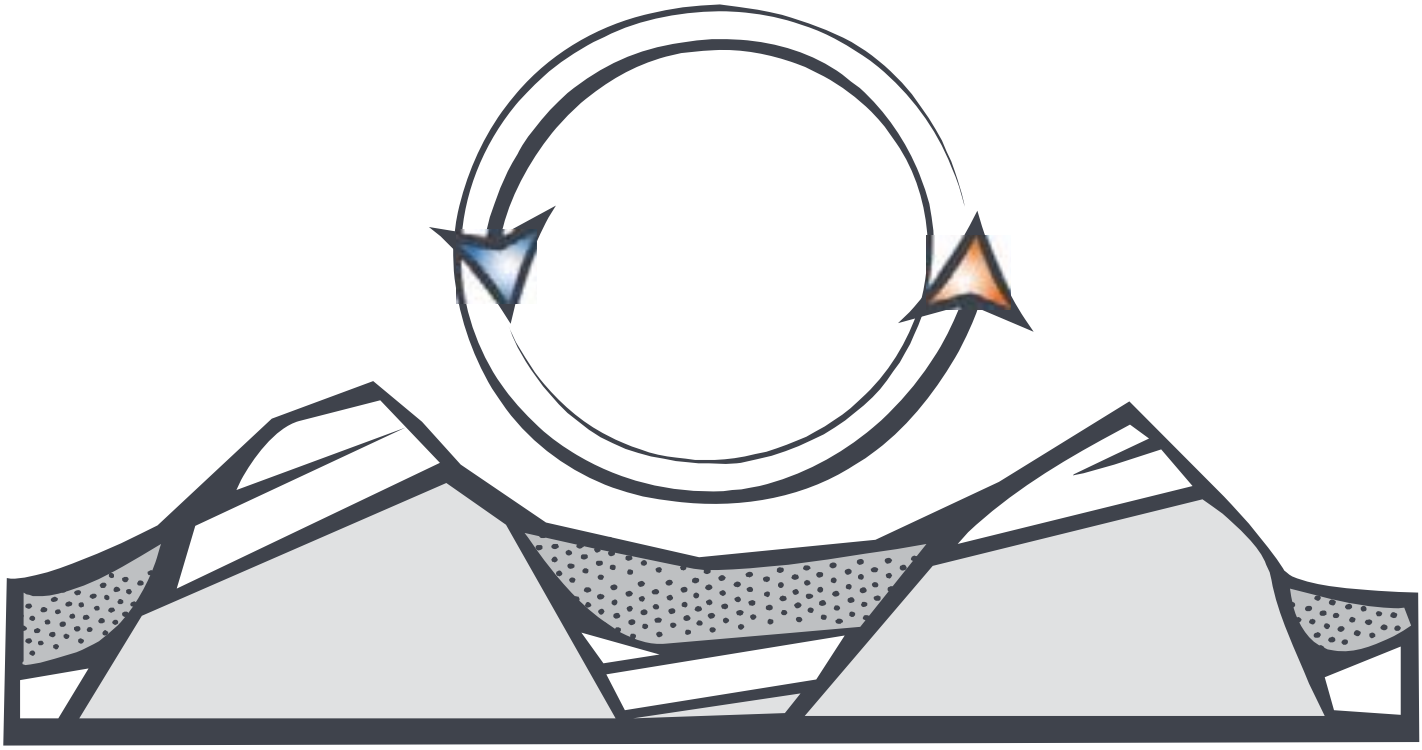

CHAPTER 2

PROPOSED ACTION AND ALTERNATIVES

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CHAPTER 2
PROPOSED ACTION AND ALTERNATIVES

2.1 INTRODUCTION

This chapter provides the details of the proposed action, alternatives to the proposed action, a discussion of alternatives considered but eliminated from detailed analysis, and an overview of the reasonably foreseeable development (RFD) scenario for geothermal resources in the western US.

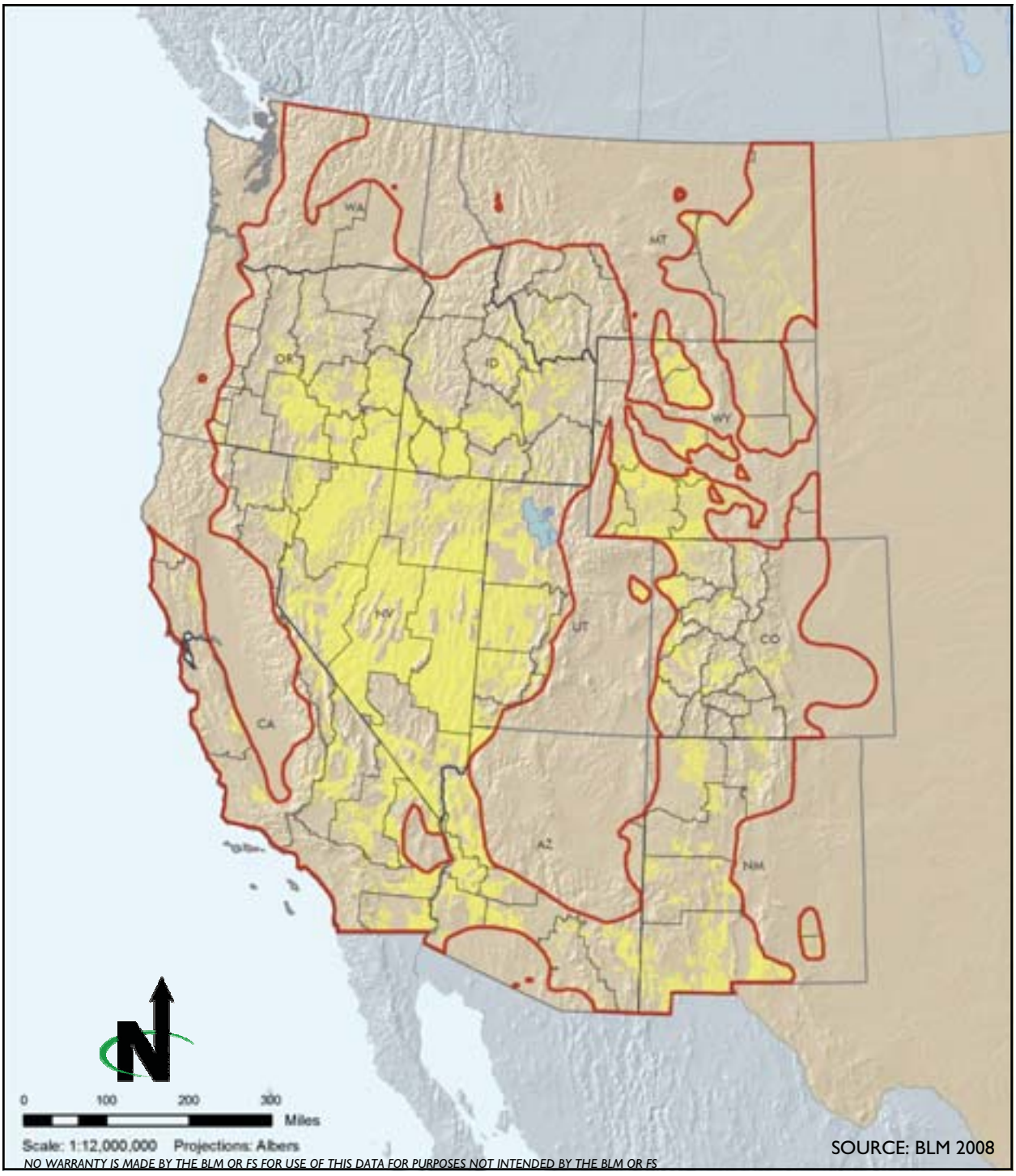
2.2 PROPOSED ACTION

The BLM and FS are proposing to facilitate geothermal leasing on BLM administered public lands and NFS lands that have geothermal potential in the twelve western states, including Alaska. This would be accomplished by the following four specific actions:

- Identify public and NFS lands with geothermal potential as being open or closed to leasing;
- Provide a comprehensive list of stipulations, best management practices, and procedures to serve as consistent guidance for future geothermal leasing and development;
- Amend BLM Resource Management Plans (RMPs) to adopt the RFDs, resource allocations and list of stipulations, best management practices, and procedures; and
- Make decisions to issue or deny geothermal lease applications on BLM and NFS lands pending as of January 1, 2005.

2.2.1 Identify Lands for Leasing

Under this proposed action, all lands in the 12 western states with geothermal potential and administered by the BLM and FS would be identified as being open to geothermal leasing with possible moderate to major constraints or closed to leasing. In the Record of Decision the BLM would amend the appropriate RMPs for these allocations. Figures 2-1 and 2-2 show the BLM Field Office boundaries within the geothermal potential area and Figures 2-3 and 2-4 show National Forests.



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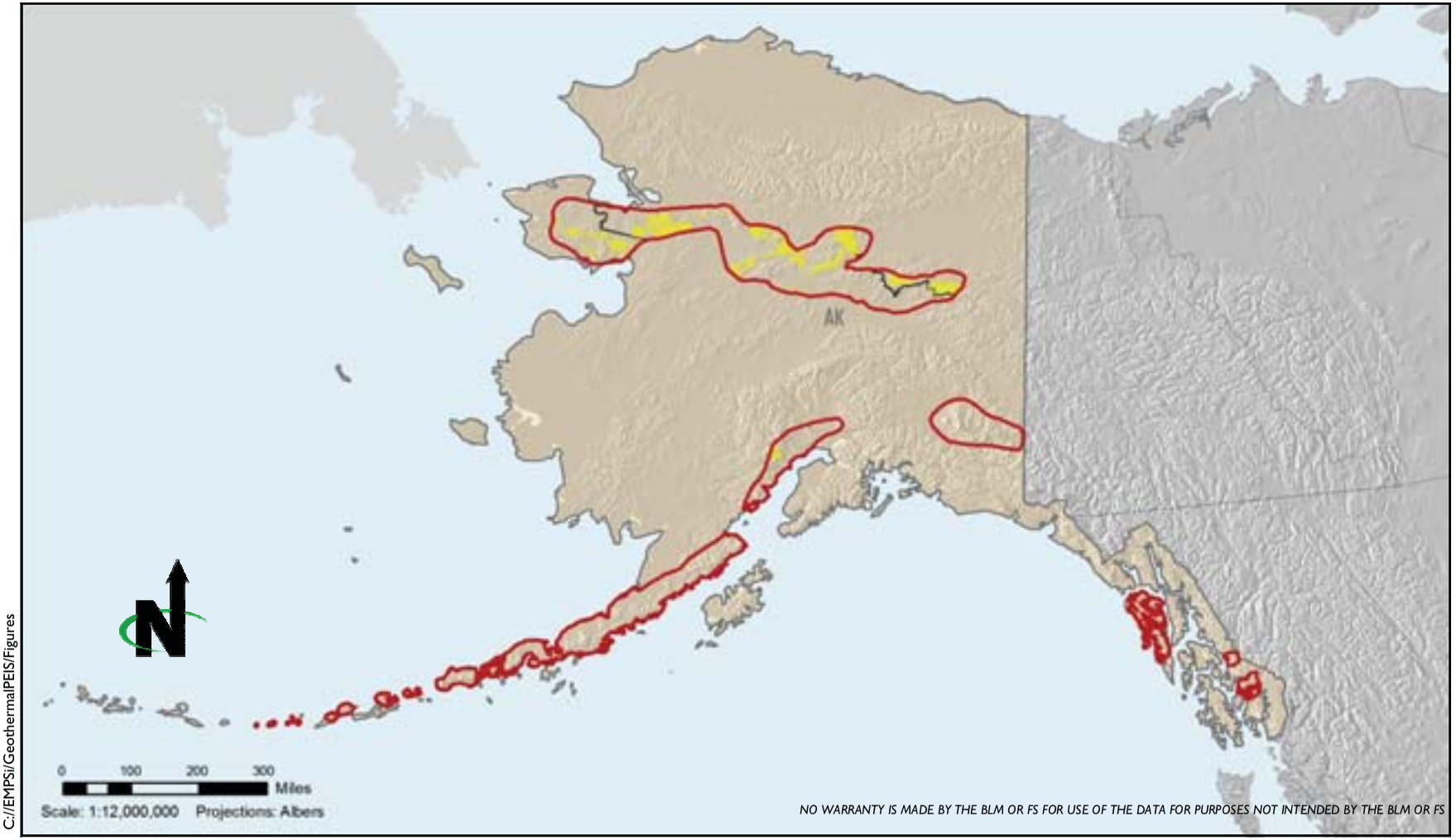
About 137 million acres of public land are within the geothermal potential area in the 11 western states and are administered by 97 field offices.

LEGEND:

- Potential Geothermal Area
- BLM Field Office Boundary
- BLM Public Land

BLM Field Office Boundaries within the Planning Area of the 11 Western States

Figure 2-1



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Almost six million acres of public land in Alaska has geothermal potential.

LEGEND:

- Potential Geothermal Area
- BLM Field Office Boundary
- BLM Public Land

BLM Administrative Boundaries in the Planning Area of Alaska

Figure 2-2

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Over 103 million acres of NFS lands are within the geothermal potential area in the 11 western states.

