Chapter 4

Environmental Consequences

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CHAPTER 4
ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

This chapter analyzes the environmental consequences of impacts expected to occur as a result of implementing any future actions (including but not limited to any decisions to lease and/or develop geothermal resources) that may be taken consistent with the three alternatives: Alternative A (the No Action Alternative), Alternative B (the Proposed Action), and Alternative C (leasing within 10 miles from the centerline of existing transmission lines and 15 miles outside of the Yellowstone National Park boundary). The scope of the analysis is commensurate with the detail of the alternatives and the availability of data, and is at a programmatic level as discussed in Section 1.9 – Scope of Analysis. Current conditions of the planning area, as described in Chapter 3, provide the baseline for assessing impacts.

4.1.1 Methods of Impact Analysis

Issuance of a geothermal lease has no direct impacts on the environment; however, it is a commitment of the resource for potential future exploration, drilling operations and development, utilization, and reclamation and abandonment, subject to environmental review and permits. Therefore, an analysis is provided of the potential impacts of these various stages that may follow a leasing decision along with the potential cumulative impacts throughout the entire planning area.

The methodology for the following impact assessment conforms to the guidance found in the following sections of the CEQ regulations for implementing NEPA: 40 CFR 1502.24 (Methodology and Scientific Accuracy); 40 CFR 1508.7 (Cumulative Impact); and 40 CFR 1508.8 (Effects). CEQ regulations require that agencies "rigorously explore and objectively evaluate" the impact of all alternatives. Since the action alternatives presented in this PEIS propose allocating public and NFS lands as open or closed to geothermal leasing and amending land use plans, none of which has any effects as explained below, rather than project level exploration, development, and utilization of the

resource, the focus of this analysis is on the impacts of these stages, which may follow leasing.

The Proposed Action and alternatives do not specifically propose development of a geothermal resource. For this reason, the analysis relies on the RFDs, which projects future geothermal leasing and development on public and NFS lands within the western US over the next 20 years based on best professional judgment. The RFD scenario assumes all lands are available for leasing, and therefore, does not consider any allocations (lands open or closed to geothermal leasing) prescribed under any of the alternatives. Its purpose is to demonstrate the level of expected development and show where the potential development might occur. It is important to note that the magnitude and extent of impacts on any resource or resource use will vary depending on the amount of land apportioned for each lease. A lease can range in size from 640 acres up to 5,120 acres.

Allocating lands and amending land use plans, in and of itself, does not cause any direct impacts as defined by the CEQ regulations, which state that such effects "are caused by the action and occur at the same time and place" (40 CFR 1508.8(a)). Prior to any ground disturbance or other future actions that would occur consistent with implementing the plan, further decision making would be required. This decision making must take place prior to future actions and involves consideration of a wide variety of factors, including, but not limited to, policy initiatives about timing of actions, whether any applications are submitted, whether funding is available, and compliance with other authorities and policies.

Similarly, lease issuance itself does not cause direct effects. The regulations governing geothermal leasing and development provide for several decision stages prior to any ground-disturbing activities taking place and may include further compliance with applicable authorities during these decision stages. Under this regulatory scheme, until BLM receives and adjudicates an application for a permit to drill or other authorization that includes specific information about a particular project, impacts of actual development that might follow lease issuance are speculative, as so much is unknown as to location, scope, scale, and timing of that development. At each decision stage, the BLM retains the authority to approve, deny, or approve subject to conditions any permit, based on compliance with applicable authorities and policies. Therefore, the analysis of effects of development in this Final PEIS reflects a more general, programmatic approach.

Any future development of geothermal resources, if and when it does take place, would result in effects. It is reasonable, therefore, to foresee that on-the-ground impacts would occur if the BLM issues geothermal leases. Those impacts would not occur, however, until some point in the future and following several decision stages. The following analysis, therefore, focuses primarily on both

direct and indirect impacts of future development of geothermal resources based on the foreseeable on-the-ground actions, taking into consideration the stipulations, BMPs, and procedures outlined in Chapter 2. These impacts cannot be analyzed site-specifically, but they can be analyzed in general terms for the leasing area based on the RFD scenario.

Consideration of the effects of future actions that might occur under the alternatives described in this chapter also takes into account the phenomena of greenhouse gas (GHG) emissions, carbon sequestration, and climate change generally. The tools necessary to quantify climatic impacts are presently unavailable (US Geological Survey 2008). As a consequence, impact assessment of specific effects of anthropogenic activities and specific levels of significance cannot be determined. Therefore, climate change analysis for the purpose of this document is limited to accounting for and disclosing GHG emissions (and other factors that contribute to climate change) that may result from future activities that may be taken to implement the plan amendments proposed and analyzed in this document. Qualitative and quantitative evaluations of potential factors that may result from the future actions that may be taken to implement each alternative within the Planning Area are included, where appropriate and practicable.

Some of the GHGs associated with geothermal exploration and development will be naturally sequestered, while the balance of those emissions will accumulate with GHG concentrations in the atmosphere. This, in turn, is believed to contribute to further manifestations of climate change. However, since geothermal energy is a renewable energy with low carbon output compared with nonrenewable sources that currently dominate the US energy landscape, the development of geothermal energy projects can result in a net decrease in GHG emissions if the energy supplied to the grid allows fossil fuel-based power production, and its related GHG emissions, to be reduced.

While the GHG emissions of future actions that may be taken under each of the alternatives analyzed in this chapter can be estimated, current science does not permit quantification (or in some cases, even articulation) of the relationship between these emissions and the phenomena associated with global climate change. That is, while the relationship appears on a global level, it is not possible to make the connections between GHG emissions and global climate change on a local or even regional level (US Geological Survey 2008).

It is projected that the Alternative A *status quo* approach to land use allocation and leasing would result in the least amount of geothermal development, the least amount of new, clean energy being brought online, and the least potential for reducing GHG emissions. It is expected that projects developed consistent with Alternative B would result in the greatest amount of geothermal

development, the greatest amount of new, clean energy being brought online, and the greatest potential for reducing GHG emissions. Projects developed consistent with Alternative C are expected to result in amounts of new, clean energy coming online and potential reductions in GHGs that are somewhere in between Alternatives A and B. As such, as much as a relationship can be drawn between GHG emissions and climate change, it is expected that the approach reflected in Alternative A would have the least beneficial impact on climate change and that the approach reflected in Alternative B would have the greatest beneficial impact on climate change.

Alternative C was developed such that projects would occur closer to existing transmission lines, meaning that on average, projects developed consistent with Alternative C would generally have less of a construction footprint (when considering transmission line length) and theoretically lower GHG emissions during the development phase. Therefore, while the approach to development reflected in Alternative B is expected to result in the greatest overall potential for reduction in GHG emissions, each project developed consistent with Alternative C may result in the greatest potential for GHG emissions on a *per project* basis.

4.1.2 Organization of Chapter 4

Because it is not possible to identify specific impacts from the decision to approve a geothermal lease or designate federal lands as open or closed to geothermal leasing, the evaluation of environmental resources has focused on those resources most likely to be affected during future geothermal development activities. Therefore, this chapter provides a programmatic presentation of common impacts from indirect and direct geothermal development by analyzing the RFD scenario and assessing potential impacts during the four sequential phases of geothermal development: (1) exploration, (2) drilling operations, (3) utilization, and (4) reclamation and abandonment. The discussion of impacts from geothermal development activities is general in nature and would occur regardless of the alternative.

Following the discussion of impacts associated with the RFDs and common impacts associated with each phase of geothermal resource development, a programmatic analysis illustrates the nature and magnitude of the impact to the resource that would be associated with any anticipated future action taken consistent with each of the respective alternatives.

4.2 LAND USES LAND USE, RECREATION, AND SPECIAL DESIGNATIONS

4.2.1 What did the Public Say about Impacts on Land Use?

Comments received during the scoping period requested that development of geothermal energy on federal lands be executed in a manner compatible with other multiple use resource values and with BLM and FS management objectives. Comments also requested the use of standard best management practices to ensure minimal fragmentation of ecosystems and an analysis of additional road and transmission line construction. Industry comments recommended the analysis of impacts from exploration practices.

4.2.2 How Were the Potential Effects of Geothermal Leasing on Land Use Evaluated?

The geothermal planning area encompasses the 12 western states, including Alaska. Under Alternative A, the no action alternative, no geothermal leasing areas would be identified. All BLM- and FS-managed lands would be open to geothermal leasing unless closed in accordance with existing land use plans or congressional designation. Under Alternative B, approximately 197,225,000 acres are identified as open to geothermal leasing (118,000,000 acres of public land and 79,000,000 acres of NFS land), narrowing the scope of analysis down from approximately 243 million acres of federal lands in the planning area. Under Alternative C, fewer indirect use lands (approximately 61,200,000 indirect use acres on public land and 37,900,000 acres on NFS lands) would be open to geothermal leasing, further narrowing the scope of the analysis.

Potential impacts on land use could occur if reasonably foreseeable future actions were to:

- Conflict with management goals and objectives set forth by the BLM or FS in order to sustain the health, productivity, and diversity of these federal lands; or
- Result in proposed uses that are incompatible with existing or adjacent land uses.

4.2.3 What are the Common Impacts to Land Use Associated with Geothermal Development?

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on land use from geothermal resource development. Issuing geothermal leases would not create any surface disturbances, and current activities on federal lands could continue as long as they did not interfere with the rights of the geothermal lessee. On lands where geothermal development is likely to occur, current uses include recreation, mining, hunting, energy development, communication sites, and right-of-way corridors.

The Reasonable Foreseeable Development Scenario for Land Use

According to the RFD scenario, it is estimated that 111 power plants could be constructed by 2015, and another 133 power plants could be constructed by 2025. The greatest development is expected to occur in California and Nevada, with the least development occurring in Arizona, Colorado, Wyoming, and Montana. The typical acreage of disturbance in a geothermal resource development phase is 53 to 367 acres. Therefore, total land use disturbance would be approximately 5,883 acres to 40,737 acres by 2015 and 12,932 acres to 89,548 acres by 2025.

BLM and FS manage approximately 676,000,000 acres in the western US, so these estimates would account for less than one percent of the total lands managed by both the BLM and FS.

Exploration

The exploration phase includes surveying and drilling temperature gradient wells. Surveying activities would impact land uses if additional roads or routes are developed to survey the potential geothermal sites. Additional roads could improve motorized and non-motorized access to previously inaccessible areas, impacting activities such as grazing and recreation. The magnitude and extent of the impact would depend on the current land use in the area. Following surveying activities, all roads and routes would be reclaimed to BLM and FS standards, thereby minimizing any long-term impacts on land uses.

Impacts on land uses from drilling temperature gradient wells would be short term and minor. Similar to surveying activities, roads would be required to access wells. Impacts from creating additional roads would be similar to those impacts described above. Several wells could be drilled per lease, and each drill site could disturb approximately 0.9 acres. Impacts would occur on lands directly under the well sites; drilling well sites may involve some leveling or grading, but impacts are primarily limited to the duration of the drilling and reclamation activities (several weeks). The drilling sites and access routes would be reclaimed to BLM and FS standards, thereby minimizing any long-term impacts on land uses.

Drilling Operations

The drilling operations phase would require production wells, injection wells, fluid sump pits, and new access roads to accommodate larger equipment. This development would impact any land use activity that is displaced as a result of the new roads and would affect land use activities that are sensitive to increases in motorized traffic (e.g., grazing).

The drilling operations phase also includes drill site development, which on average requires a 5-50 acre well pad per plant. Land under the well pad would be impacted, eliminating all other potential uses of the 5-50 acres site while the well pad is in operation.

Utilization

Geothermal utilization would result in long-term impacts on land use. Any land use activity such as grazing, recreation, hunting, mining, and other energy development activity would be impacted if the land was converted for geothermal use, displacing current activities and uses from these lands.

The utilization phase would require additional access roads for accessing the power plant and supporting well field equipment. The well field equipment consists of pipelines that vary from 24 to 36 inches in diameter. Where feasible, pipelines would parallel access roads and existing roads, minimizing the impacts on land uses. Pipelines are constructed with above-ground supports, which would minimize surface disturbance, but could affect any land use activity occurring above the ground. A power plant requires approximately 15 to 25 acres to accommodate all the needed equipment. Similar to other construction required during this phase, this would result in a direct loss of land use, displacing any current activities and uses from these lands. Installing electrical transmission lines from the power plant would disturb approximately one acre per mile of transmission line. Short-term minor impacts on land uses would occur during the installation of the powerlines; however, long-term impacts from wooden poles on land use would be minimal to negligible depending on existing land uses.

Impacts on land uses during operations within the utilization phase of geothermal resource development would be minimal. Short-term minor impacts would occur from standard operation and maintenance activities such as maneuvering construction and maintenance equipment and vehicles associated with these activities. No additional impacts would be recognized during this phase unless an additional drill site is required. Impacts from additional drill sites would be the same as those discussed under the exploration and drilling operations phases, above.

Reclamation and Abandonment

Reclamation and abandonment activities include abandoning the well after production ceases and reclaiming all disturbed areas. All disturbed lands would be reclaimed in accordance with BLM and FS standards, and land uses and activities could resume.

4.2.4 What are the Potential Impacts to Land Use Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing the alternatives described in Chapter 2.

Impacts under Alternative A

Under the no action alternative, geothermal leasing for direct and indirect use would continue to occur on a case-by-case basis. Areas closed to geothermal

leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. The number of acres likely to be affected under this alternative is unknown.

Issuing geothermal leases on a case-by-base basis is not expected to affect land use. However, issuing a geothermal lease is an inherent commitment of the resource, and it is anticipated that impacts on land use would occur during geothermal exploration, drilling operations, and utilization phases, subject to environmental reviews and permits. In the absence of designating geothermal potential areas as open or closed, individual sites could be located in a number of locations and each would result in various long- and short-term impacts on land uses. Under this alternative, no comprehensive list of stipulations, best management practices, or procedures would be distributed to serve as a consistent guidance for future geothermal leasing and development. This would result in fragmented and segregated planning for land uses, which could increase recognized environmental impacts. Due to the uncertainty of total acreage considered for geothermal leasing and development under this alternative, it is not possible to quantify the total acreage affected on Federal lands.

Impacts under Alternative B

Under Alternative B, geothermal leasing for direct and indirect use would be open on approximately 197,225,000 acres. In the 12 western US states, this accounts for 54 percent of public and NFS lands (53 percent of public lands and 57 percent of NFS lands). Lands identified as open to geothermal leasing for direct and indirect use could be open with possible moderate to major constraints, depending on environmental conditions identified during site-specific reviews conducted by field offices and ranger districts prior to issuing the leases. Approximately 25,150,000 acres of public lands and 24,370,000 acres of NFS lands would be closed to geothermal leasing for direct and indirect use because these lands were found to be incompatible with geothermal leasing, exploration, and development. Areas identified as incompatible to geothermal leasing for direct and indirect use (Section 2.2.1, Allocating Lands for Leasing) include, but are not limited to, congressional designations (e.g., Wilderness Areas, National Conservation Areas) and administrative designations (e.g., Areas of Critical Environmental Concern and Inventoried Roadless Areas). Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. Relevant stipulations (Section 2.2.2) designed to protect existing land uses include controlled surface use in areas that have the potential for adverse impacts on residential areas, schools, or other adjacent urban land uses. In addition, in accordance with the identified BMPs (Appendix D), BLM and operators would contact appropriate agencies, property owners, and other stakeholders early in the planning process to identify potentially sensitive land uses and issues. It is expected that these measures would effectively avoid or minimize impacts on land uses by identifying

conflicts early in the process and requiring specific measures to maintain public uses and values.

Impacts under Alternative C

Under Alternative C, geothermal leasing for indirect use would be open on 99,073,000 acres. All federal lands identified as open for indirect use under this alternative are within 10 miles of the centerline of existing transmission lines. Restricting the placement of indirect use geothermal resource development to nearby existing transmission lines would minimize impacts on land uses by concentrating land uses associated with energy development into designated areas.

Areas open to direct use geothermal lease applications and impacts from their anticipated subsequent development would be the same as identified under Alternative B.

4.2.5 What did the Public Say about Impacts on Special Designations?

Comments received during scoping requested that geothermal leasing and projects be prohibited in and adjacent to special designation areas. Requests were also made for examination of direct and indirect impacts on special designation areas.

4.2.6 How Were the Potential Effects of Geothermal Development on Special Designations Evaluated?

Potential effects of geothermal development on special designations were evaluated by analyzing all Congressionally designated areas in the planning area, in addition to examining all areas identified by the BLM and FS in land use plans as special administrative designation areas. Impacts on these areas resulting from any future actions taken consistent with each alternative were then considered and described.

Potential impacts on special designations could occur if reasonably foreseeable future actions were to:

- Conflict with management goals and objectives set forth by the BLM or FS in order to categorize, protect, and manage special designation areas;
- Conflict with conservation goals for the area; or
- Result in proposed land uses that are incompatible with existing or adjacent special designation areas.

4.2.7 What are the Common Impacts on Special Designations Associated with Geothermal Development?

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a

general description of common impacts on special designations from geothermal resource development.

The Reasonable Foreseeable Development Scenario for Special Designations

According to the RFD scenario, it is estimated that 111 power plants could be constructed by 2015, and another 133 power plants could be constructed by 2025. The greatest development is expected to occur in California and Nevada, with the least occurring in Arizona, Colorado, Wyoming, and Montana. Most congressionally designated areas in the planning area are withdrawn from leasing; therefore, it is anticipated that no reasonable foreseeable development activities would occur in these areas. Geothermal leasing is not precluded from administrative designations, however, and any activities that would affect the values and resources identified for protection under these designations would be prohibited. As such, it is anticipated that both impacts on special designations from reasonable foreseeable development activities would be negligible.

Exploration

Congressionally-designated areas are typically withdrawn from geothermal development, so no impacts on congressional designations are anticipated from geothermal exploration. Administrative designations are not automatically withdrawn from geothermal development; however, activities likely to affect the resources and values identified for protection under these designations would be precluded.

If exploration was permitted in either type of designation, prior to any activity occurring resources and values identified for protection under the designation would be analyzed for potential impacts. Activities affecting resources and values identified for protection in these areas would be prohibited. The effects of geothermal exploration on special designations are expected to be negligible.

Drilling Operations

Impacts on congressional and administrative designations during geothermal drilling operations would be similar to those described above under exploration. Drilling operations are not expected to occur in special designations. If drilling is permitted in either type of designation, prior to any activity occurring resources and values identified for protection under the designation would be analyzed for potential impacts. Activities affecting resources and values identified for protection in these areas would be prohibited. The effects of geothermal drilling operations on special designations are expected to be negligible.

Utilization

Impacts on congressional and administrative designations during geothermal utilization would be similar to those described above under exploration. Since geothermal development is not expected to occur in special designations, utilization is not anticipated. If geothermal development is permitted in either

type of designation, prior to any activity occurring, resources and values identified for protection under the designation would be analyzed for potential impacts. Utilization activities affecting resources and values identified for protection in these areas would be prohibited. The effects of utilization on special designations are expected to be negligible.

Reclamation and Abandonment

Impacts on congressional and administrative designations during geothermal reclamation and abandonment would be similar to those described above under exploration. Since geothermal development is not expected to occur in special designations, reclamation and abandonment activities are not anticipated. If geothermal development is permitted in either type of designation, prior to any reclamation and abandonment activity occurring resources and values identified for protection under the designation would be analyzed for potential impacts. Reclamation and abandonment activities affecting resources and values identified for protection in these areas would be prohibited. The effects of reclamation and abandonment on special designations are expected to be negligible.

4.2.8 What are the Proposed Impacts on Special Designations Associated with Geothermal Development?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing the alternatives described in Chapter 2.

Impacts under Alternative A

Under Alternative A, geothermal leasing for direct and indirect use would continue to occur on a case-by-case basis, which has historically occurred at a very slow pace. Most congressionally designated areas in the planning area are withdrawn from geothermal leasing; therefore, it is anticipated that impacts on congressional designations would be negligible. In administrative designations, where geothermal leasing for direct and indirect use is not automatically precluded, field offices and ranger districts would determine if geothermal leasing would be in conformance with the prescriptions outlined in the relevant land use plan(s).

If geothermal leasing for direct and indirect use was permitted in either type of designation, prior to any activity occurring resources and values identified for protection under the designation would be analyzed for potential impacts. Activities affecting resources and values identified for protection in these areas would be prohibited, resulting in negligible impacts on special designations.

Impacts under Alternative B

Under Alternative B, the proposed action, the BLM and FS would designate a geothermal potential area (approximately 530 million acres) allocating all public and NFS lands in this area as open or closed to geothermal leasing for direct and indirect use. Congressional and administrative designations in this area that are

incompatible with geothermal leasing, exploration, and development activities would be closed. As a result, approximately 25,150,000 acres of public lands and 24,370,000 acres of NFS lands would be designated as closed, excluding these areas from future geothermal leasing for direct and indirect use. As identified in Section 2.2.1 Allocate Lands for Leasing, congressional designations that would likely be closed include Wilderness Areas, National Conservation Areas, and National Monuments. Types of administrative designation closures could include Wilderness Study Areas and some Areas of Critical Environmental Concern. Appendices I and J provide a list of congressional and administrative designations and associated acreages[1].

The following are exceptions for areas closed to geothermal leasing for direct and indirect use:

Congressional Designations

- California Desert Conservation Area (25 million acres, of which half is BLM-administered public lands) would remain open to geothermal leasing. The California Desert Conservation Area establishes long-term goals for protection and use of the California Desert. However, public lands within the designation fall under one of four multiple-use classes. Management in these classes ranges from Class C (Controlled), where lands are managed for preservation and protection, to Class I (Intensive Use), where lands are managed for concentrated use to meet human needs (grazing, mining, energy, and utility development). Over 1.67 million acres are considered to have potential for geothermal resources within the California Desert Conservation Area, however, the multiple-use class would determine whether leasing would be permitted and to what extent.

Administrative Designations

- On either public or NFS lands, if the prescription for an administrative designation, as described in the applicable land use plan(s), allows for geothermal leasing, then at the discretion of the field office or range district, these areas could remain open to geothermal leasing.
- On NFS lands, an Inventoried Roadless Area designation would not prohibit geothermal leasing; however, a nondiscretionary restriction would be placed on any leases within the designation. As a result, these areas generally may not contain geothermal development due

[1] The sum of acres for special designations (as identified in **Appendices I and J**) does ***not*** equal total acres closed to geothermal leasing under this alternative. Federal land parcels may contain more than one special designation, so adding the acreages for each designation would result in double counting.

to restrictions on road construction and reconstruction. This stipulation would cover about 80,596,000 acres.

Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. Relevant stipulations (Section 2.2.2) designed to protect special designated areas include (1) no surface occupancy on designated and eligible river segments for wild and scenic river status, and on designated or eligible sites for the National Register of Historic Places; and (2) controlled surface use for protection of National Landmarks and National Register Districts. Under the proposed leasing procedures (Section 2.2.2), other special management areas would be evaluated prior to leases using existing land use plans and environmental documentation. In addition, in accordance with BMPs (Appendix D), BLM and operators would contact appropriate agencies, property owners, and other stakeholders early in the planning process to identify potentially sensitive land uses and issues. It is expected that these measures would effectively avoid or minimize impacts to special designated areas by requiring protection and/or maintenance of the relevant and important characteristics and values of these areas.

Impacts under Alternative C

Under Alternative C, impacts on special designations from indirect use geothermal development would be similar to those described under Alternative B; however, under this alternative the geothermal potential area for indirect use is limited to areas located within 10 miles of the centerline of existing transmission lines and 15 miles from of the Yellowstone National Park boundary. The indirect use geothermal potential area would be 99,073,000 acres, which is a 50 percent decrease from Alternative B. Similar to Alternative B, the list of areas closed to geothermal leasing for indirect use under this alternative include congressional and administrative designations that are incompatible with geothermal leasing, exploration, and development activities within 10 miles of the centerline of existing transmission lines, in addition to all areas outside of the transmission line buffer. As a result, approximately 81,950,000 acres of public lands and approximately 65,710,000 acres of NFS lands would be closed to indirect use leasing.

Areas open to direct use geothermal lease applications and impacts from their subsequent development would be the same as identified under Alternative B.

4.2.9 What did the Public Say about Impacts on Recreation?

Comments received during the scoping period requested that impacts on outdoor recreation and consequences for non-mechanized, mechanized, and motorized recreation be studied and discussed. Commentors also asked that recreational impacts from the development of land tracts and their subsequent uses be analyzed.

4.2.10 How Were the Potential Effects of Geothermal Development on Recreation Evaluated?

This section examines the typical short- and long-term impacts on recreation areas and activities from geothermal development. Potential impacts on recreation could occur if reasonably foreseeable future actions were to:

- Conflict with existing recreational uses of the area; or
- Diminish existing recreational benefits and opportunities by altering the recreational setting or activity that is allowed in an area.

4.2.11 What are the Common Impacts on Recreation Associated with Geothermal Development?

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on recreation from geothermal resource development. Since issuing geothermal leases would not create surface disturbances, current recreation activities could continue until site-specific geothermal operations begin.

The Reasonable Foreseeable Development Scenario for Recreation

According to the RFD scenario, it is estimated that 111 power plants could be constructed by 2015, and another 133 power plants could be constructed by 2025. The greatest development is expected to occur in California and Nevada. The BLM and FS combined manage approximately 1,500 recreation areas, with the greatest percentage of recreation areas located in California (23 percent). Recreation users in designated areas, as well as dispersed recreation users, would be affected by geothermal development. The development of geothermal resources would alter the physical, social, and operational character of the recreation setting, thereby altering an individual's experiences.

Exploration

Surveying and drilling activities that occur during the exploration phase of geothermal development would result in the physical restriction of recreation areas, temporarily reducing the amount of land available for recreational use and accessible trails. This would displace some recreation users and limit recreation activities. Exploration activities would be completed in one to five years, at which time recreation activities could resume.

During exploration activities, recreation users participating in activities near sites would realize a diminished recreation experience. Recreation users could experience an increase in noise, vibration, and dust. Additionally, exploration could shift the ROS setting, by varying degrees, towards an urban setting to capture the addition of visual impacts such as wells, rigs, support equipment, water trucks and other vehicles, and backhoes that would become part of the landscape.

New access roads required for exploration could increase public access to previously inaccessible areas, thereby increasing recreational opportunities for some users. However, this would also alter the experience for people seeking a more remote experience in those same areas.

Drilling Operations

The drilling operations phase would result in long-term impacts on recreation resources. Similar to effects described above under the exploration phase, drilling operations could also shift the ROS setting, by varying degrees, towards a more urban setting.

Impacts on recreation resources from new access roads required for drilling operations would be similar to those impacts described above under the exploration phase.

Utilization

Impacts on recreation resources during the utilization phase of geothermal resource development would be similar to those discussed above under the drilling operations phase. The conversion of recreation lands for geothermal utilization would displace recreation users and limit activities in some areas. People engaged in activities such as hiking, camping, birding, and hunting would be most affected by construction activities within the utilization phase. During operations within the utilization phase, recreation resources would experience short-term minor impacts from standard operation and maintenance activities such as maneuvering construction and maintenance equipment and vehicles associated with these activities, which may interfere with traffic flow of recreational visitors.

Reclamation and Abandonment

Reclamation and abandonment activities include abandoning the well after production ceases and reclaiming all disturbed areas. Increased traffic from reclamation and abandonment activities could affect timely public access as described above under the utilization phase. All disturbed lands would be reclaimed in accordance with BLM and FS standards, and recreation activities could resume, improving recreational opportunities.

4.2.12 What are the Proposed Impacts on Recreation Associated with Geothermal Development?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing the alternatives described in Chapter 2.

Impacts under Alternative A

Under the no action alternative, geothermal leasing for direct and indirect use would continue to occur on a case-by-case basis. The number of acres likely to be affected under this alternative is unknown; however, it is anticipated that

minimal changes would occur in intensity to current recreational uses due to the historically slow pace of issuing geothermal leases on federal lands.

In the absence of designating geothermal potential areas as open or closed, individual sites could be developed in a number of locations and each would result in various long-term and short-term impacts on recreation activities. Under this alternative, no comprehensive list of stipulations, best management practices, or procedures would be distributed to serve as a consistent guidance for future geothermal leasing and development for direct and indirect use. This would result in fragmented and segregated planning for recreational uses, which could increase conflicts among recreation users and increase environmental impacts.

Impacts under Alternative B

Under Alternative B, the proposed action, BLM and FS would identify all public and NFS lands as open or closed to direct and indirect use within the geothermal planning area (530 million acres). Under this alternative, all designated recreation areas (Table 3-5) and lands containing dispersed recreation opportunities would be open to geothermal leasing (direct and indirect use). This includes all public lands allocated as either a Special Recreation Management Area (SRMA) or an Extensive Recreation Management Area (ERMA). National Recreation Areas, managed by BLM and FS, however are congressional designations and would be closed to geothermal leasing for direct and indirect use. (Please refer to Section 2.2.1 for complete listing of lands designated as closed to geothermal leasing.)

The action of designating lands, coupled with issuing geothermal leases, would not create any surface disturbances and therefore would not impact recreation resources. However, issuing a geothermal lease for direct or indirect use is an inherent commitment of the resource for potential future exploration, drilling, utilization, reclamation, and abandonment, subject to environmental review and permits; therefore, it is anticipated that impacts on recreation resources would occur during the geothermal exploration, drilling operations, and utilization phases.

Once geothermal development for direct or indirect use begins under this alternative, there would be minor to moderate impacts on recreation resources. As described in Section 4.1.11, What are the Common Impacts Associated with Geothermal Leasing and Development, recreation activities could be disrupted through the physical restriction of recreational areas and user trails.

Throughout various phases of geothermal development, users' enjoyment of the area could also be impacted by noise, vibration, dust, and visual impacts. Impacts on recreation resources would occur until the reclamation and abandonment phase, at which time recreation activities could resume.

In areas where SRMA boundaries overlay open geothermal potential areas, recreation users would likely be displaced to other areas. Activities related to geothermal development would alter the recreational setting within these areas, hindering the capability of the settings to continue to produce the desired existing recreation opportunities and facilitate the recreation experience and benefit opportunities. Opportunities for visitors to the SRMA would be impacted.

Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. Relevant stipulations (Section 2.2.2) designed to minimize conflicts with recreation include (1) no surface occupancy on developed recreational facilities, special-use permit recreation sites, and areas with significant recreational use with which geothermal development is deemed incompatible (excluding direct use applications), and for designated important viewsheds; and (2) controlled surface use in areas that have the potential for adverse impacts to recreational values (both motorized and non-motorized) and the natural setting associated with the recreational activity. In addition, in accordance with BMPs (Appendix D), BLM and operators would contact appropriate agencies, property owners, and other stakeholders early in the planning process to identify potentially sensitive recreational areas and issues.

It is expected that these measures would effectively avoid or minimize impacts to recreation and recreational areas by protecting the most significant recreation resources, maintaining recreational opportunities and recreational experience, reducing user and resource conflicts, and in some instances improving recreational opportunities (i.e., allowing access via new roads, etc.).

Impacts under Alternative C

Impacts from anticipated future actions consistent with implementation of Alternative C related to indirect use would be similar to those impacts described under Alternative B; impact intensity would vary depending on the percentage of recreation areas and lands identified for dispersed recreation uses that fall within 10-miles of the centerline of existing transmission lines. Stipulations and BMPs would be applied with similar effects as under Alternative B.

Areas open to direct use geothermal lease applications and impacts from their anticipated subsequent development would be the same as identified under Alternative B.

4.3 GEOLOGIC RESOURCES AND SEISMIC SETTINGS

4.3.1 What did the Public Say about Impacts on Geologic Resources and Seismic Setting?

The public was especially concerned with protecting and preserving the resources of Yellowstone Park. Commentors offered the following suggestions to protect these resources:

- Avoiding any geothermal feature or system hydraulically liked to Yellowstone's aquifer;
- Banning geothermal resource development within 15 miles of the park;
- Expanding the protected area to include the Island Park Geothermal Area and the areas defined in the Yellowstone Compact; and
- Banning development on federal land and on private lands with federal mineral rights within the area when not absolutely sure there would be no impact to the geothermal resources within the park.

Other comments were received on the effects of geothermal fluid withdrawal (e.g., subsidence) and injection (e.g., increasing seismic activity, triggering volcanic eruptions at Yellowstone Park).

4.3.2 How Were the Potential Effects of Geothermal Development on Geologic Resources and Seismic Setting Evaluated?

The potential effects of geothermal development were evaluated by assessing the effects that anticipated future actions consistent with the alternatives would have on the geology and unique geologic resources of the project area. Geothermal leasing itself would have no direct impacts on geologic resources. Indirect impacts could occur from subsequent development activities, including large-scale surface disturbances such as mining, erosion, diversion of the heat and energy resulting in reduction of surface thermal features, off-road vehicles, excavation, and vandalism; damage and vandalism are usually concentrated near roads and trails.

Specific geologic features may have value to paleontological, scenic, recreational, or cultural resources, and impacts on these resources are discussed in their respective sections. In this section, impacts to geologic features are evaluated only from the perspective of scientific value. Effects are quantified where possible; in the absence of quantitative data, best professional judgment was used.

Seismic risk is more likely to impact geothermal facilities than operation of geothermal facilities is to increase seismic risk. The high pressure injection of

fluids directly into faults zones has been related to increases in seismic activity in some cases. However, the high pressure injection of fluids from outside the geologic system is not the same as where geothermal fluid withdrawn from the resources is used and then reinjected back into the system for a near zero net change. The near zero net change would represent much lower risk of increasing seismic activity.

Subsidence can occur where groundwater is pumped from underground aquifers at a rate exceeding the rate that it is replenished. Most of the geothermal development includes reinjection of the geothermal fluid after the heat is utilized. Therefore, the potential for subsidence is low.

