CHAPTER 15

GEOLOGIC HAZARDS AND SOILS / MINERAL RESOURCES

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This section provides an assessment of geologic features, soils, and mineral resources in the project area, which includes the PWRP facilities, the LAWA property, and the proposed agricultural and storage tank and reservoir areas.

ENVIRONMENTAL SETTING

The Initial Study Area is located within Antelope Valley at an approximate elevation of 2,400 to 2,700 feet amsl. As discussed in Chapter 2, the Antelope Valley is located in the western portion of the Mojave Desert geomorphic province, and is bounded by the San Andreas Fault and San Gabriel Mountains to the southwest, the Garlock fault and Tehachapi Mountains to the northwest, and San Bernardino to the east (see Figure 15-1). Topography of this province is controlled by the San Andreas and Garlock Fault systems and consists largely of isolated mountain ranges among desert plains.

Erosional features such as broad alluvial basins that receive non-marine sediments from the adjacent uplands dominate the Mojave Desert region. The Antelope Valley is composed of thick deposits of alluvial and lacustrine (lakebed) materials that have filled the West Antelope, East Antelope, and Kramer structural basins. These structural basins are divided by faulted bedrock that influences groundwater flow between the basins. Numerous playas or dry lakebeds within closed drainage basins are characteristic of the Mojave Desert. Throughout this province, small buttes, remnants of the ancient mountainous topography, rise above the valleys. Within the Lancaster area, Quartz Hill and the Fairmont and Antelope Buttes ascend above the valley floor to approximately 3,000 feet amsl.

The rocks of the Mojave Desert geomorphic province are some of the oldest rocks in California. Precambrian (over 570 million years old) granitic rocks and marble are well represented in the Mojave Desert. Younger strata are comprised of marine and non-marine sedimentary, volcanic, and metamorphic rocks. At the PWRP site, subsurface materials consist of Holocene-aged (less than 11,000 years old) alluvial deposits and dune sands characterized by unconsolidated sand and angular boulders, cobbles, and gravels, with silt and clay.[1]

Topography

The Initial Study Area is within the Antelope Valley which is generally flat with a very slight gradient towards the north. The Antelope Valley is part of a desert basin that is filled with alluvium sporadically interrupted by remnants of old ridges. Several of these old ridges or buttes are located just outside the Initial Study Area boundary to the southeast.

Soils

Soils within the Initial Study Area are derived from the downslope migration of loess, a wind derived deposit of fine sediments, and alluvial materials, mainly from granitic rock sources originating along the eastern slopes of the Tehachapi and San Gabriel Mountains. Soil types within the Initial Study Area as recorded by the U.S. Soil Conservation Service in 1969 are shown in Figure 15-2. Figure 15-3 shows the same information for the EMS. Appendix O provides a summary of each soil type identified in the Initial Study Area.

The soils for the bulk of the Initial Study Area consist of the Hesperia-Rosamond association. These soils are comprised of a combination of moderately permeable alluvial deposits derived from erosion of the mountains on the perimeter of the alluvial plain. The moderately permeable areas consist of sands, silty sands, and

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[1] *Ponti et al., 1981.*

gravels with modern geomorphic expression in the many alluvial fans at the edges of the basin. Hardpan, or caliche, exhibiting low permeability, is also found locally in some areas.

The Hesperia soils are typically over 60 inches thick and are well drained. They consist generally of loamy[1] fine sands, fine sandy loams, and a calcareous[2] sandy loam. The Hesperia soils make up approximately 40 percent of the soils within this association. The Rosamond association consists primarily of loamy fine sands and silty clay loams that are calcareous. They also extend to depths of over 60 inches and are moderately well drained. The Rosamond soils comprise approximately 30 percent of this association.

In general, soils within the Initial Study Area are characterized as being relatively level, well-drained, moderately to highly alkaline,[3] and contain considerable areas that are saline affected.[4] A majority of the soils in the Initial Study Area contain calcareous materials in the sub-surface horizons of the profile and consist of variably stratified loams. With the relatively dry climatic regime of the area, soils within the Initial Study Area lack substantial amounts of organic matter and are characterized by a relatively low inherent fertility. The exception to this occurs where agricultural management practices have included the incorporation of plant residues back into the soil during tilling and harvesting operations, which has, over time, increased the soil's organic matter content. As described in Appendix O, the predominant soils found in the Initial Study Area are generally suitable for agricultural production. The soils found within the EMS are similar to those within the agricultural study areas.