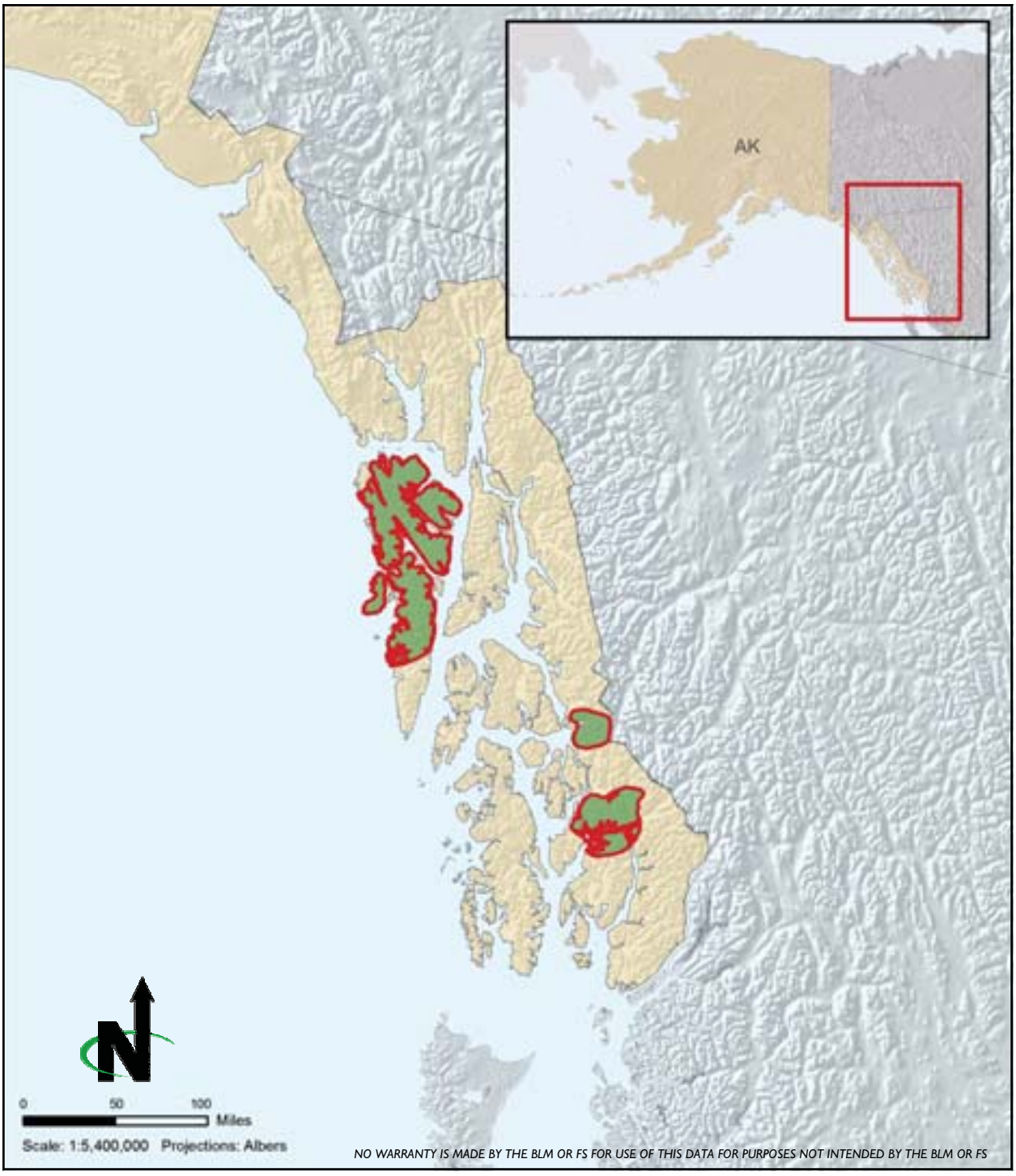
LEGEND:

Geothermal potential area

NFS lands

National Forest System Lands and Districts in the Planning Area of the 11 Western States

Figure 2-3



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Almost three million acres of NFS lands within the Tongass National Forest on the Alaskan panhandle have geothermal potential.

LEGEND:

- Geothermal potential area
- NFS lands

National Forest System Lands in the Planning Area of Alaska

Figure 2-4

The BLM and FS have determined that certain lands within the planning area are excluded from geothermal leasing on the basis of existing laws, regulations (see 43 CFR 3201.11), and Executive Orders. These non-discretionary closures include the following lands:

- National Monuments.
- National Conservation Areas (NCA) and similar designations with the exception of King Range NCA and Steese NCA.
- Wilderness Areas and National Wilderness Areas.
- Wilderness Study Areas.
- Lands within areas allocated for wilderness or further planning in Executive Communication 1504, Ninety-Sixth Congress (House Document 96-119), unless such lands are allocated to uses other than wilderness by a land and resource management plan or are released to uses other than wilderness by an act of Congress.
- National Recreation Areas.
- Designated Wild Rivers under the Wild and Scenic River Act.
- The Island Park Geothermal Area (includes NFS lands in Idaho and Montana).
- Withdrawn lands under Section 17(d)(1) of the Alaska Native Claims Settlement Act.[1]

In addition, the BLM and FS have the administrative authority to issue discretionary closures to protect special resource values. BLM and FS have had a great deal more experience managing lands for development of oil and gas resources, and many more management plans address these resources. Development of oil and gas resources result in many of the same kinds of impacts as development of geothermal resources (e.g., surface disturbance resulting from the footprints of facilities, wells, pads and pipelines, as described in Section 2.5, Reasonably Foreseeable Development Scenario); therefore, BLM and FS have determined that it is appropriate to take an approach to development of geothermal resources similar to that taken to development of oil and gas resources. Areas that require protection from the effects of development of fluid resources are more likely to require protection from the similar effects of development of geothermal resources. Because of this, the

[1] Section 17(d)(1) of the Alaska Native Claims Settlement Act (ANCSA) of 1971 authorized the Secretary of the Interior to withdraw and reserve lands for study and classification. These withdrawals closed the lands to disposal and appropriation under public land laws, including mining and mineral leasing laws. The withdrawals remain in effect on about 50 million acres of public land in Alaska. The BLM makes recommendations for revocation of the withdrawals through the planning process, and the Secretary makes the final determination. This PEIS recognizes that most land administered by the BLM in Alaska is withdrawn from geothermal leasing; however, these lands are included for analysis because the Secretary could revoke lands from withdrawal in the future. This PEIS does not make any recommendations on what lands are recommended for revocation from withdrawal; such determinations will be made in the appropriate BLM land use plans.

BLM has determined that, for ACEC's the management approach to development of oil and gas resources may appropriately serve as a surrogate for development of geothermal resources, absent more explicit geothermal-specific treatment. The following areas are proposed to be closed to geothermal leasing:

- The California Desert Conservation Area[2].
- Areas of Critical Environmental Concern where the BLM determines that geothermal leasing and development would be incompatible with the purposes for which the ACEC was designated, or those whose management plans expressly preclude new leasing or development for oil and gas or geothermal resources. A list of ACECs that are currently open and closed to fluid mineral leasing is provided in Appendix C. No new closures are proposed.
- Other lands within BLM's National Landscape Conservation System (NLCS), such as National Historic and Scenic Trails.
- National Landmarks and Research Natural Areas.
- Military reservations where geothermal development would conflict with the military mission.
- Areas previously closed to fluid minerals development in approved land use plans.

Under the Proposed Action approximately 117 million acres of BLM public land would be allocated as open to geothermal leasing subject to existing laws, regulations, formal orders, stipulations attached to the lease form, and the terms and conditions of the standard lease form. The authorized officer retains the discretion to issue stipulations that impose moderate to major constraints on use of surface of any leases in order to mitigate the impacts to other land uses or resources objectives as defined in the guiding resource management plan. In addition, 75 million acres of NFS lands would be open by statute to leasing. In total, this represents about 77 percent of public lands and NFS lands within the planning area. Conversely, the non-discretionary and discretionary closures would restrict approximately 25 million acres of BLM public land. About 31 million acres of NFS lands would be closed (by law, regulations or other authority) to geothermal leasing within the planning area. This represents about 23 percent of all public and NFS lands in the planning area. All of these lands are outside of Alaska except for about one million acres along the Alaskan panhandle within the Tongass National Forest and about 1.5 million areas in the Fairbanks District of the BLM. Tables 2-1 and 2-2 list the approximate acreage of closed areas within each BLM Office and National Forest and Figures 2-5 and 2-6 illustrate the closed and open lands in the 11 western states and in Alaska.

[2] Geothermal leasing and development is allowed in designated portions of the California Desert Conservation Area in accordance with t the California Desert Conservation Area Plan, 1980, as amended (BLM 1999).

Table 2-1
BLM Public Lands with Geothermal Potential and Proposed Closed Areas to Leasing

State	District or Field Office	Acres within Planning Area	Proposed Acres Closed	State	District or Field Office	Acres within Planning Area	Proposed Acres Closed
AK	Anchorage (District)	1,003,577	--[1]	ID	Burley	849,761	70,471
AK	Fairbanks (District)	4,868,409	1,444,836[1]	ID	Challis	908,555	139,652
AZ	Arizona Strip	626,475	328,799	ID	Cottonwood	90,236	13,963
AZ	Hassayampa	701,552	88,515	ID	Four Rivers	1,341,323	562,196
AZ	Kingman	2,219,897	373,299	ID	Jarbidge	1,565,331	131,547
AZ	Lake Havasu	1,352,613	178,908	ID	Owyhee	1,497,412	303,451
AZ	Lower Sonoran	860,805	344,285	ID	Pocatello	554,332	44,554
AZ	Safford	1,270,995	90,893	ID	Salmon	520,722	60,464
AZ	Tucson	520,863	172,746	ID	Shoshone	1,904,387	428,425
AZ	Yuma	1,273,678	186,169	ID	Upper Snake	1,883,789	224,554
CA	Alturas	502,243	89,093	MT	Billings	149,569	6,768
CA	Arcata	82,564	56,341	MT	Butte	272,829	35,014
CA	Bakersfield	560,585	330,725	MT	Dillon	909,577	165,583
CA	Barstow	2,892,852	1,488,168	MT	Lewistown	183,637	133
CA	Bishop	747,519	284,029	MT	Malta	4,093	0
CA	Eagle Lake	1,041,741	407,959	MT	Miles City	1,864,406	84,618
CA	El Centro	1,242,730	853,632	MT	Missoula	55,423	2,564
CA	Folsom	245	82	NV	Battle Mountain	10,418,555	933,360
CA	Hollister	273,697	29,240	NV	Carson City	4,988,378	677,456
CA	Needles	1,498,770	1,203,713	NV	Elko	7,504,999	536,717
CA	Palm Springs-South Coast	1,556,685	1,017,252	NV	Ely	11,416,958	1,241,356
CA	Redding	51,395	2,954	NV	Las Vegas	3,427,053	709,843
CA	Ridgecrest	1,831,281	1,296,514	NV	Winnemucca	8,232,977	546,952
CA	Surprise	1,429,744	397,653	NM	Carlsbad	186,377	0
CA	Ukiah	263,361	40,333	NM	Farmington	1,421,266	113,860
CO	Columbine	62,681	2,795	NM	Las Cruces	5,008,321	523,188
CO	Del Norte	38,151	9,160	NM	Rio Puerco	978,622	362,255
CO	Dolores	427,720	143,103	NM	Roswell	119,748	0
CO	Glenwood Springs	567,227	27,717	NM	Soccoro	1,267,162	299,915
CO	Grand Junction	420,031	66,622	NM	Taos	532,989	144,066
CO	Gunnison	613,086	164,408	OR/WA	Andrews	2,124,400	1,135,000
CO	Kremmling	367,382	13,807	OR/WA	Ashland	120,264	52,750
CO	La Jara	241,272	20,985	OR/WA	Baker	435,540	44,309
CO	Little Snake	962,869	4,457	OR/WA	Border	99,349	8,439
CO	Pagosa Springs	5,918	699	OR/WA	Butte Falls	89,136	14
CO	Royal Gorge	661,930	73,627	OR/WA	Cascades	138,091	19,008
CO	Saguache	235,741	52,516	OR/WA	Central Oregon	899,245	228,336
CO	Uncompahgre	800,299	130,462	OR/WA	Deschutes	752,662	66,748
CO	White River	884,769	22,415	OR/WA	Jordan	2,589,088	971,352
ID	Bruneau	1,604,957	316,553	OR/WA	Klamath Falls	223,670	8,634

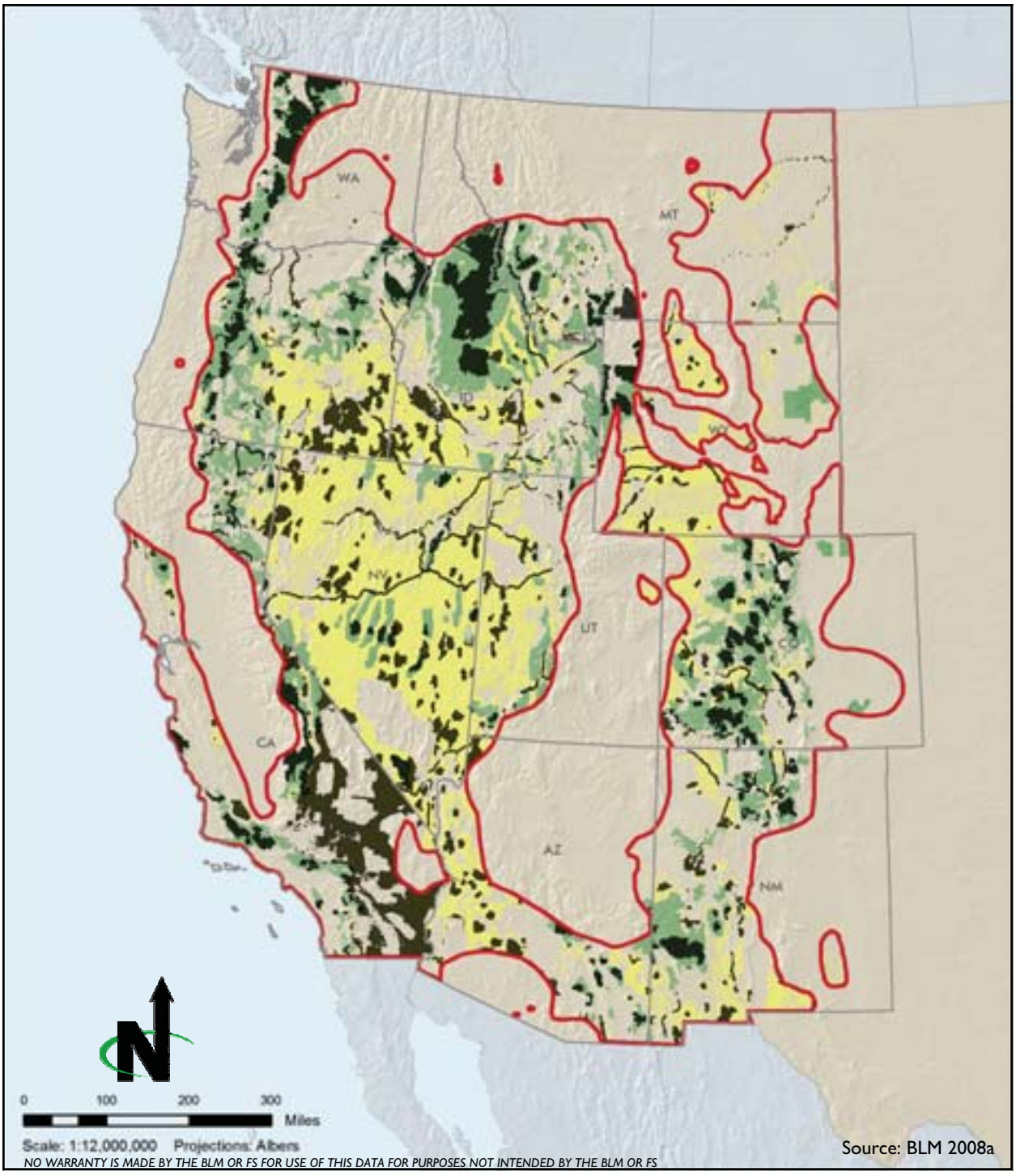
Table 2-1
BLM Public Lands with Geothermal Potential and Proposed Closed Areas to Leasing, *cont.*

State	District or Field Office	Acres within Planning Area	Proposed Acres Closed	State	District or Field Office	Acres within Planning Area	Proposed Acres Closed
OR/WA	Lakeview	3,202,665	528,942	WY	Vernal	273,336	0
OR/WA	Malheur	2,023,522	309,650	WY	Buffalo	571,947	12,301
OR/WA	Three Rivers	1,666,100	80,800	WY	Casper	517,783	9,160
OR/WA	Upper Willamette	31,890	0	WY	Cody	722,776	39,317
OR/WA	Wenatchee	152,245	5,976	WY	Kemmerer	694,085	83,508
UT	Cedar City	2,103,070	23,739	WY	Lander	1,201,156	32,423
UT	Fillmore	4,326,294	455,524	WY	Newcastle	132,947	
UT	Kanab	145,490	15,519	WY	Pinedale	704,421	39,119
UT	Richfield	400,827	49,649	WY	Rawlins	2,308,970	72,173
UT	Salt Lake	3,085,716	390,815	WY	Rock Springs	3,357,294	338,172
UT	St. George	472,200	63,378		**TOTAL**	**142,188,175**	**25,203,145**

[1] Most of the land administered by the BLM within the planning area of Alaska are withdrawn from mineral leasing under Section 17(d)(1) of the Alaska Native Claims Settlement Act of 1971. The closed acres in this table represent the acreage that would remain closed to geothermal leasing if the Secretary of the Interior revoked the withdrawal from all public lands in the planning area.