4.3.3 What are the Common Impacts on Geologic Resources and Seismic Setting Associated with Geothermal Development?

Large-scale unique geologic features (e.g., the Yellowstone area, Grand Canyon) are protected through units of the national park and national monument systems. Smaller-scale unique geologic features (e.g., natural arches, caves, sources of unique geologic specimens) that are outside the park and monument systems could be impacted by geothermal resource development activities.

The potential impacts on geologic resources from geothermal development mainly concern physical disturbance (e.g., movement, removal or destruction). These impacts are considered long term, as they cannot be reclaimed. In most BLM resource management plans, and in FS policy, leasing and associated roads and other physical disturbance must avoid sensitive geologic resources in order to be approved. Additional indirect impacts would result from greater public access to formerly inaccessible areas. Greater public access can result in increased wear and vandalism of sensitive geologic features. These impacts can be short term if roads are reclaimed.

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on geologic resources from geothermal resource development. The RFD scenario for geothermal resource use involves four sequential phases: exploration, drilling operations, utilization, and reclamation and abandonment.

The Reasonable Foreseeable Development Scenario for Geologic Resources and Seismic Setting

According to the RFD scenario, it is estimated that 111 power plants could be constructed by 2015, and another 133 power plants could be constructed by 2025. The most development is expected to occur in California and Nevada, and the least is expected to occur in Arizona, Colorado, Wyoming, and Montana. The typical acreage of disturbance in a complete buildout for geothermal resource development is 53 to 367 acres. Therefore, total land use

disturbance would be approximately 5,883 acres to 40,737 acres by 2015 and 12,932 acres to 89,548 acres by 2025.

Exploration

The exploration phase includes surveying and drilling temperature gradient wells. Surveying activities would directly impact geologic resources through disturbance at seismic survey pulse sites. Detonation of explosives would greatly disturb a small area around each detonation. Any delicate geologic resources (e.g., natural arches, balancing rocks, cave formations) within the blast area would be disturbed. The use of thumper trucks would not impact sensitive geologic resources. While the area of disturbance at each seismic pulse site would be small, a large seismic survey could include many sites. New roads or routes may be needed to allow survey equipment to access the potential geothermal sites. Roads would disturb any geologic resources within the right-of-way. The impacts of surveying activities would be short term.

The impacts to geologic resources from drilling temperature gradient wells would be minor. The siting of the wells would not likely impact geologic resources, as clear flat areas are preferable for drilling sites. Similar to surveying activities, roads would be required to access wells, which would impact any geologic resources within the right-of-way. Several wells could be drilled per lease, and each drill site could disturb approximately 0.9 acres. Impacts would occur on lands directly under the well sites.

By following BLM and FS guidelines, sensitive geologic resources would be avoided. The long-term impacts would be minor. The impacts of increased public access due to new road construction would be short term, as the roads allowing the increased public access would be reclaimed after exploration activities are complete.

Drilling Operations

The drilling operations phase would result in long-term impacts to any geologic resources within the area of disturbance. The drilling operations phase would require additional access roads to accommodate larger equipment to drill production and injection wells and to construct sump pits. Roads to accommodate production wells are typically between 0.5 and 4 miles long and 30 feet wide, for a disturbance of between 2 and 15 acres. The drilling operations phase includes drill site development, which on average requires a 5-50 acre disturbance from well pads.

Spent or used geothermal fluids may be reinjected back into the geothermal resource, evaporated in sumps or lagoons, or used for potable and nonpotable domestic and municipal uses depending on the water quality of the geothermal fluid, shallow groundwater quality, and surface water conditions. If the proposed geothermal resource development includes high-pressure reinjection, there is a

small chance that seismic activity could increase along any faults intersected by the injection well.

Any geologic resource within the areas of disturbance described above would be impacted. These impacts would be long term, as they could not be reclaimed. Impacts resulting from increased public access would also be long term for the life of the development.

Utilization

Impacts on geologic resources during initial buildout of the utilization phase of geothermal resource development would be greater than the other phases of development because of the increased footprint. The utilization phase requires construction of additional roads, wells, and structures to support full buildout of a direct use or indirect use facility. The utilization phase would require access roads to accommodate larger equipment, plus additional roads for accessing the power plant. The well field equipment includes pipelines with a disturbance zone approximately 40 feet wide. Where feasible, pipelines would parallel access roads and existing roads. The disturbance would include the pads for pipeline supports as well as the access and maintenance roads along the pipeline.

A power plant requires approximately 15 to 25 acres to accommodate all the needed equipment. Similar to other construction required during this phase, this would result in a direct disturbance of any geologic resources within the footprint of the facility. Installing electrical transmission lines from the power plant would disturb approximately one acre per mile of transmission line for lengths from 5 to 50 miles. The disturbance would include the pads for powerline support structures as well as the access and maintenance roads along the powerline.

The initial areas disturbed during construction of the utilization phase would continue to be used sporadically during standard operation and maintenance activities, such as maneuvering construction and maintenance equipment and the vehicles associated with these activities. No additional impacts would be recognized during this phase unless an additional drill site is required. Impacts from additional drill sites would be the same as discussed under the drilling operations phase, above.

Reclamation and Abandonment

Reclamation and abandonment activities include abandoning the wells after production ceases and reclaiming all disturbed areas. All disturbed lands would be reclaimed in accordance with BLM and FS standards. If the roads are reclaimed, the impacts resulting from greater public access would decrease.

4.3.4 What are the Potential Impacts on Geologic Resources and Seismic Setting Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing the alternatives described in Chapter 2.

Impacts under Alternative A

Under the no action alternative, lease applications would continue to be processed on a case-by-case basis. Areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. The number of acres likely to be affected under this alternative is unknown.

Issuing geothermal leases for direct and indirect use on a case-by-base basis includes avoiding potential impacts from anticipated future actions on unique geologic resources in many BLM field offices and FS ranger districts. In addition, unique geologic resources may receive protection through avoidance and mitigation measures for other resources, where those resources include unique geologic features. Examples include features that are part of a Class I visual landscape, features of cultural importance to Native Americans, or caves with bat populations.

Under this alternative, no comprehensive list of stipulations, best management practices, or procedures would be distributed to serve as consistent guidance for future geothermal leasing and development. The leasing approvals and stipulations would continue to be varied, as would mitigation and reclamation levels. Overall potential impacts to geologic resources from anticipated future actions would be similar to those identified in the four phases of development in Section 4.3.3, above, on a case-by-case basis.

Impacts under Alternative B

Under Alternative B, the Island Park Geothermal Area would be closed to direct and indirect geothermal resource development. The BLM or FS would apply lease stipulations (Section 2.2.2) to protect the integrity of geothermal resource features, such as springs and geysers, in areas open to geothermal resource development. The BLM or FS would include lease stipulations to protect any significant thermal features of a National Park System unit that could be adversely affected by geothermal development. In addition, any leases that contain thermal features (e.g., springs or surface expressions) would have a stipulation requiring monitoring of the thermal features during any exploration, development, and production of the lease to ensure that there are no impacts to water quality or quantity. Unique geologic resources in areas open to geothermal leasing and development for direct and indirect use would also be protected through avoidance and mitigation measures for other resources, where those resources include unique geologic features (e.g., visual and cultural resources). Alternative B includes many comprehensive closures, stipulations,

and BMPs (Appendix D) affecting these other resources that would result in more protection for associated unique geologic features than under Alternative A. It is expected that these measures would effectively avoid or minimize impacts to geologic resources and seismic settings by protecting the most sensitive areas and monitoring for and maintaining the unique resource values of all other geologic features.

Impacts under Alternative C

Alternative C focuses geothermal leasing and development for indirect use on public lands and NFS lands that are within 10 miles of the centerline of existing transmission lines and at least 15 miles outside of the Yellowstone National Park boundary. The public and NFS lands outside of these areas would be closed to indirect use leasing.

The comprehensive list of stipulations, best management practices, and procedures discussed under Alternative B would be applied to those areas open for direct and indirect use under Alternative C. Potential impacts from anticipated future actions within the transmission line area are expected to be minimal because of the previous disturbance to geologic resources during construction of the existing transmission lines. Areas open to direct use geothermal lease applications and impacts from their anticipated subsequent development would be the same as identified under Alternative B.

4.4 ENERGY AND MINERAL RESOURCES

4.4.1 What did the Public Say about Impacts on Energy and Minerals?

Public comments included whether to close particular types of public lands (e.g., National Parks, FS roadless areas) to geothermal development, consideration of existing and proposed transmission line routes, discussion of other power sales agreements in the proposed development areas, and the past reclamation of subsurface minerals and energy resource claims in the area.

The discussion of other power sales agreements in the proposed development areas is outside the scope of this PEIS. The presence of and plans for other power generation or transmission facilities near the proposed development sites are evaluated as part of the cumulative impacts analysis (Chapter 5).

The track record of past reclamation activities is outside the scope of this PEIS. The status and condition of past reclamation efforts for other energy and mineral resource developments was included in the affected environment discussion for the various environmental resources in each specific leasing area. The conditions associated with reclamation of the subject geothermal developments are included in the discussions for each environmental resource.

4.4.2 How Were the Potential Effects of Geothermal Development on Energy and Minerals Evaluated?

The potential effects of geothermal development were evaluated by assessing the effects that anticipated future actions consistent with implementation of the alternatives described in Chapter 2 would have on energy and mineral resources. Geothermal leasing itself would have no direct impacts on energy and mineral resources. Impacts would occur from subsequent development activities.

Potential impacts on energy and mineral resources could occur if reasonably foreseeable future actions were to:

- Result in the construction of transmission lines that would affect the feasibility of other energy development along the transmission corridor; or
- Develop roads that would encourage other energy and mineral exploration in otherwise undeveloped areas.

4.4.3 What are the Common Impacts on Energy and Minerals Associated with Geothermal Development?

Developing energy and mineral resources on federal lands is subject to location and operational constraints resulting from national, regional, and local laws, regulations, policies, and guidelines associated with protecting other environmental resources (e.g., endangered species). These protections include

withdrawing or closing lands to energy and mineral resource activities, exclusion areas, buffer zones around sensitive areas, limitations on surface occupancy, seasonal limitations, and other permit stipulations. Changes in these regulations and policies have the direct effect of increasing or decreasing the land available for energy and resource development and associated costs.

The impacts on energy and mineral resources from potential geothermal exploration and development activities would be greatly dependent on the local presence and characteristics of energy and mineral resources. Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on energy and mineral resources from geothermal resource development.

Common impacts from geothermal energy development include vegetation loss, air quality impacts from fugitive dust and diesel exhaust, noise emissions, soil erosion and compaction, and hazardous waste generation.

The Reasonable Foreseeable Development Scenario for Energy and Minerals

In general, any infrastructure improvements (e.g., roads, transmission lines, pipelines) associated with the exploration and development of geothermal resources would have a minor to major advantage for the exploration and development of other energy and mineral resources within the immediate area.

Any land being used for exploration and development activities would become unavailable for developing other mineral resources (e.g., aggregates, solid minerals).

Exploration

Improving existing roads and constructing new roads for geothermal resource exploration would have a negligible to minor impact on the exploration for other energy and mineral resources in the immediate area. The degree of impact would depend on the existing limits to access in the area and the distance of the roads to the other mineral resources.

Drilling Operations

The cost of improving roads would be less for later developments because roads accessing the general area will have already been developed. These impacts would be reduced with increased distance from the new roads. Drilling operations would preclude developing any other energy or mineral resources on the same land.

Utilization

Introducing new transmission lines would encourage developing other energy resources along the transmission line. Mineral resource developments would be

encouraged due to the new availability of power for their operations. These impacts would be reduced with increased distance from the power plant, roads, and transmission lines.

During the utilization phase, other operations in the immediate area of the power plant might be able to take advantage of the downstream heat from the power plant. Utilization of the geothermal resources would have minor or no impact on other energy or mineral resources.

Reclamation and Abandonment

Upon reclamation and abandonment of geothermal operations, any other ongoing operations in the area would have to take over maintenance of shared facilities (e.g., roads, transmission lines). Reclamation and abandonment of geothermal resources would have minor or no impact on other energy or mineral resources.

4.4.4 What are the Potential Impacts on Energy and Minerals Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing the alternatives described in Chapter 2.

Impacts under Alternative A

Under the no action alternative, lease applications would continue to be processed on a case-by-case basis. Areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. Geothermal resources are managed by BLM and FS as fluid leasable minerals, which includes oil and gas. Therefore, policies on closure of land to fluid minerals leasing or restrictions on the fluid minerals activities apply to both geothermal and oil and gas resources.

Some of the land classifications listed in Section 2.2.1 (e.g., ACECs, roadless areas) do not include automatic closure to fluid minerals leasing and therefore do not include closure to geothermal leasing for direct or indirect use. Other lands have exclusion or buffer zones (e.g., National Historic Trails) that vary from field office to field office based on local conditions. Where these constraints vary, they are applied or expanded at the discretion of the individual field offices. No surface occupancy/no ground disturbance constraints and other mitigation and reclamation requirements are applied on a case-by-case basis and are often dependent on site-specific conditions. The number of acres likely to be affected under this alternative is unknown.

Impacts under Alternative B

Under Alternative B, the amount of land closed to geothermal leasing for direct and indirect use would increase compared to Alternative A. Some lands currently open, or open with stipulations, to fluid minerals leasing would be

closed to geothermal leasing for direct and indirect use. Buffer zones around other features would increase as they are applied to geothermal resource leasing for direct and indirect use. These restrictions would be applied uniformly throughout the western states.

Under Alternative B, the stipulations listed in Section 2.2.2 and the BMPs listed in Appendix D would be required, with exceptions granted on a case-by-case basis. Under Alternative A, stipulations and BMPS are applied only on a case-by-case basis, as there are no consistent guidelines across field offices.

There would be less land available for exploration and development of geothermal resources for direct and indirect use under Alternative B when compared to Alternative A. The increased restrictions would result in increased operational costs.

These increased constraints would not apply to fluid minerals leasing other than geothermal resources (e.g., oil and gas leasing) or to other energy developments (e.g., solar and wind). The amount of land available to other fluid minerals leasing would not change. Those constraints that are applied on a case-by-case basis at the discretion of the field offices would not be changed to general restrictions.

There would be no immediate impact on the availability of lands for exploration and development of other energy and fluid mineral resources under Alternative B. There would be no associated increase in operational costs. However, there is potential that these additional closures and higher levels of restrictions would establish new precedents and would subsequently affect the policies and practices guiding all energy resource development and fluid minerals leasing on federal lands. Should this occur, the amount of land available to other energy resource development and fluid minerals leasing would decrease to the same degree as geothermal leasing. The increased restrictions would increase the associated operational costs.

Impacts under Alternative C

Under Alternative C, only those lands within 10 miles of the centerline of existing transmission lines and at least 15 miles outside of the Yellowstone National Park boundary would be available for indirect use geothermal resource development. The standardized stipulations and constraints discussed under Alternative B would be applied to these lands. The lands outside of the existing transmission line buffer would be closed to indirect use geothermal development.

There would be less land available for exploration and development of geothermal resources for indirect use than under Alternatives A or B. The increased restrictions would result in increased operational costs within the existing transmission line buffer.

These increased constraints would not apply to other energy resource development and fluid minerals leasing other than geothermal resources (e.g., oil and gas leasing). The amount of land available to other energy resource development and fluid minerals leasing would not change. There would be no associated increase in operational costs.

Areas open to direct use geothermal lease applications and impacts from their subsequent development would be the same as identified under Alternative B.

4.5 PALEONTOLOGICAL RESOURCES

4.5.1 What did the Public Say about Impacts on Paleontological Resources?

No comments pertaining to impacts on paleontological resources were received.

4.5.2 How Were the Potential Effects of Geothermal Development on Paleontological Resources Evaluated?

The loss of any fossil that could yield information important to prehistory, or that embodies the distinctive characteristics of a type of organism, environment, period of time, or geographic region, would be an impact on paleontological resources. Paleontological resource impacts primarily concern the potential destruction of nonrenewable fossil resources and the loss of information associated with these resources. This includes destruction as the result of surface disturbance and the unlawful or unauthorized collection of fossil remains.

Paleontological resources are preserved in sedimentary geologic units of Precambrian to Pleistocene age. Geothermal resources are, by nature, located in tectonically active areas with topographic and structural complexities that are typically characterized by extensive formational exposures that may include fossiliferous rocks. The potential for impacts on both surface and subsurface paleontological resources is directly proportional to the amount of surface disturbance associated with a proposed action. At this programmatic level of analysis, it is not possible to identify and evaluate areas of higher paleontological sensitivity with respect to locations of proposed surface disturbance. Therefore, potential impacts on paleontological resources under each alternative can only be generally estimated, and they correlate directly to the amount of anticipated surface disturbance proposed under each alternative.

To the extent possible at this level of analysis, potential impacts on paleontological resources were evaluated using the recently revised Potential Fossil Yield Classification system (PFYC, BLM 2008-009). This evaluation of potential effects on paleontological resources assumes that geothermal leasing alternatives associated with the largest acreage of disturbance correlate with the greatest likelihood of impacts on paleontologically sensitive (PFYC Class 3-5) geologic formations. This assumption may prove to be inaccurate once lease-specific analyses are undertaken, but it is appropriate for a programmatic level of analysis.

Potential impacts on paleontological resources could occur if reasonably foreseeable future actions were to result in the following:

- Result in the disturbance of paleontologically sensitive geologic formations (PFYC Class 3-5); or

- Conflict with paleontological resource management objectives and guidelines established by the BLM and FS.

4.5.3 What are the Common Impacts on Paleontological Resources Associated with Geothermal Development?

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on paleontological resources from geothermal resource development.

Impacts on nonrenewable surface or subsurface paleontological resources result from destruction by breakage and crushing during surface-disturbing actions. Surface disturbance related to geothermal development has the potential to impact an unknown quantity of fossils that may occur on or underneath the surface in areas containing paleontologically sensitive geologic units. Without mitigation, these fossils, as well as the paleontological data they could provide if properly salvaged and documented, could be destroyed, rendering them permanently unavailable. Impacts can typically be mitigated to below a level of significance by implementing paleontological mitigation. Mitigation also results in the salvage of fossils that may never have been unearthed as the result of natural processes. With mitigation, these newly exposed fossils become available for scientific research, education, display, and preservation into perpetuity at a public museum.

Impacts also result from the continuing implementation of management decisions and associated activities. For paleontological resources, impacts most commonly occur as the result of management actions that increase the accessibility of public lands, increasing the potential for loss of paleontological resources by vandalism and unlawful collecting (poaching). These impacts are difficult to mitigate to below the level of significance, but they can be greatly reduced by increasing public awareness about the scientific importance of paleontological resources through education, community partnerships, and interpretive displays, and by informing the public about penalties for unlawful destruction or unlawful collection of these resources from public lands.

Cumulative impacts result from individually minor but collectively significant actions taking place over a period of time. In general, if previously unrecorded, scientifically significant paleontological resources are present within the Planning Area, the potential cumulative impacts would be low, so long as mitigation was implemented to salvage the resources. The use of stipulations, best management practices, and paleontological resources management plans as described under Alternative B in this section would effectively recover the value to science and society of significant fossils that would otherwise have been destroyed by ground-disturbing actions.

Because paleontological resources are nonrenewable, impacts that result in their loss are considered to be long term.

The Reasonable Foreseeable Development Scenario for Paleontological Resources

The four RFD phases of geothermal development include exploration, development, production, and closeout. According to the RFD scenario, it is estimated that 111 power plants could be constructed by 2015, and another 133 power plants could be constructed by 2025. The greatest development is expected to occur in California and Nevada, with the least occurring in Arizona, Colorado, Wyoming, and Montana. The typical acreage of disturbance in a geothermal resource development phase is 53 to 367 acres. Therefore, total geothermal surface disturbance would be approximately 5,883 acres to 40,737 acres by 2015 and 12,932 acres to 89,548 acres by 2025.

Exploration

Geothermal exploration is anticipated to last from one to five years and involves first surveying and then drilling for temperature gradient wells. Surface disturbance resulting from geothermal surveys is primarily the result of access road construction and seismic and resistivity surveys. Drilling for temperature gradient wells results in surface disturbance during construction of wells and access roads.

Impacts on surface and subsurface paleontological resources could occur wherever grading for access roads and drilling sites takes place in paleontologically sensitive geographic areas or geologic units. Seismic and resistivity surveys have the potential to impact surface occurrences of paleontological resources where these activities take place in paleontologically sensitive areas/geologic units. Additional impacts could occur as the result of increased public access to previously remote paleontologically sensitive areas.

Drilling Operations

This phase requires grading for additional access roads, developing drill sites (average of two acres per well pad), and constructing pipelines, additional wells (production and injection), and sump pits.

As previously stated, impacts on surface and subsurface paleontological resources could occur wherever surface-disturbing actions related to geothermal development take place in paleontologically sensitive geographic areas or geologic units. Additional impacts could occur as the result of increased public access to previously remote paleontologically sensitive areas.

Utilization

Construction within the drilling operations phase involves assembling the infrastructure needed to use the underground geothermal reservoir and would last from two to ten years. Construction within the drilling operations phase

involves the greatest amount of surface disturbance and therefore has the greatest potential for impacting paleontological resources. This phase requires grading for access roads, developing drill sites (average of 5-50 acre well-pad disturbance per plant), and constructing pipelines, transmission lines, and power plants (approximately 15 to 25 acres per plant site).

Operations within the utilization phase lasts from ten to thirty years and involves the ongoing operation and maintenance of the geothermal field, including developing new drilling sites, as needed.

Reclamation and Abandonment

Reclamation and abandonment activities include reclamation of all disturbed areas after production ceases. Assuming that no new surface disturbance occurs during the closeout phase, no new impacts on surface or subsurface paleontological resources would be anticipated.

Following the reclamation and abandonment phase, paleontologically sensitive areas that are reclaimed and that become less accessible to the public would lower the future likelihood of loss through vandalism and unlawful collection, thus lowering future impacts associated with these activities to pre-geothermal leasing levels.

4.5.4 What are the Potential Impacts on Paleontological Resources Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of implementing the alternatives described in Chapter 2.

Impacts under Alternative A

Under the no action alternative, areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. The number of acres likely to be affected under this alternative is unknown.

Due to the uncertainty of the total acreage and specific locations considered for geothermal leasing and development for direct and indirect use under this alternative, it is not possible to quantify the total acreage of potentially affected paleontologically sensitive formations. However, issuing geothermal leases on a case-by-base basis is not expected to result in different effects on paleontological resources than Alternatives B and C. In the long term, if case-by-case leasing for direct and indirect use results in a larger cumulative geographic area of surface disturbance than Alternatives B and C, then Alternative A may have a greater likelihood of impacts on paleontological resources using the assumptions made in Section 4.5.2.

Impacts under Alternative B

Under Alternative B, the proposed action, approximately 118,000,000 acres of public land and 79,000,000 acres of FS land would be designated as open to geothermal leasing for direct and indirect use.

As stated above, due to the uncertainty of total acreage and specific locations considered for geothermal leasing and development for direct and indirect use under Alternative A, it is not possible to quantifiably compare the potential for paleontological resource impacts between anticipated future actions consistent with each of the alternatives. However, due to the Alternative C proposal that indirect use geothermal leasing be further restricted to within a 10-mile distance of the centerline of existing transmission lines, Alternative B has a higher likelihood of anticipated future actions with impacts on paleontological resources than Alternative C using the assumptions made in Section 4.5.2.

Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. In accordance with BMPs (Appendix D), operators would determine whether paleontological resources exist in a project area on the basis of the sedimentary context of the area, a records search of past paleontological finds in the area and/or, depending on the extent of existing information, paleontological survey. If paleontological resources are present at the site, or if areas with high potential have been identified, a paleontological resources management plan would be developed that identifies appropriate monitoring and protection measures. Unexpected discovery of paleontological resources during geothermal development would be brought to the attention of the responsible BLM authorized office immediately and work would be halted in the vicinity of the finds to avoid further disturbance while the finds are evaluated and appropriate mitigation measures are developed. It is expected that these measures would effectively avoid, minimize or mitigate impacts on paleontological resources by protecting and conserving significant paleontological resources as they are discovered on public lands.

Impacts under Alternative C

Under Alternative C, approximately 61,200,000 acres of public land and 37,900,000 acres of NFS land would be designated as open to geothermal leasing for indirect use. Alternative C differs from Alternative B in that the BLM and FS would only consider indirect use leasing within 10 miles from the centerline of existing 60 kV to 500 kV transmission lines.

Due to the uncertainty of the total acreage and specific locations considered for geothermal leasing and development for direct and indirect use under Alternative A, it is not possible to quantifiably compare the potential for paleontological resource impacts from anticipated future actions consistent with Alternative A and those anticipated future actions consistent with Alternatives B

and C, respectively. However, due to the Alternative C proposal that geothermal leasing for indirect use be further restricted to within 10 miles from the centerline of existing transmission lines and at least 15 miles outside of the Yellowstone National Park boundary, Alternative C has a lower likelihood of anticipated future actions with potential impacts on paleontological resources than Alternative B using the assumptions made in Section 4.5.2. Impacts within the transmission line area are expected to be minimal because of the previous disturbance to paleontological resources while constructing the existing transmission lines.

Areas open to direct use geothermal lease applications and impacts from anticipated future actions consistent with Alternative C would be the same as identified under Alternative B.

4.6 SOIL RESOURCES

4.6.1 What did the Public Say about Impacts on Soil Resources?

Commentors requested that direct and cumulative impacts on steep, unstable, easily eroded, and saline soils be assessed. Other commentors requested that the analysis include spill prevention, planning, and cleanup measures for geothermal resource development activities.

4.6.2 How Were the Potential Effects of Geothermal Development on Soil Resources Evaluated?

Chapter 3 discussed the types of soil resources (orders) and their general characteristics present in the areas with potential for geothermal development. Impacts on soil resources are discussed in generic terms of amount of disturbance typically associated with geothermal resource development. Impacts on specific soil types, including prime and unique farmlands and farmlands of statewide importance, are discussed for each proposed lease. The amount of disturbance that would be associated with the reasonably foreseeable development scenario was assessed for the soil resources present in each specific lease area.

Potential impacts on soil resources could occur if reasonably foreseeable future actions were to result in the following:

- Remove prime farmlands from production;
- Take place on slopes of greater than 40 percent;
- Increase the mid- to long-term erosion of soil resources in the area;
- Cause soil resource compaction where soil crusts are present; or
- Result in spills of hazardous materials.
- Remove forest land from production

The potential impacts of the alternatives were evaluated on the basis of amount of area that would be open for exploration and development and the general presence of soil crusts, easily eroded soils, and prime farmlands.

4.6.3 What are the Common Impacts on Soil Resources Associated with Geothermal Development?

The potential impacts on soil resources from geothermal development include physical disturbance (e.g., movement or removal), compaction, changes to erosion patterns, and changes in current use as farmland. Any development or infrastructure (e.g., wells, roads, or pipelines) on steep slopes would increase erosion and could increase risk of landslides.

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on soil resources from geothermal resource development. This RFD scenario involves four sequential phases: exploration, drilling operations, utilization, and reclamation and abandonment.

The Reasonable Foreseeable Development Scenario for Soil Resources

According to the RFD scenario, it is estimated that 111 power plants could be constructed by 2015, and another 133 power plants could be constructed by 2025. The most development is expected to occur in California and Nevada and the least is expected to occur in Colorado, Arizona, Wyoming, and Montana. The typical acreage of disturbance in a complete geothermal resource development is 53 to 367 acres. Therefore, total land use disturbance would be approximately 5,883 acres to 40,737 acres by 2015 and 12,932 acres to 89,548 acres by 2025.

Exploration

The exploration phase includes surveying and drilling temperature gradient wells. Surveying activities would impact soil resources through disturbance at seismic survey pulse sites. Detonation of explosives would greatly disturb a small area around each detonation. The soil resources beneath each thumper truck site would be compacted. While the area of disturbance at each seismic pulse site would be small, a large seismic survey could include many sites. New roads or routes may be needed to allow survey equipment to access the potential geothermal sites. The impacts of survey activities would be short term. Following surveying activities, all roads and routes would be reclaimed to BLM and FS standards, thereby minimizing any long-term impacts on land uses.

The impacts on soil resources from drilling temperature gradient wells would be minor. Similar to surveying activities, roads would be required to access wells. Several wells could be drilled per lease, for an area of disturbance of approximately 0.9 acres. Impacts would occur on lands directly under the well sites; however, impacts last only the duration of the drilling and reclamation activities (several weeks). The drilling sites and access routes would be reclaimed to BLM and FS standards, thereby minimizing any long-term impacts on soil resources.

Drilling Operations

The drilling operations phase of development would result in short-term impacts on soil resources. The drilling operations phase would require access roads to accommodate larger equipment. Roads for the production wells are typically between 0.5 and 4 miles long and 30 feet wide, for a disturbance of between 2 and 15 acres. New roads would impact any soil resources within their rights-of-way.

The drilling operations phase also includes drill site development, which on average requires a two-acre well pad. Soil resources under each well pad would be impacted.

Utilization

The utilization phase of development would result in long-term impacts on soil resources. The utilization phase would require additional access roads to accommodate larger equipment and for accessing the power plant. Well field equipment and support structures would be constructed. The well field equipment includes pipelines with a disturbance zone approximately 40 feet wide and typically one to four miles in length. Where feasible, pipelines would parallel access roads and existing roads, minimizing the impacts on soil resources. Pipelines are constructed on supports above ground, which would minimize surface disturbance. The disturbance would include the pads for pipeline supports and the access and maintenance roads along the pipeline.

A power plant requires approximately 15 to 25 acres to accommodate all the needed equipment. Similar to other construction required during this phase, this would result in a direct disturbance of the soils within the footprint of the facility.

Installing electrical transmission lines from the power plant would disturb approximately 24-240 acres with a 40-foot-wide disturbance area along transmission line for lengths from 5 to 50 miles long. The disturbance would include the pads for powerline support structures and the access and maintenance roads along the powerline.

Impacts on soil resources during the operation of the geothermal power plant would be minimal. The initial areas disturbed during construction would continue to be used sporadically during standard operation and maintenance activities, such as maneuvering construction and maintenance equipment and the vehicles associated with these activities. No additional impacts would be recognized during this phase unless an additional drill site is required. Impacts from additional drill sites would be the same as those impacts discussed under the exploration and drilling operations phases, above.

Reclamation and Abandonment

Reclamation and abandonment activities include abandoning the wells after production ceases and reclaiming all disturbed areas. All disturbed lands would be reclaimed in accordance with BLM and FS standards.

4.6.4 What are the Potential Impacts on Soil Resources Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of implementing the alternatives described in Chapter 2.

Impacts under Alternative A

Under the no action alternative, lease applications would continue to be processed on a case-by-case basis. Areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. The number of acres likely to be affected under this alternative is unknown.

Issuing geothermal leases for direct and indirect use on a case-by-base basis is not expected to affect soil resources. Impacts on soil resources would occur during subsequent exploration, drilling operations, and utilization phases. These activities at each individual site would incur various long- and short-term impacts on soil resources. Under this alternative, no comprehensive list of stipulations, best management practices, or procedures would be distributed to serve as consistent guidance for future geothermal leasing and development. The leasing approvals and stipulations would continue to be varied, as would mitigation and reclamation levels.

While all disturbed lands would be required to be reclaimed in accordance with BLM and FS standards, these standards may be applied in a varied manner for individual field offices and ranger districts. Due to the uncertainty of total acreage considered for geothermal leasing and development for direct and indirect use under this alternative, it is not possible to quantify the total acreage affected on federal lands.

Impacts under Alternative B

Under Alternative B, the proposed action, geothermal leasing for direct and indirect use would be open on 118,000,000 acres of public lands and 79,000,000 acres of NFS lands in the western US and Alaska. Lands identified as open to geothermal leasing for direct and indirect use could include moderate to major constraints to reduce potential impacts on soil resources, depending on the environmental conditions identified during site-specific reviews conducted by field offices and ranger districts prior to issuing the leases. Approximately 25,150,000 acres of public lands and 24,370,000 acres of NFS lands would be closed to geothermal leasing for direct and indirect use because the lands are incompatible with geothermal leasing, exploration, and development. Additional lands could be closed to geothermal resource leasing for direct and indirect use due to local conditions at the discretion of the individual field offices and ranger districts.

Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. Relevant stipulations (Section 2.2.2) designed to minimize impacts on soil resources include 1) no surface occupancy on slopes in excess of 40 percent and/or soils with high erosion potential; and 2) controlled surface use on slopes greater that 30 percent and/or erosive soils as defined as severe or very severe erosions

classes based on Natural Resources Conservation Service mapping. In accordance with BMPs (Appendix D), operators would identify unstable slopes and local factors that can induce slope instability. Special construction techniques would be used where applicable in areas of steep slopes, erodible soil, and stream channel crossings. Operators would also be required to adhere to a plan of development that includes spill prevention and cleanup provisions. It is expected that these measures would effectively avoid and/or minimize impacts on soil resources by protecting the most sensitive areas, minimizing erosion, maintaining soil productivity, and minimizing surface disturbance from authorized activities.

Impacts under Alternative C

Under Alternative C, geothermal leasing for indirect use would be open on 61,200,000 acres of public lands and on 37,900,000 acres of NFS land in the western US and Alaska. Geothermal resource development for indirect use would be encouraged within 10 miles of the centerline of existing transmission lines and at least 15 miles outside of the Yellowstone National Park boundary.

The comprehensive list of stipulations, best management practices, and procedures discussed under Alternative B would be applied to those areas within the transmission line buffer areas. Areas open to direct use geothermal lease applications and impacts from their subsequent development would be the same as identified under Alternative B.

