3.12 GEOLOGY AND MINERALS

3.12.1 Affected Environment

In Nevada, geothermal resources are classified for regulation and management as a mineral; therefore, issues relating to the geothermal resource are discussed in this section with mineral resources. Separate descriptions of the surficial geology, mineral resources, and geothermal resources of the WFO assessment area are presented below. The assessment of potential impact to geothermal and mineral resources resulting from additional geothermal resource development are combined.

3.12.1.1 Geology

The WFO assessment area is located in the northwest corner of the Great Basin portion of the Basin and Range physiographic province of the western United States. The Great Basin is characterized by north trending mountain ranges and intervening valleys. The pattern of mountains and valleys results from the structural history of the region where movement along faults have raised mountains in which bedrock is exposed and created basins which have filled with sediments eroded from the mountains.

The following general description of the geology exposed in mountain blocks in the assessment area is taken from the Geologic Map of Nevada (Stewart and Carlson, 1977). Information is organized around the eight hydrographic regions, which are represented in the assessment area.

Northwest Region. Volcanic rocks representing a variety of ages are exposed in the mountains in northwest Humboldt County. These mountains also present a significant exposure of intrusive rocks, especially around Continental Lake and Virgin Valleys.

Black Rock Desert Region. Mountain blocks bounding basins in central Humboldt, northwestern Pershing, and central Washoe Counties are composed principally of volcanic rock. The southern end of the Black Rock Desert Basin is marked by intrusive rock exposures on both the northern and southern sides. Mountains along the boundary between the Black Rock Desert and West Central Regions expose consolidated sedimentary rocks and their metamorphic equivalents and intrusive rocks.

Humboldt River Region. In the mountain blocks, various crystalline or consolidated sedimentary rocks are exposed. The northeastern boundary of the region in Humboldt County consists of volcanic rocks. Bedrock exposed in the eastern portion of the Humboldt River Basin includes volcanic rocks predominately and some carbonate rock. A mixture of sedimentary, volcanic, and intrusive rock bound the west side of the Humboldt River Basin in Humboldt County and both sides of the basin through the Imlay and Lovelock Valley portions of the region. Volcanic rocks dominate the bounding mountain ranges in the southern portion of Lovelock Valley and below.

West Central Region. Basins in the western part of the region are bounded by mountain ranges, which expose intrusive rocks. The eastern boundary of the region, adjacent to the Humboldt River Basin, is composed of sedimentary, metamorphic, and volcanic rocks with a scattering of intrusive outcrops.

Truckee River Region. Winnemucca Lake Valley is bounded on the west side by mountains composed of volcanic rocks and on the east side by intrusive rocks in the north and volcanic rocks in the south.

Carson Desert Region. A small piece of the Carson Desert Region, Packard Valley, extends into south central Pershing County. This basin is bounded by mountains composed primarily of sedimentary and metamorphic rocks with some exposure of volcanic rock along the west side.

Central Region. The Central Hydrographic Region in southeast Pershing County is bounded by mountain ranges containing a wide variety of rock types. These include exposures of consolidated sedimentary rocks, metamorphic rocks, volcanic rocks, and a scattering of intrusive rocks.

The lithology and structural features of the mountain blocks surrounding and throughout the assessment area are critical in the occurrence of water and mineral resources. Most of the bedrock formations lack permeability except where fault zones or fractures have been created by deformation. Thus, where there are no, or few fractures or faults, precipitation tends to run off to the adjacent valleys. Where fractures and faults are present, a portion of the precipitation may infiltrate into deep circulation patterns, which may be sufficiently deep to generate a geothermal resource.

In general, it is the bedrock formations of the region that host various metal deposits of economic value. In contrast, many of the industrial mineral deposits occur in the sediments filling valleys between mountain ranges.

3.12.1.2 Mineral Resources

Economic minerals of the region fall into the two broad categories: metals and industrial minerals. Table 3.12-1 identifies those hydraulic basins in the assessment area in which mineral resources occur. The metals deposits tend to occur in the bedrock formations of the mountain blocks while industrial minerals are commonly found in the valley fill sediments.

Important quantities of quicksilver, tungsten, gold, and iron (and lesser amounts of other commodities) have been produced from mines in Humboldt County. Mineral deposits have been found in almost all the rock units exposed in the county (Willden, 1964).