Table 2-2
National Forest System Lands with Geothermal Potential and Proposed Closed Areas to Leasing

National Forest	Acres within Planning Area	Proposed Acres Closed	National Forest	Acres within Planning Area	Proposed Acres Closed
Angeles National Forest	700,525	100,095	Manti-Lasal National Forest	122,731	0
Apache-Sitgreaves National Forests	536,398	4,290	Medicine Bow-Routt National Forest	4,480,256	251,164
Arapaho and Roosevelt National Forests	2,674,212	372,442	Mendocino National Forest	591,706	36,294
Ashley National Forest	103,322	102,446	Modoc National Forest	2,021,974	219,318
Beaverhead-Deerlodge National Forest	3,567,959	665,415	Mt Baker-Snoqualmie National Forest	1,982,455	867,834
Bitterroot National Forest	1,663,524	2,517,687	Mt. Hood National Forest	1,124,567	412,631
Boise National Forest	2,598,888	1,286,561	Nez Perce National Forest	2,251,942	1,080,134
Bridger-Teton National Forest	1,952,524	827,361	Ochoco National Forest	1,154,905	42,730
Caribou-Targhee National Forest	3,146,366	234,963	Okanogan-Wenatchee National Forests	2,760,356	1,603,993
Carson National Forest	1,587,863	235,010	Payette National Forest	2,448,898	2,031,950
Cibola National Forest	1,746,179	103,813	Pike-San Isabel National Forest	3,022,492	425,832
Clearwater National Forest	816,135	386,240	Plumas National Forest	885,124	54,651
Cleveland National Forest	561,166	75,579	Rio Grande National Forest	1,946,517	445,816
Coronado National Forest	1,235,289	346,707	Rogue River-Siskiyou National Forests	476,363	87,619
Custer National Forest	645,454	29,538	Salmon-Challis National Forest	4,396,514	3,212,832
Deschutes National Forest	2,035,714	311,583	San Bernardino National Forest	808,079	142,945
Dixie National Forest	1,005,363	72,117	San Juan National Forest	2,094,211	575,926
Eldorado National Forest	20	20	Santa Fe National Forest	1,590,268	382,810
Fishlake National Forest	982,778	2,022	Sawtooth National Forest	2,190,030	2,021,845
Fremont-Winema National Forests	2,809,670	127,477	Sequoia National Forest	997,455	477,056
Gallatin National Forest	1,844,311	842,093	Shasta Trinity National Forest	532,572	48,653
Gifford Pinchot National Forest	1,420,483	300,565	Shoshone National Forest	417,267	231,117
Gila National Forest	3,387,304	851,642	Sierra National Forest	278,387	285,108
Grand Mesa, Uncompahgre and Gunnison National Forests	3,127,154	641,943	Tahoe National Forest	363,044	1,282
Helena National Forest	737,823	7,327	Tongass National Forest	2,725,469	284,967
Humboldt-Toiyabe National Forest	6,488,056	1,252,524	Tonto National Forest	465,210	127,666
Inyo National Forest	1,945,308	678,870	Uinta National Forest	278,539	41,092
Klamath National Forest	358,948	34,335	Umatilla National Forest	1,460,071	304,809
Lassen National Forest	1,354,039	194,425	Umpqua National Forest	492,146	108,974
Lewis and Clark National Forest	31,726	0	Wallowa-Whitman National Forest	2,382,100	886,667
Lincoln National Forest	33,813	0	Wasatch-Cache National Forest	611,938	111,914
Lolo National Forest	347,596	42,118	White River National Forest	2,482,483	748,131
Los Padres National Forest	1,927,989	798,123	Willamette National Forest	1,730,586	422,731
Malheur National Forest	1,543,981	89,150	**TOTAL**	**106,484,535**	**31,510,972**



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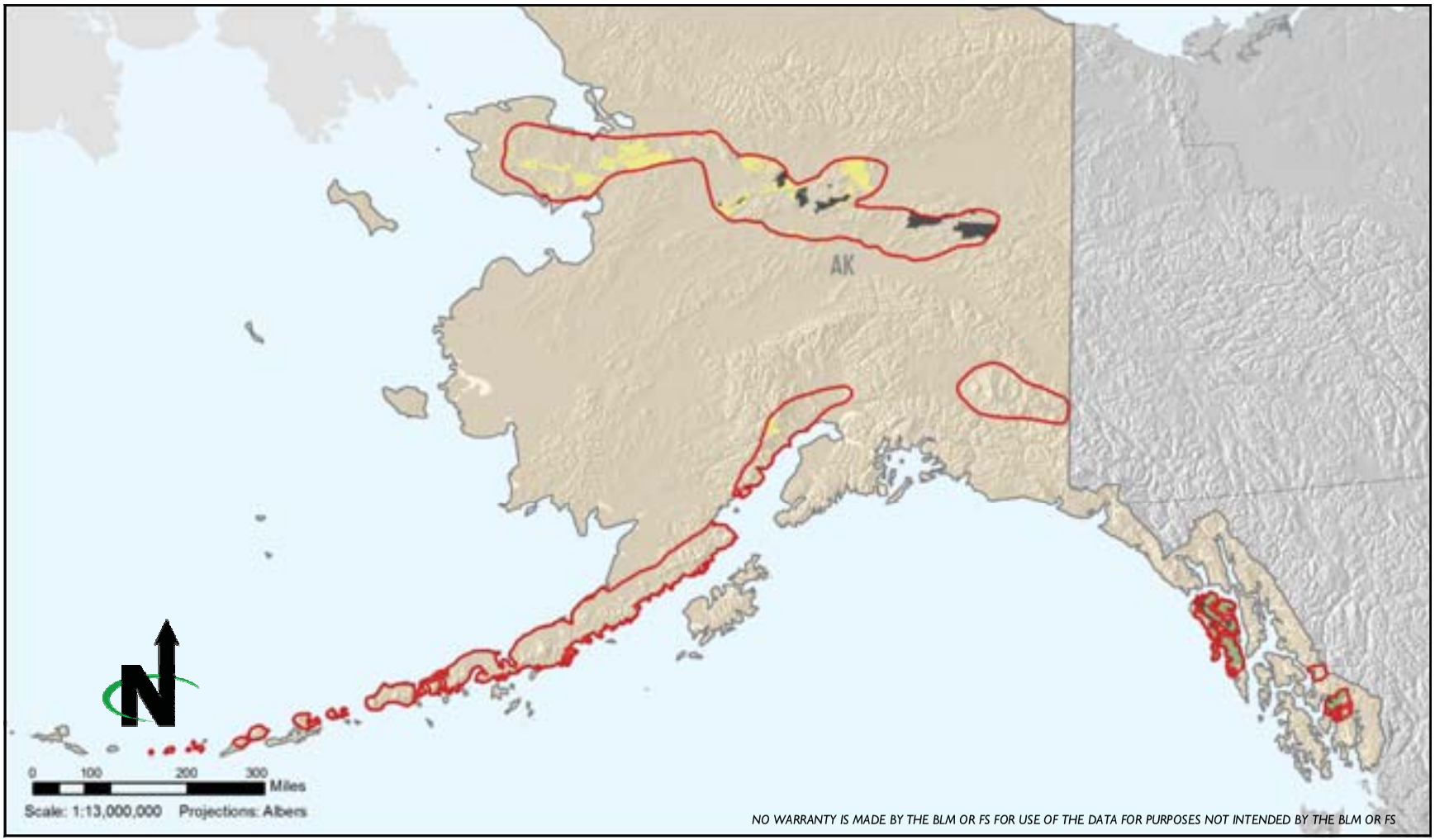
Under the Proposed Action, about 117 million acres of BLM public land and 75 million acres of NFS land would be allocated as open to geothermal leasing. National Park lands are closed.

LEGEND:

- Geothermal potential area
- Public Lands Open to Leasing
- NFS Lands Open to Leasing
- Public and NFS Lands Closed to Leasing

BLM Public and NFS Lands Open and Closed in the in the 11 Western States

Figure 2-5



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Under the Proposed Action, about 285,000 acres along the Alaskan panhandle within the Tongass National Forest and about 1.5 million acres in the Fairbanks District of the BLM would be closed to geothermal leasing. All National Park lands are closed.

LEGEND:

- Geothermal potential area
- Public Lands Open to Leasing
- NFS Lands Open to Leasing
- Public and NFS Lands Closed to Leasing

BLM Public and NFS Lands Open and Closed in Alaska

Figure 2-6

2.2.2 Lease Stipulations, Best Management Practices, and Procedures

Lease Stipulations

This section provides the list of constraints that would be applied as appropriate by the authorized officer to any new leases for lands that are available for geothermal leasing. Lease stipulations are major or moderate constraints applied to a new geothermal lease. A lease stipulation is a condition of lease issuance that provides a level of protection for other resource values or land uses by restricting lease operations during certain times or locations or by mitigating unacceptable impacts, to an extent greater than standard lease terms or conditions. A stipulation is an enforceable term of the lease contract, supersedes any inconsistent provisions of the standard lease form, and is attached to and made a part of the lease. Lease stipulations further implement the BLM's regulatory authority to protect resources or resource values.

Local land use plans take different approaches to protect resources depending on the circumstances on those planning areas. Because this is a programmatic document these geothermal stipulations have been developed to address a wide variety of landscapes, climates, and ecosystems, without disrupting the management approach of local land use plans. These stipulations were selected for inclusion based on a comprehensive review of land use plans, program guidance, geothermal development activities, published data on geothermal development impacts, industry standards, and best professional judgment. In addition, other reports on fluid mineral leasing and development (e.g., oil and gas) were consulted because of the similarity of most of the activities and impacts, such as from exploration, drilling, and site development. Where the agency determines that particular stipulations may be inappropriate for a planning area, the procedures for waivers, exception, and modifications would be followed.

Lease Exceptions, Waivers, and Modifications

To ensure leasing decisions remain appropriate in light of continually changing circumstances and new information, the BLM develops and applies lease stipulation exception, waiver, and modification criteria. An exception, waiver, or modification may not be approved unless, (1) the authorized officer determines that the factors leading to the stipulation's inclusion in the lease have changed sufficiently to make the protection provided by the stipulation no longer justified; or (2) the proposed operations would not cause unacceptable impacts. (43 CFR 3101.1-4)

- An **exception** is a one-time exemption for a particular site within the leasehold; exceptions are determined on a case-by-case basis; the stipulation continues to apply to all other sites within the leasehold. An exception is a limited type of waiver.
- A **waiver** is a permanent exemption from a lease stipulation. The stipulation no longer applies anywhere within the leasehold.

- A **modification** is a change to the provisions of a lease stipulation, either temporarily or for the term of the lease. Depending on the specific modification, the stipulation may or may not apply to all sites within the leasehold to which the restrictive criteria are applied.

An exception, waiver, or modification may be approved if the record shows that circumstances or relative resource values have changed or that the lessee can demonstrate that operations can be conducted without causing unacceptable impacts and that less restrictive requirements would meet resource management objectives.

The authorized officer may require the operator to submit a written request for an exception, waiver, or modification and information demonstrating that (1) the factors leading to the inclusion of the stipulation in the lease have changed sufficiently to make the protection provided by the lease stipulation no longer justified or (2) that the proposed operation would not cause unacceptable impacts. Requests from the operator should contain, at a minimum, a plan including related on-site or off-site mitigation efforts, to adequately protect affected resources; data collection and monitoring efforts; and timeframes for initiation and completion of construction, drilling, and completion operations. The operator's request may be included in a permit application (e.g., application for permit to drill), Notice of Staking, Sundry Notice, or letter. The BLM may also proactively initiate the process.

During the review process, coordination with other state or Federal agencies should be undertaken, as appropriate, and documented. For example, it may be appropriate to coordinate the review of wildlife exceptions, waivers, and modifications with the local office of the State wildlife agency. Staff review and recommendations should be documented along with any necessary mitigation and provided to the authorized officer for approval or disapproval. The applicant is then provided with a written notification of the decision.

Public notification (30-day public review) is generally not required for exceptions because an exception is seldom a substantial modification or waiver of a lease term or stipulation (43 CFR 3101.1-4), particularly if the exception criteria is outlined in the lease or the land use plan. Nor is public review required for waivers or modifications that the authorized officer determines are not substantial and do not substantially waive or modify the terms of the lease. "Substantial" in this case would include the exception, waiver, or modification having a "substantial" effect on the environment that was not previously considered. However, the applicable land use plan may contain additional notification requirements. The public notice, if required, should include identification of the modified lease terms and a description of the affected lands or a map.