Seismicity

The Los Angeles area contains both active and potentially active faults and is considered a region of high seismic activity.[5] The 1997 Uniform Building Code locates the entire Los Angeles and Palmdale area within Seismic Risk Zone 4. Areas within Zone 4 are expected to experience maximum magnitudes and damage in the event of an earthquake.[6] In the past 100 years, several earthquakes of magnitude 5.0 or larger have been reported on the active San Andreas, Garlock, and San Fernando fault systems. In Southern California, the last earthquake exceeding Richter magnitude 8.0 occurred in 1857. Much more frequent are smaller tremors such as the moderate 1992 Landers earthquake (Richter magnitude 7.0), and 1971 San Fernando and 1994 Northridge earthquakes (Richter magnitude 6.7). These earthquakes caused extensive damage throughout Southern California.

Regional Faults

The San Andreas Fault is a strike-slip-type fault[7] traversing Los Angeles County that has experienced

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1 *Loam – The textural-class name for soil having a moderate amount of sand, silt, and clay. Loam soils contain 7-27 percent clay, 28-50 percent silt, and 23-52 percent sand (Brady, N. C. and Weil, R. R., 1996).*

2 *Calcareous – Soils containing sufficient calcium carbonate (often with magnesium carbonate) that effervesce visibly when treated with cold 0.1 N hydrochloric acid (Brady, N. C. and Weil, R. R., 1996).*

3 *Alkaline – Any soil that has a pH of greater than 7 (Brady, N. C. and Weil, R. R., 1996).*

4 *NRCS, 1970.*

5 *An active fault is defined by the state of California as a fault that has had surface displacement within Holocene time (approximately the last 10,000 years). A potentially active fault is defined as a fault that has shown evidence of surface displacement during the Quaternary (last 1.6 million years), unless direct geologic evidence demonstrates inactivity for all of the Holocene or longer. This definition does not, of course, mean that faults lacking evidence of surface displacement are necessarily inactive. Sufficiently active is also used to describe a fault if there is some evidence that Holocene displacement occurred on one or more of its segments or branches (Hart, 1997).*

6 *Lindenburg, 1998.*

7 *"Strike-slip" faults primarily exhibit displacement in a horizontal direction, but may have a vertical component. Right-lateral strike slip movement of the San Andreas Fault, for example, means that the western portion of the fault is*

movement within the last 150 years. The San Andreas fault is a major structural feature in the region, forming a boundary between the North American and Pacific tectonic plates. Near Palmdale, the San Gabriel Mountains roughly denote the path of the San Andreas Fault. Associated with the San Andreas Fault system, there are several splays in the area of Palmdale that could experience movement including the Cemetery Fault, the Nadeau Fault, and the Littlerock Fault.[9] Other principal faults capable of producing significant ground shaking in the Palmdale area are listed in Table 2-3 of this document and include the Garlock Fault, White Wolf Fault, and Sierra Madre (San Fernando) Fault as shown on Figure 15-1. Major seismic events on any of these active faults could cause significant ground shaking and surface fault rupture.

Seismic Hazards

Surface Fault Rupture

Seismically-induced ground rupture is defined as the physical displacement of surface deposits in response to an earthquake's seismic waves. The magnitude, sense, and nature of fault rupture can vary for different faults or even along different segments of the same fault. Ground rupture is considered more likely along active faults. No special hazard zones delineated by the 1972 Alquist-Priolo Special Studies Zone Act are located within the Initial Study Area. Since no mapped active or potentially active faults are known to pass through the project area, the potential risk from fault rupture is considered very low and not discussed further in this document.

Ground Shaking

Areas most susceptible to intense ground shaking are those located closest to the earthquake-generating fault, and areas underlain by thick, loosely unconsolidated and saturated sediments. Ground movement during an earthquake can vary depending on the overall magnitude, distance to the fault, focus of earthquake energy, and type of geologic material.

While magnitude is a measure of the energy released in an earthquake, intensity is a measure of the ground shaking effects at a particular location. Areas underlain by bedrock typically experience less severe ground shaking than those underlain by loose, unconsolidated materials. The Modified Mercalli Intensity (MMI) scale (Table 15-1) is commonly used to measure earthquake effects due to ground shaking. The MMI values range from I (earthquake not felt) to XII (damage nearly total), and intensities ranging from IV to X could cause moderate to significant structural damage.