TABLE 3.12-1
GEOTHERMAL AND MINERAL RESOURCES BY HYDROGRAPHIC BASIN

Hydrographic Region	Geothermal Resources				Mineral Resources	
	Leases		KGRA	PVA Number	Metals	Industrial Minerals
	Existing	Application				
Northwest Region (1)						
1. Pueblo Valley		X		1	X	
2. Continental Lake Valley	X	X		1	X	X
3. Gridley Lake Valley		X		1		
4. Virgin Valley						X
Black Desert Region (2)						
21. Smoke Creek Desert					X	X
22. San Emidio Desert	X	X	San Emidio	8	X	X
23. Granite Basin				8		
24. Hualapai Flat		X		8	X	
25. High Rock Lake Valley					X	X
26. Mud Meadow						
27. Summit Lake Valley						
28. Black Rock Desert	X	X	Gerlach	2,3,4,8	X	X
29. Pine Forest Valley				2	X	
30. Kings River Valley						X
31. Desert Valley		X		7	X	
32. Silver State Valley				7	X	
33. Quinn River Valley				5	X	

Hydrographic Region	Geothermal Resources: Leases – Existing	Geothermal Resources: Leases – Application	Geothermal Resources: KGRA	Geothermal Resources: PVA Number	Mineral Resources: Metals	Mineral Resources: Industrial Minerals
Humboldt River Basin (4)						
64. Clovers Area				7	X	
65. Pumpernickel Valley		X		7	X	
66. Kelly Creek Area				7	X	
67. Little Humboldt Valley		X		6		X
68. Hardscrabble Area		X		6		
69. Paradise Valley		X		6	X	
70. Winnemucca Segment		X		7	X	X
71. Grass Valley	X	X		11	X	
72. Imlay Area	X	X	Rye Patch	9	X	X
73. Lovelock Valley	X	X		8,9	X	X
74. White Plains	X	X	Brady	8	X	X
West Central Region (5)						
75. Brady Hot Spring Area	X	X	Brady	8	X	X
77. Fireball Valley	X			8	X	X
78. Granite Springs Valley				8	X	X
79. Kumiva Valley				8	X	
Truckee Basin (6)						
80. Winnemucca Lake Valley		X		8	X	X
Carson River Basin (8)						
101A. Packard Valley					X	X
Central Region (10)						

Geothermal Resources					Mineral Resources	
Hydrographic Region	**Leases**		**KGRA**	**PVA Number**	**Metals**	**Industrial Minerals**
	Existing	**Application**				
128. Dixie Valley	X		Dixie Valley	13	X	
129. Buena Vista Valley		X	New York Canyon	10,12	X	X
130. Pleasant Valley				13	X	
131. Buffalo Valley		X		13	X	X
132. Jersey Valley		X		13	X	X

Pershing County. There are 45 mining districts in Pershing County. Mines of Pershing County have extracted tungsten, antimony, iron, gypsum, diatomite, mercury, gold, silver, and copper (Johnson, 1977). Since 1914 the significance of gold and silver has been overshadowed by the importance of the other minerals. The extractable mineral resources occur on the flanks of mountain ranges throughout the county. However, many of the mining districts incorporate portions of the adjacent valleys.

Washoe County. The principal metal production in Washoe County has been based on gold, silver, lead, copper, and zinc. Minor amounts of mercury, uranium, tungsten, arsenic, and antimony have also been produced. A variety of other minerals are known to occur in the county but there has been no commercial development (Bonham, 1969). Industrial mineral production has included clay, diatomite, aggregate, and sand and gravel. Metallic minerals occur generally in the bedrock formations of mountain blocks. Uranium deposits occurring in unconsolidated sedimentary formations are the exception. Industrial minerals occur in consolidated and unconsolidated sedimentary formations.

Churchill County. Mineral deposits have generally been small in Churchill County. Production has been largely in gold and silver although nonmetallic minerals became increasingly important through the 1970s. In addition to gold and silver, there are small deposits of iron and other base metals. The metal deposits generally occur in Mesozoic and Tertiary rocks. However, these deposits are in mountain ranges outside the WFO assessment area. Industrial mineral production has included sand and gravel, diatomite, pumice and perlite, salt, stone, limestone, fluorspar, and gem stones (Willden and Speed, 1974).