When Public Notice is appropriate, the following procedures may apply:

- Approval of an exception, waiver, or modification with the permit approval: A notice describing the modified lease terms, when required, may be posted for 30 days in the BLM office; posted on the BLM website; posted in a local paper as a legal notice or incorporated into a newspaper article; or the notice may be included as part of the NEPA document's public review, if the NEPA document is offered for review.
- Approval after the permit has been approved: Public notice, if required, may take the form of a 30-day posting on the BLM website, a legal notice or article in the newspaper, or a notice and associated public review conducted as part of the public review of a NEPA document.
- Approval after drilling has commenced: Unless specified in the land use plan, it is unlikely public notification would be necessary.

The BLM must analyze and document how the exception, waiver, or modification is in conformance with the land use plan and identify the plan decision (including goals, objectives, or desired outcomes) supported by the proposed exception, waiver, or modification. If existing NEPA analysis does not support the exception, waiver, or modification, the BLM must conduct the appropriate environmental review and NEPA analysis. If the proposed exception, waiver or modification is not in conformance with the land use plan or that document does not disclose the conditions under which such proposed change would be allowed, BLM must either amend the plan or deny the exception, waiver, or modification.

It may be necessary to add, delete, or modify lease stipulations in the land use plan as a result of pre-lease issuance parcel reviews, statewide lease stipulation consistency reviews, plan amendments, changed circumstances on the ground, or changed resource protection priorities. This is accomplished and documented through either the plan maintenance process (for minor changes consistent with an approved land use plan) or the plan amendment process (for changes resulting in modification of terms, conditions, or decisions in an approved land use plan).

Applicability of Stipulations

Stipulations provided in this PEIS would serve as the minimal level of protection and would be adopted into local land use plans upon signing of the ROD. For example, if an administrative unit has eligible wild and scenic rivers, the wild river stipulation would apply. If an existing land use plan offers more protective measures or has resource specific commitments (e.g., memorandum of understanding for cultural resources), those more protective measures would apply instead. Existing land use plans would also be used to help identify locations of applicability, buffer sizes, and timing conditions for the stipulations.

No Surface Occupancy Lease Stipulations

No surface occupancy (NSO) stipulations are considered a major constraint as they do not allow for surface development. For example, a lessee of a NSO area must develop any surface infrastructure outside the NSO area and use advanced technology, such as directional drilling, to access the geothermal resource. These NSO stipulations apply only when standard lease terms included on the standard lease form, Best Management Practices (Appendix D), and other stipulations would not adequately achieve resource protection.

- Designated or proposed critical habitat for listed species under the Endangered Species Act of 1973 (as amended) if it would adversely modify the habitat. For listed or proposed species without designated habitat, NSO would be implemented to the extent necessary to avoid jeopardy.
- Within the 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.
- Areas with important cultural and archaeological resources, such as traditional cultural properties and Native American sacred sites, as identified through consultation.
- Water bodies, riparian areas, wetlands, playas, and 100-year floodplains.
- Developed recreational facilities, special-use permit recreation sites (e.g., ski resorts and camps), and areas with significant recreational use with which geothermal development is deemed incompatible; excluding direct use applications.
- Designated National Scenic and Recreational Rivers under the Wild and Scenic River Act.
- Segments of rivers determined to be potentially eligible for Wild and Scenic Rivers (WSR) status by virtue of a WSR inventory, including a corridor of 0.25 miles from the high water mark on either side of the bank[3].

[3] A number of land use plans are currently undergoing revision, and as part of that process WSR inventories have been undertaken. Where a river or river segment has been found to be "eligible" for inclusion in the WSR system as part of one of these inventories, the BLM has an obligation to protect the lands along the eligible segment until a "suitability" determination has been made as part of the land use planning process. If the river or river segment is found to be "non-suitable," the lands along the river then would be available for other uses. If a river or river segment is determined to be suitable for inclusion in the WSR system, the BLM will forward that recommendation to Congress for action and will continue to protect the lands along the river.

- Designated important viewsheds, including (1) public lands designated as VRM Class I and (2) NFS lands with a Scenery Management System integrity level of Very High.
- Slopes in excess of 40 percent and/or soils with high erosion potential.
- Areas that are defined as having special resource values for subsistence needs in Alaska.

Additional NSO stipulations could be applied in conformance with the local land use plan to address site-specific resource concerns.

Timing Limitations and Controlled Surface Use Lease Stipulations

Where standard lease terms and permit-level decisions are deemed insufficient to protect sensitive resources but where an NSO is deemed overly restrictive, the BLM and FS would apply seasonal or time limited (TL) stipulations or controlled surface use (CSU) stipulations to leases. In general, timing limitations are used to protect resources that are sensitive to disturbance during certain periods. Such stipulations are generally applicable to specific areas, seasons, and resources. They are commonly applied to wildlife activities and habitat, such as winter range for deer, elk, and moose; nesting habitat for raptors and migratory birds; and breeding areas. Buffer zones are also used to further mitigate impacts from any human activities. The size of buffers can also be specific to species and location, and can change based on findings of science or movement of species. Therefore, timing limitations would be applied by the authorizing officer as appropriate for the specific lease areas and in compliance with the unit's resource management plan. The BLM and FS would consult with the appropriate agencies (e.g., state wildlife agencies) in establishing the periods and extent of area for timing limitations.

A CSU allows the BLM and FS to require any future activity or development be modified or relocated from the proposed location if necessary to achieve resource protection. The project applicant will be required to submit a plan to meet the resource management objectives through special design, construction, operation, mitigation, or reclamation measures, and/or relocation. Unless the plan is approved, no surface occupancy would be allowed on the lease. The following CSUs would be applied by the authorizing officer as appropriate for the specific area and site conditions.

- ***Protection of riparian and wetland habitat.*** This stipulation would be applied within 500 feet of riparian or wetland vegetation to protect the values and functions of these areas. Measures required will be based on the nature, extent, and value of the area potentially affected.

  Protection of visual resources. This stipulation would be applied to BLM VRM Class II areas (VRM Class III management objectives

would be met through conditions of approval applied during the permit approval process, and may be referenced in a lease notice); NFS lands with a Scenery Management System integrity level of High; and other sensitive viewsheds, such as within the visual setting of National Historic Trails or near residential areas. Unless otherwise designated, the visual setting for National Historical Trails would be managed to VRM Class II objectives for leasing.

- ***Protection of recreational areas.*** This stipulation would be applied to minimize the potential for adverse impacts to recreational values, both motorized and non-motorized, and the natural settings associated with the recreational activity.
- ***Compatibility with urban interface.*** This stipulation would be applied to minimize the potential for adverse impacts to residential areas, schools, or other adjacent urban land uses.
- ***Protection of erosive soils and soils on slopes greater then 30 percent.*** This stipulation would be applied to minimize the potential for adverse impacts to erosive soils as defined as severe or very severe erosion classes based on Natural Resources Conservation Service (NRCS) mapping.
- ***Protection of important habitat and migration corridors***. This stipulation would be applied to protect the continuity of migration corridors and important habitat.

Other Lease Stipulations

Protection of Geothermal Features

Under the following situations, the BLM or FS would apply stipulations to protect the integrity of geothermal resource features, such as springs and geysers. If it is determined that geothermal operations are reasonably likely to result in a significant adverse effect to such a feature, then BLM would decline to issue the lease.

- The BLM or FS would include stipulations to protect any significant thermal features of a National Park System unit that could be adversely affected by geothermal development. These stipulations will be added, if necessary, when the lease or permit is issued, extended, renewed or modified (43 CFR 3201.10[b]).
- 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.

Endangered Species Act Stipulation

In accordance with BLM Instruction Memorandum No. 2002-174, the BLM will apply the following stipulation on any leases where threatened, endangered, or

other special status species or critical habitat is known or strongly suspected. Additionally, the BLM will provide a separate notification through a lease notice to prospective lessees identifying the particular special status species that are present on the lease parcel offered.

> "The lease area may now or hereafter contain plants, animals, or their habitats determined to be threatened, endangered, or other special status species. BLM may recommend modifications to exploration and development proposals to further its conservation and management objective to avoid BLM-approved activity that will contribute to a need to list such a species or their habitat. BLM may require modifications to or disapprove proposed activity that is likely to result in jeopardy to the continued existence of a proposed or listed threatened or endangered species or result in the destruction or adverse modification of a designated or proposed critical habitat. BLM will not approve any ground-disturbing activity that may affect any such species or critical habitat until it completes its obligations under applicable requirements of the Endangered Species Act as amended, 16 USC 1531 et seq., including completion of any required procedure for conference or consultation."

Sensitive Species Stipulation

For agency designated sensitive species (e.g., sage grouse), a lease stipulation (NSO, CSU, or TL) would be imposed for those portions of high value/key/crucial species habitat where other existing measures are inadequate to meet agency management objectives.

Cultural Resources Stipulation

In accordance with BLM Instruction Memorandum No. 2005-003, the BLM will apply the following stipulation to protect cultural resources

> "This lease may be found to contain historic properties and/or resources protected under the National Historic Preservation Act (NHPA), American Indian Religious Freedom Act, Native American Graves Protection and Repatriation Act, E.O. 13007, or other statutes and executive orders. The BLM will not approve any ground disturbing activities that may affect any such properties or resources until it completes its obligations under applicable requirements of the NHPA and other authorities. The BLM may require modification to exploration or development proposals to protect such properties, or disapprove any activity that is likely to result in adverse effects that cannot be successfully avoided, minimized or mitigated."

Roadless Area Stipulation

The FS manages about 51,477,000 acres of land in the planning area that is designated as inventoried roadless areas. A non-discretionary restriction would

be placed on any leases within NFS inventoried roadless areas. Specifically, no new road construction or reconstruction would be allowed in designated roadless areas. If future legislation or regulation change the roadless area designation, the restriction would be revised along with any appropriate environmental review.

Best Management Practices

In addition to lease stipulations, during any subsequent exploration, drilling, utilization, or reclamation and abandonment of geothermal resources, the BLM and FS would require site specific mitigation measures (Appendix D) to permits. Best Management Practices are state-of-the-art mitigation measures and may be incorporated into the permit application by the lessee or may be included in the approved use authorization by the BLM as conditions of approval. Conditions of approval are not lease stipulations, but they are site-specific and enforceable requirements to minimize, mitigate, or prevent impacts to resource values from an intended operation. Conditions of approval can limit or amend the specific actions proposed by the operator.

Monitoring

Mitigation measures, including lease stipulations and conditions of approval as well as the general operation of geothermal developments, would be monitored by the lessee or the appropriate federal agency to ensure their continued effectiveness through all phases of development. Where mitigation measures are determined to be ineffective at meeting the desired resource conditions, the BLM and FS would take steps to determine the cause and require the operator to take corrective action. This information would also be used to inform future geothermal leasing and development.

Procedures Prior to Leasing

To ensure compliance with regulations and federal laws, the following procedures would be implemented prior to any lands being included in a competitive lease sale. Stipulations listed above would also be used to help achieve resource protection in accordance with laws and regulations.

- The FS will be consulted and provide a consent determination (including terms and conditions or stipulations) to the BLM prior to any parcels on NFS lands being offered for lease sale. As a condition of consent to the issuance of any lease, the Forest Service would be consulted on the development of a surface use plan.
- The authorized officer of the BLM or FS would consult with the appropriate Native American Tribal governments and Alaska Natives to identify tribal interests and traditional cultural resources or properties that may be affected by the federal land leases and potential for geothermal energy development. Tribal interests include economic rights such as Indian trust assets and resource

uses and access guaranteed by treaty rights. Traditional cultural resources or properties include areas of cultural importance to contemporary communities, such as sacred sites or resource gathering areas. There may be issues related to the presence of cultural properties, access rights, disruption to traditional cultural practices, cultural use of hot springs and water sources and impacts to visual resources important to tribes. Areas proposed for leasing may include lands where there are tribal interests and traditional cultural resources that are not currently identified. Consultations on leases should include a full disclosure of the lease as a commitment of the land that may eventually involve future development that could preclude other tribal uses. Consideration and research should be directed to determine if there are other ethnic and social groups that may have traditional uses or ties to the lands proposed for leases.

- The authorized officer of the BLM or FS would 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. 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. The BLM or FS would assess the adequacy of the cultural resource identification and evaluation effort for the leasing stage. 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. This PEIS addresses the Section 106 process at a programmatic level and serves as a basis for the phased consultation process. All existing memorandums of understanding and agreements regarding the identification and protection of cultural resources would remain valid.
- During the processing of any lease nomination or application in Alaska, the authorized officer of the BLM or FS would conduct a site-specific analysis of the effects of the lease on subsistence uses and needs in accordance with Section 810(a) of the ANILCA.
- The authorized officer of the BLM or FS would determine if any listed or proposed threatened or endangered species or critical habitat is present on nominated lease parcels. If so, the authorized officer would comply with Section 7 of the Endangered Species Act, which may include consultation or conferencing with the US Fish and Wildlife Service and/or NOAA Fisheries. Additional consultation would occur during the site-specific project permitting process.

- The authorized officer of the BLM or FS would review the lands for any other sensitive resources (e.g., paleontological, BLM sensitive status species, and FS species of local concern) and provide for the necessary stipulations to protect these resources and ensure compliance with the land use plan. Assessment of the resource would include consulting with agency experts, coordinating with other appropriate agencies, and site surveys if warranted.
- Prior to making leasing decisions, BLM will assess whether the existing NEPA is adequate (i.e., through completion of a DNA), or whether there is new information or new circumstances which warrant further analysis. For example, additional NEPA analysis may be required in light of new information, or a potential change in management approach regarding resources identified for special management (e.g., travel management planning or areas under consideration by BLM for management for wilderness characteristics).
- The level of environmental analysis to be required under NEPA for subsequent individual exploration, development, and production permits will be determined at the Field Office and FS unit level. In certain instances, it may be determined that a tiered environmental assessment (EA) is appropriate in lieu of an EIS. To the extent that land use plans or this PEIS anticipates issues and concerns associated with individual projects, including potential cumulative impacts, the BLM and FS will tier from land use plans and/or the PEIS analysis and decisions; thereby limiting the required scope and effort of additional project-specific NEPA analysis.

Applicants for geothermal development and production on public or NFS lands shall develop a project-specific operations plan that incorporates the applicable mitigation and best management practices provided in Appendix D and, as appropriate, the requirements of other existing and relevant BLM and FS mitigation guidance. Additional mitigation measures will be incorporated into the operations plan and into the conditions of approval or project stipulations. The operations plan will include site plans, location of facilities, wells, pipelines, transmission lines, roads, and other infrastructure.