The unconsolidated nature of underlying soils in portions of the project area, although located relatively distant from faults, can intensify ground shaking. Peak ground acceleration at the site is anticipated to be approximately equivalent to MMI VII to IX (strong to very strong) ground shaking. Ground shaking of this range of intensity would likely cause some degree of damage to project facilities; however, well-designed structures are not anticipated to experience serious damage or collapse.

Liquefaction

Liquefaction is a phenomenon whereby unconsolidated and/or near saturated soils lose cohesion and are converted to a fluid state as a result of severe vibratory motion. The relatively rapid loss of soil shear strength during strong earthquake shaking results in the temporary fluid-like behavior of the soil. Soil liquefaction causes ground failure that can damage roads, pipelines, buildings with shallow foundations, and levees. Liquefaction can occur in areas characterized by water-saturated, cohesionless, granular materials at depths less than 40 feet. Saturated unconsolidated alluvium with earthquake intensities greater than VII on the MMI Scale may be susceptible

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9 *City of Palmdale General Plan, January 1993.*

Table 15-1
Modified Mercalli Intensity Scale

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

Source: Bolt, Bruce A., Earthquakes, W. H. Freeman and Company, New York, 1988.

to liquefaction. This would include areas with shallow perched groundwater. Areas around both the Little Rock and Big Rock floodplains have been mapped as zones requiring investigation for liquefaction potential.

These areas reportedly have or can contain shallow groundwater tables in the range of 0 to 40 feet bgs.[10] The vast majority of the Initial Study Area is outside the liquefaction seismic hazard zone. Figure 15-4 shows liquefaction hazard zones with the vicinity of the PWRP.

Landslide Hazards

A landslide is a mass of rock, soil, and debris displaced down-slope by sliding, flowing, or falling. The susceptibility of land (slope) failure is dependent on the slope and geology as well as the amount of rainfall, excavation, or seismic activities. Factors that decrease resistance to movement in a slope include pore water pressure, material changes, and structure. Removing the lower portion (the toe) of a slope decreases or eliminates the support that opposes lateral motion in a slope. Shaking during an earthquake may lead materials in a slope to lose cohesion and collapse. Due to the relatively level topography within the Initial Study Area, the potential for land sliding is less than significant and is not discussed further.

Non-Seismic Geologic Hazards

Soil Salinity

Salinization is the process by which water-soluble salts accumulate in the soil. Salinization is a resource concern because excess salts hinder plant growth by causing nutrient imbalances and limiting a plant's ability to extract water from the soil. Salinization may occur from mineral weathering, fertilizers, soil amendments, and irrigation waters that are high in dissolved salts. Soil salinity is typically estimated by measuring the electrical conductivity (EC), in units of millimhos per centimeter (mmhos/cm), of solution extracted from water-saturated soil. EC increases in a solution in direct proportion to the total concentration of dissolved salts.

Salts often accumulate in the soils of arid or semi-arid regions because there is not enough rainfall to dissolve them and leach them down past the root zone. Leaching can be inhibited in soils with a high clay content or high water table. In semiarid areas, salinization often occurs on the rims of depressions and edges of drainageways, at the base of hillslopes, and in flat, low-lying areas surrounding sloughs or shallow bodies of water. These areas may receive additional water from below the surface. When the waters evaporate, the salts are left behind near or at the soil surface. Portions of the Initial Study Area are prone to naturally occurring salinization.

Any process that affects the soil-water balance may affect the movement and accumulation of salts in the soil, including climate, subsurface hydrogeology, irrigation practices, drainage, plant cover, rooting characteristics, and farming practices. For salinization to occur, the following conditions need to occur together: the presence of soluble salts (sodium, calcium, magnesium, etc.), a high water table, a high rate of evaporation, and low annual rainfall.

Erosion

Erosion is the detachment and movement of soil materials through natural processes or human activities. The detachment of soil particles can be initiated through the suspension of material by wind or water. Silt-sized particles are the most easily removed particles, due to their size and low cohesiveness. Soils residing within the Initial Study Area are susceptible to wind erosion, especially during the spring and fall months when wind speeds increase. Sporadic, torrential rains can cause major flash flood events that create significant erosion in the Mojave Desert region. In general, the Initial

[10] *California Geological Survey, Seismic Hazard Mapping, 2005.*

Study Area contains soils with a moderate to slight potential for erosion.[11]

Expansive Soils

Expansive soils possess a shrink-swell characteristic[12] that can result in structural damage over a long period of time. Expansive soils are largely comprised of silicate clays, which expand in volume when water is absorbed and shrink when dried. Highly expansive soils can cause damage to foundations and roads. In general, the soils within the Initial Study Area have a low potential for expansion and therefore present a less than significant potential impact and are not discussed further.