3.12.1.3 Geothermal Resources

Garside and Schilling (1979) characterize the entire Basin and Range physiographic province as having high heat flow. They identify a region of unusually high average heat flow in north central Nevada centered on Battle Mountain. The delineated region extends into southeastern Humboldt County, eastern Pershing County, and northeastern Churchill County. However, Garside and Schilling (1979) note that the extent of the area that should be incorporated under the unusually high average heat flow designation is not determined.

The distribution of thermal springs, spring deposits, and other indicators indicate that thermal resources are not limited to the region of the "Battle Mountain high." Rather exploration targets are typically defined by high heat flow, abundant hot springs, late Tertiary and Quaternary volcanism, recent tectonic activity, and high subsurface temperature gradients (Johnson, 1977). Garside and Schilling (1979) also note that hot springs appear to occur most frequently along major faults, which bound basin-and-range mountain blocks. Table 3.12-1 identifies those hydrographic basins in which geothermal resources exist.

Keller and others (1978) suggest that the structural extension that has occurred in the basin and range province has resulted in a thinning of the earth's crust permitting the high average heat flow. Garside and Schilling, (1979) suggest a mechanism that allows this heat to be transferred to groundwater and Welch and Preissler (1990) refine the mechanism into a conceptual model of geothermal fluid flow. Summarizing the Welch and Preissler (1990) conceptual model: A portion of the precipitation that falls on the mountains infiltrates the mountain through fractures and faults. This water migrates to depth and for time sufficient for heating of the water, which then rises through fractures or faults to discharge as hot springs. Thus, the geothermal systems function in a manner very similar to groundwater systems having the same water source and following similar paths to the valley. Geothermal and groundwater reservoirs are interconnected by virtue of the source water supply, the geologic media through which water flows, and flow system proximity. Groundwater resources are discussed in more detail in section 3.3.1.3.

Shevenell and others (2000) map warm and hot wells and springs and industrial applications of geothermal resources. They indicate warm or hot wells or springs in virtually every hydrographic basin in the assessment area. Geothermal power generation facilities are located in or are adjacent to the WFO assessment area at San Emidio Desert Valley, Brady Hot Springs, and Dixie Valley. Direct use of geothermal energy is identified in the San Emidio Desert Valley and Brady Hot Springs Valley for vegetable dehydration. Garside and Schilling (1979) summarized site-specific conditions for many of the geothermal features in the assessment area. The following review of geothermal features in the WFO assessment area relies on Shevenell and others (2000) and Garside and Schilling (1979).

Northwest Region. Shevenell and others (2000) identify warm and hot springs and wells in Continental Lake, Gridley Lake, and Virgin Valleys. Garside and Schilling (1979) describe two areas of geothermal features in the Northwest Region. Baltazor (sometimes called Continental) Hot Springs, on the eastside-bounding fault of the Pueblo Mountains, and Bog Hot Spring are located in Continental Lake Valley Hydrographic Basin. Water temperature at Baltazor Hot Springs is about 200^{o}F from a reservoir estimated to be 306^{o}F to 329^{o}F. Bog Hot Spring discharges about 1,000 gallons per minute (gpm) at about 131^{o}F; the reservoir temperature is estimated to be near 227^{o}F. These springs lie along a lineament that extends from Soldier Meadow northeastward into Oregon and may be related to the thermal area around McGee Mountain. The springs are associated with PVA 1 and lease applications and existing leases in Continental Lake Valley.

Black Rock Desert Region. Warm and hot springs, and wells are located in every hydrographic basin in the Black Rock Desert region (Shevenell, 2000).

Three PVAs in the northern end of the Black Rock Desert Hydrographic Region are each associated with some indication of thermal conditions. A mine and two wells give indication of unusual temperature conditions in the Quinn River Valley. High temperatures have been reported in the underground Cordero Mercury Mine. A well immediately down slope of the mine produces water at about 140^{o}F from a depth of 400-600 feet and a second well, 5.5 miles to the north, reports elevated temperatures. These thermal conditions are associated with PVA 5.

Howard Hot Spring and Dyke Hot Spring in Pine Forest Valley are included in PVA 2. Howard Hot Spring is reported to discharge at about 118^{o}F from a reservoir estimated to be about 262^{o}F (Garside and Schilling, 1979). Dyke Hot Spring, at the southern end of the east side bounding fault of the Pine Forest Range, is reported somewhat warmer, discharging water at about 158^{o}F from a reservoir temperature of 262^{o}F to 279^{o}F (Garside and Schilling, 1979).

