3.2 SOILS

3.2.1 Affected Environment

The purpose of this section is to identify and describe soils for the entire assessment region and analyze associated impacts to soils. This was accomplished by review of the general soils map and Natural Resources Conservation–Service Soil Survey Geographic (NRCS-SSURGO) database to determine general soil characteristics and erosion potential. Because of the large area involved, in addition to the available data sources, professional judgment and experience were also used in the assessment of impacts to the soils and the potential for soil erosion if the landscape is disturbed.

Soil orders found throughout the region containing the geothermal lease applications PVAs, and KGRAs in the WFO region and Dixie Valley region consist primarily of Entisols, Aridisols, and some Mollisols. These soils are dominantly mineral soils and are highly variable in thickness, texture, rock fragment content, and morphologic and chemical properties. Elevation, geology, climate, vegetation, and landscape position have a strong influence on the distribution of soils in the region.

3.2.1.1 General Soils Found in the Region

Aridisols. Aridisols are soils formed in dry environments that do not have water available to mesophytic plants for long periods (Soil Survey Staff, 1999). These soils may have one or more pedogenic horizons that may have formed under the present climate conditions or may be relicts of formation during former climate regimes. Aridisols are generally light colored, low in organic matter, and may have accumulations of soluble salts and calcium carbonate. Older Aridisols typically have substantial accumulations of calcium carbonate and reddened, clay-rich argillic horizons. The properties of the older Aridisols can make them less pervious to precipitation, more likely to generate surface runoff during precipitation events, and susceptible to erosion by surface runoff. Aridisols form on lake plain terraces, fan piedmonts, and lower mountain slopes.

Entisols. Entisols have little to no evidence of pedogenic horizons. This is primarily because these are the soils that have formed on deposits of very young material. They typically consist of relatively unconsolidated deposits of sand and gravel. In general, Entisols are very low in organic matter. These soils are found in or along active stream washes, in areas of eolian activity, and on various parts of hill slopes.

Mollisols. Mollisols are very dark colored mineral soils, generally with a dark colored surface horizon that is rich in organic matter, and typically are found at higher elevations. Most Mollisols are associated with grass vegetation, and some form under forest cover and generally have well-developed horizonation that includes argillic horizons. Some Mollisols are very old and are relict from former climate and vegetation conditions.

The youngest soils in the region, the Entisols, are those formed in recently deposited sand and gravel as a result of erosion and geomorphic processes that occur in fluvial, eolian, and lacustrine environments. These soils typically have ages from a few years to several hundred years.

Intermediate age soils, which formed in the middle to latest Holocene (< 4,000 years ago), are found in alluvium on wet floodplains. These soils formed in wet flood plains and have been stable long enough to have accumulated organic matter and formed a dark-colored A-horizon. These soils are probably less than 1,000 years old.

Inset alluvial fan, fluvial terraces, bars of beach plains, and pluvial lake plain terraces, may be considerably older and have soil formation commensurate with an age of early to middle Holocene (2,000-10,000 years ago). These Aridisols typically have a cambic B-horizon (a B-horizon that is slightly reddened or has recognizable structure) and may have a very thin surface horizon.

Fan piedmonts are extensive throughout the region. The surfaces on the fan piedmonts are late to mid-late Pleistocene (10,000-130,000 years ago) and have soils that are characteristic of very stable land surfaces to allow strong development. Most of the soils found on the fan piedmonts are low in organic matter.

3.2.1.2 Erosion Hazard for Soils

The susceptibility to erosion, or the erosion hazard, for soil throughout the region varies with geology, parent material, elevation, slope, aspect, vegetation cover, local microclimate, land use, and landscape history. The history and evolution of the landscape and the geomorphic processes occurring in the landscape dictate to a large degree the distribution of ages and types of soils throughout the area. The long-term history of the landscape is most important to the erosion susceptibility of soils formed on moderate to gentle slopes.

Because of the large number and complex spatial distribution of soil units throughout the region, it was only possible to make a general assessment of the erosion hazard. The principal agents affecting soil erosion in the region are primarily water on slopes and wind on the valley floors and slopes, although it is recognized that water associated with ephemeral playa lakes can have an erosional impact on soils. Soil parameters available in the NRCS-SSURGO database for Nevada allow development of erosion hazard groupings. A soil erodibility factor (K factor), slope, wind erodibility index (I), and climate (C factor) were obtained from the NRCS[9] data for the soil groups in the region. This information allows development of a general guide for estimating the erosion hazard for bare soil in Nevada.

[9] U.S. Department of Agriculture, Natural Resources Conservation Service, 2001, National Soil Survey Handbook, title 430-VI.

3.2.1.3 Soil Erosion by Water

For soils eroded by flowing water, the general erosion hazard is divided into three classes: slight, moderate, and high. The hazard is estimated by using the formula: Erosion Hazard = K factor x Slope.