Settlement

Settlement of loose, unconsolidated soils generally occurs slowly, but can cause significant structural damage such as cracked foundations or misaligned or cracked walls and windows.

Land Subsidence and Fissures

Land subsidence can occur as a result of groundwater extraction. Underlying soils can compact when water is removed. The extraction of mineral or oil resources can also result in subsidence. Substantial subsidence caused by groundwater extraction has taken place in the Palmdale area since the early 1900s. Development in the area is largely dependent upon groundwater supplies.[13] Groundwater levels declined as much as 80 feet between 1952 and 1980.[14] As a result, between 1930 and 1992, more than 6.0 feet of subsidence is estimated to have occurred in the nearby Lancaster area.[15] However, subsidence rates have not occurred uniformly throughout the Antelope Valley and Palmdale area, but are dependent upon underlying materials, the rate of water-level decline, and well locations.[16] Multiple fissures have formed within the region as a result of the lowered water table. In addition to causing structural problems, fissures can create a vertical conduit for surface contaminants to migrate to underlying groundwater, potentially degrading groundwater quality.[17]

Hydrocompaction

Hydrocompaction occurs when collapsible soils, low density fine grained soils with small pores and voids, are subjected to an increased moisture content. The moisture alters the cementation structure of the normally arid soils. The rearrangement of the soil structure causes collapse and differential settlement to occur under relatively light loading. Collapsible soils are present in the project area but have not been mapped to show the exact locations.

Mineral Resources

The California Geological Survey (CGS) classifies the regional significance of mineral resources in accordance with the California Surface Mining and Reclamation Act of 1975 (SMARA). MRZs have been designated to indicate the significance of mineral deposits. The MRZ categories are as follows:

> <u>MRZ-1:</u> Areas where adequate information indicates that no significant mineral deposits are present or where it is judged that little likelihood exists for their presence.
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> <u>MRZ-2:</u> Areas where adequate information indicates significant mineral deposits are present, or where it is judged that a high likelihood exists for their presence.

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[11] *City of Palmdale, General Plan, January 1993.*

[12] *"Shrink-swell" is the cyclical expansion and contraction that occurs in fine-grained clay sediments from wetting and drying. Structures located on soils with this characteristic may be damaged over a long period of time, usually as the result of inadequate foundation engineering.*

[13] *Londquist, 1994.*

[14] *City of Palmdale, General Plan, January 1993.*

[15] *Ikehara, 1997.*

[16] *Ibid.*

[17] *Blodgett, 1994.*

> <u>MRZ-3:</u> Areas containing mineral deposits the significance of which cannot be evaluated from available data.
>
> <u>MRZ-4:</u> Areas where available information is inadequate for assignment to any other MRZ.

The Palmdale area contains two MRZs that have been classified as MRZ-2 areas. These two areas are associated with the Little Rock Wash and the Big Rock Wash along with their respective stream beds, alluvial fans, and floodplains.[18] Sand and gravel are the primary resources that are mined in these areas for the purpose of aggregate use in construction activities. CGS has designated Little Rock Wash as Sector D and Big Rock Wash as Sector E. Each sector has been further subdivided to show areas that have been converted to urbanized areas, areas controlled by aggregate producers, areas planned for further urbanization, and unplanned areas. Sector D is estimated to contain 350 million tons of aggregate resources and Sector E 1,155 million tons. It is estimated that the 50-year demand for aggregate resources will be 172 million tons.[19]

The MRZ-2 zone associated with the Little Rock Wash appears to overlap slightly with the Initial Study Area whereas the Big Rock Wash MRZ-2 lies just south of the Initial Study Area as shown in Figure 15-5. The remainder of the Initial Study Area has been classified as an MR-3 zone. The proposed locations for the storage reservoirs are located outside of the MRZ-2 zones and will not infringe upon the access to these zones. Therefore, the potential impact to these resources is not significant and not discussed further in this document.

REGULATORY BACKGROUND

Alquist-Priolo Earthquake Fault Zoning Act

The 1972 Alquist-Priolo Earthquake Fault Zoning Act (Alquist-Priolo Act) provided for the delineation of rupture zones along active faults in California. The purpose of the Alquist-Priolo Act is to regulate development on or near fault traces to reduce the hazard of fault rupture and to prohibit the location of most structures for human occupancy across these traces. Cities and counties must regulate certain development projects within the zones, which include withholding permits until geologic investigations demonstrate that development sites are not threatened by future surface displacement.[20] Surface fault rupture is not necessarily restricted to the areas designated as Alquist-Priolo zones.