PVA 3 and several lease applications are associated with Pinto Hot Springs in the northwest corner of the Black Rock Desert Hydrographic Basin. These springs are reported to discharge at about 200°F from a reservoir estimated to have a temperature in the range of 324°F to 329°F.

Macfarlane's Bath House Spring is located on the east side of the Black Rock Desert Basin (Garside and Schilling, 1979) in association with an outcrop of Tertiary volcanic and sedimentary rocks (Willden, 1964). The spring and Tertiary rock outcrop may lay on a southwesterly extension fault, which Willden (1964) describes as bounding the northwest face of the Jackson Mountains on the east side of the Black Rock Desert Basin. This spring is associated with PVA 4.

The greatest concentrations of thermal activity in the region are at the south end of the Black Rock Desert Basin in Hualapai Flat and near the extreme south end of Black Rock Desert. These features include Wards Hot Springs and Granite Range thermal waters in Hualapai Flat. Wards Hot Springs, located along north-northeast trending normal faults, discharge at temperatures up to 220°F from a reservoir estimated to be about 258°F (Garside and Schilling, 1979). No surface expression is present in the Granite Ranch area in Hualapai Flat but thermal waters have been identified in wells.

Geothermal features at the south end of the Black Rock Desert where the Smoke Creek Desert and San Emidio Desert meet are found in the Trego and Gerlach. Springs in the Trego area discharge at about 187°F from a reservoir estimated to be between 248°F and 262°F. The Gerlach springs discharge water at about 208°F from a reservoir estimated to be between 333°F and 347°F. These springs appear to lie along a northeast trending fault that may intersect the fault alignment that controls thermal springs in the Mud Meadow area (Garside and Schilling, 1979). The geothermal features of this area are associated with PVA 8, and lease applications in Hualapai Flat and the Gerlach KGRA.

Subsurface water at the south end of San Emidio Desert has been measured at 128°F. This area is within PVA 8 and in the vicinity of the San Emidio KGRA. Numerous existing leases and lease applications are associated with this KGRA. The resource has been developed for power production. A 4-megawatt binary power plant and vegetable dehydration plant are located within this KGRA.

Humboldt River Region. In the Humboldt River Region, thermal features are present in several tributary valleys and within the Humboldt River Valley. Hot springs at the Tipton Ranch in Pumpernickel Valley discharge at up to 185°F from a reservoir estimated to have temperatures in the range of 381°F to 385°F (Garside and Schilling, 1979). These springs are associated with a northeast trending fault that bounds the Sonoma Range on the west side of the valley. Pumpernickel Valley is within PVA 7. There are lease applications in the east central and south areas of the valley.

Leach Hot Springs are in Grass Valley, which is also tributary to the Humboldt River. These springs on the west side of the Sonoma Range discharge at temperatures of up to 204°F from a reservoir estimated to be between 311°F and 349°F (Garside and Schilling, 1979). These springs appear to be associated with PVA 11 at the south end of Grass Valley. PVA 11 contains both existing leases and lease applications.

Geothermal features are scattered along the main stem of the Humboldt River throughout the WFO assessment area. Twelve springs, which discharge at temperatures from 109°F to 165°F, are noted in the Golconda area. The supporting reservoir is estimated to have a temperature of about 239°F (Garside and Schilling, 1979). Warm springs discharge along a lineament that is an extension of the range-bounding fault on the west side of the East Range. Water from these springs has temperatures of 82°F to 84°F. Faults in this area are marked by spring deposits (Garside and Schilling, 1979). These thermal features in PVA 7 along the Humboldt River on the east side of the assessment area. The warm springs at the north end of the East Range are associated with lease applications.

The central reach of the Humboldt River within the assessment area is designated as PVA 9. Thermal features within this area include spring deposits in the Humboldt/Rye Patch area (south of Imlay) and hot wells in the Colado area. Though no springs are known in the Humboldt/Rye Patch area, two areas of low mounds formed by hot spring deposits have been identified approximately one mile west of a major fault which separates Mesozoic rocks and surficial deposits (Garside and Schilling, 1979). Water temperature for the Colado wells has been measured at 150°F. These hot underground waters are thought to be associated with faults along the west side of the Humboldt Range (Garside and Schilling, 1979). Thermal features in the Humboldt area are associated with the Rye Patch KGRA, active leases, and lease applications. A 12.5-megawatt binary poser plant has been constructed and is almost ready to go on line in the Rye Patch KGRA. Existing leases and lease applications exist in the Colado area.