4.7 WATER RESOURCES AND QUALITY

4.7.1 What did the Public Say about Impacts on Water Resources and Quality?

Commentors asked that the impacts on surface water resources from geothermal development activities be discussed in the PEIS, including changes to drainage in development areas, discharges, onsite containment, water additives, stormwater discharge permits, 404 permits and waters of the US in the development areas, and impacts on water hydrology and stream channel morphology, water quality, pools, and hot springs.

Commentors asked that the impacts on groundwater resources from geothermal development activities be discussed in the PEIS, including preventing the accidental discharge of geothermal fluids with toxic chemical properties into the environment, water needs for geothermal resource development, impacts on water quantity and quality, methods of water discharge, and differences with shallow groundwater.

4.7.2 How Were the Potential Effects of Geothermal Development on Water Resources and Quality Evaluated?

Leasing land does not involve ground-disturbing activities or any type of construction, so there would be no direct impact on water resources. Impacts would result from activities pursued after leasing.

This section discusses the potential impacts of anticipated future actions consistent with each of the alternatives on the water resources in the Planning Area. Potential impacts on water resources could occur if reasonably foreseeable future actions were to result in the following:

- Involved surface disturbance such as building roads or preparing drill sites or plant sites that could increase erosion and sedimentation;
- Substantially depleted groundwater supplies or interfered substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level;
- Uses or facilities that would substantially degrade surface or groundwater quality; or
- Changing conditions such that the geothermal resource itself was degraded.

Water quality and quantity is of interest to other resources as well. Biological resources, cultural resources, and recreation may be impacted by changes to water quantity and quality. In this section, impacts on water resources are evaluated only from the perspective of changes to water availability and quality.

Impacts from the perspective of other values (e.g., impacts of water quality on livestock, or reduced flow from a sacred spring) are discussed in sections for the other resources. Effects are quantified where possible; in the absence of quantitative data, best professional judgment was used. While the development of geothermal resources would be intricately linked with groundwater and surface water rights, those rights are very specific to individual locations, aquifers, landowners, and local jurisdictions.

4.7.3 What are the Common Impacts on Water Resources and Quality Associated with Geothermal Development?

Geothermal fluids can be steam or fluid or a mixture under pressure. The geothermal fluids are extracted from the resource, and the heat is used either directly to heat air or water or indirectly to generate electrical power. Once the heat in the geothermal fluid has been used, it is considered "spent." Direct-use systems are smaller and have less impact than indirect uses. Indirect uses are discussed below.

Direct-use geothermal systems use low- to moderate-temperature fluids. Binary power systems use higher temperature geothermal fluids or use heat exchangers with lower boiling point working fluids. The steam and flash steam power plants use the mixed geothermal fluids and pure steam.

The spent geothermal fluid is usually reinjected into the geothermal resource, but it may be evaporated in lagoons or discharged to surface water depending on the relative water quality and temperature. In rare cases, the spent geothermal fluid may be potable and used for agricultural or domestic purposes. The dry steam power plants emit the steam after it has been used and reinject any condensed fluids.

Developing geothermal resources includes using surface water or groundwater for operations, mostly as cooling water. The US Environmental Protection Agency estimates that each megawatt-hour of electricity generated from geothermal resources consumes approximately 200 to 300 gallons of water (US EPA 2008f). This water is primarily used for cooling the operating steam (used to turn turbines) back into a liquid state so that it can be reinjected into the geothermal reservoir. For a given amount of electricity generated, geothermal power plants require less cooling water than fuel combustion boilers and nuclear boilers for the following reasons:

- Geothermal power plants have lower steam temperatures and therefore require less water to bring the steam (used to turn turbines) back into a liquid state.
- Cooling water from geothermal power plants is injected into the geothermal reservoir at a much higher temperature than cooling water from fuel combustion and nuclear boilers, which is typically discharged

into surface water bodies that often support aquatic ecosystems. This additional cooling of water for power facilities discharging to natural surface water bodies is necessary to minimize impacts on the ecosystems supported by those water bodies. To achieve this additional cooling to temperatures that are usually only slightly above that of the receiving water, combustion- and nuclear-based power plants often use larger volumes of cooling water.

The amount of cooling for each geothermal plant depends on the temperature and type of geothermal fluids, the methods used to generate power, the throughput, and the type of cooling used. Air cooling uses very little water. Most binary power plants do not use any water.

The chemical and thermal properties of the geothermal fluid can pose potential threats to surface water and groundwater quality. Geothermal water can contain a variety of dissolved compounds, including silica, sulfates, carbonates, metals, and halides. Any mixing of geothermal fluids with surface or groundwater where the chemical and thermal qualities of the geothermal fluids would degrade the other water in the area would potentially damage aquatic ecosystems and contaminate drinking water supplies.

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on water resources from geothermal resource development. The degree of impact would vary greatly depending on local conditions including presence of sole source aquifers, hot springs, and the existing water quality.

The Reasonable Foreseeable Development Scenario for Water Resources and Quality

In general, any ground disturbance activities associated with geothermal resource development (roads, transmission lines, pipelines) would have a minor to negligible impact on surface water and groundwater resources within the immediate area. However, if an area is already heavily impacted due to existing operations or conditions, even these minor impacts could be substantial.

Exploration

Survey activities would have little to no impact on surface or groundwater. Exploration drilling would involve some ground-disturbing activities such as road and drilling pad construction. This could lead to an increase in soil erosion, with the result that more soil might be transported in surface runoff. Best management practices (see Appendix D) to reduce sediment erosion and to prevent sediment from being transported to surface water areas would be implemented in compliance with stormwater pollution prevention requirements of the Clean Water Act. By following BLM and FS guidelines, impacts on water

resources would be avoided. The long-term impacts would be minor. The short-term impacts would be moderate and mitigable.

Drilling Operations

Geothermal fluids in the resource can be under high pressures. Drilling can create pathways for these fluids into the groundwater at shallower depths or commingling between aquifers of differing quality. The impacts of these pathways can alter the natural circulation of the geothermal fluids and impact the usefulness of the resource. Subsurface pathways also can allow the natural contaminants in the geothermal fluids to impact the shallow groundwater quality if mixing were to occur. The degree of impact depends on aquifer characteristics and whether special conditions (e.g., sole source aquifers) are present. Proper drilling practices and closure and capping of the wells can reduce this potential.

During normal operations, liquid wastes from drilling activities are stored in lined sumps before being properly disposed of in accordance with state regulations. Geothermal fluid production and associated waste production is likely to occur for short periods as wells are tested to determine reservoir characteristics. If geothermal fluids are discovered in commercial quantities, development of the geothermal field is likely. During the initial stages of testing, one well is likely to be tested at a time. If testing is successful and the well and reservoir are sufficient for development, well heads, valves, and control equipment would be built on top of the well casing to prepare for the utilization phase.

Release of geothermal fluids during well testing can cause temporary impacts on surface waters within the immediate area of the test wells if not contained. These impacts include thermal changes and changes in water quality depending on the differences in the geothermal fluid and the surface waters. Accidental spills of geothermal waters may occur due to well blowouts during drilling, leaking piping or well heads, or overflow from sump pits.

BLM and FS guidelines and state regulations for maintaining and plugging and capping wells to prevent blowouts and mandating proper well casing and drilling techniques would minimize the risk of impacting surface water and groundwater in the immediate area.

Groundwater extraction and injection wells are installed and pumped to cycle geothermal fluids within the geothermal reservoir to remove heat energy. To be effective, it is desirable to create an efficient circulation system where the injected (cool) fluid is resident in the formation long enough to heat up to the maximum temperature without significantly altering subsurface pressures. This requires a highly permeable geothermal aquifer that is preferably isolated from any shallow cool water or potable water aquifer above it. High injection pressures can fracture rock, with resultant leakage of geothermal fluids.

Typically these fluids are highly mineralized, so geothermal production systems could contaminate shallow freshwater aquifers and heat could be lost to the surface.

Extracting geothermal fluids could result in drawdowns in connected shallower groundwater aquifers, with the resulting potential to affect streams or springs that are in turn connected to the water table aquifer. The potential for these types of adverse impacts is reduced through extensive aquifer testing, which is the basis for designing the geothermal plant and for locating, designing, and operating the extraction and injection wells. Combined with the requirement to comply with state and federal regulations that protect water quality and with limitations imposed by water rights issued by the state engineer, the impacts on water quality and the potential for depleting water resources is expected to be minimized. There is a medium risk for moderate to high impacts on groundwater supplies from the use of groundwater for geothermal activities.

Utilization

During construction, ground-disturbing activities such as road and foundation pad construction and utility installation could lead to an increase in soil erosion, with the result that more soil might be transported in surface runoff. Construction activities may also increase the risk of fire which could also result in increased erosion. Best management practices to reduce sediment erosion (see Appendix D) and to prevent sediment from being transported to surface water areas would be implemented in compliance with nonpoint (stormwater) pollution prevention requirements of the Clean Water Act.

Geothermal resource utilization could affect groundwater resources because of consumption of water by evaporation and the need to reinject water to replenish the geothermal reservoir. The magnitude of the effects would vary depending on groundwater conditions and availability within the basin and on the type of geothermal plant. Availability of water resources could be a limiting factor, affecting the expansion of geothermal resource development in a given area.

During normal operations and when production wells are tested, geothermal plants produce wastewater from cooling tower blowdown. This is the spent water that is periodically discharged from the cooling system. Makeup water is used to replace or make up for the evaporative losses and blowdown in a water-cooled system. The quantity of cooling tower blowdown depends on the size of the power plant, the quality of the makeup water (lower quality water requires more frequent cycling), the nature of the additives to prevent mineral scale, and the number of times the water is cycled. The source of cooling water could be either surface water or groundwater.

Production of geothermal fluids could be expected to vary from 1to 6 million gallons per day per well. Assuming 5 million gallons per day per well as an

average production figure, a lease with two producing wells would produce 10 million gallons of fluid per day.

Once a plant is operational, most geothermal fluids produced are reinjected back into the geothermal reservoir via reinjection wells. In flash steam facilities, about 15 to 20 percent of the fluid would be lost due to flashing to steam and evaporation through cooling towers and ponds. Binary power plants are non-consumptive and use a closed loop system. Fluids could also be lost due to pipeline failures or surface discharge for monitoring and testing the geothermal reservoir. In dry steam facilities, where steam is the only geothermal fluid, very little of the steam can be cooled for reinjection.

The cooling water could be discharged either to the ground or to an evaporation pond. Discharging cooling tower blowdown or water from testing geothermal production wells could affect shallow groundwater quality if the discharged water percolated to a shallow aquifer. Discharging cooling tower blowdown water would be subject to a National Pollution Discharge Prevention System permit issued by the appropriate state oversight agency, which would require testing to ensure that the water met the discharge requirements and did not degrade groundwater quality. The state would likely require that the cooling water be discharged to a lined pond to prevent infiltration. Therefore, the potential for water quality impacts on surface water from operational discharges of a geothermal plant are expected to be minor or mitigable.

The original coolant water and the replenishment water contain salts that become concentrated in the cooling system over time, requiring that the coolant be periodically replaced. The cooling water may also contain metals or other constituents introduced from corroding pipes or from chemical additives used to inhibit corrosion or microbial growth in the system. Low-toxicity additives are available that could be used in the cooling towers to lower the potential for impacts from this source.

Air-cooled systems use less cooling water and are more common in arid regions. Air-cooled systems would have fewer impacts associated with cooling water.

During operations, geothermal fluids are kept as part of a closed loop until they are reinjected into the geothermal resource. However, small amounts of these contaminants can be accidentally released into the surface environment from venting steam to eliminate excessive pressure or through mechanical breakdowns like broken pipes. The temporary release of fluids from tests and accidents would have minor impacts on any surface waters in the immediate area.

Hot springs are surface features that indicate the presence of geothermal features deep within the earth. These springs can be part of sensitive

ecosystems, recreation areas, or traditional cultural properties. The geothermal resources that would be developed are usually at greater depths than the shallow groundwater associated with the hot springs. However, withdrawing shallow groundwater or surface water for cooling water purposes could affect nearby springs.

Reclamation and Abandonment

The reclamation and abandonment phase would involve plugging and capping production and injection wells. Improper abandonment could allow the wells to serve as pathways for geothermal fluids to migrate to other aquifers, affecting both the geothermal resource and other groundwater quality. Proper well closure and capping would reduce the risk of these impacts.

4.7.4 What are the Potential Impacts on Water Resources and Quality Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of implementing the alternatives described in Chapter 2.

Impacts under Alternative A

Under the no action alternative, lease applications would continue to be processed on a case-by-case basis. Areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. The restrictions and stipulations on geothermal exploration and development activities for direct and indirect use would also be determined by the individual field offices and ranger districts on a case-by-case basis. The number of acres likely to be affected under this alternative is unknown.

Issuing geothermal leases for direct and indirect use on a case-by-base basis includes avoiding impacts on water resources in many BLM field offices and FS ranger districts. In addition, water resources may be protected through avoidance and mitigation measures for other resources where those resources include water resources. Examples include wetlands, designated wild and scenic rivers, endangered species habitat, and springs of cultural importance to Native Americans.

Under this alternative, no comprehensive list of stipulations, best management practices, or procedures would be distributed to serve as consistent guidance for future geothermal leasing and development. The leasing approvals and stipulations would continue to be varied, as would mitigation and reclamation levels.

Impacts under Alternative B

Under Alternative B, Designated Wild Rivers under the Wild and Scenic River Act and The Island Park Geothermal Area (includes NFS lands in Idaho and Montana) would be closed to geothermal leasing for direct and indirect use.

Geothermal leasing for direct and indirect use would be open on 118,000,000 acres of public lands and on 79,000,000 acres of NFS land in the western US and Alaska. Lands identified as open for geothermal leasing for direct and indirect use could have moderate to major constraints related to potential impacts on water resources, depending on environmental conditions identified during site-specific reviews conducted by field offices and ranger districts prior to issuing the leases. Approximately 25,150,000 acres of public land and 24,370,000 acres of NFS land would be closed to geothermal leasing for direct and indirect use because these lands were found to be incompatible with geothermal leasing, exploration, and development. Additional lands might be closed to geothermal resource leasing for direct and indirect use due to local conditions at the discretion of the individual field offices and ranger districts.

Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. Relevant stipulations (Section 2.2.2) designed to minimize impacts on water resources and water quality include (1) no surface occupancy on water bodies, riparian areas, wetlands, playa, and 100-year floodplain; and (2) controlled surface use within 500 feet of riparian or wetland vegetation to protect the values and functions of these areas. In accordance with BMPs (Appendix D), operators would be required to gain a clear understanding of the local hydrology and would avoid creating hydrologic conduits between aquifers. Operators would also develop a storm water management plan for the site to ensure compliance with applicable regulations and to prevent off-site migration of contaminated water or increased soil erosion. It is expected that these measures, along with the measures outlined to protect soil resources, would effectively minimize impacts on water resources and quality by protecting sensitive surface and ground water resources, protecting wetland and riparian habitats, reducing water quality degradation (i.e., contamination and sedimentation), and meeting applicable water quality standards.

Impacts under Alternative C

Under Alternative C, approximately 61,200,000 acres of public land and 37,900,000 acres of NFS land would be identified as open to geothermal leasing for indirect use. Alternative C differs from Alternative B in that the BLM and FS would only consider indirect use leasing within 10 miles from the centerline of existing 60 kV to 500 kV transmission lines and at least 15 miles outside of the Yellowstone National Park boundary.

The comprehensive list of stipulations, best management practices, and procedures discussed under Alternative B would be applied to those areas within the transmission line buffer.

Areas open to direct use geothermal lease applications and impacts from their subsequent development would be the same as identified under Alternative B.

4.8 AIR QUALITY AND ATMOSPHERIC VALUES

4.8.1 What Did The Public Say About Impacts on Air Quality and Atmospheric Values?

Comments received during scoping requested that BMPs such as emissions monitoring, diesel exhaust abatement, dust control, and a requirement for Equipment Emissions Mitigation Plans be incorporated into lease terms. Comments included requests for the PEIS to discuss the criteria pollutants expected to be emitted from the various sources typically associated with geothermal projects as well as the timeframe for these emissions over the various project phases. From a regulatory standpoint, commentors requested that the PEIS discuss the applicability of General Conformity, New Source Review, and Operating Permits to geothermal projects. Commentors also requested that the PEIS address the reduction of regional air emissions that would be expected by expanding geothermal energy use.

4.8.2 How Were the Potential Effects of Geothermal Development on Air Quality and Atmospheric Values Evaluated?

Methodology

Potential effects of geothermal development on air quality were evaluated by examining the typical air emissions associated with the various stages of geothermal development, and comparing those emissions with areas of nonattainment across the planning area (shown in Table 3-13, Counties within the Planning Area that are Designated Nonattainment or Maintenance Areas for Criteria Pollutants). While geothermal leasing itself would not impact air quality, the impacts of development on leased areas could affect air quality in the future. These potential effects on air quality are those that may result from pollutants that are typically generated by geothermal development.

Other regulatory requirements that would likely be required at the project-specific phase of analysis and permitting are examined here and were considered in determining both the impact criteria and in developing the impact analysis.

A secondary analysis was conducted to estimate the carbon dioxide emissions that would be generated by geothermal power development, compared with conventional, fossil-fuel based energy production. This analysis was conducted using the estimates of mass of carbon dioxide generated per kilowatt hour by geothermal, natural gas, petroleum, and coal power production, as shown in Table 3-14.

Conformity Requirements

Section 176(c) of the Clean Air Act, 42 USC § 7506(c), requires federal agencies to ensure that actions undertaken in nonattainment areas are consistent with the Clean Air Act and with federally enforceable air quality management plans.

The EPA has promulgated separate rules that establish conformity analysis procedures for transportation-related actions and for other (general) federal agency actions. The EPA general conformity rule applies to federal actions occurring in nonattainment areas when the total direct and indirect emissions of nonattainment pollutants (or their precursors) exceed specified thresholds. The emission thresholds that trigger requirements of the conformity rule are called de minimis levels.

At project level analysis and permitting, the BLM and FS would need to ensure that any proposed action, including construction emissions subject to state jurisdiction, conform to an approved State Implementation Plan (SIP). Emissions authorized by a Clean Air Act permit issued by the state or by the local air pollution control district would not be assessed under general conformity but through the permitting process.

Air Permitting

The Clean Air Act and its subsequent amendments require the permitting of stationary sources. Permitting requirements for major air sources are contained in two different programs. The first program is the New Source Review program, which consists of two preconstruction programs: The Prevention of Significant Deterioration program for permitting sources in attainment areas, and the nonattainment area permitting program. The second program is the Operating Permits Program, for permitting a source once it is in operation.

New Source Review

Congress established the New Source Review permitting program as part of the 1977 Clean Air Act Amendments. New Source Review permitting is a preconstruction permitting program that:

- Ensures that air quality is not significantly degraded from the addition of new and modified factories, industrial boilers, and power plants. In areas with unhealthy air, New Source Review permitting assures that new emissions do not slow progress toward cleaner air. In areas with clean air, especially pristine areas like national parks, New Source Review permitting assures that new emissions do not significantly worsen air quality.
- Assures people that any large new or modified industrial source in their neighborhoods will be as clean as possible, and that advances in pollution control occur concurrently with industrial expansion.

New Source Review permitting permits are legal documents to which facility owners/operators must abide. The permits specify what construction is allowed, what emission limits must be met, and often how the source must be operated. They may contain conditions to make sure that the source is built to match parameters in the application that the permit agency relied on in their analysis.

For example, the permit may specify stack heights that the permit agency used in their analysis of the source. Some limits in the permit may be there at the request of the source to keep them out of other requirements. For example, the source may take limits in a minor New Source Review permitting permit to keep the source out of Prevention of Significant Deterioration permit. To assure that sources follow the permit requirements, permits also contain monitoring, recordkeeping, and reporting requirements.

The New Source Review permitting process includes a public involvement component. Members of the public can use the New Source Review permitting program to ensure that sources are complying with the requirements that apply to them. New Source Review permitting gives the public the opportunity to:

- Comment on and request a public hearing on permits before they are issued.
- Appeal permits issued pursuant to the State Implementation Plan. The appeal procedures will depend on the state the source is located in.
- Appeal EPA-issued permits or permits issued by state or local agencies that are issuing the permit on behalf of the EPA to the Environmental Appeals Board and the federal courts.

Authority to Construct and Permit to Operate

For a specific project, the local air district would issue an Authority to Construct permit during the drilling operations stage of a project to address air emissions from stationary sources, which at that stage of development would be the production wells. For a power plant, an Authority to Construct is usually initially acquired for the power plant, including the wells. Once the power plant is operational and any initial operational problems have been worked out, the air district then issues a Permit to Operate. Depending on the type of project and the amount and type of air emissions, abatement systems may be required by the local air district during this phase of permitting.

The EPA's Operating Permits Program was established through Title V of the Clean Air Act Amendments of 1990 and is considered to be the most important procedural reform in the amendments and the centerpiece for compliance with the entire act. Title V requires the establishment of an operating permit program for major stationary sources that would ensure compliance by industry with all applicable requirements of the act, enhance EPA's ability to enforce the Clean Air Act, generate state and tribal revenue to administer the program, enhance the ability of a permitting agency to track compliance and evaluate a source's air quality, ensure public involvement by allowing review and comment of draft permits, and increase certainty for industry by providing all source requirements in one permit document.

Impact Criteria

Potential impacts on air quality could occur if reasonably foreseeable future actions were to result in the following:

- Conflict with or obstruct implementation of the applicable air quality attainment plan;
- Violate any stationary source air quality standard or contribute to an existing or projected air quality violation; or
- Expose sensitive receptors (e.g., concentrations of children, elderly, or persons with respiratory conditions) to major pollutant concentrations.

4.8.3 What are the Common Impacts on Air Quality and Atmospheric Values Associated with Geothermal Development?

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on air quality from geothermal resource development.

The nature and extent of geothermal-related development activities that would affect air quality would vary by project, depending on several factors: 1) whether the project is for direct use or indirect use; 2) the size of the project; and 3) for indirect projects, which type of power plant technology is used. Potential air quality impacts would be evaluated on a project-specific basis, as NEPA would be conducted for each of the potential phases of geothermal development activity: exploration, drilling operations, utilization, and reclamation and abandonment. Air permits would also be obtained, as necessary, for each individual phase, and activities at all sites would need to be carried out in conformance with the applicable SIPs. This section will qualitatively address the air quality impacts typically associated with each phase of development, and then examine the role the development of geothermal energy applications is likely to play in air quality nationwide.

Some activities resulting in air quality emissions are common to all phases of a geothermal project lifecycle, while others are specific to certain phases. Table 4-1 summarizes the activities and the criteria pollutants of concern related to those activities. Emissions from each phase of development are discussed in the following text.

The Reasonable Foreseeable Development Scenario for Air Quality and Atmospheric Values

As stated in the RFD scenario, it is estimated that 111 power plants would be constructed across the 12-state project area by 2015, and a further 133 power plants would be constructed by 2025. The average capacity of these power

Table 4-1
Activities and Related Pollutants from Geothermal Project Phases

Activity	Pollutant	Project Phase	Factors
Exhaust from vehicular traffic	Carbon monoxide, carbon dioxide, oxides of nitrogen, volatile organic compounds, particulates, sulfur dioxide, air toxics	All	Vehicle-miles traveled (VMT)
Fugitive dust from vehicle traffic on paved and unpaved roads	Particulates	All	VMT, road conditions
Fugitive dust from earth-moving activities	Particulates	All	Acres disturbed, soil conditions
Exhaust from construction equipment	Carbon monoxide, carbon dioxide, oxides of nitrogen, volatile organic compounds, particulates, sulfur dioxide, air toxics	All	Volume of fuel used, engine/abatement technology
Release of geothermal fluid vapor	carbon dioxide, hydrogen sulfide, mercury, arsenic, boron	Exploration, drilling operations, utilization	Chemical composition of geothermal resource, duration and volume of flow testing, frequency, duration, and volume of well blow-outs, type of power plant

plants is estimated to be 50 megawatts. For direct use, it is estimated that by 2015, applications could be developed in the amount of 1,600 thermal megawatts; by 2025, applications could be developed in the amount of 4,200 thermal megawatts. For indirect use, the RFD scenario estimates that up to 40,737 acres of land would be disturbed by 2015, and up to 89,548 acres of land would be disturbed by 2025. Such disturbances would be spaced both temporally across approximately 15 years, and spatially across the 12-state project area.

Exploration

Air quality impacts associated with exploration are short term and generally limited to the release of fugitive dust from surface disturbance and emissions from vehicles and construction and drilling equipment. Initial exploration activities such as surveying and sampling would have minimal air quality impacts from accessing exploration sites in roadless areas and from disturbing small areas of land for the placement of surveying equipment. Secondary exploration activities, specifically site clearing, exploration well pad development, and the drilling of temperature gradient wells would have more intensive exhaust-related emissions and would last for longer periods of time. Total time for exploration activities typically ranges between one and five years.

Drilling Operations

Air emissions during the drilling operations phase of a geothermal project include fugitive dust and emissions from combustion engines, as described above, but as successful wells are drilled, the new source of potential air pollution is from the venting of geothermal fluids to the atmosphere. Well venting introduces the potential for release of hydrogen sulfide, carbon dioxide, mercury, arsenic, and boron when these compounds are contained in the geothermal resource. The local air district may require establishing an air monitoring program, particularly if the well is proposed as a power generation project. Hydrogen sulfide is generally the primary pollutant of concern for air districts considering permitting a geothermal well.

The following specific activities during the drilling operations phase would result in emissions of fugitive dust and exhaust from combustion engines:

- Vehicle traffic on access roads (worker vehicles, equipment, watering trucks, materials delivery trucks);
- Removing vegetative cover;
- Constructing roads, well pads, lay-down areas, and landscaping involving excavation, moving soils, and grading;
- Drilling production wells – Drilling times vary considerably with the type of rock and depth of resource. Drilling rates of approximately 150 feet per day have been reported (Finger and Hoover 2003), bringing drill rig operating times into an estimated range of 10 days for a 1,500 foot well to nearly 70 days for a 10,000 foot well;
- Drilling injection wells; and
- Constructing fluid sump pits.

Utilization

Constructing a geothermal power plant and its associated infrastructure during the onset of the utilization phase would create the greatest amount of fugitive dust and exhaust from combustion engines.

By the onset of operations within the utilization phase, particularly for indirect use applications, an air monitoring system is usually already in place from the drilling operations phase. Such a monitoring system has typically been collecting pertinent baseline data about the nature of the emissions from the wells and later, for indirect uses, the power plant(s) over the course of development and construction.

Direct use applications likely have very few wells (typically one or two) and no emissions. Similarly, for a binary power plant, no emissions are realized during operations in the utilization phase, except for during well venting during maintenance activities, or leaks in the heat exchangers, which could result in the release of volatile organic compounds. Flash and dry steam power plants emit geothermal vapors to the atmosphere, potentially releasing the range of pollutants listed above under the drilling operations phase.

Fugitive dust and exhaust from combustion engines during operations within the utilization phase would be generally limited to worker and maintenance vehicle traffic.

Table 4-2 shows the carbon dioxide emission estimates from the projected 2015 and 2025 geothermal power plant electricity generation detailed in the RFD scenario, and compares it with estimated emissions for the same power generation from traditional fossil fuel sources. Calculations were based on the rate of carbon dioxide production per kilowatt-hour shown in Section 3.8, Air Quality for the various energy sources, derived from Bloomfield *et al.* (2003).

As shown in Table 4-2 it is estimated that development of the number of geothermal power plants estimated in the RFD scenario would result in emissions of approximately 554 tons of carbon dioxide per hour in 2015, and 1,216 tons of carbon dioxide per hour in 2025. Were the same electrical capacity to be produced by natural gas, petroleum, or coal, carbon dioxide emissions would be six-fold, nine-fold, and ten-fold, respectively.

Direct use applications are also expected to reduce carbon dioxide emissions through energy consumption offsets; however, it is difficult to quantify such offsets since in some cases, access to geothermal resources for direct use applications may actually stimulate economic growth around the resource and result in other types of emissions in a location that would otherwise not have the same degree of development and emission-generating activities.

Table 4-2
Hourly Carbon Dioxide Emissions at 2015 and 2025

	Geothermal (0.20 lbs. CO_2/kWh)	Coal (2.095 lbs. CO_2/kWh)	Petroleum (1.969 lbs. CO_2/kWh)	Natural Gas (1.321 lbs. CO_2/kWh)
2015 emissions per hour (5,540 MW)	554[1] tons	5,760 tons	5,410 tons	3,630 tons
2025 emissions per hour (12,160 MW)	1,216 tons	12,670 tons	11,910 tons	7,990 tons

[1]Sample calculation:
(5,540 MW) x (1,000 kW/MW) x (0.2 lbs CO_2/kW-h) x (0.0005 ton/lb) = 550 tons

Reclamation and Abandonment

Air quality impacts during reclamation and abandonment activities would be generally limited to emissions from vehicles and construction equipment and to fugitive dust from the movement of vehicles. Depending on the flow and temperature of the geothermal fluids or steam at the well heads at the time of abandonment, well capping could result in the potential release of the range of pollutants listed above under the drilling operations section.

4.8.4 What are the Potential Impacts on Air Quality and Atmospheric Values Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing the alternatives described in Chapter 2.

The relationship between GHG emissions and climate change is discussed earlier, under Section 4.1. The discussion here is limited to a comparison in terms of possible GHG emissions and the potential for offsets between the respective approaches to development reflected in each of the alternatives.

Impacts under Alternative A

Under the no action alternative, lease applications would continue to be processed on a case-by-case basis. Areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. Under Alternative A, the pace of development of geothermal power plants or direct use projects would be lower than under Alternatives B and C, making it more likely that fossil-fuel based power plants would continue to be developed and that emissions at 2015 and 2025 would more closely resemble the estimates in the fossil-fuel based columns than in the geothermal column of Table 4-2. Compared with the other alternatives, Alternative A is expected to have the least beneficial effect on reducing GHG emissions.

Impacts under Alternative B

Alternative B would be expected to provide larger-scale and longer-term opportunities for improvements in air quality and reductions in greenhouse gases than Alternative A. At the project-level NEPA analysis, Clean Air Act conformity requirements would apply only to those lease areas within maintenance and nonattainment areas.

The large-scale development of geothermal energy applications for direct and indirect use across the western US has the potential to offset substantial emissions of criteria pollutants at the national level. Such development would help individual states meet their renewable portfolio standards and their increasing energy needs, while maintaining or improving air quality. The air quality impacts of geothermal exploration, drilling operations, utilization, and reclamation and abandonment are considered to be much less than the impacts associated with the alternative—development of nonrenewable energy sources such as oil, natural gas, and coal.

The wide-scale development of geothermal energy applications for direct and indirect use would at the least decrease the need for future development of more-polluting energy-generating applications, such as oil, natural gas, and coal, and would slow the increase in greenhouse gases being generated by the US. At best, the wide-scale development of geothermal energy applications for direct and indirect use would be an integral part of a shifting energy landscape in the US to renewable energy sources that would result in an overall decrease in greenhouse gas emissions.

Under Alternative B, emissions resulting from development at 2015 and 2025 would more closely resemble the estimates in the geothermal columns than in the fossil-fuel columns of Table 4-2. Compared with the other alternatives, anticipated future actions consistent with Alternative B are expected to have the greatest beneficial effect on reducing GHG emissions because of the greater potential for GHG offsets, as described in Section 4.8.3.

Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. In accordance with BMPs (Appendix D), operators would be required to minimize air quality impacts from fugitive dust, vehicle exhaust, and equipment operations. Operators would prepare and submit to the BLM an Equipment Emissions Mitigation Plan. Requirements for emissions controls would be incorporated into the terms of individual geothermal leases. It is expected that these measures would effectively minimize impacts on air quality and atmospheric values by reducing sources of air quality degradation including particulates and hydrocarbons.

Impacts under Alternative C

Impacts from anticipated future actions consistent with Alternative C would be greater than those consistent with Alternative A, but less than those consistent with Alternative B, since smaller land areas would be available for indirect use development, and less development would be likely to occur. While Alternative C would allow for a more expeditious achievement of offsets than Alternative A for states within the project area, Alternative C would be inferior to Alternative B in this regard.

Under Alternative C, emissions at 2015 and 2025 would likely be somewhere between the estimates in the geothermal columns and in the fossil-fuel columns of Table 4-2. Compared with the other alternatives, anticipated future actions following leasing under Alternative C are expected to have a greater beneficial effect on reducing GHG emissions than Alternative A, and a lesser beneficial effect than Alternative B.

Areas open to direct use geothermal lease applications and impacts from their subsequent development would be the same as identified under Alternative B.

At the project-level NEPA analysis, Clean Air Act conformity requirements would apply only to those lease areas within maintenance and nonattainment areas.

