTEREST

January 2013

Figure 3.1-7