West Central Region. A scattering of warm or hot springs, or wells are indicated in the Kumiva and Granite Springs Valleys (Shevenell, 2000) but the principal thermal feature in the region is located around Brady Hot Springs. These springs are located northeast of Fernley on the boundary between the Humboldt River and West Central Hydrographic Regions. Thermal features of the Brady Hot Springs area have been recognized since before 1885. Commercial development was initiated in the late 1950s (Willden and Speed, 1974). Between 1959 and 1979, 20 major geothermal wells were drilled in the area. The waters were used for drinking by California emigrants, developed for bathing around 1929, and for food dehydration in the late 1970s (Garside and Schilling, 1979). The resource has also been developed for power production (Shevenell and others, 2000) and is currently producing 21 megawatts of electricity. A vegetable dehydration plant is still using this resource.

Presently there is no surface discharge of thermal waters at Brady Hot Springs. Former springs and the underground resource are oriented along the north-northeast trending Thermal Fault, which bounds the west side of the Hot Springs Range. The reservoir likely receives recharge by underflow from Fireball Valley to the northwest and the Fernley area to the south. All discharge at present occurs by pumping (Garside and Schilling, 1979).

Desert Peak is located a few miles east of Brady Hot Spring in the northern Hot Springs Range. The resource has been developed for power production and is currently producing 9.9 megawatts of electricity. The reservoir is estimated to have temperatures near 406^{o}F (Garside and Schilling, 1979).

Brady Hot Springs and the Desert Peak area are both within PVA 8. Brady Hot Springs area has been designated a KGRA. Numerous lease applications exist in the Desert Peak area.

Truckee River Region. There are warm and hot wells located at the south end of Winnemucca Lake Valley and warm springs identified on the west side of the valley (Shevenell, 2000) in the southwest corner of the WFO assessment area, Pershing and Washoe Counties. Garside and Schilling (1979) do not have site-specific information on the character of these geothermal features. The valley lies within PVA 8 immediately south of the San Emidio KGRA. There are lease applications in the southern third of the valley.

Carson Desert Region. A number of warm wells are identified in the Packard Valley Basin (Shevenell, 2000) on the southern boundary of the WFO assessment area, Pershing County. However, Garside and Schilling (1979) document no site-specific information on these geothermal features. Packard Valley lies southeast of PVA 9 and west of PVA 12, which includes the New York Canyon KGRA. There are no identified lease applications in Packard Valley.

Central Region. Five valleys of the Central hydrographic region lie within the WFO assessment area. These include: Buena Vista, Buffalo, Dixie, Pleasant, and Jersey Valleys. All five valleys contain geothermal features. No site-specific information on the nature of geothermal features in Pleasant Valley is available in Garside and Schilling (1979).

In Buena Vista Valley, Kyle Hot Springs discharge water at between 159^{o}F and 204^{o}F from a reservoir estimated to have a temperature in the range of 340^{o}F to 381^{o}F (Garside and Schilling, 1979). These springs are located approximately one mile west of the mountain front fault on the western side of the East Range and are associated with several intersecting fault sets. The area surrounding Kyle Hot Springs has been designated PVA 10 and includes a lease application.

The New York Canyon kaolin deposit in southern Buena Vista Valley is a hot spring type deposit, which occurs near a mountain front fault. A development drill hole drilled in 1963 produced steam from a depth of 140 feet (Garside and Schilling, 1979). This area is associated with the New York Canyon KGRA in PVA 12.

Buffalo Valley Hot Springs are reported to have temperatures of up to 174^{o}F derived from a reservoir estimated to be 257^{o}F. These springs are associated with a recognized fault along the western side of the Fish Creek Mountains (Garside and Schilling, 1979) east of the WFO assessment area in Lander County.

Thermal springs discharge at temperatures of 84^{o}F to 135^{o}F in Jersey Valley. These springs are thought to be supported by a reservoir with temperatures between 288^{o}F and 360^{o}F. The springs lie along a possible projection of a mountain front fault (Garside and Schilling, 1979).

The predominant thermal springs of northern Dixie Valley are the Sou Hot Springs and the Lower Ranch Hot Spring. Sou Hot Springs discharge at 163^{o}F to 185^{o}F from a reservoir estimated to be about 212^{o}F to 237^{o}F. Lower Ranch Hot Spring has a discharge temperature of 104^{o} from an estimated reservoir temperature of 201^{o}F to 212^{o}F.