Seismic Hazards Mapping Act

The California Seismic Hazards Mapping Act, which became law in 1991, was developed to protect the public from the effects of strong groundshaking, liquefaction, landslides, or other ground failure, and from other hazards caused by earthquakes. This act requires the state geologist to delineate various seismic hazard zones and requires cities, counties, and other local permitting agencies to regulate certain development projects within these zones. Before a development permit is granted for a site within a seismic hazard zone, a geotechnical investigation of the site must be conducted and appropriate mitigation measures incorporated into the project design. The CGS (formerly the California Division of Mines and Geology) has released Seismic Hazards Maps for the Palmdale area shown in Figure 15-4.

California Building Code

The California Building Code is another name for the California Building Standards Code.[21] CCR Title 24

[18] *California Division of Mines and Geology, Update of Mineral Land Classification of Portland Cement, 1994.*

[19] *Kohler, Susan L., Aggregate Availability in California, California Geological Survey, July 2002.*

[20] *Hart, 1997.*

[21] *CBSC, 1995.*

is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating all building standards.[22] The California Building Code incorporates by reference the Uniform Building Code with necessary California amendments. The Uniform Building Code is a widely adopted model building code in the United States published by the International Conference of Building Officials. About one-third of the text within the California Building Code has been tailored for California earthquake conditions.[23]

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Thresholds of Significance

A geologic, soils, or mineral resource impact would be considered significant if it would result in any of the following, which are adapted from the CEQA Guidelines, Appendix G.

- Exposure of people or structures to adverse effects including loss, injury, or death from geologic hazards, soils and/or seismic conditions that could not be overcome by special design using reasonable construction and/or maintenance practices.
- Construction on substrate that consists of material subject to liquefaction in the event of ground shaking.
- Construction on or near steep slopes that could be damaged as a result of slope failure or landslides.
- Deformed foundations from exposure to expansive soils (those characterized by shrink-swell potential).
- Construction located on unstable soil that would potentially result in lateral spreading, subsidence, or collapse.
- Result in the loss of availability to a known mineral resource that would be of value to the region.
- Result in the loss of availability to a locally important mineral resource recovery site.

Impact 15-1: The project would increase the potential for soil erosion caused by construction of treatment and storage facilities as well as from agricultural operations.

Land clearing, grading, and temporary stockpiling of site soils would be required for construction of treatment and storage facilities, which could leave exposed soils susceptible to wind and water-induced erosion. During storm events, storm water runoff could erode soils in construction areas. Gusting winds, particularly in the late summer and fall months, could erode exposed topsoils. Once the storage reservoirs are in place, the exposed edges of the soil berms would be susceptible to wind and storm water erosion. Prior to construction of treatment and storage facilities, and prior to conversion of any additional agricultural lands, District No. 20 will prepare a SWPPP to obtain coverage under the state-wide general construction storm water NPDES permit. Implementation of BMPs outlined in the SWPPP for construction activities would ensure that construction does not adversely affect surface soils. Erosional impacts would be considered less than significant with incorporation of best management practices included in the SWPPP which shall become part of the project.

Agricultural operations could increase soil erosion due to wind and storm water-induced erosion of newly plowed agricultural areas. Gusting winds, particularly in the spring, late summer, and fall months, could erode exposed topsoils. This impact

[22] *Bolt, 1988.*
[23] *ICBO, 1997.*

would be increased during tilling operations. Implementation of erosion control measures in the FMP would minimize the potential adverse effect.

Mitigation Measure

Mitigation Measure 15-1: District No. 20 shall include agricultural BMPs for erosion control within the updated FMP. Measures could include but not be limited to preventing runoff from agricultural areas, minimizing tilling operations during high wind periods, maintaining moist soil conditions, maintaining crop ground cover as much as possible, and planting wind breaks to minimize wind erosion.

Significance After Mitigation

Less than significant.

Impact 15-2: Potential seismic groundshaking, subsidence, and expansive soils could cause structural damage to the storage tank, storage reservoirs, treatment facilities, and pipelines.