2.2.3 Amend BLM Land Use Plans

Analyses conducted in this PEIS support the amendment of specific BLM land use plans for land where potentially developable geothermal resources are located. Plans proposed for amendment under this PEIS are identified in Table 2-3.

Table 2-3
Land Use Plans Proposed for Amendment under the PEIS

State	District or Field Office†	Land Use Plan(s)
AK	Anchorage	Ring of Fire RMP
	Central Yukon	Central Yukon RMP
	East Interior	Kobuk-Seward RMP
AZ	Arizona Strip	Arizona Strip RMP*
	Kingman	Kingman RMP
	Lake Havasu	Lake Havasu RMP
	Yuma	Lower Gila South RMP*
		Yuma RMP*
	Safford	Safford RMP
	Tucson	Safford RMP
		Phoenix RMP*
	Hassayampa	Lower Gila North MFP*;
		Phoenix RMP*
	Lower Sonoran	Phoenix RMP*
		Lower Gila South RMP
CA	Barstow	West Mojave RMP
	El Centro	E. San Diego County RMP
	Palm Springs-S. Coast	South Coast RMP*
	Alturas	Alturas RMP
		Cedar Creek/Tule Mountain Integrated RMP*
	Arcata	Arcata RMP
		Headwaters RMP
	Bakersfield	Caliente RMP*
		Hollister RMP
	Bishop	Bishop RMP
	Eagle Lake	Eagle Lake RMP
	Hollister	S. Diablo Mountain Range and Central Coast RMP
	Redding	Redding RMP
	Surprise	Surprise RMP
CO	Glenwood Springs	Glenwood Springs RMP*
	Grand Junction	Grand Junction RMP*
	Gunnison	Gunnison RMP
	Kremmling	Kremmling RMP*
	Little Snake	Little Snake RMP*
	Royal Gorge	Northeast RMP
		Royal Gorge RMP
	Uncompahgre	Uncompahgre Basin RMP*
	White River	White River RMP

Table 2-3
Land Use Plans Proposed for Amendment under the PEIS, *cont.*

State	District or Field Office†	Land Use Plan(s)
ID	Bruneau	Bruneau MFP
	Four Rivers	Cascade RMP*
		Kuna MFP*
		Jarbidge RMP*
	Owyhee	Owyhee RMP
	Cottonwood	Chief Joseph MFP*
	Challis	Challis RMP
	Pocatello	Malad MFP*
		Pocatello RMP*
	Salmon	Lemhi RMP
	Upper Snake	Big Desert MFP*
		Big Lost MFP*
		Little Lost-Birch MFP*
		Medicine Lodge RMP*
	Burley	Cassia RMP
		Twin Falls MFP
		Monument RMP
	Jarbidge	Jarbidge RMP*
	Shoshone	Bennett Hills/ Timmerman Hills MFP
		Magic MFP
		Monument RMP
		Sun Valley MFP
MT	Billings	Billings Resource Area RMP*
	Butte	North Headwaters RMP*
	Dillon	Dillon RMP
	Lewistown	Judith Valley Phillips RMP*
	Malta	West HiLine RMP*
	Miles City	Big Dry RMP*
		Powder River Resource Area RMP*
	Missoula	Garnet Resource Area RMP
NV	Battle Mtn	Shoshone-Eureka RMP
		Tonopah RMP
	Carson City	Carson City Consolidated RMP
	Elko	Elko RMP
		Wells RMP
	Ely	Ely RMP*
	Las Vegas	Las Vegas RMP
	Winnemucca	Paradise-Denio MFP*
		Sonoma-Gerlach MFP*

Table 2-3
Land Use Plans Proposed for Amendment under the PEIS, *cont.*

State	District or Field Office†	Land Use Plan(s)
NM	Rio Puerco	Rio Puerco RMP*
	Soccoro	Socorro RMP*
	Farmington	Farmington RMP
	Taos	Taos RMP*
	Las Cruces	MacGregor Range RMP
		Mimbres RMP*
		White Sands RMP
	Carlsbad	Carlsbad RMP
	Roswell	Roswell RMP
OR	Burns†	Three Rivers RMP
	Eugene†	Eugene District RMP*
	Lakeview†	Klamath Falls Resource Area RMP*
		Upper Klamath Basin and Wood River Wetland RMP*
	Medford†	Medford RMP*
	Prineville†	Two Rivers RMP*
		Brothers/LaPine RMP*
		John Day RMP*
		John Day River MP*
		Lower Deschutes RMP
	Roseburg†	Roseburg RMP*
	Salem†	Salem RMP*
UT	Cedar City	Cedar Beaver Garfield Antimony RMP
		Pinyon MFP
	Fillmore	House Range Resource Area RMP
		Warm Springs Resource Area RMP
	Kanab	Paria MFP*
		Vermilion MFP*
		Zion MFP*
	Richfield	Mountain Valley MFP*
		Henry Mountain MFP*
		Parker Mountain MFP*
	Salt Lake	Box Elder RMP
		Iso-tract MFP
		Park City MFP
		Pony Express RMP
		Randolph MFP
	St. George	St. George (formerly Dixie) RMP
	Vernal	Book Cliffs MFP*
		Diamond Mountain RMP*
WA	Spokane†	Spokane RMP

Table 2-3
Land Use Plans Proposed for Amendment under the PEIS, *cont.*

State	District or Field Office†	Land Use Plan(s)
WY	Buffalo	Buffalo RMP
	Casper	Platte River RMP*
	Cody	Big Horn Basin RMP
		Cody RMP*
	Kemmerer	Kemmerer RMP*
	Lander	Lander RMP*
	Newcastle	Newcastle RMP
	Pinedale	Pinedale RMP*
		Snake River RMP
	Rawlins	Great Divide RMP*
		Green River RMP*
	Rock Springs	Green River RMP*
	Worland	Grass Creek RMP*
		Waskakie RMP*

MP = Management Plan; MFP = Management Framework Plan; RMP = Resource Management Plan
* = Plans are under revision but the record of decision has not been signed and is not expected until after the record of decision for this PEIS. These field offices could elect to amend their existing RMP/MFP with the decisions in this PEIS until their RMP record of decision is signed.
† = Oregon and Washington Districts manage RMPs in their respective states.

Proposed amendments include (1) adoption of the proposed resource allocations of lands being open or closed to geothermal leasing (see Section 2.2.1) at the level of use indicated in the RFD (see Section 2.5); and (2) adoption of moderate and major constraints on use (stipulations and best management practices) and procedures appropriate for resource values present, for leasing as outlined in Section 2.2.2.

The rationale for amending these plans includes the following:

- The land use plan does not address geothermal leasing.
- The land use plan does not allocate areas as being open or closed to geothermal leasing.
- The land use plan does not assess the reasonably foreseeable development scenario for geothermal development, or the analysis requires updating.
- The land use plan does not have adequate or appropriate stipulations or best management practices to apply to geothermal leases to protect sensitive resources.

Some plans within the 12-state project area were excluded from amendment under this PEIS for a variety of reasons, including the following: (1) the plan falls outside of the area with geothermal potential, (2) the plan was previously amended or revised to adequately address geothermal leasing and development,

(3) the plan currently is being amended or revised in a separate NEPA review and that amendment or revision will address geothermal leasing and development, or (4) some other reason(s) exist(s) to exclude the plan from amendment under this PEIS (e.g., a plan revision is scheduled in the foreseeable future and there is likely little interest in geothermal leasing for the area in the near term). Other land use plans could be amended or revised at some point in the future to address geothermal leasing. The BLM anticipates that the analyses contained in this PEIS would be incorporated into those amendments and revisions, as appropriate.

2.2.4 Pending Lease Applications

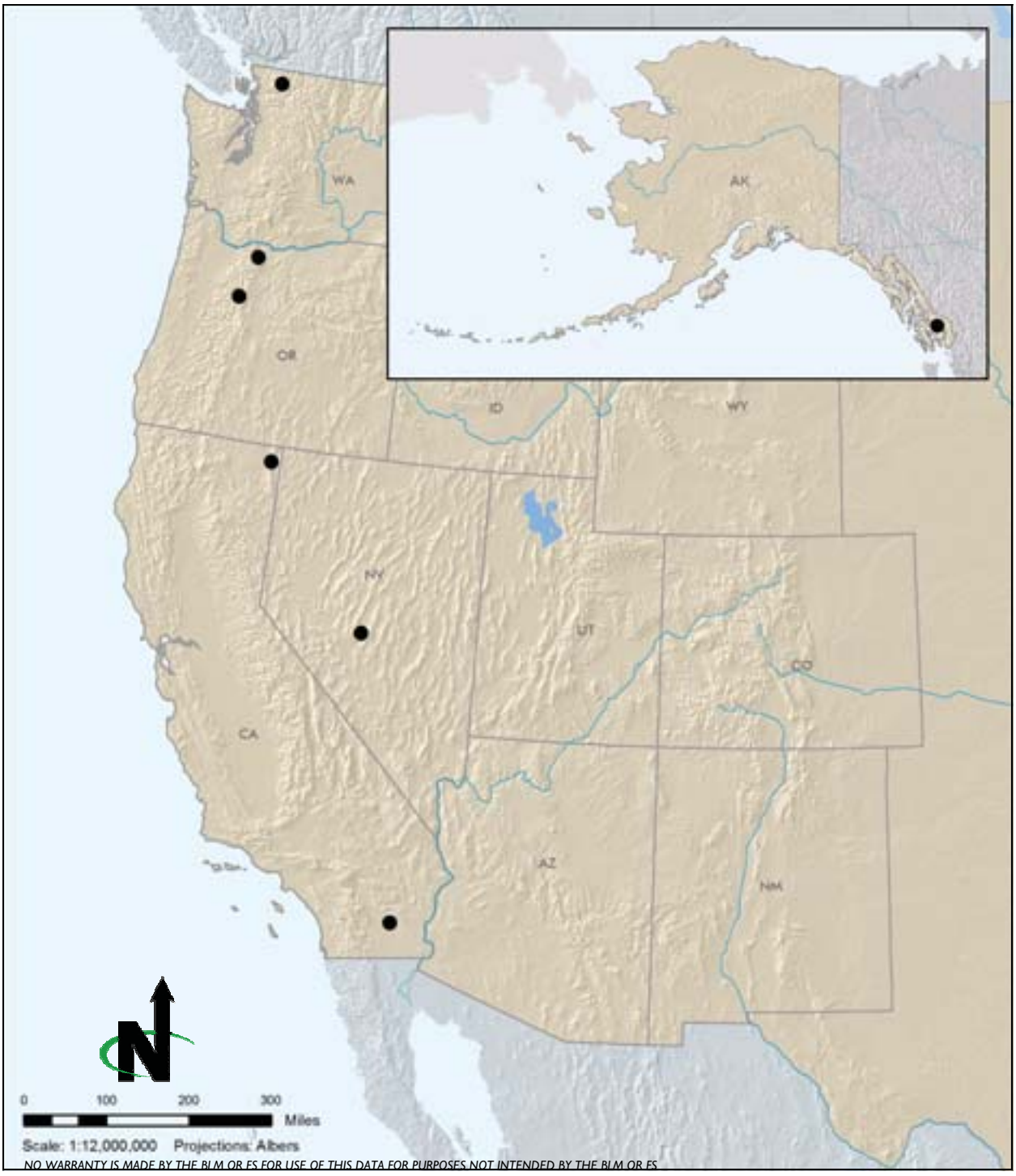
The Energy Policy Act of 2005 requires that the Secretary of the Interior and the Secretary of Agriculture enter into a Memorandum of Understanding (see Appendix B) regarding coordination of leasing and permitting for geothermal development of public lands and National Forest System lands under their respective jurisdictions and further:

> "that the Memorandum of Understanding shall establish a program reducing the backlog of geothermal lease application pending on January 1, 2005, by 90 percent within the 5-year period beginning on the date of enactment of this Act, including, as necessary, by issuing leases, rejecting lease applications for failure to comply with the provisions of the regulations under which they were filed, or determining that an original applicant (or the applicant's assigns, heirs, or estate) is no longer interested in pursuing the lease application."

As of January 1, 2005, there were 194 pending lease applications; 130 on BLM public lands and 64 on NFS lands (Clarke 2006). Since January 1, 2005 the BLM and FS have processed or resolved many of the lease applications. Based on a detailed review of the status of pending leases, the BLM and FS have identified a total of 19 lease applications that require site-specific analysis in this PEIS to allow decisions to be made on whether to issue the lease or deny the application. Chapter 10 provides more details on the status of pending leases. These 19 leases are grouped together in seven geographic clusters (Table 2-4 and Figure 2-7). The analysis of the lease areas is provided in Volume II.

Table 2-4
Pending Lease Applications (Prior to January 1, 2005)

Group	State	BLM or FS Office	Serial Number	Acres
1	AK	Tongass NF	AKAA 084543	2560
1	AK	Tongass NF	AKAA 084544	2560
1	AK	Tongass NF	AKAA 084545	2560
2	CA	El Centro FO	CACA 046142	2161
2	CA	El Centro FO	CACA 043965	1160
3	CA	Modoc NF	CACA 042989	480
3	CA	Modoc NF	CACA 043744	2560
3	CA	Modoc NF	CACA 043745	2560
4	NV	Battle Mtn FO and Toiyabe NF	NVN 074289	605
5	OR	Mount Hood NF	OROR 017049	1538
5	OR	Mount Hood NF	OROR 017051	2480
5	OR	Mount Hood NF	OROR 017052	2480
5	OR	Mount Hood NF	OROR 017053	1376
5	OR	Mount Hood NF	OROR 017327	1294
6	OR	Willamette NF	OROR 054587	1115
7	WA	Mt Baker NF	WAOR 056025	2403
7	WA	Mt Baker NF	WAOR 056027	2560
7	WA	Mt Baker NF	WAOR 056028	2544
7	WA	Mt Baker NF	WAOR 056029	1941



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There are 19 pending noncompetitive lease application sites in seven different geographic areas evaluated in the PEIS. These are addressed in Volume II.

LEGEND:

- Pending lease application site

Evaluated Pending Lease Site Areas in the in the 11 Western States and Alaska

Figure 2-7

2.3 ALTERNATIVES

Three alternatives are evaluated in detail in the PEIS, the no action alternative and two action alternatives. Each is discussed below. A comparison of the the action alternatives is presented in Table 2-5.