PVA 13 encompasses northern Dixie Valley, Jersey Valley, and most of Buffalo Valley. There are lease applications in Buffalo Valley; these are across the valley from Buffalo Hot Springs. Lease applications in Jersey Valley are associated with the hot springs present there. The entire northern portion of Dixie Valley within the WFO assessment area is in the Dixie Valley KGRA. A power plant producing 66 megawatts of electricity has been developed in Dixie Valley.

3.12.1.4 Oil and Gas Resources

Central Region. In 1993 a gold exploration-drilling project struck oil-laden geothermal water (175°F) at Kyle Hot Springs in Buena Vista Valley (PVA 10). The area was leased and drilled for oil and gas resources. There has been no known oil or gas production from the property; however, exploration has continued to the present. It is thought that the oil is Tertiary in age and lacustrine in origin.

3.12.2 Environmental Impacts

3.12.2.1 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,” impacts to geology, mineral, and geothermal resources, expected from leasing would be minimal. Updated stipulations and mitigation measures would be developed, after additional NEPA analysis has been completed, for each lease application.

The following are the potential environmental impacts on geology and minerals when analyzing the “reasonably foreseeable development scenario.”

Exploration. The impacts to mineral and geothermal resources would be very minor or non-existent during the exploration and testing phase, where it is anticipated that a minimal amount of fluid would be withdrawn from the reservoir. This means that initial activities related to surface exploration and even test drilling and evaluation could proceed without adverse impacts to mineral resources. Any impacts to mineral resources should occur only when production of geothermal fluids begins. This is the last stage of the process and there would be considerable data available to assess possible impacts to mineral resources.

The mineral resources in the assessment area can be divided into two general categories: 1) static and 2) dynamic. The static or immobile resources are generally valuable metals, industrial minerals, etc., which are securely bonded in the rocks. An example is a gold/silver deposit in volcanic rocks. It is anticipated that the development of a geothermal resource near this type of deposit would have virtually no impact on this resource unless there were associated thermal fluids, and that these thermal fluids had some value or importance in maintaining or extracting the mineral resource. A more probable impact would be to the groundwater resource in the mining area, which would be covered in another section.

Development and Production. The major impacts resulting from the development and production of new geothermal resources would be to dynamic mineral resources (thermal springs and existing geothermal production facilities). Thermal springs or areas where thermal waters seep to the surface have been impacted in areas with current geothermal production where spring flow has been reduced or dried up completely. This is a result of geothermal well operation reducing reservoir pressures, which impacts thermal spring discharge. Potential exists for this environmental impact even when there is a 100 percent injection of spent geothermal fluids. These springs generally discharge under a low hydraulic head and therefore are easily impacted by slight reductions in reservoir pressures.

This reduction, or loss, of thermal spring flow would result in a second tier of environmental impacts, which would be felt in the biological community, which in turn relies on the impacted spring. These secondary impacts would be delineated in other sections of this report.

It is assumed that 100 percent of all thermal fluids produced from wells would be injected; however, the location of production and injections wells could be such that some land subsidence could occur. Land subsidence could also have other environmental impacts in a localized area.

Existing geothermal facilities could certainly be adversely impacted by the development of new geothermal wells in an area. In many situations it is unclear whether this is an environmental or economic impact. Any new geothermal production facility could certainly reduce both reservoir temperature and pressure at the wells supplying fluids to existing geothermal plants. This could possibly result in some environmental impacts but would most likely impact the economic viability of the existing plants.

Summary. The following environmental effects could be anticipated:

- Exploration and testing would have no, or negligible, environmental impact on mineral or geothermal resources.
- Production of geothermal fluids in any hydrographic basin has the possibility of impacting thermal springs in the basin. Detailed hydrologic data, provided in site-specific EAs, would be required to make a firm determination.
- If exploration, development, or production occurs in PVA 10, there is a high likelihood of encountering oil-laden geothermal fluids, which could cause impacts to the oil reservoir.
- Localized land subsidence could occur even with 100 percent inject of spent geothermal fluids.

- Impacts on existing geothermal production facilities would be primarily economic but the combined impact of old and new production facilities could have an enhanced impact on thermal springs in a basin.

3.12.2.2 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.