4.9 VEGETATION

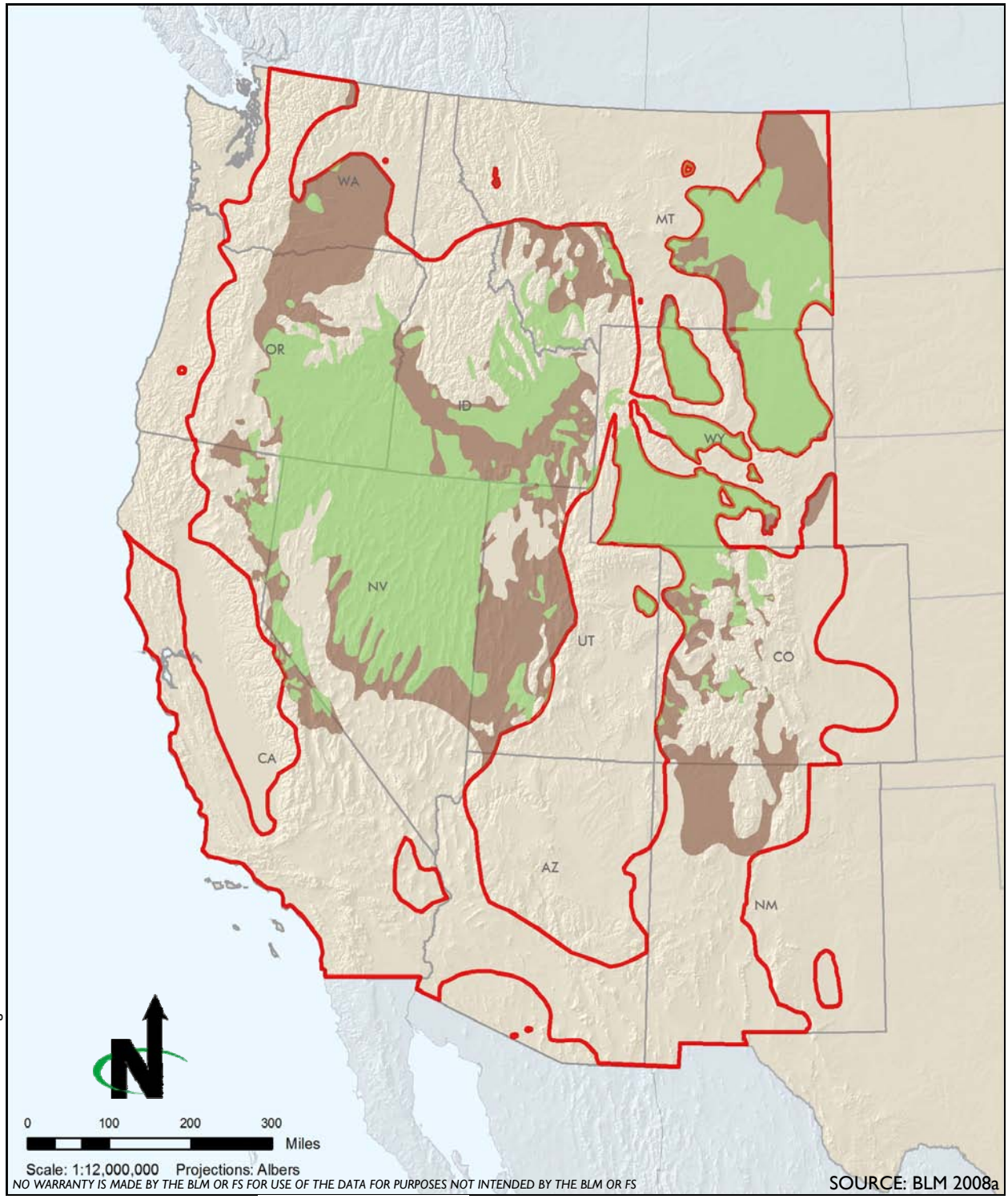
4.9.1 What did the Public Say about Impacts on Vegetation and Important Habitats and Communities?

Comments collected during scoping relating to vegetation and important habitats requested that the analysis of impacts address riparian and wetland habitat, important sagebrush habitats, winter range habitat, important terrestrial and aquatic plant and animal habitat, and the potential for introduction of invasive species. The effects of fragmentation and removal on these areas were the main concern addressed during scoping.

4.9.2 How Were the Potential Effects of Geothermal Development on Vegetation and Important Habitats and Communities Evaluated?

Leasing geothermal resources would not affect vegetation or important habitats and communities. These resources would be affected only by development of specific geothermal development projects that occurred subsequent to the leasing action. Potential impacts of geothermal development were evaluated based on the typical disturbance of geothermal projects for the various stages of development and then assessed based on projected location and intensity, as described in the RFD. The types of vegetation and important habitats and communities that could be affected by geothermal development on public and NFS lands depend on the ecoregions they exist and the specific location of the proposed project.

Figures 3-10 through 3-13 show the distribution of public and NFS lands with a potential for geothermal development, relative to ecoregion divisions and provinces that occur in the 12 western states. The types of vegetation, habitats, and communities that could be affected by geothermal development depend on the ecoregion in which the project is located (Appendix G provides more information on ecoregions). Specific impacts of a project depend on the types of vegetation and habitats present at the project location within the ecoregion province. The ecoregion provinces with the greatest extent of areas with medium to high potential for geothermal development are the Intermountain Semi-Desert and Desert and the American Semi-Desert and Desert (Figure 3-12 and 3-13). The vegetation communities in these ecoregions are largely arid and semiarid grass and shrub lands, including sagebrush (Figure 3-14). There is a notable decrease is distribution of sage brush obligate species, including sage grouse (Figure 4-1), which highlights the importance of the sagebrush community. Appendix G presents descriptions of the vegetation found within public and NFS lands with a potential for geothermal development across ecoregions of the 12 western states.



C:/EMPSi/GeothermalPEIS/Figures

Greater sage grouse require contiguous, undisturbed areas of high-quality habitat during their four distinct seasonal periods of breeding, summer-late brooding and rearing, fall, and winter.

Legend

Potential Geothermal Area

Sage Grouse Region

Current

Historic

Current and Historical Sage Grouse Distribution in the Western United States

Figure 4-1

Impacts discussed are associated with the elimination and degradation of habitat occurring at project sites, in immediately adjacent areas, or within the individual project watershed(s). Potential impacts on vegetation and important habitats could occur if reasonably foreseeable future actions were to result in the following:

- Affect a plant species, habitat, or natural community recognized for ecological, scientific, recreational, or commercial importance;
- Affect a species, habitat, or natural community that is specifically recognized as biologically significant in local, state, or federal policies, statutes, or regulations;
- Establish or increase noxious weed populations;
- Destroy or extensively alter habitats or vegetation communities in such a way that would render them unfavorable to native species; or
- Conflict with BLM or FS management strategies.

4.9.3 What are the Common Impacts Associated with Geothermal Development?

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on vegetation and important habitats from geothermal resource development.

The nature and extent of geothermal-related development activities that would affect vegetation and important habitats and communities would vary by project, depending on several factors: 1) whether the project is for direct use or indirect use; 2) the size of the project; 3) the geographic location; and 4) for indirect use, the type of plant. Potential vegetation and important habitat impacts would be evaluated on a project-specific basis, as NEPA would be conducted for each of the potential phases of geothermal development activity: exploration, development, operation, and closeout. This section will qualitatively address the impacts on vegetation and important habitats and communities.

The Reasonable Foreseeable Development Scenario for Vegetation and Important Habitats and Communities

The RFD scenario estimates 111 power plants would be constructed across the 12-state project area by 2015, and an additional 133 power plants would be constructed by 2025. The average capacity of these power plants is estimated to be 50 megawatts. This estimate assumes that up to 40,737 acres of land would be disturbed by 2015, and up to 89,548 acres would be disturbed by 2025 as part of indirect use geothermal projects. For direct use, it is estimated that applications could be developed in the amount of 1,600 thermal megawatts by 2015 and 4,200 thermal megawatts by 2025. Disturbance from development

would be spaced both temporally across approximately 15 years, and spatially across the 12-state project area.

Regardless of the location of geothermal development projects, the nature of the impacts from exploration and development to vegetation and important habitats and communities would be similar in all ecoregions. Vegetation would be affected by direct destruction and removal, fugitive dust, exposure to contaminants, and the introduction of invasive species. The extent of the impacts is typically associated with the size of the area that is disturbed and the types of vegetation habitats and communities present. The ability of an area to recover from disturbance also affects the extent of the damage.

Impacts common to all vegetation and important habitats are discussed below, followed by an analysis of how those impacts might affect important habitats and communities within the planning area. Finally, any impacts that are specific to a certain stage of geothermal development (exploration, development, operation, or closeout) are discussed. Geothermal activities can cause the following stressors and associated impacts on vegetation and important habitats. Table 4-3, Potential Impacts of Vegetation and Important Habitats, provides a breakdown of the likelihood for impacts to occur during each phase of geothermal development (exploration, development, production, and closeout).

- Habitat disturbance - Site clearing, well drilling, constructing access roads and geothermal facilities, and maintenance and operational activities would disturb habitat, which would cause mortality and injury, increase the risk of invasive species, and alter water and seed dispersion and wildlife use, which can further affect vegetation communities.
- Direct Removal and Injury - Vegetation would be cleared for roadways, vehicle staging, buildings, pipelines, and transmission lines. Activities could result in loss of soil, loss of seed bank in soil, deposition of dust, and destruction of biological soil crusts. Maintenance around project components such as drill pads, buildings, pipelines, or other facilities would involve mowing, herbicide treatment, and other mechanical or chemical means of removal and control. This would result in a net loss of important habitats and communities throughout the planning area.
- Invasive Vegetation - Disturbance and access by vehicles and human foot traffic may expose areas to colonization by invasive and nonnative species, making it more difficult for endemic species to reestablish in disturbed areas and threatening the continued existence of endemic species (BLM 2007c).

Table 4-3
Potential Impacts of Vegetation and Important Habitats

Ecological Stressor	Geothermal Activity	Impact	Potential Level of Impact			
			Exploration	Drilling Operations	Utilization	Reclamation and Abandonment
Habitat disturbance	Site clearing and grading; well drilling and construction; pipelines, access road, and ancillary facility construction; construction and maintenance vehicle travel	Loss of vegetation, increase risk of invasive species, alter water and seed dispersion	Moderate	Moderate	Moderate to high	Low
Direct removal and Injury	Site clearing and grading; well drilling and construction; pipelines, access road, and ancillary facility construction; construction and maintenance vehicle travel	Direct destruction of vegetation, increase of invasive species	Moderate to high	Moderate to high	High	Low to moderate
Invasive vegetation	Site clearing and grading; well drilling and construction; pipelines, access road, and ancillary facility construction; construction and maintenance vehicle travel	Change species composition, increase risk of fire, eliminate native species	Low to moderate	Low to moderate	Moderate to high	Low to moderate

Table 4-3
Potential Impacts of Vegetation and Important Habitats

Ecological Stressor	Geothermal Activity	Impact	Potential Level of Impact			
			Exploration	Drilling Operations	Utilization	Reclamation and Abandonment
Fire	Site clearing and grading; well drilling and construction; construction and maintenance vehicle use; cigarette smoking	Direct mortality to vegetation, loss of seed bank, erosion, increased potential for invasive species, loss of species diversity	Low	Low	Moderate to high	Low
Erosion	Site clearing and grading; well drilling and construction; pipelines, access road, and ancillary facility construction; construction equipment travel	Reduced habitat quality, direct loss of vegetation, loss of topsoil and seed bank, increased risk of invasive species	Low to moderate	Low to moderate	Moderate	Moderate
Exposure to contaminants	Accidental spill during equipment refueling; accidental release of stored fuel or hazardous materials; drilling mud spill or accidental spill of geothermal fluids and working fluids; accidental spill of herbicides	Growth impairment, direct mortality, changes in species composition	Low	Low	Low	Low

Table 4-3 Potential Impacts of Vegetation and Important Habitats - Notes

The assessment of impact level is based on the RFD; and activities and projected disturbance associated with each stage geothermal development, as well evaluation of the efficacy of BMPs, stipulations and procedures available to eliminate or mitigate the potential impacts. Duration of the impact as well as potential for accidents factor into the assessment.

Low- The activities involved in geothermal development do not present a risk or have effective precautions, stipulations and BMPs, that would minimize the potential, intensity, and duration of impact associated the prospective ecological risk factor.

Moderate- The activities involved in geothermal development have a greater potential for impacts on wildlife, including accidents, unavoidable removal of habitat, and indirect disturbance. Impacts may be unavoidable and may endure beyond the conclusion of the activity.

High- The activities involved in geothermal activities would have direct and unavoidable impacts. BMPs and stipulations are not available to eliminate impacts. Additionally, the risk of accident may be higher or the duration of the impact may be last well beyond the conclusion of the geothermal activities.

- Fire – Equipment operation, increased vehicular and human traffic, using drilling muds, and extracting geothermal fluids can increase the risk of fires. Vehicles, electrical lines, and smoking can all result in accidental fires. Fires destroy vegetation and can aid in the establishment of invasive species.
- Erosion - Containment basins, site clearing, grading, constructing access roads, site runoff, and vehicle and human foot traffic cause erosion. The effects of erosion include top soil removal, seed bank loss, native vegetation loss, invasive species establishment, stream sedimentation, and flooding (which can affect riparian vegetation and riparian habitats).
- Exposure to Contaminants - Vehicle fuel, hydraulic fluid, solvents, cleaners, and geothermal fluids can all be harmful to vegetation and important habitats. Accidental spills can contaminate soils and water and directly harm vegetation. Licensed herbicide use would control vegetation around geothermal facilities and support structures. Spills of herbicides or acute exposure to herbicides can have adverse effects on non-target vegetation.

Riparian and Wetland Habitat

Riparian and wetland habitats are of high value to fish and wildlife and perform critical environmental functions such as flood control and water purification (NRC 1995). These habitats may be affected by activities associated with all phases of geothermal projects. Impacts on wetlands are regulated under the River and Harbors Act and Section 404 of the Clean Water Act. US Army Corp of Engineers permitting would be required for each project that disturbs wetlands under its jurisdiction, both within and outside of corridors. In addition, Executive Order 11990, Protection of Wetlands, requires all federal agencies to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands.

Riparian and wetland habitat may be cleared to provide access to geothermal sites, and water may be extracted from groundwater sources to support geothermal exploration, production, and operation. Habitat removal may result in increased stream temperatures, reduced wildlife presence, increased erosion, and sedimentation. Water extraction may result in lowered groundwater tables, which can affect stream flows and duration and can dewater wetland and marsh habitat. Changes in riparian and wetland hydrology can affect vegetation species assemblages and may eventually alter the wildlife species composition. Accidental spill of fuel, solvents, or geothermal working fluids could degrade water quality and affect riparian vegetation.

Riparian and wetland habitat can be adversely affected by invasive species such as salt cedar and Russian olive, which can be introduced during disturbance. Salt cedar is highly tolerant of high salinity soils, low water tables, wildfires, livestock

browsing, and conventional weed controls. Native plant species are damaged by unusually large guilds of insects and plant pathogens, but salt cedar has few natural insect or plant pathogens in the planning area. Salt cedar and other invasive riparian plants can lower water tables, and they often establish soon after disturbance.

Riparian and wetland habitat in California, Nevada, and Idaho would be more susceptible to geothermal development than other states based on projections for geothermal development on public and NFS lands (Section 2.4, Reasonably Foreseeable Development Scenario). This would include ecoregions provinces in the Mediterranean, temperate desert, and tropical/subtropical desert divisions (Figures 3-11 and 3-13). However, geothermal development in California, Nevada, and Idaho would likely occur in drier areas where the riparian and wetland habitats are less abundant. Therefore, geothermal projects are less likely to be located directly adjacent to these habitats. Riparian and wetland habitats are relatively scarce throughout the west and are very important in drier ecoregions, thus should be avoided. The BLM and FS have best management practices intended to limit the impacts of actions that occur on public and NFS lands. Additionally, wetlands and riparian habitat are protected under the Clean Water Act and regional land use and forest plans.

Sagebrush

Sagebrush habitat is spread across almost the entire project area (with the exception of Alaska) and covers approximately 93 million in the western US, of which about 66 percent is on public and NFS lands (Connelly et al 2004). Within the planning area about 36 percent of the lands have sagebrush habitat. Sagebrush habitat is found throughout and is almost exclusive to the temperate desert ecoregion division, although sagebrush within the planning area is also found in the temperate steppe ecoregion division. The states with the greatest sagebrush cover within the planning area are Idaho (23 percent), Nevada (38 percent), Oregon (23 percent), and Wyoming (27 percent). The RFD scenario forecasts that by 2025 geothermal development would affect up to 89,548 acres over the 12-state planning area. If all geothermal development were to occur on sagebrush habitat, it would affect approximately 0.1 percent of the sagebrush habitat in the planning area. If geothermal development were to occur proportionately within all habitats, then forecasted development would affect 0.04 percent of sagebrush habitat within the planning area. Based on RFD scenarios, the amount of sagebrush habitat that would be disturbed is likely somewhere between the two forecasted estimates, as a greater proportion of development is forecasted to occur in states with a greater percentage of sagebrush habitat in areas of geothermal potential (Connelly et al. 2004).

Sagebrush habitat would be cleared for roadways, drill pads, buildings, and other infrastructure. Sagebrush is susceptible to fire and can take from 15 to 30 years to reestablish to pre-burn density and cover following a fire (Miller and Rose 1999). Invasive species increase the incidence and intensity of fires in sagebrush

habitat (Connelly et al. 2004). Native sagebrush communities may not reestablish after intense or frequent fires, and conditions favorable to native sagebrush species may not be available in the future in these areas (BLM 2004e). Frequently repeated fires reduce or prevent reestablishment of sagebrush seedlings from nearby unburned plants. Fires may kill some seeds of native grasses in upper soil layers, significantly reducing seedling emergence in burned areas (BLM 2004e).

Both the BLM and FS maintain a list of best management practices meant to protect important habitats such as sagebrush during development. The BLM has developed specific guidance for managing sagebrush communities meant to protect and conserve sagebrush habitat during land use and development projects (BLM 2004e). More information on the compatibility of geothermal development with sagebrush communities and sage grouse can be found in Text Box 4.10-1 in Chapter 4.10, Fish and Wildlife.

Old Growth Forests

Geothermal projects occurring in old growth forests would require forest clearing. Old growth forests on federal lands are managed under FS and BLM forest plans. Both the FS and BLM have shifted their management of forested lands away from resource extraction and toward ecosystem management to protect old growth forests (Thomas et al. 2006). Old growth forests on public lands are found predominately in the Pacific Northwest (the marine ecoregion division), the Southern Sierra Nevada Mountains (Mediterranean and temperate desert ecoregion divisions), the Rocky Mountains (temperate desert division), and scattered areas through the southwest.

Old growth forests, which may have never been physically disturbed by activities such as logging, typically contain centuries-old trees or other plants that cannot be reestablished and would be permanently lost. Loss of such habitat would be considered a greater impact than loss of previously disturbed habitat. Most sensitive and high quality habitats, such as old growth forests, are found in the areas being excluded under the proposed action such as roadless areas, wilderness areas, and ACECs. Based on the RFD scenario, many of the areas within the planning area containing old growth forests are not expected to see development. Should development occur in areas with old growth forests, the development would not conflict with the applicable forest management plan and would undergo site-specific analysis prior to site development. In most cases, old growth forests would be avoided during development. In all cases, site-specific NEPA evaluation would occur to assess the impacts of projects within old growth forests. This would include compliance with the Endangered Species Act, which protects habitat for listed species such as the spotted owl, for which old growth forests are considered critical habitat.

Exploration

Exploration would disturb small areas of vegetation and habitat during the construction of access roads and drill pads. Habitat would be removed, and vegetation would likely be destroyed. Surveying and drilling activities could result in impacts from weed infestation. If the area is not used for development and production, it would be reclaimed within three years. Native species would be used to revegetate the area.

Drilling Operations

Large areas of vegetation would be cleared for expanded well pads, (to accommodate production wells, injection wells and sump pits), roadways, and other critical infrastructure. This would destroy vegetation, create erosion potential, and increase incidence of invasive weed infestation. Drilling operations would require increased vehicle traffic, which would require staging areas and parking areas. Increased traffic would create more fugitive dust and pollutants and would increase the potential for fuel spills and other contaminants associated with vehicle use.

Water used for drilling activities could affect wetland and riparian areas in surrounding areas, depending on how it is accessed. Drilling requires large amounts of water, and local drawdown of water tables can have a direct effect on wetlands and groundwater flows, which can directly affect riparian vegetation.

Utilization

The greatest amount of disturbance, vegetation clearing and injury would occur during the initial construction within the utilization phase. Large areas of vegetation would be cleared for well pads, power plants, pipelines, roadways, and other critical infrastructure. This would destroy vegetation, create erosion potential, and increase incidence of invasive weed infestation. Drilling operations would require increased vehicle traffic, which would require additional staging areas and parking areas. Increased traffic would create more fugitive dust and pollutants and would increase the potential for fuel spills and other contaminants associated with vehicle use.

Drilling operations could increase the spread of invasive species that can outcompete and alter the plant species assemblages in surrounding habitat through direct and indirect effects. The dispersal of invasive plant seeds by vehicles may affect native plant communities. In such cases, plant communities dominated by native vegetation may be replaced with plant communities dominated by invasive species. Other adverse impacts from the spread of invasive species may include the following:

- A decrease in biological diversity of ecosystems;
- A reduction in water quality and availability for wildlife species;

- A decrease in the quality of habitats for wildlife;
- Alterations in habitats needed by threatened and endangered species; and
- Health hazards, because some species are poisonous to humans, wildlife, and livestock.

Wetland and riparian areas would be affected by roadways and bridges that may be built to access drilling operation areas. Runoff from construction could increase turbidity in streams, and potential spills of fuels and other contaminants from vehicles and on-site construction activities could affect water quality. Water used for drilling activities could affect wetland and riparian areas in surrounding areas, depending on how it is accessed. Drilling requires large amounts of water, and local drawdown of water tables can have a direct effect on wetlands and groundwater flows, which can directly affect riparian vegetation.

Vegetation and important habitats would be affected by site maintenance activities that involve mowing or cutting vegetation, exposure to contaminants and herbicides, decreased water quality due to surface runoff, vehicle traffic that produces fugitive dust, and direct injury from human and vehicle traffic. Water tables could also be affected by the withdrawal of geothermal fluids that, over time, could reduce groundwater storage and potentially affect stream flows.

Wetlands and aquatic resources could be affected by human activities associated with increased access to public and NFS lands in the immediate vicinity of a geothermal project site. Potential impacts from increased access may include disturbance of vegetation in wetland and aquatic habitats and the introduction of invasive vegetation.

Site maintenance activities at geothermal project sites would likely include the licensed application of herbicides to control vegetation along access roads and around buildings and power plant structures for indirect-use projects. The accidental spill of herbicides may affect native vegetation in surrounding areas. Potential effects of such exposure are discussed in the following section.

Increased human activity associated with the utilization phase would increase the potential for fire. The potential for wildland fires would be greatest in the arid and semiarid ecoregions and would be expected to occur most often in summer and autumn, when native and invasive grasses have died back and fuel loads are at their greatest. Sagebrush is especially vulnerable to fires and may incur both short- and long-term effects (BLM 2004e). Big sagebrush plants are readily killed by fire, while native grasses and forbs are generally unharmed by fires (BLM 2004e).

Access roads and maintenance activities would increase vehicle and human traffic, which may result in direct injury to vegetation and increased incidence of invasive plants. Clothing and vehicles tires can carry seeds that spread invasive species (Marsh and Douglas 1997).

Reclamation and Abandonment

Reclamation and abandonment could have similar impacts as those described for construction as buildings and structures are removed, but on a smaller scale. Fire, erosion, and invasive vegetation would be the predominant potential impacts during the reclamation and abandonment phase. After all buildings and facilities are removed, the affected areas would be reclaimed and vegetation and habitats would be restored.

4.9.4 What are the Potential Impacts Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing each of the alternatives described in Chapter 2.

Impacts under Alternative A

Under the no action alternative, lease applications would continue to be processed on a case-by-case basis. Areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. The number of acres that could impact vegetation and important habitats is unknown; however, impacts would be site-specific and similar to the impacts under the four phases of geothermal development identified under Section 4.9.3. Under this alternative, no comprehensive list of stipulations, best management practices, or procedures would be distributed to serve as consistent guidance for all future geothermal leasing and development for direct and indirect use. This would result in fragmented and segregated planning for vegetation and important habitats which often exponentially increases impacts. Development of the individual leasing approvals, stipulations, and best management practices would also continue to vary per site and delay application processing time.

Impacts under Alternative B

Under this alternative, the land closed to geothermal leasing for direct and indirect use would increase. The BLM and FS would close approximately 25,150,000 acres of public lands and 24,370,000 acres of NFS lands that are incompatible with geothermal leasing, exploration, and development.

These closed lands would protect vegetation and important habitats, specifically high-value habitats such as old growth forests and wetland and riparian areas, more than the no action alternative (Alternative A). Additionally, major constraints would be applied to leases to protect vegetation and important habitats from adverse impacts. For lands not closed to direct and indirect use

leasing, potential geothermal development could still occur as forecasted in the RFD scenario.

Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. Relevant stipulations (Section 2.2.2) designed to minimize impacts on vegetation include (1) no surface occupancy on water bodies, riparian areas, and wetlands; (2) controlled surface use in areas that would adversely impact the continuity of migration corridors or important habitat; and 3) controlled surface use within 500 feet of riparian or wetland vegetation to protect the values and functions of these areas. In accordance with BMPs (Appendix D), operators would review existing information on species and habitats in the vicinity of the project area to identify potential concerns. Operators would also employ timing restrictions and design features (outlined in the BMPs in Appendix D) to avoid, minimize, or mitigate negative impacts on sensitive habitats. It is expected that these measures would effectively minimize impacts on vegetation by reducing human caused disturbance to species and habitats; indentifying revegetation, soil stabilization, and erosion reduction measures; managing for invasive/weed species; and promoting the enhancement and/or restoration of existing habitat conditions when appropriate.

Impacts under Alternative C

Under this alternative, 61,200,000 acres of public land and 37,900,000 acres of NFS lands within 10 miles of the centerline of existing transmission lines and at least 15 miles outside of the Yellowstone National Park boundary would be open to leasing for indirect use and subject to major and moderate constraints as detailed in Chapter 2. Approximately 81,950,000 acres of public land and 65,710,000 acres of NFS lands would be closed to leasing for indirect use.

There would be less land available for exploration and development of geothermal resources for indirect use than under Alternatives A or B.

Under this alternative there would be less impact on vegetation and important habitats and communities than the other alternatives, as large areas would be closed to leasing for indirect use. Lands open to leasing within 10 miles of the centerline of existing transmission lines and at least 15 miles outside of the Yellowstone National Park boundary would be subject to constraints that are intended to protect vegetation and important habitats. Additionally, lands within existing transmission line ROWs often have existing access and maintenance roads constructed that could potentially be used for geothermal development, further limiting the potential impacts on vegetation and important habitats.

Areas open to geothermal lease applications for direct use and impacts from their anticipated subsequent development would be the same as identified under Alternative B.

4.10 FISH AND WILDLIFE

4.10.1 What did the Public Say about Impacts on Fish and Wildlife?

Comments collected during scoping focused on the potential impacts on big game species, sagebrush-dependent species, the potential for habitat fragmentation and disturbance, and risks to seasonal habitat such as wintering areas. Other comments were directed toward impacts on important habitats such as riparian habitat, wetlands, and old growth forest that are also addressed in Section 4.9, Vegetation.

4.10.2 How Were the Potential Effects of Geothermal Development on Fish and Wildlife Evaluated?

Leasing of geothermal resources does not affect fish and wildlife. These resources would be affected only by development of specific geothermal projects. Potential impacts of geothermal development were evaluated based on the typical disturbance of geothermal projects for the various stages of development and then assessed based on projected location and intensity, as described in the RFD scenario. The types of fish and wildlife that could be affected by geothermal development on public and NFS lands depend on the specific location of the proposed project, the time of year, the project design, and its environmental setting.

Specific impacts of a geothermal project depend on the size of the project and the methods used for construction. Impacts on wildlife are associated strongly with impacts on wildlife habitat. Wildlife depend on specific habitats for foraging, breeding, migration, and cover. General impacts on vegetation, riparian, wetland, sagebrush, and old growth habitats are discussed in Section 4.9, Vegetation. The wildlife present in and the extent of impacts depends on the ecoregion in which geothermal activities occur. Impacts discussed in this section are associated with the elimination and degradation of wildlife habitat at project sites, in immediately adjacent areas, or within the watershed, as well as impacts on wildlife from noise disturbance, displacement, mortality from vehicle collisions, and effects from invasive species. Potential impacts on fish and wildlife could occur if reasonably foreseeable future actions were to result in the following:

- Adversely affect a population by substantially reducing its numbers, causing a fish or wildlife population to drop below self-sustaining levels, or causing a substantial loss or disturbance to habitat. Such effects could include vehicle impacts and crushing, increased predation, habitat fragmentation, or loss of seasonal habitat;
- Have a substantial adverse impact on nesting migratory birds, including raptors, as protected under the Migratory Bird Treaty Act;
- Interfere with the movement of any resident or migratory fish or wildlife species, or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites;

and conflict with the wildlife management strategies of the BLM or FS.

4.10.3 What are the Common Impacts on Fish and Wildlife Associated with Geothermal Development?

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on fish and wildlife from geothermal resource development.

The nature and extent of geothermal-related development activities that would affect fish and wildlife would vary by project, depending on several factors: 1) whether the project is for direct use or indirect use; 2) the size of the project; 3) the geographic location; and 4) for indirect use, the type of plant. Fish and wildlife and wildlife habitat would be evaluated on a project-specific basis, as NEPA would be conducted for each of the potential phases of geothermal development activity: exploration, drilling operations, utilization, and reclamation and abandonment. This section will qualitatively address the impacts on fish and wildlife.

Impacts common to fish and wildlife across the entire planning area are discussed below, followed by impacts that are specific to a certain stage of geothermal development (exploration, drilling operations, utilization, or reclamation and abandonment).

The Reasonable Foreseeable Development Scenario for Fish and Wildlife

The public and NFS lands that would be affected within the planning area cover approximately 246,736,368 acres. The RFD scenario estimates that by 2025 less than 0.1 percent (89,548 acres) of that land would be disturbed by geothermal projects. The disturbance would be spread both spatially and temporally across the planning area. Many of these disturbed areas would be reclaimed shortly after disturbance.

The effects of implementing the RFD scenario would have very little effect on most species populations. The fish, reptile, amphibian, bird, and mammal populations in the planning area are diverse and widespread and typically have high rates of mortality and natality. Thus, implementing the RFD scenario would affect relatively small areas of habitat and would typically affect individual species instead of large populations. The instances where individuals, communities, or populations can be affected from geothermal activities involve the following stressors and associated impacts on vegetation and important habitats:

- Habitat disturbance - The fragmentation of wildlife habitat for species requiring large contiguous tracts can be affected by site clearing, well drilling, construction of access roads and geothermal facilities, and maintenance and operational activities that would

disturb habitat. These activities could cause disruption of breeding and migration, mortality and injury, increased risk of invasive species, and alteration of water and seed dispersion and wildlife use, which can further affect vegetation communities.

- Invasive Vegetation - Disturbance and access by vehicles and human foot traffic may expose areas to colonization by invasive and nonnative species, making it more difficult for endemic species to reestablish in disturbed areas and threatening the continued existence of endemic species (BLM 2007c). This can affect wildlife by reducing habitat quality and species diversity, thereby affecting foraging and breeding behavior.
- Injury or Mortality - Wildlife could be injured or killed during roadway clearing, vehicle staging, building construction, and other activities. Small or less mobile animals such as reptiles, amphibians, and rodents would be most susceptible to injury or mortality from geothermal activities. Maintenance around project components such as drill pads, buildings, pipelines, or other facilities would involve mowing, herbicide treatment, and other mechanical or chemical means of controlling vegetation that could directly affect species that depend on that vegetation for food, cover, or other habitat needs.
- Erosion and runoff - Site clearing, grading, access roads construction, containment basins, site runoff, and vehicle and human foot traffic cause erosion. The effects of erosion include the loss of habitat for terrestrial species and increased turbidity, which can directly affect fish and other aquatic biota.
- Fire – Increased vehicular and human traffic, equipment operation, and geothermal fluid extraction can increase the risk of fire. Vehicles, electrical lines, and smoking can all result in accidental fires. During fires, wildlife can be killed or injured. After fires, wildlife may be forced to move to other habitats or may be without suitable habitat for important behavioral activities.
- Noise - Constructing and operating geothermal facilities can produce noise far above normal ambient levels. Many species are sensitive to increases in noise that may cause disruption of breeding, migration, wintering, foraging, and other behavioral activities.
- Exposure to Contaminants - Vehicle fuel, hydraulic fluid, solvents, cleaners, and geothermal fluids can all be harmful to fish and wildlife. Accidental spills can contaminate soils and water and indirectly harm wildlife. Licensed herbicide use would likely be used to control vegetation around geothermal facilities and support structures. Spills of herbicides or acute exposure to herbicides can have adverse effects on wildlife.

Fish and Aquatic Biota

Impacts on fish and aquatic biota from geothermal projects are directly linked to impacts on riparian and wetland habitats in most cases. Impacts would result primarily from activities occurring near or in water bodies. Potential causes include ground disturbance, vegetation removal, groundwater withdrawal, road construction and excavation, structure and other facility installation (e.g., transmission towers or pipelines), and release of water contaminants. The effects of such actions could include changes in hydrology, increased turbidity, changes in water quality (e.g., temperature, dissolved oxygen, pollutants), loss of riparian vegetation (an indirect aquatic food source), restriction of fish movement and migration, and changes in predator and human use of the aquatic habitat. Impacts would vary in severity based on the type of aquatic habitat, the density, type, and number of species, and the method and stage of geothermal development.

Disturbance of adjacent ground and direct stream disturbance could result in increased turbidity. Sediments resulting from geothermal development would settle on the stream bottom downstream of the disturbance. The size of the particles and the stream flow would dictate how far the sediment is carried. Some fish such as salmonids and some aquatic insects are highly susceptible to increased turbidity. Particles in water can impair their ability to absorb oxygen, decrease survival of eggs, larvae, and fry, interfere with feeding and spawning, and decrease their ability to elude predators.

Stream flow rates are affected by the upland vegetation and adjacent terrain; therefore, geothermal development could alter stream flows and affect aquatic species and habitat. Typically, BMPs are instituted to control, reduce, or eliminate impacts on fish and aquatic biota by limiting how close development can occur and the grade of the slope that can be developed and by reclaiming areas immediately following the commencement of geothermal activities.