Table 2-5
Comparison of Geothermal Resource Allocations between the Action Alternatives

	Alternative B: Proposed Action (acres)	Alternative C: Leasing Near Transmission Lines (acres)
Public Lands in Planning Area	142,188,175	142,188,175
NFS Lands in Planning Area	106,484,535	106,484,535
Public Lands Open to Indirect Use[1]	116,985,030	61,423,576
Public Lands Open to Leasing for Direct Uses	116,985,030	116,629,322
NFS Lands Open to Leasing for Indirect Use[1]	74,973,563	31,244,459
NFS Lands Open to Leasing for Direct Uses	74,973,563	74,973,563
Public Lands Closed to Indirect Use[1]	25,203,145	80,248,147
Public Lands Closed to Leasing for Direct Uses	25,203,145	25,042,401
NFS Lands Closed to Leasing for Indirect Use[1]	31,510,972	75,240,076
NFS Lands Closed to Leasing for Direct Uses	31,510,972	31,510,972

[1] Indirect use includes commercial electrical generation.

2.3.1 Alternative A: No Action

Alternative A is the no action alternative. Under this alternative, no BLM land use plans would be amended and the existing plan decisions, stipulations, and allocations would not change. Therefore, any plans that do not address geothermal leasing would not be amended and the public and NFS lands would not be allocated as open or closed to geothermal leasing.

Processing of pending geothermal lease applications would continue; however, they would be evaluated on a case-by-case basis using analysis in the existing land use plans. Likewise, future lands nominated for leasing would be evaluated using analysis in existing land use plans. This could require additional NEPA documentation and possibly amendments to the plans. Taking no action would not facilitate the leasing process and does not meet the stated purpose and need; however, it is analyzed in detail to provide a baseline from which to evaluate the other alternatives in accordance with CEQ guidance.

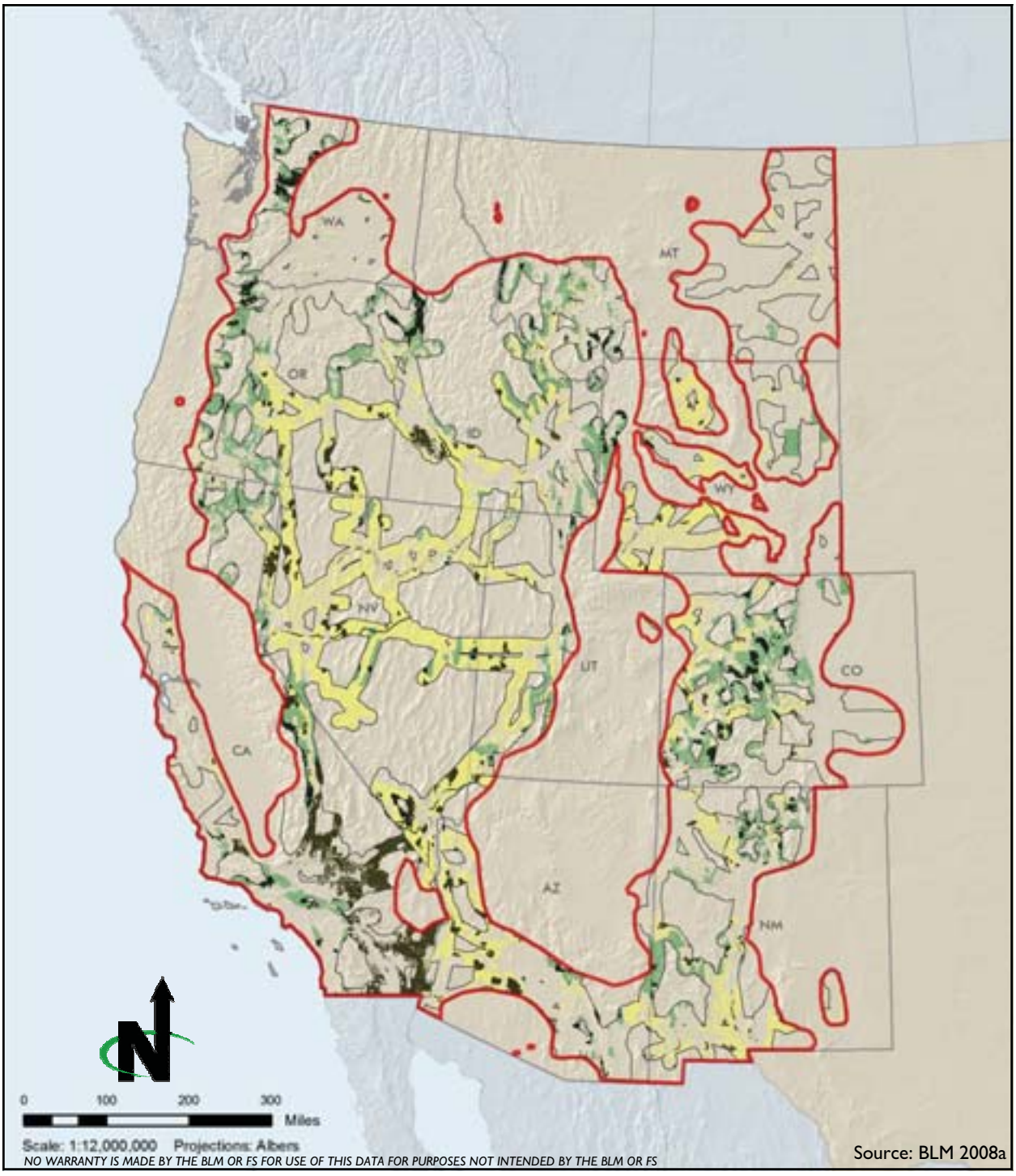
2.3.2 Alternative B: Proposed Action

As discussed above (*Section 2.2 – Proposed Action*) approximately 117 million acres of public land would be allocated as open and 75 million acres of NSF land would be legally open to geothermal leasing for direct and indirect use subject to existing laws, regulations, formal orders, stipulations attached to the lease form, and the terms and conditions of the standard lease form. The authorized officer retains the discretion to issue leases with stipulations that impose moderate to major constraints on use of surface of any leases in order to mitigate the impacts to other land uses or resources objectives as defined in the guiding resource management plan. This represents about 77 percent of public lands and NFS lands within the planning area. The remaining 25 million acres of public land and 31 million acres of NFS lands in the planning area would be closed to geothermal leasing. The closed areas encompass non-discretionary and discretionary (BLM only) determinations, including the statutorily closed Island Park Geothermal Area. This area encompasses about 14,000 acres of NFS lands around west and southwest boundary of Yellowstone National Park for the explicit purpose of protecting the geothermal features of the Park. The BLM would amend 122 land use plans to adopt the allocations, RFDs, and specific stipulations, best management practices, and procedures.

2.3.3 Alternative C: Leasing Lands near Transmission Lines

Under Alternative C, the BLM and FS would only consider leasing lands for commercial electrical generation if they are within a 20-mile corridor (10-mile from centerline) from existing transmission lines and lines currently under development at 60kV to 500kV (Figure 2-8). All lands within this corridor would be designated as closed or open with moderate to major constraints to leasing using the criteria outlined for the Proposed Action. Island Park Geothermal Area would also be closed (as with Alternative B); however, the area would be expanded to include no leasing within 15 miles from the boundary of Yellowstone National Park. Given the limited transmission line grid and demand for localized power sources for remote communities, the lands available for geothermal leasing in Alaska would be the same as for Alternative B - Proposed Action. Leases for direct use would be considered for the entire planning area and would not be constrained by the location of transmission lines. Therefore, direct use leasing would be the same as the proposed action.

Under this alternative, approximately 61 million acres of public land and 31 million acres of NFS lands would be open for geothermal leasing for commercial electrical generation. These lands would be subject to moderate to major constraints as detailed in the Proposed Action. This alternative would increase the amount of land that would be unavailable for geothermal leasing with in the planning area; specifically, about 80 million acres of public land and 75 million acres of NFS lands would be closed. Other lands outside the corridor would



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Under Alternative C, only BLM public and NFS lands near transmission lines would be available for leasing for commercial electrical generation. Direct use and Alaska would be the same as the Proposed Action.

LEGEND:

- Geothermal potential area
- Public Lands Open to Leasing
- NFS Lands Open to Leasing
- Public and NFS Lands Closed to Leasing

Alternative C: BLM Public and NFS Lands Near Transmission Lines

Figure 2-8

not be closed to leasing, but would have to be evaluated on a case-by-case basis as described under the No Action Alternative. This alternative was developed in response to written and verbal recommendations during public scoping.

2.4 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

2.4.1 No Leasing or Development of Geothermal Resources on Public or NFS Lands

The No Lease Alternative would not allow leasing of any geothermal resources. Under this alternative, all pending and future geothermal lease applications and nominations would not be approved so as to preclude any and all environmental consequences. This alternative was considered but eliminated from detailed analysis because it violates the multiple-use provisions of FLPMA and is inconsistent with the President's National Energy Policy, the Energy Policy Act of 2005, and Executive Order 13212. Consequently, the No Lease Alternative was not carried forward for detailed analysis.

2.5 REASONABLY FORESEEABLE DEVELOPMENT SCENARIO

The following reasonably foreseeable development (RFD) scenario serves as a basis for analyzing environmental impacts resulting from future leasing and development of federal geothermal resources within the western US over the next 20 years. A variety of factors (e.g., economic, social, and political) are beyond the control of the BLM and FS and will influence the demand for geothermal resources. Therefore, the RFD scenario is a best professional estimate of what may occur if public and NFS lands are leased. It is not intended to be a "maximum-development" scenario; however, it is biased towards the higher end of expected development and shows where the potential development might occur. If future development eventually exceeds RFD predictions, then the BLM and FS will assess the impacts to the resources under the context of the analysis provided in the PEIS or specific land use plans and determine if additional analysis is warranted.

The RFD was based on a review of recent government and industry reports providing assessments of geothermal potential across the western US (Western Governors' Association 2006; DOE and BLM 2003; NREL 2006; BLM 2007a; Geothermal Energy Association 2007a) and the typical impacts associated with geothermal development (GeothermEx 2007). Few quantitative evaluations have been conducted at this scale, and those that exist are considered largely speculative due to the wide array of variables around future geothermal development. These variables include the speculative estimation of unexplored geothermal resources, the development of geothermal technologies that may allow for extraction of resources currently unusable, the unknown nature of future energy markets, and the unknown future of regulatory and political climates. While some reports cite substantial barriers to geothermal development, current movements in energy markets as well as political and

regulatory climates look favorable for an expansion of geothermal energy development to move forward.

2.5.1 RFDs for Electrical Generation (Indirect Use)

Nearly 50 percent of the nation's geothermal energy production occurs on Federal land, largely in California and Nevada. The BLM manages 58 producing geothermal leases that provide geothermal energy to 34 power plants, with a capacity of 1,275 megawatts and produced about 4.6 gigawatt hours of electricity during fiscal year 2007.

Projected Power Plant Development

It is estimated that the 12 states in the project area have 5,500 MW of geothermal potential considered viable for commercial development by 2015, with a further 6,600 MW being forecast by 2025. This capacity is expected to be realized through approximately 110 additional power plants by 2015, and a further 132 power plants by 2025. Using these values, it is estimated that the average viable capacity at any particular site is 50 MW by 2025 (Western Governors' Association 2006). This projection is in addition to existing and plan capacity for the given locations.

Location of Development

Development would be distributed across the area shown by the geothermal potential map, developed as part of this PEIS (see Figures 1-5 and 1-6). The greatest development is expected to occur in California and Nevada, and the least in Wyoming and Montana. A state-by-state breakdown of the potential is provided in Table 2-6, listing the states in order of decreasing capacity and decreasing expected intensity of development.

State-by-state potentials are further broken down into specific areas in Table 2-7, along with the likely development capacities for those areas. The table also includes the BLM Field Offices and National Forests associated with the high potential areas. These potential development sites are based on current best available information. Additional locations unknown or unexpected at this time may occur. Development at any site will require additional NEPA evaluation to address site-specific resource values and analyze potential impacts.

Table 2-6
Estimated Future Geothermal Electrical Generation Development by State

State	Estimated Commercial Development by 2015 (MW)	Estimated Commercial Development by 2025 (MW)
California	2375	4703
Nevada	1473	2880
Idaho	855	1670
Oregon	380	1250
Utah	230	620
Washington	50	600
New Mexico	80	170
Alaska	20	150
Arizona	20	50
Colorado	20	50
Montana*	0	0
Wyoming*	0	0

Source: Western Governors' Association 2006; BLM and DOE 2003.
* While not evaluated in detail for large scale commercial electrical generation, Montana and Wyoming have potential for small scale direct use electrical generation.