The intensity of the ground shaking at the PWRP and associated facilities would depend on the causative fault and the distance to the epicenter, the moment magnitude, and the duration of shaking. The probabilistic seismic hazard assessment estimates maximum shaking intensity could produce very strong (MMI IX) ground accelerations. In such an event, seismic ground shaking would be expected to damage project facilities and destabilize levee slopes not adequately designed to withstand seismic hazards. Potential structural damage to reservoir berms could cause uncontrolled release of impounded water and localized flooding. Any reservoir constructed with either a berm more than 25 feet in height or containing an impoundment capacity of more than 50 acre-feet would fall under the jurisdiction of the California Division of Safety of Dams. Under their jurisdiction, the construction of the dams could not commence until authorized in writing.

Subsidence rates in the Palmdale area are irregular, although generally associated with groundwater extraction. Most ground settlement in the region has occurred west of the Initial Study Area along SR-14 from the City of Palmdale up through Lancaster and into EAFB.[24] Surface ground fissures have been observed in the City of Lancaster and at EAFB. Subsidence could damage building foundations, structures, and storage reservoir levees.

Expansive soils can increase in volume when their moisture content becomes elevated. Moisture control on these types of soils is essential for reducing the potential for swelling. The natural moisture content at any of the construction locations could increase as a result of the proposed program for several reasons: (1) the removal of any pre-existing vegetation will decrease local transpiration rates and increase the moisture content of the soil, and (2) natural moisture evaporation would be prevented by the construction of concrete structures or storage reservoirs. If soil expansion were to occur along one of the levee systems, structural damage could occur. To alleviate this potential impact the following mitigation measure would be implemented.

Mitigation Measure

Mitigation Measure 15-2: District No. 20 shall conduct additional geotechnical investigations in the specific areas where storage and treatment facilities are planned. The investigations will identify appropriate engineering considerations as recommended by a certified engineering geologist or registered geotechnical engineer for the planned facilities. Recommendations made as a result of these investigations to protect new structures from seismic hazards shall become part of the project.

[24] *DWR, Antelope Valley Groundwater Basin, 2004.*

Significance After Mitigation

Less than significant.

Impact 15-3: Use of treated effluent for irrigation could increase soil salinity over the long term and impact soil chemistry.

The application of recycled irrigation water may increase salts in the upper soil layers due to its TDS content, resulting in negative effects on soil quality. Elevated salinity in soils can reduce surface water infiltration, reduce the availability of water to plants, cause dispersion of soil structure, and cause surface crusting. This could be a significant impact of the project.

In order to prevent salt build up in the soil horizon, enough water must be applied to periodically flush accumulating salts down beneath the root zone. The project includes use of tertiary treated effluent, which would assist in reducing nitrates but not necessarily reduce TDS. Soil salinity can be managed through agricultural best management practices depending on site-specific conditions. As part of the project, District No. 20 is preparing an FMP that identifies farm practices to be conducted as part of the PWRP effluent management operations. The following mitigation measure will ensure that soil salinity management is included as an integral part of District No. 20's farm management practices.

<u>Mitigation Measure</u>

Mitigation Measure 15-3: District No. 20 shall include agricultural BMPs for salinity management within the FMP. The FMP shall apply adaptive management methods and monitoring to ensure that long-term agricultural methods do not adversely impact soil chemistry and quality. BMPs could include, but not be limited to, conducting periodic soil sampling, flushing salts into the vadose zone periodically, and rotating crops to maximize salt removal.

Significance After Mitigation

Less than significant.

Impact 15-4: Infiltration of effluent water from the storage reservoirs into soils potentially susceptible to hydrocompaction could cause subsidence and settlement, and could increase liquefaction hazards.

Soils susceptible to hydrocompaction can be sensitive to increased moisture content. The storage of treated effluent water in the reservoirs could potentially infiltrate underlying soils. The increased moisture content could potentially alter the structure of the soils and make it subject to settlement. Significant settlement could threaten the integrity of the berms that contain the stored water. The susceptibility of underlying soils to hydrocompaction is not known since geotechnical evaluations have not been completed.

In addition, saturated soils could increase the liquefaction hazard beneath and within the berms. As part of the project, the reservoirs would be constructed with artificial liners to minimize infiltration. Nonetheless, final designs would consider increased settlement and liquefaction hazards associated with minor infiltration and provide appropriate structural support. In addition, prior to final designs, a geotechnical analysis would be conducted of the site as part of the project to determine the susceptibility to hydrocompaction and liquefaction.

<u>Mitigation Measure</u>

No mitigation measures are required.

Significance of Impact

Less than significant.