The severity of impacts associated with sedimentation depends largely on the receiving waters and the timing of the sedimentation event. Waters that are typically clear and cold are most susceptible to increased turbidity. These waters include higher mountain streams, often at more northern latitudes. These waters are more common to salmonid species (salmon, trout, char, and whiting). Some fish and aquatic species are adapted to large pulse events that occur seasonally and often are associated with large amounts of runoff and sediment. These species are found primarily in warmer waters and in desert climates were monsoons are normal.

Removal of riparian vegetation can increase water temperatures in adjacent streams. Trees and overhanging shrubs limit the amount of solar heat radiation that reaches the water and help maintain microclimates of higher humidity and lower temperatures. Increased water temperatures can impair growth, limit reproduction, alter competitive advantage (sometimes favoring invasive species),

and limit survival in the affected area during periods of elevated temperature. Water temperatures for cold-water species (trout and salmon) cannot exceed 68°F for more than short periods of time. Warm-water species are also subject to increases in water temperatures where waters have reached the upper bounds of the tolerable range. Small streams and water bodies are more susceptible to increased temperatures resulting from removal of vegetation. The BLM and FS have best management practices that limit the amount of riparian vegetation that can be removed. This includes a stream buffer that typically excludes development and surface disturbance.

Streams, rivers, and other waterways are at risk of exposure to toxic materials (fuel, herbicides, hydraulic fluid, drilling muds, geothermal working fluids) present as part of geothermal projects. The severity of impacts caused by toxics would depend on the type and amount introduced to the waterway, as well as on the time, location, and nature of the water body. Toxics are not expected to enter waterways, as stipulations and best management practices are intended to protect waterways from fuel spills and accidental releases.

Geothermal development can also cause impacts on fish and aquatic biota by facilitating access to areas. Human traffic may increase as the result of new roadways. Increased use can cause erosion and compaction of soil and may increase fishing or harvesting pressure.

Essential Fish Habitat (EFH) for salmonids within the planning area is found in Alaska, California, Idaho, Oregon, and Washington. EFH for salmonids consists predominately of coastal streams and rivers that lie north of Point Conception in Central California to Cape Prince of Whales in Alaska. EFH could be affected by the same activities and stressors mentioned above that affect other fish and riparian and wetland habitats. Erosion from project activities can cause increased turbidity in waterways. Changes in stream flows resulting from water use can also affect EFH, as can contaminants such as spilled fuel or herbicides that make their way into waterways.

Wildlife

Wildlife would be affected by the alteration, removal, reduction, or fragmentation of habitat. Habitat at drilling pads, facilities, roadways, and transmission corridors would be affected. The extent of the disturbance would be a function of the level of preexisting disturbance, the size, scale, and phase of geothermal development, and the type and quality of habitat. Geothermal development would have the greatest impact on wildlife if it were to affect specialty habitats such as riparian areas, wetlands, or wintering and breeding areas.

Fragmentation would affect wildlife by altering how wildlife species use the habitat. Fragmentation can separate wildlife populations into smaller populations, making them more vulnerable to predation, drought, and disease and limiting

genetic diversity within breeding groups. Movement between habitat tracts is more difficult after fragmentation. Roads have been shown to impede the movements of invertebrates, reptiles, and small and large mammals (Strittholt et al. 2006. Habitat fragmentation can create increased edges for access by predators and invasive species and can facilitate access by hunters, reducing the density and diversity of wildlife species found in the original habitat (Anderson et al. 1977). Habitat fragmentation and degradation is considered a causal factor for the decline in sage grouse throughout most of its range (Strittholt et al. 2006). Text box 4.10-1 provides more information on sage grouse impacts and compatibility with geothermal development on public and NFS lands.

Animals displaced by fragmentation would occupy nearby habitats, which could lead to an increase in competition for resources and result in decreased health and potentially death for less fit individuals. The impacts resulting from displacement after habitat removal and fragmentation depend on many factors, including the sensitivity of a species to edge and area effects, the duration and rate of habitat loss and fragmentation, and the proximity of a chosen habitat to the disturbed area (Hagan et al. 1996).

Areas adjacent to disturbance resulting from geothermal development would likely be avoided by wildlife; therefore, the amount of habitat actually affected from disturbance and fragmentation extends beyond the habitat disturbed. The effective habitat loss (amount of habitat actually used by wildlife) due to new roadways was reported to be 2.5 to 3.5 times as great as actual habitat loss (Reed et al. 1996).

Fragmentation can facilitate the spread and introduction of invasive plant species (a more thorough discussion of effects on vegetation is found earlier in this section). Roads and other corridors can facilitate the dispersal of invasive species by altering existing habitat conditions, stressing or removing native species, and allowing easier movement by wild or human vectors (Trombulak and Frissell 2000).

Wildlife can be affected by invasive vegetation. Invasive plant species may be unpalatable for native animal species, making it difficult for them to forage. This can alter the population structure of entire habitats. Birds are most directly affected by invasive plants, as their food source is often seeds from native grasses and shrubs. Invasion of exotic species on public lands has been estimated at more than 5,000 acres per day. Cheatgrass is expected to dominate or completely convert more than half of the native sagebrush habitat in the United States (Strittholt et al. 2000); thus, sage grouse can be directly affected by cheatgrass infestations on sagebrush habitats.

Wildlife habitat in riparian areas is especially vulnerable to devastation by weeds because of the extra moisture and seed transport into these areas. Perennial pepperweed, leafy spurge, Russian knapweed and tamarisk (also known as salt

cedar) easily form monocultures along riparian areas and adjacent uplands. Purple loosestrife forms solid stands, crowding out food plants needed by ducks and geese and reducing suitable nesting sites. Muskrats and long-billed marsh wrens leave infested areas (Thompson et al 1987). Tamarisk has been able to outcompete willow and other riparian plants in many locations, greatly diminishing the quantity and quality of riparian habitat for migrant songbirds and vegetation-dependent birds like the endangered Yuma clapper rail at the Salton Sea and elsewhere (Dudley 1995).

The direct injury and mortality of wildlife would likely occur as a result of geothermal development associated with the RFD scenario. Equipment used for clearing vegetation, roadways, well pads, and facility sites and vehicles used during operation and closeout would affect wildlife that are not mobile enough to avoid construction operations. Reptiles, amphibians, and small mammals would be most susceptible. More mobile wildlife species such as deer, birds, and large predators may avoid the initial clearing activity by moving into habitats in adjacent areas. Some of these animals may not survive if surrounding areas are at carrying capacity, or they may outcompete current residents.

Access road development increases land use by recreationalists and other users of public and NFS lands. This increases the amount of human presence and the potential impacts on wildlife from hunting, vehicle collision, harassment, and legal or illegal taking of wildlife. Access roads not needed for maintenance would be removed following exploration and development, and public use of these access roads would be restricted; therefore, roadkills would not be expected to result in a significant impact from a wildlife population perspective.

Noise from geothermal activities can have adverse impacts on wildlife. Principal sources of noise from geothermal activities would include trucks and the operation of drilling rigs and heavy machinery. The most adverse impacts associated with noise could occur if critical lifecycle activities were disrupted (e.g., mating and nesting). All wildlife could be disturbed by noise. Disturbance occurring during mating, nesting, or rearing of young can cause wildlife to abandon mating and nesting activities and can strand young, leaving them susceptible to predation and starvation.

On the basis of the types of equipment that would likely be used such as drill rigs and graders, the noise levels associated with the equipment would range from about 80 to 90 dBA within 50 feet; site preparation noise would be at the mid-40-dB level approximately 0.25 mile from the site (Section 3.19 Noise).

Hazardous materials resulting from accidental fuel spills, drilling muds, geothermal fluids, or releases of hazardous materials could result in the exposure of wildlife at the geothermal project sites. Potential impacts on wildlife would vary according to the material spilled, the volume of the spill, the location of the spill, and the species that could be exposed. Spills could contaminate soils

and surface water and could affect wildlife associated with these media. A spill would be expected to have a population-level adverse impact only if the spill was very large or contaminated a crucial habitat area where a large number of individual animals were concentrated. The potential for accidental spills to have adverse effects on wildlife populations is unlikely, because the amounts of fuels and hazardous materials are expected to be small, so an uncontained spill would affect only a limited area (much less than one acre). In addition, wildlife use of the area would be minimal, greatly reducing the potential for exposure.

The location and timing of geothermal activities (especially exploration and development) may affect the migratory and other behavioral activities of some species. Construction activities could affect local wildlife by disturbing normal behavioral activities such as foraging, mating, and nesting. Wildlife may cease foraging, mating, or nesting or may vacate active nest sites in areas where geothermal activities are occurring; some species may permanently abandon the disturbed areas and adjacent habitats. In addition, active exploration and development may affect movements of some birds and mammals; for example, they may avoid a localized migratory route because of ongoing construction (BLM 2005b).

Reptiles and Amphibians

Geothermal activities may result in increased erosion and runoff from cleared and graded sites. This erosion and runoff could reduce water quality in on-site and surrounding water bodies that are used by amphibians, thereby affecting reproduction, growth, and survival. Water quality impacts during exploration, development, and closeout would be short term. Any impacts on amphibian populations would be localized to the surface waters receiving site runoff. Although the potential for runoff would be temporary, pending the completion of activities and the stabilization of disturbed areas with vegetative cover, erosion could result in significant impacts on local amphibian populations if an entire recruitment class is eliminated (e.g., complete recruitment failure for a given year because of siltation of eggs or mortality of aquatic larvae).

As mentioned above, reptiles and amphibians would have a difficult time vacating areas under geothermal development and could be crushed or injured during geothermal site and access roadway clearing. Following habitat removal or degradation, reptiles and amphibians may become more susceptible to predators or may be forced into adjacent habitats were the areas have reached carrying capacity.

Birds

The birds that are most susceptible to being adversely affected by geothermal projects are those whose mating or nesting habitats may be directly affected by geothermal activities. Birds that use the areas for foraging or migration would be relatively unaffected, as they would fly to adjacent habitat. Sagebrush species such as sage grouse would be directly affected.

Sage Grouse and Geothermal Development

Most concerns about the effects of geothermal development on sage grouse have focused on the potential impacts associated with reducing, fragmenting, and modifying grassland and shrubland habitats, particularly sagebrush. The Gunnison sage grouse (*Centrocercus minimus*) and particularly the greater sage grouse (*C. urophasianus*) are of concern relative to sagebrush habitat reduction and fragmentation that is occurring within every state in the planning area except Alaska. Sagebrush habitat in the planning area, as mentioned above, is found almost exclusively in the temperate desert ecoregions province, though some areas in the far eastern portion of the planning area can be found in the temperate steppe ecoregion division.

The Gunnison sage grouse is restricted to southwestern Colorado and southeastern Utah, while the greater sage grouse inhabits every planning area state except Alaska, Arizona, and New Mexico. The following discussion emphasizes the more widely distributed greater sage grouse. Figure 4.10-1 shows current and historic sage grouse distribution throughout the project area. Table 4-4 shows the percentage of lands occupied by sage grouse when compared to historical distribution within the planning area.

Table 4-4
Percentage of Lands Occupied by Sage Grouse vs. Historic Distribution within the Planning Area

State	Percent of Historic
Alaska	N/A
Arizona	0% (extirpated)
California	70.2%
Colorado	64.6%
Idaho	78.3%
Montana	85.8%
Nevada	19.1%
New Mexico	0% (extirpated)
Oregon	46.0%
Utah	25.2%
Washington	3.82%
Wyoming	4.6%

Source: Shroeder 2002

Populations of greater sage grouse can vary from nonmigratory to migratory (having either one-stage or two-stage migrations) and can occupy an area that exceeds 1,040 square miles on an annual basis. The distance between leks (areas used for courtship) and nesting sites can exceed 12.4 miles (Connelly et al. 2004). Nonmigratory populations can move 5 to 6 miles between seasonal habitats and have home ranges up to 40 square miles. The distance between

summer and winter ranges for one-stage migrants can be 9 to 30 miles apart. Two-stage migrant populations make movements between breeding habitat, summer range, and winter range. Their annual movements can exceed 60 miles. The migratory populations can have home ranges that exceed 580 square miles (Bird and Schenk 2005). The greater sage grouse has a high fidelity to a seasonal range. They also return to the same nesting areas annually (BLM 2004e; Connelly et al. 2004).

The greater sage grouse needs contiguous, undisturbed areas of high-quality sagebrush habitat. They are omnivorous and consume primarily sagebrush and insects. Over 99 percent of their diet in winter consists of sagebrush leaves and buds. Sagebrush is also important as roosting cover, and the greater sage grouse cannot survive where sagebrush does not exist (Connelly et al. 2004).

Leks are generally areas supported by low, sparse vegetation or open areas surrounded by sagebrush that provide escape, feeding, and cover. They can range in size from small areas of 0.1 to 10 acres to areas of 100 acres or more (Connelly et al. 2000). The lek/breeding period occurs March through May, with peak breeding occurring from early to mid-April. Nesting generally occurs 1 to 4 miles from lek sites, although it may range up to 11 miles (BLM 2004e). The nesting/early brood-rearing period occurs from March through July. Tall, dense grass combined with tall shrubs at nest sites decreases the likelihood of nest depredation. Hens have a strong year-to-year fidelity to nesting areas (BLM 2004e). The late brood-rearing period occurs from July through October (BLM 2004). The greater sage-grouse occupies winter habitat from November through March. Suitable winter habitat requires sagebrush 10 to 14 inches above snow level with a moderate canopy cover. Wintering grounds are potentially the most limiting seasonal habitat for greater sage grouse (BLM 2004e; Connelly 2000).

Loud, unusual sounds and noise from construction and human activities disturb sage grouse and birds in general and can reduce sage grouse use of leks (Connelly et al. 2004). Disturbance at leks appears to limit reproductive opportunities and may result in regional population declines. Most observed nest abandonment is related to human activity (NatureServe 2007). Thus, site construction, operation, and site maintenance activities could be a source of auditory and visual disturbance to sage grouse.

Geothermal facilities, well pads, transmission lines, pipelines, and access roads may adversely affect habitats important to sage grouse by causing fragmentation, reducing habitat value, or reducing the amount of habitat available (Connelly et al. 2004). Geothermal facilities, transmission lines, pipelines, and other structures can also provide perches and nesting areas for raptors and ravens that may prey upon sage grouse. Sage grouse are also susceptible to vehicular collision along dirt roads because they are sometimes attracted to the dirt roads to take dust baths (Strittholt et al. 2000).

Measures that have been suggested for managing sage grouse and their habitats (Connelly et al. 2000) that have pertinence to geothermal projects include the following:

- Identify and avoid both local (daily) and seasonal migration routes.
- Consider sage grouse and sagebrush habitat when designing, constructing, and utilizing project access roads and trails.
- Avoid siting geothermal developments in breeding habitats.
- Adjust the timing of activities to minimize disturbance to sage grouse during critical periods.
- When possible, locate geothermal-related facilities away from active leks or near other sage grouse habitat.
- When possible, restrict noise levels to 10 dB above background noise levels at lek sites.
- Minimize nearby human activities when birds are near or on leks.
- As practicable, do not conduct surface-use activities within crucial sage grouse wintering areas from December 1 through March 15.
- Maintain sagebrush communities on a landscape scale.
- Provide compensatory habitat restoration for impacted sagebrush habitat.
- Avoid the use of pesticides at sage grouse breeding habitat during the brood-rearing season.
- Develop and implement appropriate measures to prevent the introduction or dispersal of noxious weeds.
- Avoid creating attractions for raptors and mammalian predators in sage grouse habitat.
- Consider measures to mitigate impacts at off-site locations to offset unavoidable sage grouse habitat alteration and reduction at the project site.

The BLM manages more sage grouse habitat than any other entity; therefore, it has developed, in conjunction with the NFS and state agencies, a National Sage Grouse Habitat Conservation Strategy for BLM-administered public lands to manage public lands in a manner that would maintain, enhance, and restore sage grouse habitat, while providing for multiple uses of BLM-administered public lands (BLM 2004e). The strategy is consistent with the individual state sage grouse conservation planning efforts. The purpose of this strategy is to set goals and objectives, assemble guidance and resource materials, and provide more uniform management direction (BLM 2004e). The strategy includes guidance for addressing sagebrush habitat conservation in BLM land use plans and for

managing sagebrush plant communities for sage grouse conservation. This guidance is designed to support and promote the conservation of sagebrush habitats for sage grouse and other sagebrush-obligate wildlife species on public lands, and presents a number of suggested management practices (SMPs). These SMPs include management or restoration activities, restrictions, or treatments that are designed to enhance or restore sagebrush habitats. BMPs that are or may be pertinent to geothermal projects include the following:

- Develop monitoring programs and adaptive management strategies;
- Control invasive species;
- Prohibit or restrict ATV activity;
- Consider sage-grouse habitat needs when developing restoration plans;
- Avoid placing facilities in or next to sensitive habitats such as leks and wintering habitat.
- Locate or construct facilities so that facility noise does not disturb grouse activities or leks;
- Consolidate facilities as much as possible;
- Initiate restoration practices as quickly as possible following land disturbance;
- Install antiperching devices on existing or new powerlines in occupied sage grouse habitat; and
- Design facilities to reduce habitat fragmentations and mortality to sage grouse.

In addition to BLM's National Sage Grouse Habitat Conservation Strategy, the Western Association of Fish and Wildlife Agencies has produced two documents that together comprise a Conservation Assessment for Greater Sage Grouse. The first is the Conservation Assessment of Greater Sage-Grouse and Sagebrush Habitats (Connelly et al. 2004). The second document is the Greater Sage-Grouse Comprehensive Conservation Strategy (Stiver et al. 2006).

The density of several forest-dwelling bird species can increase within a forest stand soon after the onset of fragmentation, as a result of displaced individuals moving into remaining habitats (Hagan et al. 1996). Nests along habitat edges created from geothermal projects could be more vulnerable to predators. The developed geothermal areas may also encourage population expansion of invasive bird species such as the house sparrow and European starling, which compete with many native species. Fragmenting forests into small patches is detrimental to many migrant songbird species (Parker et al. 2005).

Noise can have direct effects on birds of all species by affecting their ability to hear, defend territory, identify predators, and learn songs (Larkin 1996). Studies have examined the effects of continuous noise on bird populations, including the effects of traffic noise, coronal discharge along electricity transmission lines, and turbines. Results indicate reduced densities as far as two miles from noise sources (Larkin 1996), with threshold effects at a level of 47 dBA for all species combined and 42 dBA for the most sensitive species; the observed reductions in population density were attributed to a reduction in habitat quality caused by elevated noise levels (Reijinen et al. 1996). This threshold sound level is at or below the sound levels generated by truck traffic that would likely occur at distances of 250 feet or more from access roads or geothermal project sites, and equivalent to that of construction noise almost 2,500 feet away.

Big Game

Geothermal projects could reduce the amount of suitable winter cover and forage available to big game, depending on their location. Long-term displacement of elk, mule deer, pronghorn, or other species from crucial winter habitat or calving areas due to habitat disturbance would directly impact these animals. An inability to use calving or wintering areas can directly affect populations because they may be unable to reproduce or may become stressed during harsh winter months, which can lead to death or decreased fitness.

Big game animals may also be affected if a geothermal facility, pipeline, or access road were to interfere with migratory movements. Herd animals, such as elk, deer, and pronghorn, could potentially be affected if projects affect migration paths between winter and summer ranges or in calving areas. Large predators, such as grizzly bear and mountain lion, require access to prey species and rely on migration corridors to follow prey species and hunt. Loss of habitat continuity along migration routes could severely restrict the seasonal movements necessary to maintain healthy big game and large predator populations (Watson 2005).

Exploration

The overall impact of geothermal exploration on fish and wildlife populations at a geothermal project site would depend on the type and amount of wildlife habitat at the site, as well as the amount of area that would be disturbed. The main impacts on wildlife during exploration are habitat removal, the potential for direct injury and mortality from vehicle travel, temporary noise impacts, and long-term effects from invasive species that may be introduced during exploration or reclamation of the affected area. Exploration activities are short term, and impacts on fish and wildlife would be temporary, with the exception of invasive species. Exploration activities often have very little disturbance on wildlife and wildlife habitat, as they may use existing roadways and disturbed areas during drilling of temperature gradient wells. Impacts from exploration would be similar to those described for development, but to a lesser extent and over a shorter time frame. The severity of impacts during each stage of a

geothermal project (exploration, drilling operations, utilization, and reclamation and abandonment) is listed below in Table 4-5.

Drilling Operations

The overall impact of drilling operation activities on wildlife populations at a geothermal project site would depend on the type and amount of wildlife habitat that would be disturbed, the nature of the disturbance (e.g., complete, permanent reduction because of structures or drill pads, or temporary disturbance in construction support areas), and the wildlife that occupy the project site and surrounding areas.

Clearing and grading activities would result in the direct injury or death of wildlife that are not mobile enough to avoid construction operations (e.g., reptiles, small mammals, and young), that use burrows (e.g., ground squirrels and burrowing owls), or that are defending nest sites (e.g., ground-nesting birds). Although more mobile species of wildlife, such as deer and adult birds, may avoid the initial clearing activity by moving into habitats in adjacent areas, it is conservatively assumed that adjacent habitats are at carrying capacity for the species that live there and could not support additional biota from the construction areas. The subsequent competition for resources in adjacent habitats would likely preclude the incorporation of the displaced individual into the resident populations.

Sump pits could impact wildlife species by providing a catch basin for rainwater (an assumed water source). Sump pits often contain high concentrations of minerals and chemicals from the drilling fluids, which can be toxic to wildlife. In addition, smaller species of wildlife may drown in the sump pits, which are often lined with plastic to prevent seepage and vegetation growth, making it difficult for wildlife to escape.

Utilization

Constructing a geothermal project and its ancillary facilities may impact wildlife through the reduction, alteration, or fragmentation of habitat, which represents the greatest impact on wildlife. All existing habitat within the drilling operations footprint, along new access road corridors, and within new utility right-of-ways would be disturbed. The amount of habitat that would be disturbed would be a function of the size of the proposed geothermal project and would range from approximately 53 acres to 367 acres (RFD) for indirect-use projects. Direct-use applications typically would disturb far less habitat, potentially less than one acre. The existing degree of disturbance already present in the project site area would also affect the total disturbed area resulting from geothermal drilling operations. Wildlife and wildlife habitat adjacent to disturbed areas could also be affected. Clearing and grading activities would impact wildlife greater than under the drilling operations phase due to the increased footprint of full build out.

Table 4-5
Impacts on Wildlife and Wildlife Habitat during Full Buildout of a Geothermal Development

Ecological Stressor	Geothermal Activity	Impact	Potential Level of Impact			
			Exploration	Drilling Operations	Utilization	Reclamation and Abandonment
Habitat disturbance	Site clearing and grading; well drilling, construction; pipelines, access road, and ancillary facility construction; construction and maintenance vehicle travel; operational noise	Disruption of breeding, migration, wintering, and foraging behavior	Moderate	Moderate	Moderate to high	Low to moderate
Invasive vegetation	Site clearing and grading; well drilling, construction; pipelines, access road, and ancillary facility construction; construction and maintenance vehicle travel	Reduced habitat quality and species diversity. Alter habitat use for foraging and breeding	Low to moderate	Low to moderate	Moderate to high	Low to moderate
Injury or mortality	Site clearing and grading; well drilling, construction; pipelines, access road, and ancillary facility construction; construction and maintenance vehicle travel	Destruction and injury of wildlife, mostly those with limited mobility	Low to moderate	Low to moderate	Moderate	Low to moderate

Table 4-5
Impacts on Wildlife and Wildlife Habitat during Full Buildout of a Geothermal Development

Ecological Stressor	Geothermal Activity	Impact	Potential Level of Impact			
			Exploration	Drilling Operations	Utilization	Reclamation and Abandonment
Erosion and runoff	Site clearing and grading; well drilling, construction; pipelines, access road, and ancillary facility construction; construction equipment travel	Reduced reproductive success of amphibians using on-site surface waters; drinking water affected. May limit survival of fish eggs and fry, increase predation, and reduce fish survival	Moderate	Moderate	Moderate to high	Moderate
Fire	Site clearing and grading; well drilling, construction; pipelines, access road, and ancillary facility construction; construction and maintenance vehicle travel	Direct injury and mortality, loss of habitat, loss of food source, and loss of cover	Low to moderate	Low to moderate	Moderate	Low
Noise	Site clearing and grading; well drilling, construction; pipelines, access road, and ancillary facility construction; construction and maintenance vehicle travel	Disruption of breeding, migration, wintering, and foraging behavior	Moderate to high	Moderate to high	High	High

Table 4-5
Impacts on Wildlife and Wildlife Habitat during Full Buildout of a Geothermal Development

Ecological Stressor	Geothermal Activity	Impact	Potential Level of Impact			
			Exploration	Drilling Operations	Utilization	Reclamation and Abandonment
Exposure to contaminants	Accidental spill during equipment refueling; accidental release of stored fuel or hazardous materials; drilling mud spill or accidental spill of geothermal fluids and working fluids	Exposure may affect survival, reproduction, development, or growth of fish and wildlife	Low	Low	Low	Low

The assessment of impact level is based on the RFD; and activities and projected disturbance associated with each stage geothermal development, as well evaluation of the efficacy of stipulations and BMPs available to eliminate or mitigate the potential impacts. Duration of the impact as well as potential for accidents factor into the assessment.

Low- The activities involved in geothermal development do not present a risk or have effective precautions, BMPs, and stipulations that would minimize the potential, intensity, and duration of impact associated the prospective ecological risk factor.

Moderate- The activities involved in geothermal development have a greater potential for impacts on wildlife, including accidents, unavoidable removal of habitat, and indirect disturbance. Impacts may be unavoidable and may endure beyond the conclusion of the activity.

High- The activities involved in geothermal activities would have direct and unavoidable impacts. BMPs and stipulations are not available to eliminate impacts. Additionally, the risk of accident may be higher or the duration of the impact may be last well beyond the conclusion of the geothermal activities.

Any effects of habitat reduction, disturbance, or fragmentation on wildlife would be related to the type and abundance of the habitats affected and to the wildlife that occur in those habitats. Large developments (367 acres) could represent a significant impact on local wildlife, especially to species whose affected habitats are uncommon and not well represented in the surrounding landscape. However, smaller projects and geothermal projects on previously disturbed lands or accessible by existing roadways would affect far less habitat.

Noise from drill rigs and construction activities during the utilization phase can disturb wildlife in adjacent habitats up to 2,500 feet away. Noise can cause wildlife to avoid habitats, disrupt behavioral patterns, and potentially cause a long-term decline in wildlife populations.

Wildlife habitat could also be impacted if invasive vegetation becomes established in the construction-disturbed areas and adjacent off-site habitats. The establishment of invasive vegetation could reduce habitat quality for wildlife and could locally affect wildlife occurrence and abundance.

During operations within the geothermal utilization phase, grass mowing and brush cutting may be required once every few years. These activities would result in minor impacts on wildlife. Mobile animals would be displaced to adjacent undisturbed habitats. Less mobile wildlife could be killed or injured during mowing and cutting; however, the overall significance of such impacts on local wildlife populations would likely be minor, because of the likely limited quality and carrying capacity of the maintained habitats.

The presence of a geothermal facility could disrupt movements of terrestrial wildlife, particularly during migration. Herd animals such as elk, deer, and pronghorn antelope could potentially be affected by power plants, pipelines, facilities, or drill pads that are placed along migration paths between winter and summer ranges or in calving areas. The geothermal facility and associated structures and access roads would be maintained as areas of low vegetation that may hinder or prevent movements of some wildlife species.

Increased human activity also increases the potential for fires. Fire may affect wildlife through direct mortality, reduction of habitat, and/or a reduction in habitat quality. In general, short-term and long-term fire effects on wildlife are related to fire impacts on vegetation, which in turn affect habitat quality and quantity, including the availability of forage and cover.

The licensed use of pesticides and herbicides at a geothermal development would not be expected to adversely affect local wildlife. Applications of these materials would be conducted by following label directions and in accordance with applicable permits and licenses. However, accidental spills or releases of these materials could impact exposed wildlife.

Reclamation and Abandonment

The impacts associated with reclamation and abandonment would be similar to those associated with the drilling operations phase but to a lesser extent and for a shorter time period. Reclamation and abandonment activities would include vehicle traffic and structure removal, which would cause noise and may damage adjacent wildlife habitat. Reclamation and abandonment would also increase the potential for runoff and erosion, as lands would be disturbed during the removal of buildings, structures, pipelines, and transmission towers. Once all structures are removed, geothermal wells would be capped, and disturbed areas would be reclaimed with native vegetation to provide habitat for wildlife.

4.10.4 What are the Potential Impacts on Fish and Wildlife Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing the alternatives described in Chapter 2.

Impacts under Alternative A

Under the no action alternative, lease applications would continue to be processed on a case-by-case basis. Areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. The number of acres that could impact fish and wildlife is unknown; however, impacts would be site-specific and similar to the impacts under the four phases of geothermal development identified under Section 4.10.3. Under this alternative, no comprehensive list of stipulations, best management practices, or procedures would be distributed to serve as consistent guidance for all future geothermal leasing and development for direct and indirect use. This would result in fragmented and segregated planning for wildlife and wildlife habitats which often exponentially increases impacts. Development of the individual leasing approvals, stipulations, and mitigation levels would also continue to vary per site and delay application processing time.

Impacts under Alternative B

Under this alternative, the land closed to geothermal leasing for direct and indirect use would increase. The BLM and FS would close approximately 25,150,000 acres of public land and 24,370,000 acres of NFS lands to geothermal leasing that are incompatible with geothermal leasing, exploration, and development.

These closed lands would protect wildlife and wildlife habitats from potential development. Wildlife in closed areas would not be affected by geothermal development. This alternative would have fewer impacts on fish and wildlife and their habitats, specifically in important wildlife habitats such as roadless areas, wilderness areas, and areas of critical environmental concern, than Alternative A.

Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. Relevant stipulations (Section 2.2.2) designed to minimize impacts on fish and wildlife include (1) no surface occupancy on water bodies, riparian areas, and wetlands; (2) controlled surface use in areas that would adversely impact the continuity of migration corridors or important habitat; and 3) controlled surface use within 500 feet of riparian or wetland vegetation to protect the values and functions of these areas. In accordance with BMPs (Appendix D), operators would review existing information on species and habitats in the vicinity of the project area to identify potential concerns. Operators would also employ timing restrictions and design features (outlined in the BMPs in Appendix D) to avoid, minimize, or mitigate negative impacts on vulnerable fish and wildlife while maintaining or enhancing habitat values for other species. It is expected that these measures would effectively minimize impacts on fish and wildlife by protecting and maintaining key habitats, reducing habitat fragmentation, reducing human caused disturbance to species and habitats, managing for invasive/weed species, and promoting the enhancement and/or restoration of existing habitat conditions when appropriate.

Impacts under Alternative C

Under this alternative, approximately 61,200,000 acres of public land and 37,900,000 acres of NFS lands within 10 miles of the centerline of existing transmission lines and at least 15 miles outside of the Yellowstone National Park boundary would be open to leasing for indirect use subject to major and moderate constraints as detailed in the Chapter 2. About 81,951,000 acres of public land and 65,712,000 acres of NFS lands would be closed to leasing for indirect use.

There would be less land available for exploration and development of geothermal resources for indirect use than under Alternatives A or B.

Under this alternative, there would be less impact on fish and wildlife and their habitats than the other alternatives, as large areas would be closed to leasing for indirect use. Lands open to leasing within the corridors would be subject to constraints that are intended to protect wildlife and wildlife habitats.

Additionally, lands that contain existing transmission lines often have existing access and maintenance roads constructed that could potentially be used during geothermal development, further limiting the potential impacts on fish and wildlife species.

Areas open to direct use geothermal lease applications and impacts from their subsequent development would be the same as identified under Alternative B.

4.11 THREATENED AND ENDANGERED SPECIES AND SPECIAL STATUS SPECIES

4.11.1 What did the Public Say about Impacts on Threatened and Endangered and Special Status Species?

Comments collected during scoping relating to threatened and endangered and special status species addressed a general concern for all special status species and requested that impacts on special status species be addressed. Concerns related to special status species found in sagebrush habitats and the potential impacts resulting from geothermal development were included in public comments. Comments also addressed the need to provide adequate analysis related to loss and fragmentation of habitat and requested that measures be included to protect special status species potentially affected by geothermal projects. Concerns related to how geothermal development might affect several specific species were expressed.

4.11.2 How Were the Potential Effects of Geothermal Development on Threatened and Endangered and Special Status Species Evaluated?

Potential impacts on threatened and endangered and special status species could occur if reasonably foreseeable future actions were to result in the following:

- Violate the ESA, Bald and Golden Eagle Protection Act, MBTA, or applicable state laws; or
- Adversely affect any individual or population of federally listed species.

4.11.3 What are the Common Impacts on Threatened and Endangered and Special Status Species Associated with Geothermal Development?

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on threatened and endangered and special status species from geothermal resource development.

The Reasonable Foreseeable Development Scenario for Threatened and Endangered and Special Status Species

Geothermal exploration, drilling operations, utilization, and reclamation and abandonment could affect threatened, endangered, and sensitive species in the same manner that vegetation, wildlife, and aquatic resources could be affected (see Section 4.10, Fish and Wildlife). Threatened and endangered species, including federal and state-listed species and BLM and FS special status species, could be affected as a result of 1) habitat disturbance, 2) the introduction of invasive vegetation, 3) injury or mortality, 4) erosion and runoff, 5) fugitive dust, 6) noise, 7) exposure to contaminants, and 8) interference with behavioral activities. Which species may be at risk to construction-related effects would depend on the ecoregion in which the project is located (Figure 3-11) and the specific habitat present at or near the site. An important distinction regarding

impacts on special status species is that impacts on small localized areas or affecting only a few individuals can have adverse impacts on special status species. Many special status species are dependent on unique habitats or have small remaining populations. Impacts that directly affect these unique habitats or individuals, even when small, can have significant impacts on special status species.