Table 2-7
Commercially Viable Geothermal Capacity for Electrical Generation by High Potential Area and Associated BLM Field Offices and National Forests

State	Area of Potential	Projected MW at 2015	Projected MW at 2025	Associated BLM FO	Associated National Forest
CA	Border	0	30	El Centro	none
CA	Brawley	200	463	El Centro	none
CA	Calistoga	10	20	Ukiah	none
CA	Clear Lake Volcanic Field area	20	50	Ukiah	none
CA	Coso area	75	150	Ridgecrest	none
CA	Dunes	0	10	El Centro	none
CA	East Mesa	50	100	El Centro	none
CA	Glamis	0	10	El Centro	none
CA	Heber	20	50	El Centro	none
CA	Honey Lake & Wendell & Amidy	10	10	Eagle Lake	none
CA	Kelly HS	0	10	Alturas	none
CA	Mono - Long Valley	120	240	Bishop	Inyo
CA	Medicine Lake / Glass Mountain	480	480	Alturas	Modoc
CA	Morgan Springs-Growler Springs (includes parts of Lassen not in the National Park)	0	50	Redding	Lassen

Table 2-7
Commercially Viable Geothermal Capacity for Electrical Generation by High Potential Area and Associated BLM Field Offices and National Forests, *cont.*

State	Area of Potential	Projected MW at 2015	Projected MW at 2025	Associated BLM FO	Associated National Forest
CA	Mount Signal	25	25	El Centro	none
CA	Niland	75	150	El Centro	none
CA	Randsburg area	10	40	Ridgecrest	none
CA	Salton Sea area	860	2000	El Centro	none
CA	Superstition Mountain	25	25	El Centro	none
CA	Surprise Valley/Lake City	25	50	Surprise	none
CA	The Geysers	150	300	Ukiah	Mendocino
CA	Westmorland	50	100	El Centro	none
CA	Truckhaven	25	50	El Centro	none
CA	Mount Shasta - Military Pass Road area	120	240	Redding	Shasta
CA	East Brawley	25	50	El Centro	none
NV	Aurora	120	240	Carson City	Toiyabe
NV	Baltazor Hot Springs	15	30	Winnemucca	none
NV	Beowawe Hot Springs	50	100	Elko	none
NV	Blue Mountains	30	90	Winnemucca	none
NV	Brady Hot Springs	10	20	Winnemucca	none
NV	Buffalo Valley, Big Smoky Valley, Smith Creek Valley, and Monitor Valley	100	200	Battle Mountain	none
NV	Colado	30	60	Winnemucca	none
NV	Crescent Valley	50	100	Battle Mountain	none
NV	Desert Peak area	20	50	Winnemucca	none
NV	Dixie Valley	70	70	Carson City	none
NV	Sulfur Hot Springs (Double - Black Rock)	0	50	Elko	Humboldt
NV	Emigrant	50	100	Elko	none
NV	Fallon / Carson Lake	50	150	Carson City	none
NV	Fish Lake Valley	50	75	Battle Mountain	none
NV	Fly Range (Granite Ranch)	10	20	Winnemucca	none
NV	Great Boiling Springs (Gerlach)	30	60	Winnemucca	none
NV	Hawthorne	20	40	Carson City	none
NV	Hazen (Black Butte)	10	20	Carson City	none
NV	Hot Sulphur Springs (Tuscarora)	20	40	Elko	none
NV	Hyder Hot Springs	10	20	Winnemucca	none
NV	Kyle Hot Springs	15	30	Winnemucca	none
NV	Kyle Hot Springs (Granite Mtn.)	15	30	Winnemucca	none

Table 2-7
Commercially Viable Geothermal Capacity for Electrical Generation by High Potential Area and Associated BLM Field Offices and National Forests, *cont.*

State	Area of Potential	Projected MW at 2015	Projected MW at 2025	Associated BLM FO	Associated National Forest
NV	Leach Hot Springs	18	36	Winnemucca	none
NV	Lee & Allan Hot Springs	30	60	Carson City	none
NV	McGee Mountain	10	20	Winnemucca/ Surprise	none
NV	New York Canyon	35	70	Winnemucca	none
NV	North Valley / Black Warrior Peak	37	49	Winnemucca	none
NV	Pinto Hot Springs	29	58	Winnemucca	none
NV	Pirouette Mountain	23	46	Carson City	none
NV	Pumpernickel Valley	30	60	Winnemucca	none
NV	Pyramid Lake Indian Reserve	25	50	Carson City	none
NV	Rye Patch (Humboldt House District)	15	30	Winnemucca	none
NV	Salt Wells	50	50	Carson City	none
NV	San Emidio Desert area (Empire)	13	20	Winnemucca	none
NV	Shoshone-Reese River	18	36	Battle Mountain	none
NV	Silver Peak	50	100	Battle Mountain	none
NV	Soda Lake area	20	35	Carson City	none
NV	South Hot Springs	10	20	Carson City	Toiyabe
NV	Steamboat Springs	50	100	Elko	Toiyabe
NV	Stillwater area	30	60	Elko	Humboldt
NV	Trinity Mountains	50	75	Carson City	none
NV	Wabuska	10	20	Carson City	none
NV	Wilson Hot Springs	10	20	Carson City	Toiyabe
NV	Other non-geographically named locations.	150	300	Battle Mountain, Carson City, Elko, Winnemucca	Toiyabe
ID	Crane Creek - Cove Creek area	25	50	Four Rivers	none
ID	Raft River	150	200	Burley	none
ID	Big Creek Hot Springs	10	20	Salmon	Salmon-Challis
ID	Rexburg	20	100	Upper Snake	none
ID	Willow Springs	100	200	Upper Snake	none
ID	China Cap	100	200	Pocatello	none
ID	Other potential locations	450	900	Four Rivers, Burley, Jarbidge, Shoshone	
OR	Newberry Caldera	240	480	Prineville	Deschutes
OR	Crump's Hot Springs	20	40	Lakeview	none

Table 2-7
Commercially Viable Geothermal Capacity for Electrical Generation by High Potential Area and Associated BLM Field Offices and National Forests, *cont.*

State	Area of Potential	Projected MW at 2015	Projected MW at 2025	Associated BLM FO	Associated National Forest
OR	Three Creeks Butte	20	40	Prineville	Deschutes
OR	Trout Creek area	10	20	Prineville	Deschutes
OR	Neal Hot Springs	25	50	Vale	none
OR	Lakeview ~ Hot Lake area	20	20	Lakeview	none
OR	Summer Lake	20	50	Lakeview	Fremont
OR	Three Sisters, Mt Rose (east), Mt Hood	25	500	Prineville	Ochoco, Deschutes, Mt Hood
OR	Other potential locations	0	50	Burns, Vale, Prineville	none
UT	Cove Fort-Sulphurdale	50	200	Fillmore	Fishlake
UT	Roosevelt Hot Springs	100	250	Cedar City	none
UT	Thermo Hot Springs	50	100	Cedar City	none
UT	New Castle	10	20	Cedar City	none
UT	Other (Monroe, Mineral Mountain, etc.)	20	50	Richfield	Fishlake
WA	Mt Baker	50	100	Wenatchee	Mt. Baker-Snoqualmie
WA	Other Cascade volcanoes (Mt Adam area, Wind River area)		500	Wenatchee	Gifford Pinchot, Mt. Baker-Snoqualmie, Okanogan-Wenatchee
NM	Lower Rio Grande Rift (Including Tortugas Mtn. & Rincon)	50	100	Las Cruces	Gila (Lower Rio Grande Rift)
NM	Lightning Dock	20	40	Las Cruces	none
NM	Radium Springs, McGregor, San Diego, Lower Frisco	10	30	Las Cruces	none
AK	Hot Springs Bay Valley, Bell Island Hot Springs, Circle Hot Springs, Unalaska	20	150	Anchorage and Eastern Interior	Tongass (Bell Is. only)
AZ	Clifton, Gillard	20	50	Safford	Apache/ Sitgraves National Forest

Table 2-7
Commercially Viable Geothermal Capacity for Electrical Generation by High Potential Area and Associated BLM Field Offices and National Forests, *cont.*

State	Area of Potential	Projected MW at 2015	Projected MW at 2025	Associated BLM FO	Associated National Forest
CO	Waunita, Routt, Cottonwood, Mt Princeton, Poncha and Pagosa Hot Springs. Wagon Wheel Gap, Orvis, Ouray.	20	50		Routt (Routt), Uncompahgre (Orvis, Ouray), Rio Grande (Wagon Wheel Gap), San Juan (Poncha), Gunnison (Pagosa, Waunita), Arapaho/Gunnison (Cottonwood, Mt. Princeton)

Source: Western Governors' Association 2006; BLM and DOE 2003.

Typical Phases in Geothermal Development

This RFD for geothermal resource use involves four sequential phases: (1) exploration, (2) drilling, (3) utilization, and (4) reclamation and abandonment. The success or failure of each phase affects the implementation of subsequent phases, and, therefore, subsequent environmental impacts. Development of geothermal resources is unique to the industry, but many activities are similar in scope to other fluid minerals (e.g., oil and gas), such as surveying, drilling, site-development (well pads and roads), and reclamation and abandonment. The general assumptions outlined in the following four phases serve to establish RFD scenarios for analyzing future environmental impacts that may result from the BLM issuing leases for geothermal resources within the identified area of geothermal potential. It should be noted that the RFD scenario permits a general evaluation of the types of impacts that may occur but cannot accurately predict the magnitude and extent of these impacts. This is due in part to the uncertainty about the timing, location, distribution of the geothermal resources, and the likely types of development.

Table 2-8 provides the estimated acreages of land disturbance for each phase in geothermal development for a typical power plant. The actual area of disturbance varies greatly depending upon site conditions and the type and size of power plant being constructed; therefore, a range is provided. Acreages are not provided for the Reclamation and Abandonment phase since this phase involves the return of previously disturbed lands to their existing conditions. The total potential amount of area disturbed under the utilization phase includes development activities. Much of the land would be reclaimed after the initial exploration, drilling, and construction; therefore, the actual amount of land

occupied during operation, would be less. A typical development generally requires several leases or the use of private or other adjacent lands. The details of each phase of development are described below.

Table 2-8
Typical Disturbances by Phase of Geothermal Resource Development

Development Phase	Disturbance Estimate per Plant
Exploration	**2 – 7 acres**
Geologic mapping	negligible
Geophysical surveys	30 square feet[1]
Gravity and magnetic surveys	negligible
Seismic surveys	negligible
Resistivity surveys	negligible
Shallow temperature measurements	negligible
Road/access construction	1- 6 acres
Drilling 6 temperature gradient wells	0.9 acres[2]
Drilling Operations and Utilization	**51 – 350 acres**
Well field development	5 – 50 acres[3]
Road improvement/construction	4 – 32 acres[4]
Powerplant construction	15 – 25 acres[5]
Installing wellfield equipment including pipelines	5 – 20[6]
Installing transmission lines	24 – 240[7]
Well workovers, repairs and maintenance	Negligible[8]
TOTAL	**53 – 367 acres**

[1] Calculated assuming 10 soil gas samples, at a disturbance of less than three square feet each.
[2] Calculated assuming area of disturbance of 0.05 to 0.15 acre per well and six wells.
[3] Size of the well pad varies greatly based on the site-specific conditions. Based on a literature review, well pads range from 0.7 acres up to 5 acres (GeothermEx 2007; FS 2005). Generally a 30MW to 50 MW power plant requires about five to 10 well pads to support 10 to 25 production wells and five to 10 injection wells. Multiple wells may be located on a single well pad.
[4] One-half mile to nine miles; assumes about ¼ mile of road per well. Estimates 30-foot wide surface disturbance for a 18-20 foot road surface, including cut and fill slopes and ditches.
[5] 30 MW plant disturbs approximately 15 acres; 50 MW plant disturbs approximately 25 acres.
[6] Pipelines between well pad to plant assumed to be ¼ or less; for a total of 1½ to seven miles of pipeline in length, with a 25 foot wide corridor
[7] Five to 50 miles long, 40 feet wide corridor.
[8] Disturbance would be limited to previously disturbed areas around the well(s).

Phase One: Geothermal Resource Exploration

Before geothermal resources are developed, a geothermal resource developer explores for evidence of geothermal resources on leased or unleased land. Exploration includes ground disturbance but does not include the direct testing of geothermal resources or the production or utilization of geothermal resources. Exploration operations include, but are not limited to, geophysical operations, drilling temperature gradient wells, drilling holes used for explosive charges for seismic exploration, core drilling or any other drilling method, provided the well does not reach the geothermal resource. It also includes

related construction of roads and trails, and cross-country transit by vehicles over public land. Exploration involves first surveying and then drilling temperature gradient wells. It generally takes between one and five years to complete exploration.

Surveying includes conducting or analyzing satellite imagery and aerial photography, volcanological studies, geologic and structural mapping, geochemical surveys, and geophysical surveys of leasable areas that could support geothermal resource development. The surveys consist of collecting electrical, magnetic, chemical, seismic, and rock data. For example, water samples from hot springs could be used to determine the subsurface characteristics of a particular area. Once the data is compiled, geologists and engineers examine the data and make inferences about where the higher temperature gradients may occur. High temperature gradients can indicate the location of potential underground geothermal reservoirs capable of supporting commercial uses.

Surveys may require creating access using four-wheel drive vehicles, or by helicopters or on foot to areas with no roads or very poor roads. Cutting of vegetation may be required in some areas to facilitate access. In some cases, gas collectors may be installed to measure soil gases. These collectors have partially buried sensors and may disturb small areas of less than three square feet (BLM 2007b).

While not widely used for geothermal surveys, seismic surveys have the greatest survey impact on the local environment. These surveys typically involve setting up an array of geophones and creating a pulse or series of pulses of seismic energy. The pulse is created either by detonating a small charge below the ground surface (requires drilling a narrow "shot hole") or by a vibroseis truck that is driven through the survey area. Data is transmitted from the geophones to a central location. The geophones may be installed on the ground's surface, in small excavations made specifically for burying the geophones, and/or in existing wells. These surveys are typically undertaken over the course of a few days. In areas where there is a lot of natural seismic activity, longer term installation of geophones may be undertaken to record naturally occurring earthquakes. Such cases do not involve a vibroseis truck (BLM 2007b).

Resistivity surveys include various methodologies from laying out long cables (up to 1,000 feet or more) on the land surface, or setting up equipment repeatedly in small areas (a few tens of square feet at the most for each measuring site). Minor, temporary disturbances are associated with each site for the burial of sensors (BLM 2007b).

The second step of the exploration phase is to drill temperature gradient wells on leased or unleased land. This process confirms a more precise location of high temperature gradients. Temperature gradient wells can be drilled using a

truck-mounted rig and range from 200 feet to over 4,000 feet deep. The number of gradient wells also varies, depending on the geometry of the system being investigated and the anticipated size of power development. Geologists examine either rock fragments or long cores of rock that are brought up from deep within the well. Water samples are taken from any groundwater encountered during drilling. Also, temperatures are measured at depth. Both well temperatures and the results of rock sample analyses are used to determine if additional exploration is necessary to identify the presence and characteristics of an underground geothermal reservoir. After collecting the desired materials and data, the wells are completed with sealed, water-filled tubing from surface to bottom, often with cement around the tubing (BLM 2007b).

Most temperature gradient wells are drilled with a small rotary rig (often truck-mounted) similar to that used for drilling water wells, or a diamond-coring rig, similar to that used for geologic sampling in mineral exploration and civic works projects. Neither rig of this size requires construction of a well pad or earth moving equipment unless the site is sharply graded. Support equipment is needed, including water trucks, tanks for mixing and holding drilling fluids, personnel and supply transport vehicles, and sometimes a backhoe for earth-moving activities is needed to prepare the drilling site. A temperature gradient drilling operation can be run by about three on-site personnel and others traveling to the site periodically with materials and supplies (BLM 2007b).

Temperature-gradient well drilling requires road access. Whenever possible, a driller would access the temperature gradient well site using existing roads. When existing roads are not available, new access roads may need to be constructed for the truck-mounted rig to reach the site; this could require one to six acres of disturbance.

Preparing the site for drilling could include leveling the surface and clearing away vegetation. Several temperature gradient wells are usually drilled to determine both the areal extent of the temperature anomaly and where the highest temperature gradient occurs. Each drill site could disturb approximately 0.10 acres, and the drill rig could be approximately 60 feet tall. During exploration, a driller is not permitted to produce any fluids out of, or inject any fluids into, the well; therefore, the site may also host a sump or tanker truck. Additionally, a diesel generator may also be used at the site to power equipment. The well site itself involves excavation of a small cellar (typically less than three feet square and less than three feet deep) to allow the conductor casing to be set beneath the rig. Drilling may last for several weeks.