TABLE 3.2-1
EROSION HAZARD VALUES (WATER)

Erosion Hazard	Value
Slight	<4
Moderate	4-8
High	>8

Erosion Hazard: Slight

- Includes soils of all soil texture classes formed on slopes of less than 4 percent
- Includes soils formed on slopes of less than 15 percent for these soil textures: sand, fine sand, loamy sands and coarse sandy loams

Erosion Hazard: Moderate

- Includes soils formed on slopes of 4-15 percent for these soil textures: loam, silt loam, very fine sandy loam, sandy clay loam, clay loam, and clay
- Includes soils formed on slopes of 15-30 percent for these textures: sand, fine sand, loamy sands and coarse sandy loams

Erosion Hazard: High

- Includes soils formed on slopes of 15-30 percent for these textures: loam, silt loam, very fine sandy loam, sandy clay loam, clay loam, and clay
- Includes soils of all other textures formed on slopes greater than 30 percent

3.2.1.4 Soil Erosion by Wind

For soils eroded by wind, the general erosion hazard is also divided into three classes: slight, moderate, and high. The hazard is estimated by the formula: Erosion Hazard = I (wind erodibility index) x C (climatic factor).

TABLE 3.2-2
EROSION HAZARD VALUES (WIND)

Erosion Hazard	Value
Slight	<40
Moderate	40-80
High	>80

Erosion Hazard: Slight

- Includes soils of all texture classes with greater than 35 percent rock fragment
- Includes soils formed on slopes that are greater than 35 percent

Erosion Hazard: Moderate

- Soils having textures of clay, silty clay, silty clay loams, clay loams, silt loam, loam, very fine sandy loam, and sandy loam have a moderate wind erosion hazard

Erosion Hazard: High

- Soils having textures of loamy fine sand, fine sand and sand have a high wind erosion hazard

3.2.1.5 Soil Erosion Related to Landform Type

The general erosion hazard classes above can be grouped within broad classes of landforms (Table 3.2-3). This provides an additional means to assess the potential for erosion caused by impacts related to development of geothermal resources. These landforms represent the major types found in the region that encompasses PVAs, KGRAs, and pending lease applications.

TABLE 3.2-3
ASSOCIATIONS OF LANDFORM TYPE AND ESTIMATE EROSION HAZARDS RELATED TO WATER AND WIND

Landforms	Erosion Hazard	
	Water	Wind
Playa/lake plain	Slight	Moderate
Beach Plain (lake bars)	Slight to moderate	Slight to moderate
Sand sheet	Slight	High
Fan piedmont	Moderate	Slight
Mountains	High	Slight

Existing leases west of Blue Mountain are estimated to have a high wind erosion hazard. Existing and pending leases in the Desert Peak and Cinnabar Hill area have potential for high wind erosion hazard.

3.2.2 Environmental Impacts

3.2.2.1 Proposed Action

Direct Impacts – There are no direct impacts to issuing leases for future geothermal exploration, development, and production activities.

Indirect Impacts – When considering the "reasonably foreseeable development scenario," geothermal exploration and development activities can be expected to cause disturbance to the landscape and soils. This could include clearing and grading access roads and trails, well sites, pipelines, power lines, and other infrastructure associated with exploration and production. Reclamation would be required following exploration and production activities.

Associated impacts would likely include, but are not limited to:

- Reduced vegetation productivity by removal of topsoil
- Increased compaction
- Increased erosion, both water and wind
- Alter soil chemistry by chemical spills
- Mixing soil horizons can change properties such as infiltration, salinity, alkalinity or texture

The amount of soil erosion would depend on the location of the exploration sites with respect to geology, slope, landform soil association, elevation, and aspect. Off-road vehicle travel could impact exposed soils. Increased runoff from road surfaces would contribute to sediment erosion, possible contamination of streams with excessive sediment that could impair beneficial uses, and contribute to dust emissions.

The following are the potential environmental impacts on soils quality when analyzing the "reasonably foreseeable development scenario."

Exploration. The environmental impacts on soils during the exploration phase is expected to be minor in nature, of a short duration, and localized to a small area.

Development. The greatest environmental impact on soils is expected to occur during the development phase. During this phase development drilling would occur, a mainline road would be constructed, pipelines and access roads would be built, and a power plant and electrical transmission lines constructed. Each of the activities would disturb the soils in the affected areas.

Production. Soil disturbance is expected to be minimal during the production phase. Most, if not all soil disturbances would have already occurred.

Close-out. During the close-out phase, soil disturbance would again reach a peak as production and injection wells are capped, pipelines are dismantled, the power production plant and support facilities would be dismantled, and the electrical transmission line removed. All production materials would be removed from the site and the landscape would be returned to it original grade and condition.

3.2.2.2 No Action Alternative

Direct Impacts – There are no direct impacts to issuing leases for future geothermal exploration, development, and production activities.

Indirect Impacts – Indirect impacts from the No Action Alternative would be similar to those described in the Proposed Action; however, updated mitigation measures and stipulations would not apply using the 1982 Geothermal EA.