Impacts on threatened, endangered, and sensitive wildlife species could include injury or mortality or could involve reduction or fragmentation of habitat, reduction or displacement of habitat features such as cover and forage, exposure to contaminants (e.g., diesel fuel or geothermal working fluid) from a spill, and destruction of individual biota (e.g., from drilling and clearing activities or from vehicle collisions). Because of the regulatory requirements of the ESA and various state regulations, and the requirements specified in BLM Manual 6840 Special Status Species Management and other resource-specific regulations and guidelines, appropriate survey, avoidance measures would be identified and implemented prior to any geothermal activities to avoid adversely affecting any sensitive species or the habitats on which they rely.

4.11.4 What are the Potential Impacts on Threatened and Endangered and Special Status Species Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing the alternatives described in Chapter 2.

Impacts under Alternative A

Under the no action alternative, lease applications would continue to be processed on a case-by-case basis. Areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. The number of acres that could impact threatened, endangered, and special status species is unknown; however, impacts would be site specific and similar to the impacts under the four phases of geothermal development identified under Section 4.11.3. Under this alternative, no comprehensive list of stipulations, best management practices, or procedures would be distributed to serve as consistent guidance for all future geothermal leasing and development for direct and indirect use. This would result in fragmented and segregated planning for threatened, endangered, and special status species, which often exponentially increases impacts. Development of the individual leasing approvals, stipulations, and best management practices would also continue to vary per site and delay application processing time. Section 7 consultation under the ESA would be required under this and all alternatives and is meant to limit potential impacts on listed species and their habitat.

Impacts under Alternative B

Anticipated future actions taken consistent with implementing Alternative B would impact threatened, endangered, and special status species less than Alternative A. Under this alternative, the land closed to geothermal leasing for direct and indirect uses would increase. The BLM and FS would close approximately 25,150,000 acres of public land and 24,370,000 acres of NFS land to geothermal leasing for direct and indirect use that are incompatible with geothermal leasing, exploration, and development. Lands closed to leasing would protect special status species and their habitat. Many of the areas that would be closed for leasing include high-value habitats for many special status species such as old growth forests and wetland and riparian areas.

Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. Relevant stipulations (Section 2.2.2) designed to minimize impacts on Threatened and Endangered Species and Special Status Species include no surface occupancy for designated or proposed critical habitat for listed species under the Endangered Species Act (ESA) of 1973 (as amended) if it would adversely modify the habitat. For listed or proposed species without designated habitat, no surface occupancy would be implemented to the extent necessary to avoid jeopardy. Lease stipulations would also be included that limit disturbance or activities to specific seasonal or temporal time frames that are meant to protect Threatened or Endangered Species and Special Status Species. These stipulations are routinely used to protect breeding, nesting, and wintering behaviors that are critical for survival. Section 7 consultation under the ESA would be required under this and all alternatives and is meant to minimize potential impacts on ESA-listed species and their habitat. For agency designated sensitive species (e.g. sage grouse), lease stipulations would be imposed for those portions of high value species habitat where other existing measures are inadequate to meet agency management objectives. It is expected that these measures would effectively minimize impacts on Threatened and Endangered Species and Special Status Species by maintaining habitats necessary for the survival and recovery of these species; minimizing human caused habitat destruction, degradation and fragmentation; and minimizing human interaction with these species at critical times and locations.

Impacts under Alternative C

Under this alternative, approximately 61,200,000 acres of public land and 37,900,000 acres of NFS lands within the corridor would be open to leasing for indirect use and subject to major and moderate constraints, as detailed in Chapter 2. About 81,951,000 acres of public land and 65,712,000 acres of NFS land would be closed to leasing for indirect use.

Under this alternative there would be less potential for impacts on threatened and endangered and special status species than the other alternatives, as large areas would be closed to leasing for indirect use, many of them important

habitat areas for these species. Lands open to leasing within 10 miles of the centerline of existing transmission lines and at least 15 miles outside of the Yellowstone National Park boundary would be subject to major and minor constraints meant to protect specific resources, including threatened, endangered, and special status species. A major constraint of no surface occupancy or no ground disturbance would be placed on areas adjacent to potential habitat for threatened, endangered, and special status species and areas of high value for these species.

Under this alternative, lease stipulations may also be included that limit disturbance or activities to specific seasonal or temporal time frames that are meant to protect special status species. These stipulations are routinely used to protect breeding, nesting, and wintering behaviors that are critical for survival.

Additionally, those lands leased for indirect use of geothermal resources within existing transmission corridors often have existing access and maintenance roads constructed that could potentially be used for geothermal development, further limiting the potential impacts on special status species. Section 7 consultation under the ESA would be required under this and all alternatives and is meant to limit potential impacts on listed species and there habitat.

Areas open to direct use geothermal lease applications and impacts from their anticipated subsequent development would be the same as identified under Alternative B.

4.12 WILD HORSES AND BURROS

4.12.1 What did the Public Say about Impacts on Wild Horses and Burro?

No public comments were received regarding impacts on wild horses or burros.

4.12.2 How Were the Potential Effects of Geothermal Development on Wild Horses and Burros Evaluated?

Impacts on wild horses and burros were evaluated by: 1) considering the acreages of herd areas and herd management areas contained within the planning area; 2) considering the types of impacts that geothermal projects may have on wild horse and burro populations; and 3) describing both the impacts and the relative land areas that could be impacted by anticipated future actions consistent with the three alternatives described in Chapter 2.

Potential impacts on wild horses and burros could occur if reasonably foreseeable future actions were to result in the following:

- Conflict with management goals and objectives set forth by the BLM for protecting and managing wild horses and burros; or
- Interfere with the movement of wild horses and burros.

4.12.3 What are the Common Impacts on Wild Horses and Burros Associated with Geothermal Development?

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on wild horses and burros from geothermal resource development. Issuing geothermal leases would not disturb wild horse and burro populations or habitat, so the discussion is limited to impacts related to anticipated future actions.

The Reasonable Foreseeable Development Scenario for Wild Horses and Burros

According to the RFDs, it is estimated that 111 power plants could be constructed by 2015, and another 133 power plants could be constructed by 2025. For direct use, it is estimated that by 2015, applications could be developed in the amount of 1,600 thermal megawatts and by 2025, applications could be developed in the amount of 4,200 thermal megawatts. For indirect use, the RFD scenario estimates that up to 40,737 acres of land would be disturbed by 2015, and up to 89,548 acres of land would be disturbed by 2025. Wild horse and burro populations are found on public lands in 10 of the 12 western states included in the planning area. Population numbers and acreages of herd areas and herd management areas vary by state (see Table 3-25 Project Area Wild Horse and Burro Statistics).

Exploration

Activities and noise associated with exploration could alter wild horse and burro travel routes and grazing grounds. Surveying activities could alter migration routes if additional roads or routes are developed to survey potential geothermal sites and if fence construction blocks travel paths. Additional roads would improve human access to previously inaccessible areas, creating potential for habitat degradation. Noise from vehicles and drilling could disrupt grazing activities and encourage change in travel routes if animals react by avoidance. The magnitude and extend of the impact would depend on current land use in the area.

Drilling Operations

Impacts on wild horses and burros during the drilling operations phase could include noise disturbance and the alteration of travel routes and grazing grounds, as described above for exploration. Additional long-term impacts could result from installing additional access roads, production wells, injections wells, and sump pits. Sump pits could impact wild horses and burros by providing a catch basin for rainwater (an assumed water source). Sump pits often contain high concentrations of minerals and chemicals from the drilling fluids, which can be toxic to wild horses and burros. Acreage dedicated to well pads and needed equipment would reduce habitat. Pipelines placed aboveground could pose minimal-to-moderate obstacles in migration, depending on placement and size.

Utilization

Additional long-term impacts could result from installing added access roads, power lines, and other utilities needed for power plants and direct use facilities. Acreage dedicated to well pads and needed equipment would reduce habitat. Pipelines placed above ground could pose minimal-to-moderate obstacles in migration, depending on placement and size.

Noise disturbance from standard operation and maintenance activities would occur. No additional impacts would be recognized during this phase unless an additional drill site is required. Impacts from additional drill sites would be the same as those impacts discussed above under the drilling operations phase.

Reclamation and Abandonment

Impacts on wild horses and burros from reclamation and abandonment activities would be limited to noise disturbance, as described above under exploration. All disturbed lands would be reclaimed in accordance with BLM standards and would be made available as habitat unless otherwise planned.

4.12.4 What are the Potential Impacts on Wild Horses and Burros Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing the alternatives described in Chapter 2. In the absence of site-

specific data, including site location and timing, impacts on wild horses and burros would vary by lease area.

Under Alternative B, the potential area open for geothermal leasing is 197 million acres of public and NFS lands. Approximately 45 percent of wild horse and burro Herd Management Area lands occur within the potential area. Under Alternative C, even fewer Herd Management Area lands (approximately 30 percent of wild horse and burro Herd Management Area lands) occur on lands open to geothermal leasing, further narrowing the scope of the analysis.

Impacts under Alternative A

Under the no action alternative, lease applications would continue to be processed on a case-by-case basis. Areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. The acreage used by wild horses and burros and likely to be affected under this alternative is unknown.

Impacts on wild horses and burros could occur during the exploration, drilling operations, and utilization phases. By not designating geothermal potential areas as open or closed, individual geothermal projects could be developed in a number of locations, each resulting in various long- and short-term impacts on wild horse and burro populations. Under this alternative, no comprehensive list of stipulations, best management practices, or procedures would be distributed to serve as consistent guidance for future geothermal leasing and development for direct and indirect uses. This could result in inconsistent planning on lands designated as herd areas and herd management areas. Due to the uncertainty of lands considered for direct and indirect use geothermal leasing and development under this alternative, it is not possible to quantify the total habitat acreage or number of animals that would be affected on Federal lands.

The Wild Free-Roaming Horses and Burros Act of 1971 dictates that one responsibility of the BLM is to protect, manage, and control wild horses and burros. As such, additional stipulations and mitigation measures may be applied on a case-by-case basis to leases where direct and indirect use geothermal resource development will impact these species.

Impacts under Alternative B

Under Alternative B, geothermal leasing for direct and indirect use would be open on approximately 197 million acres. Lands identified as open for geothermal leasing for direct and indirect use could be open with moderate to major constraints, depending on environmental conditions identified during site-specific reviews conducted by field offices prior to issuing the leases. Approximately 45 percent of wild horse and burro Herd Management Area land in the project area would be open for geothermal leasing for direct and indirect use.

Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. In accordance with BMPs (Appendix D), employees, contractors, and site visitors would be instructed to avoid harassment and disturbance of wild horses and burros during reproductive (e.g., breeding and birthing) seasons. Observations of potential problems regarding wild horses or burros would be reported to the authorized officer immediately. As described under the no action alternative, additional stipulations and mitigation measures may be applied on a case-by-case basis by the BLM if wild horses or burros are present within the proposed leasing area. Stipulations and mitigation measures could include requiring a habitat restoration plan to avoid (if possible), minimize, or mitigate negative impacts. It is expected that these measures would effectively avoid or minimize impacts on wild horses and burros by avoiding human interaction with wild horses and burros at key times and locations and minimizing habitat impacts.

Impacts under Alternative C

Under Alternative C, geothermal leasing for indirect use would be open on approximately 99 million acres. All federal lands identified as open to geothermal leasing for indirect use under this alternative are within 10 miles of the centerline of existing transmission lines. Restricting the placement of geothermal resource development for indirect use to within 10 miles of the centerline of existing transmission lines and at least 15 miles outside of the Yellowstone National Park boundary would minimize impacts on wild horse and burro populations by concentrating land uses associated with energy development into designated areas and limiting opportunity for development in herd areas and herd management areas.

Areas open to geothermal lease applications for direct use and impacts from their anticipated subsequent development would be the same as identified under Alternative B.

4.13 LIVESTOCK GRAZING

4.13.1 What did the Public Say about Impacts on Livestock Grazing?

No public comments specifically addressed impacts on livestock grazing on public or NFS lands from the proposed action. The US EPA requested that the EIS identify and analyze areas with potential use conflicts, in which livestock grazing would be included.

4.13.2 How Were the Potential Effects of Geothermal Development on Livestock Grazing Evaluated?

Potential impacts on livestock grazing could occur if reasonably foreseeable future actions were to result in the following:

- Decrease acreages available to grazing;
- Decrease AUM number or forage; or
- Cause harassment or death of livestock.

4.13.3 What are the Common Impacts on Livestock Grazing Associated with Geothermal Development?

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on livestock grazing from geothermal resource development. Issuing leases would not impact livestock grazing operations on federal lands, so the discussion focuses on impacts related to anticipated future actions following leasing.

The Reasonable Foreseeable Development Scenario for Land Use

The four phases of geothermal development involve different levels of geothermal activity. The varying levels of geothermal activity influence the level of impact on livestock grazing. Direct and indirect use of geothermal resources would have similar impacts.

Exploration

Geothermal exploration affects large areas of grazing in the short term during temporary construction of well pads, exploration wells, and roads. Impacts would include loss of forage, reduced forage palatability because of dust on vegetation, and displacement of livestock from construction noise. Additional roads could also impact livestock by opening up areas that were not previously accessible, thereby increasing disturbance or harassment of livestock. However, creating new access roads to areas where livestock graze would help livestock operators manage their stock more efficiently.

Drilling Operations

Geothermal drilling operations affect larger areas of grazing in the longer term during construction of additional production wells, injection wells, and sump pits after exploration.

Sump pits could impact livestock grazing by providing a catch basin for rainwater (an assumed water source). Sump pits often contain high concentrations of minerals and chemicals from the drilling fluids, which can be toxic to grazing animals.

Utilization

Impacts during initial construction within the utilization phase are similar to but greater than the drilling operations phase and include loss of forage, reduced forage palatability because of dust on vegetation, restriction of livestock movement from pipelines and protective fencing surrounding the development area, harassment of livestock from additional access to livestock grazing areas, and temporary displacement of livestock from construction noise.

In the long term, a smaller amount of permanent grazing acreage is lost during geothermal operation than under the exploration, drilling operations, or initial construction during the utilization phases. No new construction would take place, as the project footprint would already be designated. Impacts would be similar to but less than the impacts identified under drilling operations, above. The length of time that impacts would occur depends on the availability of the geothermal resource itself.

Reclamation and Abandonment

Impacts on livestock grazing during the reclamation and abandonment phase would be short term and limited to the footprint of developed areas. Impacts would include increased noise and dust from demolition of existing pipelines and facilities. In the long term, restored vegetation would provide forage for grazing that was originally lost in development.

4.13.4 What are the Potential Impacts on Livestock Grazing Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing the alternatives described in Chapter 2.

Impacts under Alternative A

Under the no action alternative, lease applications would continue to be processed on a case-by-case basis. Areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. The number of acres that could impact livestock grazing practices is unknown; however, impacts would be site-specific and similar to the impacts under the four phases of geothermal

development identified under Section 4.13.3. Under this alternative, no comprehensive list of stipulations, best management practices, or procedures would be distributed to serve as consistent guidance for all future geothermal leasing and development for direct and indirect use. Development of the individual leasing approvals, stipulations, and best management practices would continue to vary per site and delay application processing time. Depending on the constraints identified by the leasing officer and identified within existing land use plans, areas identified as open or closed to leasing for direct and indirect use could create or take away conflicts that might result between grazing and geothermal development practices (such as harassment of livestock and other impacts identified under Section 4.13.3, above). It is important to note that some land use plans may be outdated and may not address geothermal leasing or development for direct or indirect use.

Impacts under Alternative B

Under Alternative B, planning area lands within grazing allotments would be identified as open or closed to geothermal leasing for direct and indirect use (See Table 4-6). Approximately 82 percent of available grazing allotments within public lands would be open to geothermal leasing for direct and indirect use, and approximately 95 percent of available grazing allotments within NFS lands would be open to geothermal leasing for direct and indirect use under Alternative B.

Table 4-6
Acreages of Grazing Allotments Open and Closed to Geothermal Leasing within the Planning Area under Alternative B

	Acres of Grazing Allotments on Public Lands	Acres of Grazing Allotments on NFS lands
Open to Leasing (Direct and Indirect Use)	102,179,879	66,455,039
Closed to Leasing (Direct and Indirect Use)	22,951,428	3,732,254
Total	125,131,307	70,187,293

Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. In accordance with BMPs (Appendix D), operators would employ dust control measures to reduce impacts on livestock forage during construction and demolition. Litter and noxious weeds would be controlled and removed regularly during construction and operation. BMPs would also require that geothermal

development be designed to minimize the number of structures. In addition geothermal companies should work with livestock permittees to mitigate impacts on water by producing off-site water developments. If appropriate, produced water from geothermal operations could be made available to livestock for use if water quality were sufficient. This additional water could increase livestock distribution and available forage for livestock that would otherwise be lost to development. It is expected that these measures would effectively minimize impacts on livestock grazing by reducing impacts on forage.

Impacts under Alternative C

Under Alternative C, impacts on grazing are analyzed within areas open to leasing for indirect use within 10 miles of the centerline of existing transmission lines. Approximately 43 percent of available grazing allotments within public lands would be open to geothermal leasing for indirect use, and approximately 40 percent of available grazing allotments within NFS lands would be open to geothermal leasing for indirect use under Alternative C (see Table 4-7). Impacts within 10 miles of the centerline of existing transmission lines and at least 15 miles outside of the Yellowstone National Park boundary would be similar to Alternative B, but less area would be designated as open to geothermal leasing for direct use, and potential impacts from geothermal operations would be decreased and centralized to already disturbed transmission line areas. Areas open to direct use geothermal lease applications and impacts from their subsequent development would be the same as identified under Alternative B (see Tables 4-6 and 4-7).

Table 4-7
Acreages of Grazing Allotments Open and Closed to Geothermal Leasing under Alternative C

	Acres of Grazing Allotments on Public Lands	Acres of Grazing Allotments on NFS Lands
Open to Leasing for Indirect Use	53,772,871	28,120,522
Closed to Leasing for Indirect Use	71,358,436	42,066,771
Total	125,131,307	70,187,293
Open to Leasing for Direct Use	102,179,879	66,455,039
Closed to Leasing for Direct Use	22,951,428	3,732,254
Total	125,131,307	70,187,293

4.14 CULTURAL RESOURCES

4.14.1 What did the Public Say about Impacts on Cultural Resources?

Several comments from agencies and the public specifically addressed cultural resources. These are summarized below.

- The Idaho Conservation League and Utah Environmental Congress requested that the PEIS examine direct and cumulative impacts resulting from reasonably foreseeable geothermal development on sensitive historical or cultural resources, including sites eligible for the National Register of Historic Places and Native American respected sites and their settings (which encompass the viewsheds visible from the site).
- The Save Medicine Lake Coalition stated that the National Forests' timber stands, clean air, pure waters, cultural sites, and wildlife habitats cannot continue to be torn apart and put in harm's way by experimental or inexact geothermal technology.
- The Wilderness Society and Western Resource Advocates provided the following comments:
  - The agencies should specifically outline the environmental issues this PEIS will analyze in detail and include archaeological, cultural, or historic resources in the analysis. Should the agencies decide not to analyze any of these issues in detail, they should provide a detailed explanation of the grounds for not considering these issues, including how a failure to analyze them is not a violation of NEPA.
  - For both the setting of cultural resources and the enjoyment of recreation opportunities, the PEIS should consider preserving the scenic values associated with these areas.
  - The PEIS should acknowledge the likelihood of the presence of cultural resources and sacred sites in areas with geothermal energy potential and commit to both a Class III inventory and proactive consultation prior to leasing an area or permitting development.
  - The PEIS should include a commitment not to permit leasing or siting of geothermal energy projects in or immediately adjacent to areas with important cultural and archaeological resources.
- Ormat, Inc. stated that the PEIS should analyze exploration impacts, including analyzing at least three well pads for each of the resources considered. The effects of well drilling and testing are well known. The analysis of exploration drilling should be included and covered in the PEIS such that the lessee would only need to conduct site-specific cultural and season-appropriate biological surveys and

implement standard mitigation measures in order to construct the well pad and drill and test the wells.

- The US EPA stated that when identifying the areas of moderate to high potential for geothermal resources, the PEIS should also identify environmentally sensitive areas and areas with potential use conflict, including areas that are affiliated with Native American tribes, historic properties, Native American sacred sites or sensitive areas, and cultural resources. The scope of impacts on cultural resources should include the direct, indirect, and cumulative impacts on historic properties, districts, or landscapes.
- Individuals offered the following comments:
  - Consideration must be given to protecting outstanding historic, recreational, and biological resources that might be impacted. The PEIS should consider these impacts and should develop alternatives that would protect each of these resources.
  - With respect to the PEIS, information on potential cultural sites and issues should be included.

4.14.2 How Were the Potential Effects of Geothermal Development on Cultural Resources Evaluated?

This section addresses impacts on prehistoric and historic archaeological sites, structures, and buildings only. Native American Traditional Cultural Properties, sacred sites, and other concerns are addressed in Section 4.15, Tribal Interests and Traditional Cultural Resources. Historic trails are addressed under Section 4.16, National Scenic and Historic Trails. Consultations on programmatic actions including allocating areas as open or closed to leasing and determining lease stipulations are ongoing. These allocations do not grant any rights or authorize any activities affecting cultural resources. Impact analysis focuses on the anticipated future actions consistent with the implementation of the alternatives described in Chapter 2.

Methods

The authorized surface administrative unit of the BLM or FS would consult with Tribes and State Historic Preservation Officers regarding historic and cultural resources per Section 106 of the National Historical Preservation Act. The presence of archaeological sites and historic properties in the lease area would be determined on the basis of a records search of recorded sites and properties in the area and, depending on the extent and reliability of existing information, an archaeological survey. Archaeological sites and historic properties present in the leasing area would be reviewed to determine whether they meet the criteria of eligibility for listing on the National Register of Historic Places. Additional specific consultation requirements would be determined on a project-by-project level and during the ADP process.

Impact Criteria

Potential impacts on cultural resources could occur if reasonably foreseeable future actions were to:

- Conflict with management goals and objectives set forth by the BLM or FS in order to sustain cultural resources and their qualities;
- Result in proposed uses that are incompatible with maintaining and identifying cultural resources and their qualities; or
- Have an adverse affect on historic properties under Section 106 of the National Historic Preservation Act (36 CFR 800).

Assumptions

The PEIS includes standard NSO/NGD stipulations to protect cultural resources. An authorizing officer could grant exemptions to these stipulations on a case-by-case basis after determining that NSO/NGD is not warranted to achieve resource protection. Additional NSO/NGD stipulations could be applied by the authorizing officer to address specific location resource concerns. The following areas would have NSO/NGD stipulations:

- Within the setting of National Register eligible sites, including traditional cultural properties, where setting is critical to their eligibility; and
- Areas with important cultural and archaeological resources, including Native American sacred sites.

4.14.3 What are the Common Impacts on Cultural Resources Associated with Geothermal Development?

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on cultural resources from geothermal resource development.

The Reasonable Foreseeable Development Scenario for Cultural Resources

According to the RFD scenario, it is estimated that 111 power plants could be constructed by 2015, and another 133 power plants could be constructed by 2025. A representative amount of disturbance for one plant is 53 to 367 acres. Land directly disturbed in the project area would be approximately 5,883 acres to 40,737 acres by 2015 and 12,932 acres to 89,548 acres by 2025. The impacts of each phase of development are discussed below.

Exploration

The exploration phase includes surveying and drilling temperature gradient wells. Surveying activities would impact cultural resources if additional roads or routes are developed across or within a resource's historic landscape in order

to survey the potential geothermal sites. Additional roads could lead to increased disturbances within a resource's boundaries or within a resource's historic landscape, possibly leading to increased illegal collecting and vandalism. The magnitude and extent of the impact would depend on the current state of the resources and their eligibility for the National Register of Historic Places. Any permanent construction or ground disturbances within a resource's boundaries or within its historic landscape would be long-term impacts.

The magnitude and extent of impacts on cultural resources from drilling temperature gradient wells would depend on the current condition of the resources and their eligibility for the National Register of Historic Places. Similar to surveying activities, roads would be required to access wells, and impacts would be similar to those described above for surveying. Several wells could be drilled per lease, and drill sites could disturb approximately 0.9 acres. Impacts would occur on lands directly under the well sites. If wells and appurtenances are constructed within the boundaries of an archaeological site or within its historic landscape, impacts would be long term. If wells and appurtenances are constructed within the boundaries of building or structural resources or their historic landscape, impacts would be considered short term if the modern construction is temporary and long term if the modern construction is permanent.

Drilling Operations

Geothermal drilling operations would result in long-term impacts on cultural resources if allowed within the boundaries of an archaeological deposit or its historic landscape. If new construction would be removed during reclamation and abandonment, impacts from the drilling operations phase on historic buildings or structures would be limited to the period of operation. The drilling operations phase would require access roads to accommodate larger equipment. New roads would have similar impacts to those identified during the exploration phase.

The drilling operations phase includes drill site development, which on average would require ground disturbance within a two-acre area plus a buffer to accommodate additional production wells, injection wells, and fluid sump pits. Any cultural resources or historic landscapes of cultural resources would be directly impacted by the ground disturbance.

Utilization

A power plant would require ground disturbance over approximately 15 to 25 acres and would impact any cultural resources within that area. The new power plant itself would represent a large modern development on a historic landscape. Installing electrical transmission lines from the power plant would disturb approximately one acre per mile of transmission line. Ground disturbance from the transmission line towers would impact cultural resources within their footprint and adjacent areas. Similar to the power plant, the towers

and lines themselves could represent a large modern development on a historic landscape. Where feasible, pipelines would parallel access roads and existing roads, which presumably would have already disturbed cultural resources within proximity. However, if the existing road was designed to avoid cultural resources, a new pipeline may impact a previously undisturbed cultural resource. Long-term impacts on cultural resources would result from constructing these modern developments within the boundaries of archaeological sites. If the modern developments were within the viewshed of historic structures and buildings, impacts on those cultural resources would be long term if the developments would remain after closeout and short term if they would be removed.

Reclamation and Abandonment

Reclamation and abandonment activities include abandoning the well after production ceases and reclaiming all disturbed areas. All disturbed lands would be reclaimed in accordance with BLM and FS standards. Impacts on archaeological sites from previous phases would remain, and additional impacts could occur if reclamation and abandonment activities extend beyond previously disturbed areas. Unless the development and changes from exploration, drilling operations, and utilization phases are removed and the preexisting conditions are reestablished, all impacts on historic buildings and structures from previous phases would continue as well.

4.14.4 What are the Potential Impacts on Cultural Resources Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing the alternatives described in Chapter 2. In the absence of site-specific data, including site location, only a general analysis of impacts on cultural resources is possible at this time. Under all alternatives, the NSO/NGD stipulations described in 4.14.2 would be applied.

Impacts under Alternative A

Under the no action alternative, lease applications would continue to be processed on a case-by-case basis. Areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. The number of acres likely to be affected under this alternative is unknown.

Issuing geothermal leases for direct and indirect use on a case-by-base basis is not expected to affect cultural resources. The case-specific studies required prior to issuance of a lease would be expected to prevent impacts on cultural resources. Under this alternative, however, no comprehensive list of stipulations, best management practices, or procedures would be distributed to serve as consistent guidance for future geothermal leasing and development and protection of cultural resources. This would result in fragmented and segregated

planning for preventing impacts, which often exponentially increases recognized environmental impacts. Due to the uncertainty of total acreage considered for geothermal leasing and development under this alternative, it is not possible to quantify the total acreage affected on federal lands.

Impacts under Alternative B

Under Alternative B, geothermal leasing for direct and indirect use would be closed on 25,150,000 acres of public land and on 24,370,000 acres of NFS land, protecting cultural resources in those areas. In areas identified as open to leasing for direct and indirect use, impacts would be concentrated in those areas identified in Section 3.14 as containing cultural resources. States identified in the RFD as having the majority of development, including California, Idaho, Nevada, and Oregon, would be expected to incur the greatest cultural resource impacts from direct and indirect geothermal uses.

Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. Relevant stipulations (Section 2.2.2) designed to minimize impacts on cultural resources include no surface occupancy within the setting and boundary of properties designated or eligible for the National Register of Historic Places, including National Landmarks and National Register Districts and Sites; and additional lands outside the designated boundaries to the extent necessary to protect values where the setting and integrity is critical to their designation or eligibility. Under the proposed leasing procedures (Section 2.2.2), the authorized officer of the BLM or FS would be required to consult with the appropriate Native American Tribes, Alaska Natives, and State Historic Preservation Officers regarding historic and cultural resources per Section 106 of the National Historical Preservation Act prior to leasing. The presence of archaeological sites and historic properties would be determined on the basis of a records search and literature review of recorded sites and properties in the proposed lease area and a buffer around the lease area, if appropriate. Additional historical, cultural or ethnographic research, consultation and/or inventories may be required to identify resources, determine effects, mitigate adverse effects and complete the Section 106 process.

In accordance with BMPs (Appendix D), if cultural resources are present at the site, or if areas with a high potential to contain cultural material have been identified, a cultural resource management plan would be developed that identifies appropriate monitoring and protection measures. Unexpected discovery of cultural resources during geothermal development would be brought to the attention of the responsible BLM authorized office immediately and work shall be halted in the vicinity of the finds to avoid further disturbance while the finds are evaluated and appropriate mitigation measures are developed. It is expected that these measures would effectively avoid and/or minimize impacts on cultural resources by identifying, preserving and protecting

significant cultural resources, districts and landscapes; and maintaining viewshed of important cultural resources as appropriate; and reducing indirect impacts from land uses on cultural resources.

Impacts under Alternative C

Under Alternative C, geothermal leasing would be closed to indirect use on 81,951,000 acres of public land and on 65,712,000 acres of NFS land, protecting cultural resources in those areas. This would protect cultural resources on greater acres than under Alternative B. Impacts on cultural resources within the 99,073,000 acres that would remain open to leasing for indirect use would be similar to those described under Alternative B, although the area of impact would be less.

Areas open to direct use geothermal lease applications and impacts from their anticipated subsequent development would be the same as identified under Alternative B.

4.15 TRIBAL INTERESTS AND TRADITIONAL CULTURAL RESOURCES

4.15.1 What did the Public Say about Impacts on Tribal Interests and Traditional Cultural Resources?

Several general comments were made regarding avoiding sensitive areas, cultural resources, heritage resources, and sites eligible for the National Register of Historic Places.

The Idaho Conservation League and Utah Environmental Congress requested that the PEIS specifically address impacts on "... *Native American respected (sic) sites, and their settings."*

The Wilderness Society and Western Resource Advocates advised that *"...hot springs are often the sites for important cultural resources, while also serving as popular recreation areas. For both the setting of cultural resources and the enjoyment of recreational opportunities, preserving the scenic values associated with these areas must be considered. ...The PEIS should acknowledge the likelihood of the presence of cultural resources and sacred sites in areas with geothermal energy potential and commit to both a Class III inventory and proactive consultation prior to leasing an area or permitting development."*

In extensive comments, the United States Environmental Protection Agency wrote that *"the PEIS should describe the process and outcome for government-to-government consultation between the BLM, the USFS, and each of the tribal governments within the project area, issues that were raised (if any), and how those issues were addressed in the selection of the proposed alternatives."*

The agency also recommended *"...that BLM and USFS initiate consultation with the potentially affected tribes specific to their interests and concerns about cultural resources. The scope of impacts on cultural resources should include the direct, indirect, and cumulative impacts on*

- *sacred sites;*
- *traditional cultural properties or landscapes;*
- *hunting, fishing, gathering areas (including impacts on the ecosystems that support animals and plants and that are, or once were, part of the Tribes and tribal descendants traditional resource areas;*
- *access to traditional and current hunting, fishing and gathering areas and species;*
- *changes in hydrology or ecological conditions of springs, seeps, wetlands, and streams, that could be considered sacred or have traditional resource use associations;*

- *travel routes that were historically used and travel routes that may be currently used; and*
- *historic properties, districts or landscapes."*

The agency recommends that *"the PEIS should address the existence of Indian sacred sites in the project area. It should address Executive Order 13007, distinguish it from Section 106 of the NHPA, discuss how BLM and the USFS will avoid adversely affecting the physical integrity of sacred sites if they exist, and address other requirements of the Executive Order."*

The agency recommends that *"that if adverse effects to traditional cultural properties, sacred sites, or other areas of cultural resource concern are identified, any Memorandum of Agreement (MOA) developed to resolve these concerns ...should be fully executed before the ROD is issued, and the ROD should provide for implementation of the MOA's terms."*

4.15.2 How Were the Potential Effects of Geothermal Development on Tribal Interests and Traditional Cultural Resources Evaluated?

Methods

As described in Section 3.15, tribal interests and traditional cultural resources are identified primarily through consultations with federally recognized Indian tribes on a government-to-government basis. Direct consultations are also needed to identify traditional cultural resources in the case of non-federally recognized tribes and other potentially affected communities. In some cases, ethnohistorical research or focused ethnographic studies are used to gather information and oral traditions related to particular locations and resource uses. These studies usually focus on researching the historical uses of the area, defining the important traditional places, natural resources and landscape features, identifying named places and documenting contemporary tribal uses of the project area. Field visits can be arranged for elders or persons with traditional knowledge who may associate a place or site with a tradition, practice, oral history, ancestral use, or belief important to the community's cultural life. Contemporary ties may be rediscovered to ancestral archaeological sites recorded as part of the planning process..

Tribal governments, along with the BIA and the Interior Office of the Special Trustee for American Indians, are sources for identifying Indian trust and treaty rights. Initial contacts have been made by the BLM and FS, and some responses have been received. Generally, specific tribal interests, and especially traditional cultural resources and sacred sites, cannot be identified on a programmatic basis, as analysis of specific impacts on these resources cannot be conducted at this scale. Coordination through BLM and FS tribal liaisons and other established programs would continue. Tribes and other parties would be engaged to identify

interests and traditional cultural resources in the individual lease areas that may be impacted by geothermal development.

While not fully defined, tribal interests, trust resources, reserved treaty rights, and traditional cultural resources are present in the planning area. The potential effects of geothermal development were evaluated by consulting existing planning and guidance documents, ethnographic literature, local knowledge, and input from BLM, FS, and contractor staff and cultural resource specialists. Potential effects on common tribal interests and resource types are described to allow comparison of the programmatic alternatives, with the knowledge that site-specific consultation would be necessary to provide a full accounting of affected interests and resources and to define the context and intensity of impacts.

Impact Criteria

Potential impacts on tribal interests or traditional cultural resources could occur if anticipated future actions consistent with implementing the alternatives described in Chapter 2 were to:

- Conflict with land uses, management, and economic well being of adjacent or nearby reservations, trust lands, restricted Indian allotments, and federally tribal-dependent Indian communities;
- Conflict with the exercise of off-reservation treaty and reserved rights, including grazing rights, hunting and fishing rights, gathering rights and interests, and water rights;
- Conflict with the exercise of Alaska Native Subsistence Rights;
- Conflict with federal trust responsibilities to tribes and individual Indians regarding real property, physical assets, or intangible property rights;
- Conflict with existing court decisions, laws, policies, executive orders, and agency agreements with tribes regarding land and resource use;
- Result in proposed uses that are incompatible with maintaining and identifying cultural resources and their qualities;
- Have an adverse effect on historic properties or their settings, especially traditional cultural properties and cultural landscapes under Section 106 of the NHPA (36 CFR 800);
- Impact or restrict access to traditionally used hunting, fishing, and gathering areas and species;
- Change or reduce access to traditionally used or culturally important water sources and hot springs;
- Impact culturally important trails or trail systems; or

- Impact sacred sites or their settings, access, or use.

Assumptions

In accordance with 43 CFR 2301.11, the BLM is prohibited from issuing leases on Indian trust or restricted lands within or outside the boundaries of Indian reservations. These are lands in which the title is held by the United States in trust for an Indian or an Indian tribe or lands in which the title is held by Indians or an Indian tribe but is subject to restriction by the United States against transferring such property.

The authorized surface administrative unit of the BLM or FS would coordinate with Indian Tribal governments to identify issues regarding the lease and potential for geothermal energy development, including issues related to the presence of cultural properties, access rights, disruption to traditional cultural practices, and impacts on visual resources important to the tribe(s).

The authorized surface administrative unit of the BLM or FS would coordinate with tribes and State Historic Preservation Officers regarding historic and cultural resources per Section 106 of the NHPA. The presence of archaeological sites and historic properties in the lease area shall be determined on the basis of a records search of recorded sites and properties in the area and, depending on the extent and reliability of existing information, an archaeological survey. Archaeological sites and historic properties present in the leasing area shall be reviewed to determine whether they meet the criteria of eligibility for listing on the NRHP. Additional specific consultation requirements would be determined on a project-by-project level and during the ADP process.

The PEIS includes standard NSO/NGD stipulations to protect cultural resources. An authorizing officer could grant exemptions to these stipulations on a case-by-case basis after determining that NSO/NGD is not warranted to achieve resource protection. Additional NSO/NGD stipulations could be applied by the authorizing officer to address specific location resource concerns. The following areas would have NSO/NGD stipulations:

- Within the setting of National Register-eligible sites, including traditional cultural properties, where setting is critical to their eligibility; and
- Areas with important cultural and archaeological resources, including Native American sacred sites.

4.15.3 What are the Common Impacts on Tribal Interests and Traditional Cultural Resources Associated with Geothermal Development?

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a

general description of common impacts on tribal interests and traditional cultural resources from geothermal resource development.

Areas proposed for leasing would likely include lands where there are tribal interests and traditional cultural resources that are not currently identified. The BLM or the FS would coordinate with Indian Tribal governments to identify issues and concerns regarding the lease and potential for geothermal energy development. Agency staff also may be aware of locally sensitive areas and resources from previous consultation and identification efforts of tribal trust and treaty concerns. However, affected groups may not wish to enter into direct consultation or may prefer not to discuss specific traditional use areas or sacred sites until development plans are proposed and there is a perception that interests or resources would be threatened.

Issuing geothermal leases confers on the lessee a right to future exploration and development of geothermal resources within the lease area. Thus, it is a conditional commitment or granting of a right that may interfere with other uses or interests such as land-into-trust applications by tribes, or acquisition (restoration) of a tribe's ancestral land base or resources. There may also be unidentified conflicts with existing tribal treaty rights or claims of ownership related to hot springs and water sources.

Leasing does not confer on the lessee the right to conduct any ground-disturbing activities to explore for or develop geothermal resources without further review and permitting. Impacts may be minimized or avoided through any required consultations, environmental review, and NSO/NGD stipulations. Types of impacts that could occur from exploration, drilling operations, utilization, and reclamation and abandonment include direct disturbance of locations or landscapes associated with traditional beliefs, resource gathering areas, hunting and fishing areas, water sources, hot springs, ancestral sites, human remains, and trails. Other impacts could result from alterations of visual, aural, or other aspects of setting both on the lease site and in adjacent areas; increased access and vandalism; decreased access or interference with the exercise of treaty rights or cultural uses; and the potential for erosion, pollution, habitat loss, and less tangible changes to natural features and resources that tribal members may consider sacred.

Consultation and review at the different stages of exploration and development would avoid or address many potential impacts; however, there may be residual effects on traditional cultural resources that may be difficult or impossible to adequately mitigate.

The Reasonable Foreseeable Development Scenario for Tribal Interests and Traditional Cultural Resources

According to the RFD scenario, it is estimated that 111 power plants could be constructed by 2015, and another 133 power plants could be constructed by

2025. The most development is expected to occur in California and Nevada, with the least occurring in Colorado, Arizona, Wyoming, and Montana. A representative amount of disturbance of the geothermal resource development phase is 53 to 367 acres. Land directly disturbed would be approximately 5,883 acres to 40,737 acres by 2015 and 12,932 acres to 89,548 acres by 2025. This is only a small percentage of the land managed by the BLM and FS in the western US.

Surface exposures of geothermal resources such as hot springs are commonly very important to tribes and are often connected with ritual use and spiritual meaning. Exploration, drilling operations, and utilization from these sources would likely impact traditional cultural resources and could possibly impact other tribal interests. Impacts could include loss of access, interference with use, and changes in flow or temperature of hot springs. Since the thermal water in these springs is often considered sacred, there is a potential for loss of sacred sites, and the healing energy and power they provide to the tribal users who value them.

Also relevant are impacts on the setting and cultural landscapes of tribal interests and traditional cultural properties, which can extend far beyond the land that is directly disturbed. Consultation, review, and permitting are required for the exploration, drilling operations, and utilization phases.

Exploration

The exploration phase includes surveying and drilling temperature gradient wells. Surveying can include a variety of field studies and sampling. Surveying and drilling temperature gradient wells would likely require some minor surface disturbance for site access, site investigations, and placement of several small well sites. Grading typically would not be required at well sites, but land would be disturbed by equipment use. Drilling wells would require temporary equipment placement and would generate noise.

Potential impacts could result if tribal interests or traditional cultural resources are located on lands disturbed by road, sampling, and well locations. Access roads, investigations, and establishing well sites can also lead to impacts from vandalism, unauthorized collection of ancestral sites, alteration of cultural landscapes, noise, and interference with traditional religious or cultural practices such as resource gathering or hunting. The context and intensity of the impact would depend on the resources that may be present and identified, and whether the resources can be avoided. Impacts may be minimized or avoided through any required consultations, environmental review, and NSO/NGD stipulations. Compared to the other phases of geothermal development, exploration involves the least potential for permanent, long-term impacts.

Drilling Operations

Potential impacts are similar to the exploration phase, with additional construction to accommodate injection wells and sump pits.

Utilization

The utilization phase, combined with drilling operations above, would directly disturb 51 to 350 acres to accommodate construction, well pads, power plants, additional roads, pipelines for direct use applications, and electrical transmission lines. Landscapes would be changed by the addition of large structures, security lighting, transmission lines, and steam plumes and by the loss of natural cover, landforms, and habitats. Construction would require heavy equipment use and many workers on-site and would result in noise, vehicular traffic, and fugitive dust.

Potential impacts could result if tribal interests or traditional cultural resources are located on land disturbed or converted to other uses by the construction. Exercise of tribal treaty rights and use of traditional cultural resources, resource gathering areas, and sacred sites on adjacent lands may not be possible due to intrusions to setting, loss of habitat, and security fencing. Areas considered sacred and the qualities that make them important to traditional practitioners may be permanently lost. Creating access roads and introducing large numbers of workers on-site may impact resources through vandalism, unauthorized collection, and damage of ancestral sites. Impacts on setting, important view sheds, and cultural landscapes may extend far beyond the project area. The context and intensity of the impact would depend on the resources that may be present and identified and whether the resources can be avoided. Impacts may be minimized or avoided through any required consultations, environmental review, and NSO/NGD stipulations. The utilization phase involves the most potential for permanent, long-term impacts.

Short-term minor impacts would occur from standard operation and maintenance activities, such as maneuvering construction and maintenance equipment and vehicles associated with these activities. Additional impacts could occur during this phase if production is expanded or if an additional drill site is required. Consultation and monitoring may be required to ensure that commitments regarding exclusion zones and access for traditional users are maintained.

Reclamation and Abandonment

Reclamation and abandonment activities include abandoning the well after production ceases and reclaiming all disturbed areas. All disturbed lands would be reclaimed in accordance with BLM and FS standards. In some areas, land may be reused for other purposes rather than restored.

While visual and aural settings could be restored and it may be possible to restore some habitats, it is unlikely that some cultural or sacred uses could be restored. Changes in flow or temperature of hot springs would not be restored, and cultural uses and religious value may be permanently lost.

4.15.4 What are the Potential Impacts on Tribal Interests and Traditional Cultural Resources Associated with the Proposed Action and Alternatives?

The following discussion analyzes the general environmental consequences expected to occur as a result of implementing the alternatives described in Chapter 2. Impacts are discussed generically, because the presence, absence, or location of tribal interests and traditional cultural resources and their relation to potential geothermal development are not known.

Impacts under Alternative A

Under the no action alternative, geothermal leasing for direct and indirect use would continue to occur on a case-by-case basis. Geothermal leases for direct and indirect use would be issued based on existing land use plans and future amendments and revisions. Many current land use plans do not specifically address geothermal leasing and its effects on tribal interests and traditional cultural resources.

Under this alternative, areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. Standardized protections through closures, lease stipulations, best management practices, or procedures for tribal interests and traditional cultural resources would not be implemented for public and NFS lands in the western states. Similar protections for other resource values that can also preserve tribal interests and traditional cultural resources would not be implemented. Because uniform standards would not apply, there may be inconsistent identification and consideration of impacts on tribal interests and traditional cultural resources.

The BLM would still be prohibited from issuing leases for direct and indirect use on Indian trust or restricted lands within or outside of the boundaries of Indian reservations. Compliance with NEPA, NHPA, and Executive Orders 13007 and 13084 would still be required, reducing the potential for impacts. Issuing geothermal leases for direct and indirect use on a case-by-base basis or through land use plan provisions could result in higher or lower levels of protection and consideration of tribal interests and traditional cultural resources than through the PEIS. The types of impacts that could occur would be similar to those described in Section 4.15.3, above, for each phase of the RFD scenario. The number of acres likely to be affected under this alternative is unknown.

Impacts under Alternative B

Under Alternative B, the proposed action, geothermal leasing for direct and indirect use would be open on approximately 118,000,000 acres of public land and 79,000,000 acres of National Forest System land in the 12 western states. Lands identified as open for geothermal leasing for direct and indirect use could be open with moderate to major constraints, depending on environmental conditions identified during site-specific reviews conducted by field offices and

ranger districts prior to issuing leases. Approximately 48,520,000 acres would be closed to geothermal leasing for direct and indirect use because these lands were found to be incompatible with geothermal leasing, exploration, and development. Existing land use plans would be amended to reflect the leasing standards of this PEIS, but individual field offices and ranger districts could modify these standards in keeping with pre-existing agreements on resource protections. Higher or lower levels of protection and consideration of tribal interests and traditional cultural resources could result in areas where development is currently governed through land use plan provisions or agreements.

Under Alternative B, the potential for impacts on tribal interests and traditional cultural resources would be the same as described for each phase of the RFD scenario described in Section 4.15.3. Impacts on tribal interests and resources on most public and NFS lands would be minimized or avoided through consistent guidance for future geothermal leasing, including closures, any required consultations, environmental reviews, and stipulations. Indian trust or restricted lands within or outside the boundaries of Indian reservations would remain closed to leasing for direct and indirect use. For all lands open to geothermal leasing, compliance with NEPA, NHPA, and Executive Orders 13007 and 13084 would be required reducing the potential for impacts. No surface occupancy would be allowed in areas with important cultural and archaeological resources, such as traditional cultural properties and Native American sacred sites, as identified through any required government-to-government consultation with tribes (Section 2.2.2). It is expected that these measures, along with the measures outlined under cultural resources, will minimize impacts on tribal interests and traditional cultural resources, however there may be residual effects that are difficult or impossible to adequately mitigate.

Impacts under Alternative C

Under Alternative C, approximately 61 million acres of public lands and 38 million acres of NFS lands would be identified as open for indirect use leasing within 10 miles of existing transmission lines and at least 15 miles outside of the Yellowstone National Park boundary.

Potential impacts on tribal interests and traditional cultural resources would be similar in type to those described in Section 4.15.3 for each phase of the RFD scenario. Indirect use geothermal leasing would be concentrated and encouraged primarily within transmission line buffers, reducing the need to disturb additional lands and visual settings and reducing potential impacts in other areas. By locating leases and future development in places that may already have some level of disturbance, it is less likely that certain kinds of tribal interests and traditional cultural resources would be present or impacted.

Areas open to direct use geothermal lease applications and impacts from their subsequent development would be the same as identified under Alternative B.

4.16 NATIONAL SCENIC AND HISTORIC TRAILS

4.16.1 What did the Public Say about Impacts on National Scenic and Historic Trails?

Although several comments pertained to cultural resources in general, only three specifically addressed National Scenic and Historic Trails. The California Wilderness Coalition, The Wilderness Society, and The Wilderness Society and Western Resource Advocates all requested that no permitting be allowed in or adjacent to designated National Scenic and Historic Trails.

4.16.2 How Were the Potential Effects of Geothermal Development on National Scenic and Historic Trails Evaluated?

Potential impacts on National Scenic and Historic Trails could occur if reasonably foreseeable future actions were to:

- Conflict with management goals and objectives set forth by the agency or agencies responsible for trail-wide management and by the BLM or FS with on-site jurisdiction in order to sustain these resources and their visual or historic qualities;
- Result in proposed uses that are incompatible with maintaining and identifying National Scenic and Historic Trails and their qualities within and adjacent to their boundaries;
- Utilize all or any portion of a National Scenic and Historic Trail during any phase of geothermal development; or
- Install facilities or transmission lines within a National Scenic and Historic Trail's historic or scenic landscape.

Assumptions

The analysis assumes that land occupied by National Scenic and Historic Trails would be closed to leasing and that controlled surface use stipulations (CSUs) to leases would be used to apply BLM VRM Class II management objectives, unless otherwise designated. Some trail segments are currently protected by larger surface occupancy or visual buffers, and the BLM field office or FS ranger district with on-site jurisdiction would have the discretion to retain more restrictive buffers. Some trail segments are collocated with modern highways or other disturbances, and BLM VRM Class II management objectives may not be appropriate.

4.16.3 What are the Common Impacts Associated with Geothermal Development?

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on National Scenic and Historic Trails from geothermal resource development.

The Reasonable Foreseeable Development Scenario for National Scenic and Historic Trails

According to the RFD scenario, it is estimated that 111 power plants could be constructed by 2015, and another 133 power plants could be constructed by 2025. The typical acreage of disturbance in a complete geothermal resource development is 53 to 367 acres. Therefore, total land use disturbance would be approximately 5,883 acres to 40,737 acres by 2015 and 12,932 acres to 89,548 acres by 2025. The four phases of geothermal development involve different levels of geothermal activity. The varying levels of geothermal activity influence the level of impact on National Scenic and Historic Trails. Impacts for each phase for a typical plant are discussed below.

Exploration

The exploration phase includes surveying and drilling temperature gradient wells.

Surveying activities would impact historical and scenic trails if additional roads or routes are developed across or within the trail's historic or scenic landscape. Additional roads could lead to increased disturbances along trails and within their landscapes. The magnitude and extent of the impact would depend on the current modern uses in the area. Any permanent construction or disturbances would be long-term impacts.

The magnitude and extent of impacts on National Scenic and Historic Trails from drilling temperature gradient wells would again depend on the current modern uses in the area. Similar to surveying activities, roads would be required to access wells, and impacts would be similar. Several wells could be drilled per lease, and drilling activity could disturb approximately 0.9 acres. Ground disturbances would occur on lands directly under the well sites, which does not typically involve leveling or grading; these impacts would last only the duration of the drilling and reclamation activities (several weeks). If wells and appurtenances are constructed within the route of a National Scenic and Historic Trail or within a trail's historic or scenic landscape, impacts would be considered short term if structures are temporary and long term if structures are permanent.

Drilling Operations

Geothermal drilling operations would result in impacts on National Scenic and Historic Trails if allowed within the boundaries of a trail or its landscape. The drilling operations phase would require access roads to accommodate larger equipment. New roads would have similar impacts to those identified during the exploration phase.

The drilling operations phase also includes drill site development, which on average requires a two-acre well pad to accommodate additional production wells, injection wells, and sump pits. Land under the well pad may include a

portion of a National Scenic or Historic Trail route and would be impacted by ground disturbance.

Utilization

Construction of a geothermal power plant and its associated infrastructure (e.g., well field equipment) during the onset of the utilization phase would create impacts if a portion of a National Scenic or Historic Trail route would be impacted by ground disturbance. These impacts would be limited to the construction period.

The well field equipment consists of pipelines that vary from 24 to 36 inches in diameter. Where feasible, pipelines would parallel access roads and existing roads, some of which may be National Scenic and Historic Trails. A power plant requires approximately 15 to 25 acres to accommodate all the needed equipment and would represent a large modern development on a historic or scenic landscape. Installing electrical transmission lines from the power plant would disturb approximately one acre per mile of transmission line. Lines may cross trails and their landscapes. Long-term impacts on National Scenic and Historic Trails would result from construction of these modern developments within the route or historic or scenic landscape of the affected trail.

Reclamation and Abandonment

Reclamation and abandonment activities include abandoning the well after production ceases and reclaiming all disturbed areas. All disturbed lands would be reclaimed in accordance with BLM and FS standards. Unless the development and changes from the exploration, drilling operations, and utilization phases are removed and the preexisting conditions are reestablished, all impacts on National Scenic and Historic Trails from those previous phases would continue.

4.16.4 What are the Potential Impacts Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing the alternatives described in Chapter 2. In the absence of site-specific data, including site location, only a general analysis of impacts on National Scenic and Historic Trails is possible at this time.

Impacts under Alternative A

Under the no action alternative, lease applications would continue to be processed on a case-by-case basis. Areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. The number of acres likely to be affected under this alternative is unknown.

Issuing geothermal leases for direct and indirect use on a case-by-base basis is not expected to affect National Scenic and Historic Trails. The case-specific

studies required prior to issuance of a lease would be expected to prevent many impacts on National Scenic and Historic Trails. Development would require construction of facilities and transmission lines, which could alter the historic or scenic landscape of the affected trails. Under this alternative, no comprehensive list of stipulations, best management practices, or procedures would be distributed to serve as a consistent guidance for future geothermal leasing and development. This would result in fragmented and segregated planning for preventing impacts on National Scenic and Historic Trails, which often exponentially increases recognized environmental impacts. Due to the uncertainty of total acreage considered for geothermal leasing and development under this alternative, it is not possible to quantify the total acreage affected on federal lands.

Impacts under Alternative B

Under Alternative B, the proposed action, geothermal leasing for direct and indirect use would not be allowed on National Scenic or Historic Trails, and BLM VRM Class II management objectives would be applied. This would prevent or reduce impacts from occurring within the route of a designated trail and its historic or scenic landscape. Development would require construction of facilities and transmission lines, which could alter the historic or scenic landscape of the affected trails. Approximately 6,173 miles of National Scenic and Historic Trails traverse the planning area and would be afforded additional protections under Alternative B. However, if a trail's associated historic or scenic landscape extends farther than one mile from the route, the trail could be impacted by the various phases of geothermal development.

Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. Relevant stipulations (Section 2.2.2) designed to minimize impacts on National Scenic and Historic Trails include (1) no surface occupancy within the setting and boundary of properties designated or eligible for the National Register of Historic Places, including National Landmarks and National Register Districts and Sites; and additional lands outside the designated boundaries to the extent necessary to protect values where the setting and integrity is critical to their designation or eligibility; and (2) controlled surface use in sensitive viewsheds within the visual setting of National Scenic and Historic Trails to maintain VRM Class II objectives, unless otherwise designated.. In addition, in accordance with BMPs (Appendix D), BLM and operators would contact appropriate agencies, property owners, and other stakeholders early in the planning process to identify potentially sensitive recreational areas and issues such as trails. It is expected that these measures would effectively avoid or minimize impacts on National Scenic and Historic Trails by protecting the most significant trails, maintaining recreational opportunities and recreational experience, and reducing user and resource conflicts.

Impacts under Alternative C

Under Alternative C, geothermal leasing for direct and indirect use would not be allowed on National Scenic or Historic Trails, and BLM VRM Class II management objectives would be applied to scenic and historic landscapes. This would result in impacts similar to those under Alternative B, but with fewer landscapes afforded the additional standard protections around designated trails during leasing and development for indirect use. Leasing and development would presumably be more likely to occur in areas that may be already altered by transmission lines, and new disturbances to scenic or historic landscapes may be avoided.

4.17 VISUAL RESOURCES

This section analyzes impacts on visual resources as a result of activities described in the RFD scenario, which involves the four sequential phases of geothermal development: 1) exploration, 2) drilling operations, 3) utilization, and 4) reclamation and abandonment.

4.17.1 What did the Public Say about Impacts on Visual Resources?

Scoping was conducted to determine issues of concern with respect to the proposed project. The following issues of concern relating to visual resources were identified during scoping:

- Effects on scenic resources from road and other transmission corridor developments;
- Effects on open space from development;
- Effects on scenic values associated with cultural resources and recreation from geothermal development; and
- General and specific BMPs to preserve scenic quality.

4.17.2 How Were the Potential Effects of Geothermal Development on Visual Resources Evaluated?

Potential impacts on visual resources are based on interdisciplinary team knowledge of public lands and National Forest System lands, review of literature, and information gathered from the public during the planning process. To the extent practical, spatial data were used to compare environmental conditions with the alternatives. Various actions that might create changes to the basic landscape elements (such as form, line, color, and texture) were considered in identifying potential impacts. Effects are quantified where possible. In the absence of quantitative data, best professional judgment was used to describe impacts using qualitative terms. Impacts were assessed according to the following assumptions:

- Scenic resources would remain in demand on public lands and NFS lands;
- The demand for recreational use would continue to increase, thereby increasing the value of open spaces and undeveloped landscapes containing scenic resources;
- Any new surface-disturbing geothermal activities would be subject to further NEPA analysis, which would include an analysis to determine consistency with applicable visual resource objectives. NEPA analysis within VRM Management Class I, II, and III would include contrast rating evaluations and photo simulations in accordance with BLM Handbook H-8431-1, Visual Resource Contrast Rating; and

- Proposed activities that would not initially meet applicable visual resource objectives for an area would be mitigated to the extent needed to meet the objectives. Those proposed activities that could not be mitigated would not be authorized.

Impacts on visual resources can be either positive or negative, depending on the type and degree of visual contrasts introduced to a landscape. Where modifications repeat the general elements of the natural landscape, the degree of visual contrast is lower, and the impacts are generally perceived less negatively. Where modification introduces pronounced changes, the degree of contrast is greater, and impacts are often perceived more negatively.

The potential risk of impacts on visual resources is assessed for five significance criteria. Potential impacts on visual resources could occur if reasonably foreseeable future actions were to result in the following:

- Have adverse effects on a scenic vista;
- Damage a scenic resource within a scenic roadway;
- Degrade the existing visual character or quality of the site and its surroundings;
- Create a new source of light or glare; or
- Be incompatible with the VRM system, the SMS, or other applicable visual resource objectives.

Receptors sensitive to disturbances of visual resources are varied and depend on the landscape's visual resources; the project's location; the view distance, angle, and duration; the location of travel routes; public areas of interest; the season; the topography; recreation activities; and the number of viewers. Because of this, it is important to note that site-specific impact assessment is needed to thoroughly assess impacts on visual resources from a particular project. Without precise information about a specific project, it is not possible to detail the visual impacts. However, by using the RFD scenario as a general description of expected geothermal resource development activities, a generalized assessment of the possible impacts on visual resources can be made by describing the range of expected visual changes.

4.17.3 What are the Common Impacts on Visual Resources Associated with Geothermal Development?

Future actions based on the RFD scenario could result in impacts on visual resources. Due to the inability to predict precise future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on visual resources from geothermal resource development. The exact level of impact would depend on the actual intensity of geothermal resource development activity.

The Reasonable Foreseeable Development Scenario for Visual Resources

The four sequential phases of geothermal development involve different levels of geothermal activity. The varying levels of geothermal activity influence the level of impact on visual resources.

Exploration

Exploration can involve field surveys and temperature gradient well activities. Field surveys are typically conducted on foot or by using four-wheel drive vehicles and involve collecting data pertaining to the local geothermal resource. Temperature gradient wells are typically drilled using a truck-mounted rig and support equipment. The temperature gradient wells range from 200 feet to over 4,000 feet deep. No permanent structures are constructed for field surveys or temperature gradient wells. As a result of field surveys and temperature gradient well activities, the following alterations to visual resources would occur during the exploration phase:

- Vegetation damage;
- Scarring of the terrain from vehicles;
- Truck-mounted drilling rig and support equipment detracting from the natural environment; and
- Lighting during drilling and for safety.

Minimal reclamation is needed to return visual resources to pre-disturbance conditions, because exploration activities are limited in duration and are relatively small in physical size and areal extent. The BLM and FS would develop and approve reclamation requirements. Compared to the other phases of geothermal development, exploration involves the least amount of permanent, long-term disturbance to the visual environment.

Stipulations involving NSO/NGD would be applied to public lands designated as VRM Class I and National Forest System lands designated as Very High in order to protect scenic resources. Activities that would not comply with NSO/NGD stipulations would not be allowed on those lands.

National Forest System lands designated as High involve landscapes where the valued landscape character appears intact. Deviations may be present but must repeat the form, line, color, texture, and pattern common to the landscape character so completely and at such scale that they are not evident. National Forest System lands designated as Moderate involve landscapes where the valued landscape character appears slightly altered. Noticeable deviations must remain visually subordinate to the landscape character being viewed.

The objective of VRM Class II public land is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low.

Management activities may be seen but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

The impacts on visual resources from the exploration phase on these three types of lands would be evident and would create a landscape that does not appear intact, mostly from the use of a truck-mounted drilling rig. A drilling rig would be a noticeable deviation and would attract the attention of casual observers. It is assumed that BLM and FS best management practices, standard operating procedures, and requirements for geothermal explorations would be implemented for all land designations to reduce impacts on visual resources. Also, at the very least, mitigation measures would be necessary for National Forest System lands designated as High and Moderate and public lands designated as VRM Class II to further reduce impacts on visual resources. Mitigation may also be necessary for lands with visual resources of lesser quality once site-specific analysis is conducted.

Drilling Operations

Drilling operations can involve assembling infrastructure in order to use the geothermal resource. For indirect use, the infrastructure can include roads, sump pits, production-size wells, injection wells, well field equipment, and reclamation around wells. The production-size wells can be over two miles (10,560 feet) deep. As a result of assembling infrastructure, the following alterations to visual resources would occur during the drilling operations phase:

- Visibility of activities involving construction work;
- Vegetation damage;
- Altering the natural landform or contours;
- Clearing of vegetation for roads;
- Building new roads;
- Scarring of the terrain from construction work;
- Fugitive dust from construction activities and newly exposed soils; and
- Lighting during construction.

Furthermore, depending on the location, this phase of geothermal activity could also alter a scenic vista or scenic roadway, fragment the open space of the landscape, or reduce the aesthetics of recreation or cultural areas.

Reclamation would occur after development activities to return visual resources to pre-disturbance conditions. Areas where reclamation would occur include

temporary roads, staging areas, and well head areas. The BLM and FS would develop and approve reclamation requirements.

Stipulations involving NSO/NGD would be applied on public lands designated as VRM Class I and National Forest System lands designated as Very High in order to protect scenic resources. Activities that would not comply with NSO/NGD stipulations would not be allowed on those lands.

The impacts on visual resources on National Forest System lands designated as High and Moderate and public lands designated as VRM Class II would be the same as those described above under exploration. National Forest System lands designated as Low involve landscapes where the valued landscape character appears moderately altered. Deviations begin to dominate the valued landscape character being viewed, but they borrow valued attributes such as size, shape, edge effect, and pattern of natural openings; vegetative-type changes; or architectural styles outside the landscape being viewed. They should not only appear as valued character outside the landscape being viewed but should be compatible or complimentary to the character within. The objective of VRM Class III public lands is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

The impacts on visual resource from the drilling operations phase on these two types of lands would dominate the valued landscape and the view of the casual observer. It is assumed BLM and FS best management practices, standard operating procedures, and requirements for geothermal development would be implemented for all land designations to reduce impacts on visual resources. Also, mitigation measures would be necessary for National Forest System lands designated as Low and public lands classified as VRM Class III to further reduce impacts on visual resources. Mitigation may also be necessary for lands with visual resources of lesser quality once site-specific analysis is conducted.

Utilization

The utilization phase involves final construction of infrastructure in order to use the geothermal resource. Infrastructure can include roads, sump pits, production-size wells, injection wells, well field equipment, power plant facilities, and transmission lines. For indirect use, utilization also involves additional production well development and the operation and maintenance activities at the geothermal site. The utilization phase could last from 10 to 30 years. For direct use, utilization can involve similar activities; however, the utilization phase typically lasts for several decades, if not longer. The infrastructure needed for direct use of the geothermal reservoir also includes piping to convey the high-temperature water.

As a result, the following alterations to visual resources would occur during the utilization phase:

- Visibility of activities involving construction work;
- Vegetation damage;
- Alteration of the natural landform or contours;
- Clearing of vegetation for additional production wells;
- Building new structures and roads;
- Scarring of the terrain from construction work;
- Fugitive dust from construction activities and newly exposed soils;
- Release of steam plumes;
- Conversion of undeveloped land to land with human-made structures; and
- Lighting during construction.

Furthermore, depending on the location, this phase of geothermal activity could alter a scenic vista or scenic roadway, fragment the open space of the landscape, or reduce the aesthetics of recreation or cultural areas. These potential impacts would be an advancement of the impacts that occurred during the drilling operations phase.

Stipulations involving NSO/NGD would be applied to public lands designated as VRM Class I and National Forest System lands designated as Very High in order to protect scenic resources. Activities that would not comply with NSO/NGD stipulations would not be allowed on those lands.

The impacts on visual resources on National Forest System lands and public lands would be greater than those described above under the drilling operations phase.

Reclamation and Abandonment

For indirect and direct use, reclamation and abandonment involves abandoning the well after production ceases and reclaiming all disturbed areas in conformance with BLM and FS standards. As a result, the following alterations to visual resources would occur during the reclamation and abandonment phase:

- Visibility of activities involving demolition work and removal of surface structures and equipment;
- Regrading disturbed areas to pre-disturbance contours;
- Fugitive dust from demolition activities and newly exposed soils; and
- Removing weeds and replanting native vegetation.

Furthermore, depending on the location, this phase of geothermal activity could also enhance a scenic vista, a scenic roadway, the landscape's open space, or the aesthetics of recreation or cultural areas to pre-geothermal project conditions. It could also restore these types of visual resources to pre-geothermal development conditions, assuming no other project developments or activities were initiated in the surrounding area during the lifespan of the geothermal project that further degraded the visual resources associated with scenic vistas, roadways, open space, or recreation or cultural areas.

Stipulations involving NSO/NGD would be applied to public lands designated as VRM Class I and National Forest System lands designated as Very High in order to protect scenic resources. Activities that would not comply with NSO/NGD stipulations would not be allowed on those lands. The level of disturbance to visual resources on public lands and National Forest System lands with other visual resource objectives would be commensurate with the objectives for visual resources.

It is assumed BLM and FS best management practices, standard operating procedures, and requirements for geothermal reclamation and abandonment would be implemented for all land designations to protect visual resources during reclamation and abandonment activities. This phase is expected to result in a more long-term, natural appearance to the landscape.

4.17.4 What are the Potential Impacts on Visual Resources Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing the alternatives described in Chapter 2.

Impacts under Alternative A

Under the no action alternative, lease applications would continue to be processed on a case-by-case basis. Areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. Older land use plans may fail to properly address potential geothermal resource development for direct or indirect use, thereby threatening visual resources from potential geothermal resource development activity that was not taken into consideration when the land use plan was originally prepared. Case-by-case evaluation could require additional NEPA documentation and possibly amendments to individual land use plans. The amendments to individual land use plans could be similar to or different from the alternatives analyzed in this PEIS, resulting in greater opportunities to degrade or protect visual resources, depending on local conditions.

Impacts under Alternative B

Under the proposed action, approximately 118 million acres of public land and 79 million acres of National Forest System lands would be open to geothermal leasing for direct or indirect use subject to existing laws, regulations, formal orders, and the terms and conditions of the standard lease form. The impacts under this alternative are the same as the impacts described above under Section 4.17.3.

Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. Relevant stipulations (Section 2.2.2) designed to protect the existing visual resources include (1) no surface occupancy for public lands designated as VRM Class I and NFS lands with a Scenery Management System integrity level of Very High; and (2) controlled surface use for sensitive viewsheds, including public lands with a VRM Class II, NFS lands with a Scenery Management System integrity level of High, or near National Historic Trails or residential areas. In addition, in accordance with the identified BMPs (Appendix D), BLM, FS, and operators would use site-design and other measures to achieve the appropriate VRM and Scenery Management System objectives. It is expected that these measures would effectively avoid or minimize impacts on visual resources by evaluating proposed surface disturbing activities for impacts on visual resources and incorporating appropriate visual resource design techniques to mitigate impacts.

Impacts under Alternative C

The impacts under this alternative are the same as the impacts described under Alternative B. However, the amount and degree of impacts on visual resources would be less under this alternative. Under Alternative C, the BLM and FS would only consider leasing lands for indirect use geothermal development within 10 miles from the centerline of existing transmission lines and at least 15 miles outside of the Yellowstone National Park boundary. All lands within this buffer would be designated as open and closed to leasing for indirect use using the criteria outlined in Chapter 2.

Approximately 61 million acres of public land and 38 million acres of National Forest System lands would be open to leasing for indirect use. Compared to Alternative B, there would be fewer impacts, because less land would be available for geothermal leasing for indirect use. Due to the proximity of the land to transmission lines, it is assumed that the land has moderate to low scenic value or has other human-made structures and detractions that have altered the natural landscape. As a result, the degree of change to visual resources would be less under Alternative C, because the land being considered for potential geothermal resource development is assumed to already be altered to some extent. This would not be the case for Alternative B, because land with potentially higher scenic value due to its distance from existing infrastructure

(i.e., transmission lines) would be considered for potential geothermal resource development (for both direct and indirect use).

Areas open to direct use geothermal lease applications and impacts from their subsequent development would be the same as identified under Alternative B.

4.18 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

4.18.1 What did the Public Say about Impacts on Socioeconomics and Environmental Justice?

A number of comments relevant to socioeconomics and environmental justice were received.

The California Wilderness Coalition requested that the PEIS describe and discuss the costs associated with allowing and maintaining geothermal leases for each alternative.

The Idaho Conservation League and Utah Environmental Congress stated that the leasing plan needs to ensure that each geothermal power plant is cost effective and guarantee that the most kilowatts will be produced with the least amount of environmental impact. In addition, they requested that the PEIS examine direct and cumulative economic impacts for the RFD, including the economic costs of loss or degradation of public lands, wildlife habitats, quality of life, and infrastructure strains that accompany oil and gas development. They suggested that the BLM's Economic Profile System be used for this analysis.

Ormat, Inc. noted that the PEIS should recognize the numerous important long-term benefits of expanding geothermal energy, including creating new jobs, rural economic development, and income to state and local governments.

The Wilderness Society and Western Resource Advocates provided detailed recommendations for socioeconomic analysis. They suggested that the PEIS provide the following components in the analysis:

- Data and analysis that fully accounts for negative impacts from habitat fragmentation, loss of quality of life, and loss of quality recreation that geothermal development might have on tourism, recreation, hunting, and fishing; and
- An analysis of the income and jobs associated with recreation, hunting, and fishing for each alternative.

The organizations provided suggested references to guide the economic analysis of geothermal energy development.

In an extensive comment, the US Environmental Protection Agency directed the PEIS to evaluate minority and low-income populations in the project area and address the potential for disproportionate impacts on these populations. The letter also included detailed recommendations for facilitating public involvement with these populations. In addition, the EPA suggested that the procedure used for distributing royalties be outlined in the PEIS.

4.18.2 How Were the Potential Effects of Geothermal Development on Socioeconomics and Environmental Justice Evaluated?

Impacts were analyzed in terms of the predicted increase in megawatts of geothermal energy and the associated changes expected in employment, income, tax revenue, royalties, public infrastructure needs, and other socioeconomic factors. Quantitative estimates were provided, when available, based on the best available data. Where quantitative data were not available, professional judgment was used to describe impacts using qualitative terms.

In discussion of the RFD scenario, impacts are described for a standard 50-megawatt plant. Quantitative estimates are provided for selected economic indicators for the state and project area based on megawatt estimates.

When secondary impacts are discussed, an economic multiplier effect of 2.5 is applied, based on standard multiplier effects observed in the geothermal industry (US DOE 2006b). This means that one dollar of investment in a geothermal venture produces $2.50 in economic activity, or for every job created at a geothermal plant an additional 2.5 jobs are created. Only some of the secondary impacts would occur in the local community.

The degree of future geothermal development and the associated economic impacts are related to a number of uncertain economic factors. The existence of state- or federal-level renewable energy portfolios may increase the demand for renewable energy in the future. Section 1.8.3, Climate Change Policy, describes the current status of renewable energy standards. In addition, federal production tax credits may make renewable energy more cost competitive in the future. Current production tax credits provide a 1.9 cent tax credit for each kilowatt-hour of power produced by an eligible facility (or $19 per megawatt-hour), as adjusted annually for inflation. The current production tax credit is set to expire on December 31, 2008, but if extended it would likely increase the amount of geothermal development.

Potential impacts on socioeconomics and environmental justice could occur if reasonably foreseeable future actions were to result in the following:

- Impact other land uses that currently create revenue;
- Impact local industry that supports other land uses such as recreation and hunting;
- Impact the nonmarket values of open space;
- Affect expenditures or income within the study area associated with the project;
- Induce growth or population concentrations;
- Displace a proportion of available residences in a community;

- Create a demand for additional housing that could not be sustained within the project area;
- Cause a decrease in local or project area employment;
- Displace or disrupt businesses;
- Generate student enrollment that exceeds the school district's capability to accommodate students; or
- Have a disproportionately high and adverse impact on minority or low-income populations.

4.18.3 What are the Common Impacts on Socioeconomics and Environmental Justice Associated with Geothermal Development?

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on socioeconomics and environmental justice from geothermal resource development.

The Reasonable Foreseeable Development Scenario for Socioeconomics and Environmental Justice

According to the RFD scenario, it is estimated that 111 power plants could be constructed by 2015, and another 133 power plants could be constructed by 2025. The greatest development is expected to occur in California and Nevada, with the least occurring in Arizona, Colorado, Wyoming, and Montana. Each power plant is predicted to have 50 megawatts of production capacity by 2025. Based on these estimates, direct economic impacts of geothermal plants and secondary impacts of new plant development are described below for the different phases of geothermal development. Table 4-8 provides a summary of the effects of RFD geothermal electricity generation broken down by state.

The largest impact on socioeconomics from power plants would result from employment and income directly associated with geothermal electricity plant construction and operation. Estimates for these impacts are discussed for each phase below. Currently, the government and government enterprise; retail trade; health care and social assistance; and accommodation and food services sectors provide the largest source of jobs for most states in the project area (Bureau of Economic Analysis 2007). Geothermal power plants may impact employment and incomes in these and other sectors. Impacts are discussed for each phase of development below.

Geothermal power plants can also generate substantial property taxes for the local county. Property taxes are based on the estimated value of the company assets. At the rate generated in Imperial County, California, as described in Chapter 3, an additional 367 million dollars in property tax may be produced in the project area annually under the RFD scenario. Land values for private tracts

Table 4-8
Direct Economic Impacts of Geothermal Electricity Generation under the Reasonably Foreseeable Development Scenario

	California	Nevada	Idaho	Oregon	Utah	Washington	New Mexico	Alaska	Arizona	Colorado	Montana	Wyoming	Total
Estimated Geothermal Electrical Generation by 2025 (MW)	4,730	2,880	1,670	1,250	620	600	170	150	50	50	n/a	**0**	**12,170**
Total Construction Jobs (temporary jobs)[1]	14,663	8,928	5,177	3,875	1,922	1,860	527	465	155	155	n/a	0	**37,727**
Construction Income (million $)[2]	851.4	518.4	300.6	225.0	111.6	108.0	30.6	27.0	9.0	9.0	n/a	0	**2,190.6**
Operations and Maintenance Jobs (permanent full-time jobs)[3]	3,500	2,131	1,236	925	459	444	126	111	37	37	n/a	0	**9,006**
Operations and Maintenance Income (million $)[4]	302.7	184.3	106.9	80.0	39.7	38.4	10.9	9.6	3.2	3.2	n/a	0	**778.9**
Property Tax Estimate (annual, in million $)[5]	143.3	87.3	50.6	37.9	18.8	18.2	5.2	4.5	1.5	1.5	n/a	0	**368.9**
Federal royalty estimate (30-year total, in million $)[6]	1,513.6	912.6	534.4	400	198.4	192	54.4	48	16	16	n/a	0	**3894.4**

[1] Assuming an average of 3.1 total construction jobs/MW, as discussed in Hance 2005.
[2] Assuming a rate of $9 million for 50-MW plant, as discussed in BLM 2007.
[3] Assuming a rate of .74 permanent full-time jobs per MW, as discussed in Hance 2005.
[4] Assuming a rate of $3.2 million annually for a 50-MW plant, as discussed in BLM 2007.
[5] At rate generated in Imperial County (NRC 2007).
[6] With average electricity price of 6 cents/kWh and 95 percent capacity factor, following Kagel 2006.

of land bordering geothermal development areas could also change, based on the development potential and possible profitability exhibited on adjacent geothermal lands. Potential increased land values could in turn provide additional revenue for counties. Secondary jobs and expenditures in the community are also likely to increase sales tax, providing extra income for the state and county government.

Royalties are another revenue stream for governments. Over 30 years, a 50-megawatt power plant would contribute an estimated $16 million to federal, state, and local governments in the form of royalties (Table 4-8). This calculation is based on Geothermal Steam Act royalty collection rates, as described in Chapter 3, and assumes an average electricity price of 6 cents per kilowatt-hour and 95 percent capacity factor. Without adjusting for inflation, every year for the first ten years a 50-megawatt geothermal plant would contribute $218,453 to the state, $109,226 to the federal government, and $109,226 to the county government. From the eleventh year on, without adjusting for inflation, every year the plant would contribute $436,905 to the state, $218,452 to the federal government, and $218,452 to the county (Kagel 2006). It should be noted that royalties are set as a percent of revenue and would therefore be dependant on future electricity prices, which are difficult to predict. An additional source of revenues come from bonus bids paid to acquire leases and lease rental fees. These fees vary by location, but can constitute an important source of revenue for states and counties during the period prior to production.

For direct use, it is estimated that applications could be developed in the amount of 1,600 thermal megawatts by 2015 and 4,200 thermal megawatts by 2025. Using low-temperature geothermal resources (between 70°F and 300°F) may generate revenue and creates jobs for some states. For example, four commercial geothermal greenhouses in rural, southern New Mexico employed up to 400 people. In 2002, these projects generated nearly $23 million in sales and paid more than $6 million in payroll. A one-million-square-foot greenhouse in rural Utah employs between 80 and 120 people throughout the year (National Geothermal Collaborative 2007).

Direct use of geothermal energy can offset the cost of heating and cooling associated with electricity. On average, geothermal heat pumps use 25 to 50 percent less electricity than conventional heating or cooling systems (US DOE 2006b). At four elementary schools in Lincoln, Nebraska where geothermal heat pumps have been installed, the heating and cooling savings total about $144,000 yearly, with total energy cost savings of 57 percent (NREL 1998).

The specific economic impacts of direct use are more difficult to predict than the impacts of power plants, as they are highly variable. Estimates are not available for direct-use phases of development.

Exploration

The exploration phase includes surveying and drilling temperature gradient wells. Activities such as gradient well drilling and seismic surveys could provide temporary jobs for the local community near geothermal resources. Expenditures for fuel, lodging, food, and other needs would provide a stimulus to the local economy.

Other land uses would generally not be impacted during the exploration phase; therefore, no long-term economic impact on these uses would occur. No long-term increases in population or growth would occur in this phase, and demand for schools would not increase.

The impacts on socioeconomic or environmental justice in this phase are expected to be low throughout the project area.

Drilling Operations

Drilling operations can involve assembling infrastructure in order to use the geothermal resource. For indirect use, the infrastructure can include roads, production-size wells, injection wells, well field equipment, and fluid sump pits.

Geothermal resource drilling operations would impact socioeconomics. The level of impact would vary depending on the size and location of geothermal development.

Air quality, water quality, noise, cultural resource, geological resource, and hazardous material impacts potentially resulting from geothermal development could impact minority or low-income populations on private lands adjacent to leasing areas. These potential environmental justice impacts would be mitigated through best management practices applied to specific project leases. Areas open to potential geothermal leasing may include lands of tribal concern, or having traditional cultural resources or sacred sites. Intergovernmental coordination with affected tribes prior to specific leases should limit negative impacts on Native American populations. Tribal consultation is further discussed in Section 4.15, Tribal Interests and Traditionally Cultural Resources.

Utilization

The utilization phase involves finalizing construction of infrastructure in order to use the geothermal resource. For indirect use, the infrastructure can include additional roads, sump pits, production-size wells, well field equipment, power plants, electric transmission lines, and reclamation around wells. For direct use, the infrastructure can include piping to convey the high-temperature water.

Construction employment for installing access roads, pipelines, transmission lines, drill sites, and power plants would likely occur, though the amount would vary depending on the resource potential. The type of employment and number of available jobs would also vary as the construction proceeds. Construction

employment is expressed in person-month or person-year units. One person-month corresponds to the employment of one person during one month. Similarly, one person-year corresponds to the employment of one person during one year. Construction of a new geothermal plant averages 17 to 33 months and requires 37.4 person-months per megawatt, or 3.1 person-years per megawatt of power capacity installed (Hance 2005a). Based on these numbers, construction of a typical 50-megawatt power plant and the associated transmission lines would require 1,870 person-months, or 155 person-years. The personnel involved in well and transmission line construction would be temporary. Due to the variation in jobs available at different stages in construction, average employment would vary at any one time. Based on the estimates for construction worker income as described in the Truckhaven Geothermal Leasing EIS (BLM 2007l), income for construction jobs is estimated to be $9 million for a 50-megawatt plant (Table 4-8). Based on project area megawatt predictions, an estimated 37,727 total construction jobs and $2,190.6 million in construction income may be added by geothermal development under the RFD scenario.

Expenditures for equipment, materials, fuel, lodging, food, and other needs would stimulate the local economy over the duration of development. Applying a standard economic multiplier, development of a 50-megawatt power plant is estimated to create an additional 387 jobs and $22.5 million in income. The level of these impacts would vary depending on the community; therefore, this is a general estimate only. Some of the secondary impacts would occur in the local communities in which geothermal development occurs, while others would occur at a regional or national level.

The cost of geothermal plant development would vary depending on size and location of plants. A review of costs for current plants determined that average capital costs for new geothermal plant development is $1,969 per kilowatt or $98 million for a 50-megawatt plant (Hance 2005b).

Some economic impacts may occur should income and employment associated with ranching, recreation, hunting, mining, or other land use activities be altered by geothermal development. Constructing geothermal facilities will alter the landscape and nonmarket values of the immediate area, however the extent of impact would vary with each project. In the short term, other land uses and income derived from these uses may be displaced by geothermal development. In the long term, many other land uses may be compatible with geothermal use due to the small footprint of geothermal plants; however the aesthetic value would be permanently altered.

Habitat fragmentation created from constructing geothermal roads and pipelines in areas that contain wilderness characteristics could impact recreation, hunting, and wildlife viewing associated with these areas. Due to the fragmentation of the

recreation and tourism industry, it is difficult to measure the effects to local businesses and economies. However, studies have shown that recreation and tourism development contributes to rural well-being, increasing local employment, wage levels, and income, reducing poverty, and improving education and health (USDA 2005). Public and forest service lands are both primary destinations and places of transition to other recreational destinations on Federal, State, or private lands, affecting economies both inside and outside of the project area. Recreation can be a significant source of income for some rural communities, especially communities adjacent to public lands or NFS lands. Congressionally closed areas discussed in Section 1.5, Leasing and Development Process of Geothermal Resources on Federal Lands would generally be closed to geothermal leasing; therefore, impacts on pristine wilderness environments would be minimal. As stated above, geothermal construction could impact values of areas that may contain wilderness characteristics adjacent to these wilderness areas. In general, while the recreational setting may change due to development in some areas, other recreational opportunities would become available due to increased accessibility. Therefore, the overall impact on recreation-related economics should be minimal. Please refer to Sections 4.2 Land Use, Recreation, and Special Designations and 4.13, Livestock Grazing for a detailed discussion of the impacts of geothermal development on these land use activities. The level of local economic impact of geothermal development activities on other land uses would vary depending on the location, timing, and size of geothermal development; therefore, specific impacts on jobs or incomes in these industries cannot be determined for the RFD scenario.

Another possible impact would be to broaden the economic base of the communities within the region of influence of geothermal resource area. This impact is particularly relevant in rural communities where employment sectors have typically been limited and unemployment rates are high.

Construction activities may require the in-migration of workers for certain occupational categories, which in turn could affect rental housing markets and schools and could create the need for additional state and local government expenditures and employment. Construction could also impact local businesses by pulling workers away from local positions to work on the temporary buildout. The population growth and need for additional infrastructure in a community would depend on a number of factors related to specific geothermal development sites, including skill level of local workers, unemployment rate in the local area, and existing state of rental market and public infrastructure.

For indirect use, operations could last from 10 to 30 years. For direct use, operations can involve similar activities; however, the utilization phase typically lasts for several decades, if not longer. During operations, jobs would continue

to be available, but the high levels of construction jobs seen during the initial period of this phase would be reduced.

Based on employment numbers in a 2005 survey of the geothermal industry, an average of .74 person-years per megawatt annually is required for geothermal power plant operation and maintenance (Hance 2005a). Using this ratio, a 50-megawatt geothermal plant would require approximately 37 person-years annually or 37 permanent, full-time jobs. Using Truckhaven EIS estimates, payroll for these employees is estimated at $3.2 million annually (BLM 2007l) (Table 4-8). Based on RFD scenario megawatt predictions, 9,006 jobs and $778.9 million in payroll income is anticipated for operations and maintenance activities in 2025.

As during initial construction during the utilization phase, expenditures for equipment, materials, fuel, lodging, food, and other needs would stimulate the local economy over the duration of plant operation. Applying a standard economic multiplier, operations during the utilization phase of a 50-megawatt power plant are estimated to create an additional 93 jobs and $8 million in income. The exact level of these impacts would vary depending on the community; therefore, this is a general estimate only. Some of the secondary impacts would occur in the local communities in which geothermal development occurs, while others would occur at the regional or national level.

The operation of power plants may require the in-migration of workers for certain occupational categories. The population growth and need for additional infrastructure in a community would depend on specific projects and communities, but impacts would generally be less than those seen during the initial construction of the drilling operations phase, where a greater number of workers would be required.

Cost of geothermal plant operation would vary depending on the size and location of plants. The Western Governors Association estimated an average operation and maintenance cost of 22 cents per megawatt-hour (Western Governors' Association 2006b).

The potential impacts on economic streams for other land uses are the same as discussed in the drilling operations phase, above.

As with the drilling operations phase, the waste management and disposal associated with operation and additional well development could impact minority or low-income populations on lands adjacent to geothermal development areas. These potential environmental justice effects would be mitigated through best management practices.

Reclamation and Abandonment

Reclamation and abandonment activities include abandoning the well after production ceases and reclaiming all disturbed areas. All disturbed lands would be reclaimed in accordance with BLM and FS standards. The closeout phase would likely involve additional construction jobs for reclaiming disturbed areas. As in other phases, expenditures for equipment, materials, fuel, lodging, food, and other needs would stimulate the local economy. Best management practices would be used to minimize dust, noise, and other disturbance adjacent to communities so that potential environmental justice effects would be avoided. Reclamation could increase the aesthetic value and bring back income to local industry that supports use of that land for recreation and other uses.

4.18.4 What are the Potential Impacts on Socioeconomics and Environmental Justice Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing the alternatives described in Chapter 2.

Impacts under Alternative A

Under the no action alternative, lease applications would continue to be processed on a case-by-case basis. Areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans.

The specific economic impacts of this alternative cannot be determined. Employment, tax income, and other economic factors would likely continue to reflect the trends discussed in Chapter 3.

Under this alternative, no comprehensive list of stipulations, best management practices, or procedures would be distributed to serve as consistent guidance for future geothermal leasing and development for direct and indirect use. This would result in fragmented and segregated planning for socioeconomics and environmental justice, which often exponentially increases impacts.

Impacts under Alternative B

Under the proposed action, approximately 118 million acres of public land and 79 million acres of NFS lands would be identified as open to geothermal leasing for direct and indirect use subject to existing laws, regulations, formal orders, and the terms and conditions of the standard lease form. The impacts under this alternative are the same as the impacts described above in Section 4.18.3, What are the Common Impacts Associated with Geothermal Development.

Under Alternative B, a comprehensive list of stipulations, best management practices, and procedures would be provided to serve as consistent guidance for future direct and indirect use geothermal leasing. By designating specific areas as

open or closed to geothermal leasing for direct and indirect use, implementing major and minor constraints and other measures focusing on best management practices, negative impacts on socioeconomics or environmental justice would be minimized.

Impacts under Alternative C

Under Alternative C, geothermal leasing for indirect use would be open on 61 million acres of public land and 38 million acres of NFS land. All federal lands identified as open for indirect use geothermal leasing under this alternative are located within 10 miles of the centerline of existing transmission lines and at least 15 miles outside of the Yellowstone National Park boundary.

The specific economic impacts of anticipated future actions consistent with this alternative on indirect use development cannot be determined. The general impacts are the same as discussed under Alternative B; however, the amount and degree of the impacts would be less under this alternative. Restricting the placement of indirect use geothermal resource development to existing transmission line areas would likely minimize impacts on socioeconomics and environmental justice by concentrating energy development into designated areas. Due to the proximity of the land to existing transmission lines, the land being considered for potential geothermal resource development under Alternative C is assumed to already be altered to some extent and to be closer to existing communities. Geothermal development on these lands is less likely to impact other land uses. Areas open to direct use geothermal lease applications and impacts from their subsequent development would be the same as identified under Alternative B.

4.19 HEALTH AND SAFETY

4.19.1 What did the Public Say about Impacts on Health and Safety?

Comments were related to the inclusion of appropriate BMPs and the consideration of using a Health Impact Assessment if concerns about potential health impacts from individual projects are identified.

4.19.2 How Were the Potential Effects of Geothermal Development on Health and Safety Evaluated?

Methodology

Potential effects of geothermal development on human health and safety were evaluated by examining the typical hazards associated with the various stages of geothermal development.

Impact Criteria

Potential impacts on health and safety could occur if reasonably foreseeable future actions were to:

- Create a hazard to the public through the routine transport, use, or disposal of hazardous materials;
- Create a hazard to the public through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment;
- Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within 0.25 mile of an existing or proposed school; or
- Be located on a site that is included on a list of hazardous materials sites compiled by the federal or state government and, as a result, would create a hazard to the public.

4.19.3 What are the Common Impacts on Health and Safety Associated with Geothermal Development?

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on human health and safety from geothermal resource development.

Impacts on human health and safety from geothermal development projects could include:

- Exposure of individuals to drilling mud and geothermal fluid or steam during exploration and development drilling activities;

- Exposure of individuals to hydrogen sulfide contained in geothermal fluid or steam during exploration, development, and operation phases;
- Exposure of individuals to hazardous materials used and stored at facilities, such as petroleum, oil, lubricants, paints, solvents, and herbicides;
- Exposure of individuals to electrical fires or wildfires caused by project activities;
- Exposure of individuals to electric shock involved in maintenance of transmission lines and substations;
- Vehicular accidents due to increased traffic on local roads;
- A variety of potential accidents inherent in drilling operations, as listed in Section 3.19, Health and Safety; and
- A variety of potential accidents inherent to industrial facilities.

The Reasonable Foreseeable Development Scenario for Health and Safety

As stated in the RFD scenario, it is estimated that 111 power plants would be constructed across the 12-state project area by 2015, and a further 133 power plants could be constructed by 2025. The average capacity of these power plants is estimated to be 50 megawatts. For direct use, it is estimated that by 2015, applications could be developed in the amount of 1,600 thermal megawatts and by 2025, applications could be developed in the amount of 4,200 thermal megawatts. Each of these individual projects would introduce at least some of the aforementioned potential impacts on human health and safety.

Exploration

Potential health and safety impacts during the exploration phase would include those described above in Section 4.20.3 that are related to exposure of individuals to: 1) drilling mud during drilling activities; 2) hazardous materials used such as petroleum, oils, and lubricants; and 3) a variety of potential accidents inherent in drilling operations, as listed in Section 3.20, Health and Safety. Potential health and safety impacts would last for the duration of exploration activities, which is estimated to be between one and five years for an individual project.

Drilling Operations

Potential health and safety impacts during the drilling operations phase would include those described above in Section 4.20.3 that are related to exposure of individuals to: 1) drilling mud and geothermal fluid or steam during drilling activities; 2) hydrogen sulfide contained in geothermal fluid or steam; 3) hazardous materials used such as petroleum, oils, and lubricants; 4) wildfires caused by project activities; 5) vehicular accidents due to increased traffic on local roads; and 6) a variety of potential accidents inherent in drilling operations,

as listed in Section 3.20, Health and Safety. Potential health and safety impacts during the drilling operations phase would range from two to ten years for an individual project. Additional potential impacts could arise from construction activities that were not present during exploration such as exposure to paints, solvents, herbicides, electrical fires, and other hazards typical of construction activities.

Utilization

Potential health and safety impacts during the utilization phase would include those described above in Section 4.20.3 that are related to exposure of individuals to: 1) geothermal fluid or steam during system failures, maintenance activities, or well blowouts; 2) hydrogen sulfide contained in geothermal steam emissions; 3) hazardous materials used such as petroleum, oils, lubricants, paints, solvents, and herbicides; 4) electrical fires and wildfires caused by project activities; 5) electric shock involved in maintenance of transmission lines and substations; and 6) vehicular accidents due to increased traffic on local roads. Potential health and safety impacts would last for the duration of operational activities, which is estimated to be between 10 and 30 years for an individual project.

Reclamation and Abandonment

Potential health and safety impacts during the reclamation and abandonment phase would include those described above in Section 4. 20.3 that are related to exposure of individuals to: 1) heat and hydrogen sulfide from geothermal fluid or steam during well capping; 2) hazardous materials used during dismantling of structures and reclamation of site such as petroleum, oils, and lubricants; 3) electrical fires or wildfires; 4) vehicular accidents; and 5) a variety of potential accidents inherent to demolition activities.

4.19.4 What are the Potential Impacts on Health and Safety Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing the alternatives described in Chapter 2.

Impacts under Alternative A

Under the no action alternative, lease applications would continue to be processed on a case-by-case basis. Areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. Impacts would be site specific and similar to the impacts under the four phases of geothermal development identified under Section 4.20.3.

Impacts under Alternative B

There would be no impact on human health and safety from implementation of Alternative B; however, impacts resulting from anticipated future actions

consistent with implementing Alternative B would be greater than such impacts under Alternative A. Alternative B would be expected to provide greater opportunities for large-scale and long-term improvements in air quality-related health indicators than Alternative A.

Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. In accordance with BMPs (Appendix D), operators would be required to implement actions that would protect public health and safety. For example, operators would be required to minimize air quality impacts, develop hazardous material management plans, develop waste management plans, establish safety zones, and develop fire management strategies. It is expected that these measures would effectively minimize impacts to health and safety from geothermal related actions.

Impacts under Alternative C

There would be no impact on human health and safety from implementation of Alternative C; however, impacts resulting from anticipated future actions consistent with implementing Alternative C would be greater than under Alternative A but less than under Alternative B, since fewer individual projects would likely be developed than under Alternative B. While Alternative C would allow greater opportunity than Alternative A for states within the project area to improve air quality regionally and therefore improve air quality-related health indicators, Alternative C would be inferior to Alternative B in this regard.

4.20 NOISE

4.20.1 What did the Public Say about Impacts on Noise?

No comments relating to noise were received during scoping.

4.20.2 How Were the Potential Effects of Geothermal Development on Noise Evaluated?

Methodology

Potential effects of geothermal development on noise were evaluated by examining the typical noise generation at the various stages of geothermal projects and the existing regulations and public health and safety guidance regarding noise exposure.

Regulations

Local city and county noise ordinances vary from site to site. As long as geothermal projects operate in compliance with the applicable regulations, they are not considered a noise nuisance in surrounding residential communities. All power facilities must meet local noise ordinances according to the phase of construction and operation.

Once geothermal operation sites are established, a further examination of state-specific laws and regulations would be required to ensure compliance with all noise pollution regulations.

Impact Criteria

Potential impacts on noise could occur if reasonably foreseeable future actions were to:

- Generate new sources of substantial noise;
- Increase the intensity or duration of noise levels to sensitive receptors; or
- Result in exposure of more people to high noise levels.

4.20.3 What are the Common Impacts on Noise Associated with Geothermal Development?

Due to the inability to predict future development scenarios, including types of development, timing, and location, the following impact analysis provides a general description of common impacts on air quality from geothermal resource development. Common noise impacts associated with each phase of development are described below.

The Reasonable Foreseeable Development Scenario for Noise

Noise pollution from geothermal power plants is typically considered during exploration, drilling operations, and utilization phases (Geothermal Energy

Association 2007a), with less emphasis on reclamation and abandonment. Direct use applications, due to the typically fewer wells and lack of electrical transformers, are considered to be less noise-generating, with most noise occurring during exploration and development.

Exploration

Noise generated during exploration is temporary in nature and is related to surveying and well drilling. Some temporary construction-related noise from access road and well-pad construction is also likely. All activities associated with exploration are not expected to exceed 65 units of decibels A-weighted at a distance of approximately 500 feet (BLM 2007b; 2005d).

Drilling Operations

Noise generated during drilling operations would be similar to that under exploration, although longer durations of the noise related to the well drilling, simulation, and testing phase would be expected. In addition, construction of injection wells and sump pits would increase local noise in the short term.

Utilization

Construction of the direct use facility or power plant would generate noise for an estimated two to ten years. The principal noise sources would be turbine operations and noise generated from cooling towers, with additional noise from vehicles entering and exiting the proposed facilities. Cooling towers are relatively tall and have noise-generating fans at the top, making them frequently the main source of noise during operation (Massachusetts Institute of Technology 2006).

It is anticipated that noise levels in the surrounding areas from operational activities would not exceed the 65 units of decibels A-weighted at a distance of approximately 500 feet. In extreme cases (e.g., enhanced geothermal systems) noise levels could exceed the noise threshold; however, prior to any construction-related activities, site specific analysis would be conducted to ensure all noise regulations would be met prior to approval (Massachusetts Institute of Technology 2006). Noise levels can be reduced by the addition of mufflers or other soundproofing.

Direct use applications do not have the noise-generating components of transformers, power houses, or cooling towers. Noise sources are generally limited to fluids moving through pipes and any pumping facilities associated with extraction and injection of geothermal fluids.

Reclamation and Abandonment

Noise associated with reclamation and abandonment activities would be limited to noises typical of any construction site, as facilities are dismantled and removed and the site is reclaimed.

4.20.4 What are the Potential Impacts on Noise Associated with the Proposed Action and Alternatives?

The following discussion analyzes the environmental consequences or impacts expected to occur as a result of anticipated future actions consistent with implementing the alternatives described in Chapter 2.

Impacts under Alternative A

Under the no action alternative, lease applications would continue to be processed on a case-by-case basis. Areas closed to geothermal leasing by statute, regulation, or orders would remain closed, and discretionary closed areas would be assessed based on local land use plans. Direct use and indirect use geothermal projects can be expected to continue to come online and generate noise at the existing pace of development.

Impacts under Alternative B

Impacts resulting from anticipated future actions consistent with implementing Alternative B would be greater than such impacts under Alternative A. Widespread geothermal leasing and development for direct and indirect use across the planning area would introduce many new noise sources; however, sensitive receptors such as schools, hospitals, and churches are typically not located on public lands, making it unlikely that such sensitive receptors would be exposed to noise resulting from geothermal development. Operations would have minimal noise impacts in most areas on federal lands; however, areas with minimal noise sources (i.e., remote areas) would experience a greater change in the noise characteristics. Projects would be required to meet state-specific regulations, reducing any impacts on off-lease area sensitive receptors or residential areas. Impacts on onsite workers would be minimal through the use of required hearing protection in noise-intensive operations.

Under this alternative, the BLM and FS would issue a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing for direct and indirect use. In accordance with BMPs (Appendix D), operators would be required to implement actions that would minimize impacts associated with noise. For example, operators would be required to take measurements to assess the existing background noise levels at a given site and compare them with anticipated noise levels. Operators would adequately muffle and maintain construction equipment and would notify nearby residents in advance of blasting or other noisy activities. It is expected that these measures would effectively minimize impacts on noise from geothermal related activities.

Impacts under Alternative C

Impacts resulting from anticipated future actions consistent with implementing Alternative C would be greater than such impacts under Alternative A, but less than such impacts under Alternative B since smaller land areas would be

available for development and less development for indirect use would be likely to occur.

Areas open to direct use geothermal lease applications and impacts from their subsequent development would be the same as identified under Alternative B.