Temperature gradient wells are not intended to directly contact the geothermal reservoir, and therefore produce no geothermal fluids. In areas of known artesian pressures, any drilling expected to penetrate the groundwater table would include blow-out prevention equipment. In cases where a temperature

gradient well does penetrate a geothermal zone, any release of geothermal fluids at the surface is likely to be minimal due to the small well diameters and the use of blow-out prevention equipment (BLM 2007b).

Drilling fluids may include drilling mud (bentonite clay, activated montmorillonite clay and crystalline silica-quartz), drilling mud additives (caustic soda, sodium bicarbonate, and anionic polyacrylamide liquid polymer), cement (Portland cement and calcium chloride), fuel (diesel), lubricants (usually petroleum-based) and coolants. The specific fluids and additives depends on a variety of factors, including the geologic formations being penetrated and the depth of the well. Releases of drilling muds are not permitted; a sump and tanker truck are required to capture all fluids. The risk of spills of other fluids is similar to that of any other project involving the use of vehicles and motorized equipment (BLM 2007b).

All surface disturbances would be reclaimed to the satisfaction of BLM and FS. If a temperature gradient well was unsuccessful, it would be abandoned, and the drill site would be reclaimed. Abandonment includes plugging, capping, and covering the wells. Reclamation includes removing all surface equipment and structures, regrading the site to predisturbance contours, and replanting native or appropriate vegetation to facilitate natural restoration.

Phase Two: Drilling Operations

Once exploration has confirmed a viable prospect for commercial development and necessary leases have been secured, the drilling of exploration wells to test the reservoir can proceed. Drilling Operations include flow testing, producing geothermal fluids for chemical evaluation or injecting fluids into a geothermal reservoir. This would also involve the construction of sumps or pits to hold excess geothermal fluids. It could involve development of minor infrastructure to conduct such operations.

Drilling is an intense activity that requires large equipment (e.g., drill rig) and can take place 24 hours a day. A drilling operation generally has from 10 to 15 people on-site at all times, with more people coming and going periodically with equipment and supplies. Getting the rig and ancillary equipment to the site may require 15 to 20 trips by full-sized tractor-trailers; with a similar amount for de-mobilizing the rig. There would be 10 to 40 daily trips for commuting and hauling in equipment (BLM 2007b).

If a reservoir is discovered, characteristics of the well and the reservoir are determined by flow testing the well. If the well and reservoir were sufficient for development, a wellhead, with valves and control equipment, would be installed on top of the well casing. Excess geothermal fluids are stored in temporary pits or sumps, generally lined with plastic (small sumps) or clay (large sumps). The water is left to evaporate and any sludge is removed and properly disposed.

Phase Three: Utilization

Utilization and production is the next phase after a viable reservoir is determined and includes the infrastructure needed for commercial operations, including access roads, construction of facility structures, building electrical generation facilities, drilling and developing well fields, and installing pipelines, meters, substations, and transmission lines. The utilization phase could last from 10 to 50 years and involves the operation and maintenance of the geothermal field(s) and generation of electricity.

The type of development utilization that occurs is based on the size and temperature of the geothermal reservoir. Geothermal resources can be classified as low temperature (less than 90°C, or 194°F), moderate temperature (90°C to 150°C, or 194 to 302°F), and high temperature (greater than 150°C, or 302°F). Only the highest temperature resources are generally used for generating electrical power; however, with emerging technologies and in colder climates such as Alaska, even the lower temperature resources are proving usable for electrical generation.

High temperature reservoirs are suitable for the commercial production of electricity. Three types of power plants that harness geothermal resources are dry steam plants, flash steam plants, and binary-cycle plants. Occasionally a hybrid between flashed steam and binary system is also used. Dry steam power plants use the steam from the geothermal reservoir as it comes from the wells and route it directly through turbine/generator units to produce electricity. Flash steam power plants use water at temperatures greater than 182°C (360°F). Water is pumped under high pressure to the generation equipment at the surface, the pressure is suddenly reduced, allowing some of the hot water to convert, or "flash," into steam, and the steam is used to power the turbine/generator units to produce electricity. Binary-cycle power plants use water from the geothermal reservoir to heat another "working fluid." The working fluid is vaporized and used to turn the turbine/generator units. The geothermal water and the working fluid never come in contact with each other. Binary-cycle power plants can operate with lower water temperature 74°C to 182° C (165°F to 360°F) and produce few air emissions. See Chapter 1 for a more detailed discussion.

Development of the lease would involve the following construction and operations:

- Access roads—New access roads to accommodate the larger equipment associated with the development phase could be constructed. In general, a plant can require 1/2 –mile to nine miles of roads in order to access the site, well pads, and power plant. Depending on the type and use-intensity of the road, the areas of surface disturbance is about 30-feet wide for a 18-20 foot wide road surface, including cut and fill slopes and ditches.

- Drill site development— Multiple wells may be drilled per lease. Production-size wells can be over two miles (10,560 feet) deep. The number of wells is dependent upon the geothermal reservoir characteristics and the planned power generation capacity. For example, a 50MW (net) power plant could require up to 25 production wells and 10 injection wells. It is common that multiple wells would be installed on a well pad. The size of the well pad is dependent upon site conditions and on the number of wells for the pad, but they are typically about one to five acres, including minor cut and fill. In order to drill these deep holes, a large drilling rig or derrick would be erected. A small shed (usually no more than 10 feet by 10 feet) may be constructed at each well site to house equipment associated with well head equipment and for maintenance and monitoring. The sheds are painted to blend in with the surrounding environment. Drilling operations can occur 24 hour a day.
- Wellfield equipment—A geothermal power plant is typically supported by pipeline systems in the plant's vicinity. The pipeline systems include a gathering system for produced geothermal fluids, and an injection system for the reinjection of geothermal fluids after heat extraction takes place at the plant. Pipelines are usually 24 to 36 inches in diameter. Pipelines transporting hot fluids or steam to the plant are covered with insulation, whereas injection pipelines are generally not. When feasible, they would parallel the access roads and existing roads to the destination of the geothermal resource's steam or water. Pipelines are typically constructed on supports above ground, resulting in little if any impact to the surrounding area once construction is complete and the corridor has been revegetated. The pipelines typically have a few feet of clearance underneath them, allowing small animals to easily cross their path. The pipelines are typically painted to blend in with the surrounding environment. In general, plants have about 1½ to even miles of pipes with a corridor width of about 25 feet.
- Power plant—A 50 MW plant would utilize a site area of up to 20 to 25 acres to accommodate all the needed equipment, including the power plant itself, space for pipelines geothermal fluids and reinjection, a switch yard, space for moving and storing equipment, and buildings needed for various purposes (power plant control, fire control, maintenance shop, etc.). The power plant itself would occupy an estimated 25 percent of this area for a water-cooled plant, or about 50 percent for an air-cooled plant. Where topography permits, the power plant could be situated so as to be less visible from nearby roads, trails, scenic vistas or scenic highways. The site of the plant requires reasonable air circulation to allow for efficient operation of the plant's condensers. A smaller, 20

MW plant would typically require approximately five to ten acres for the entire complex.

- Electric transmission lines—Transmission lines may range in length from 5 miles to 50 miles with a corridor width of approximately 40 feet. Wooden poles would most likely support them, and one acre could be disturbed per mile of transmission line.
- Reclamation—When a production well is successful, a wellhead with valves and control equipment is installed on top of the well casing. If a production well is unsuccessful, the production well would be abandoned. Abandonment includes plugging, capping, and reclaiming the well site.

The number of personnel required during construction varies significantly, but at any one point there may be a few hundred laborers and professionals on-site with attendant vehicle traffic. The number of people required for routine operation of a power plant is typically three per shift; however, additional personnel (as many as 12 total, depending on plant size) may be on site during the day for maintenance and management (BLM 2007b)

Activities associated with operation and maintenance and energy production would involve managing waste generated by daily activities, managing geothermal water, landscaping, and the maneuvering of construction and maintenance equipment and vehicles associated with these activities.

Phase Four: Reclamation and Abandonment
This phase involves abandoning the well after production ceases and reclaiming all disturbed areas in conformance with BLM and FS standards. Abandonment includes plugging, capping, and reclaiming the well site. Reclamation includes removing the power plant and all surface equipment and structures, regrading the site and access roads to predisturbance contours, and replanting native or appropriate vegetation to facilitate natural restoration.

Areas of Disturbance from Power Plant Development
The phase of development resulting in the greatest area of disturbance is the geothermal resource development stage, which includes the expansion of well pads and access roads, drilling of the production and reinjection wells, construction of the power plants, pipelines, and electrical transmission lines. Projected ranges for areas of disturbance from each of these components on both a per-plant basis (Table 2-8) and cumulatively across the entire planning area for both 2015 and 2025 are shown in Table 2-9.

Table 2-9
Cumulative Range of Acre Disturbances for the RFD

Component	Total Acreage Range per 50MW Plant[1]	Projected 2015 Acreage Range Across Planning Area[2]	Projected 2025 Acreage Range Across Planning Area[2]
Access roads	4 – 32	220 – 3,520	484 – 7,744
Well pads	5 – 50	550 – 5,500	1,210 – 12,100
Pipelines	5 – 20	550 – 2,200	1,210 – 4,840
Power plants	15 – 25	1,650 – 2,750	3,630 – 6,050
Electrical transmission lines	24 – 240	2,640 – 26,400	5,808 – 58,080
TOTAL	**53 – 367**	**5,610 – 40,370**	**12,342 – 88,814**

[1] See assumptions in Table 2-8.
[2] Calculated assuming 110 power plants at 50 MW each by 2015, and a further 132 power plants of 50 MW each by 2025.

Geothermal Fluid Production and Associated Waste

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. The rate of fluid production from a geothermal reservoir is unknown until the development testing phase is completed. 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, wellheads, valves, and control equipment would be installed on top of the well casing.

Using data from other areas of geothermal development, it appears that production of geothermal fluids could be expected to vary widely from one to six million gallons per well, per day. Assuming five 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.

Most geothermal fluids produced are re-injected back into the geothermal reservoir, via reinjection wells. In flash steam facilities about 15-20 percent of the fluid would be lost due to flashing to steam and evaporation through cooling towers and ponds. Binary power plants utilize a closed loop system, therefore, well production and reinjected operate with no fluid loss. Fluids could also be lost due to pipeline failures or surface discharge for monitoring/testing the geothermal reservoir.

The routinely used chemicals for a binary geothermal plant include the hydrocarbon working fluid (such as iso-butane or n-pentane) and the lubricating oil used in the downhole pumps. If a well's pressure falls below the "bubble point," if it possible that downhole scaling might occur. This would require either a mechanical clean-out with a drilling rig or a coiled-tubing unit, or an "acid job," during which acid (typically hydrochloric acid or less commonly

hydrogen fluoride) is injected into the wellbore to dissolve the scale. If scaling is persistent, the operator may choose to adopt routine injections of a scale-inhibitor chemical, such as polymaleic anhydride or polyacrylic acid, used in dosages of one to 10 parts per million (US BLM 207b).

2.5.2 RFDs for Direct Use

Geothermal waters are being used directly for a wide variety of applications across the western US. These uses include:

- Agricultural uses, such as controlling environmental conditions for growing crops, flowers, or trees;
- Aquacultural uses, such as controlling environmental conditions for raising fish or other animals;
- District heating and cooling systems for college campuses, residential neighborhoods, municipal buildings, national park buildings, and other types of buildings;
- Public safety uses, such as eliminating ice and snow on public sidewalks;
- Public health uses through food processing, such as dehydration, washing, and processing; and
- Recreational uses, such as hot tubs, steam baths, and mud baths.

Direct use applications are distributed across the project area, with the greatest number being in California, Idaho, Oregon and Colorado. Table 2-10 lists the six major categories of direct use applications, and the prevalence of each within the 12 states covered by this PEIS. The size of these applications range from less than 0.1 to 30 thermal megawatts, with most being between one and six thermal megawatts.

Table 2-10
Distribution of Direct Use Applications within Project Area

Direct Use Application	AK	AZ	CA	CO	ID	MT	NM	NV	OR	UT	WA	WY
Greenhouses	4	0	4	1	13	4	4	0	4	5	0	1
Aquaculture	0	4	17	4	5	1	0	5	2	1	0	1
Spas/pools	10	6	57	18	36	19	12	13	18	11	6	16
Space heating	7	1	18	15	9	10	1	6	22	2	0	1
District heating	0	0	3	1	5	0	2	4	2	0	0	0
Industrial	0	0	1	0	0	1	0	0	1	0	0	0

Source: Oregon Institute of Technology 2008

Projected Applications Development

Quantitative estimates of the thermal energy of likely-to-be-developed direct use applications over the 2015 to 2025 timeframe are not available for the western US in the way that they are for indirect uses; however, for the US as a whole, the DOE National Renewable Energy Laboratory has developed estimates of thermal megawatts that are developable. It is estimated that by 2015, direct use applications could be developed in the amount of 1,600 thermal megawatts, and by 2025, this number is estimated to be 4,200 thermal megawatts (NREL 2006).

The cost in exploration of geothermal resources for direct use is a limiting factor in many direct use proposals. Drilling exploration wells is cost-intensive and there is no guarantee of finding a sufficient resource on first attempt. Unlike most geothermal electric power projects that are funded by corporations who can handle both the risk and substantial costs of exploration activities, most direct use projects are implemented by smaller companies or individual entrepreneurs or communities that have less financing and smaller projected profits.

Advances in exploratory technology and methodology as well as new grant programs to help project proponents get exploration underway could result in an acceleration of development of direct use applications across the western US.

Location of Development

Direct uses do not require the same high-temperature waters that are required for electricity generation; therefore, the geographic areas considered to have potential for direct use applications are much broader than the areas considered having potential for indirect use. The potential areas of development of direct use applications are indicated by the bounds of the geothermal potential map, developed as part of this PEIS (see Figures 1-5 and 1-6).

Direct use resources are more likely to be developed when they are in proximity to existing communities. In the 12 state project area, it is estimated that there are 293 "collocated" cities and communities with a combined population of 7.4 million that could potentially utilize geothermal heat through direct uses. The collocated communities counted here are defined as being within five miles of a known geothermal resource having a temperature of at least 122°F (50°C) (Oregon Institute of Technology 2008).

Typical Phases in Development

Phase One: Exploration

Existing direct use applications are largely collocated with, and draw directly from, existing surface geothermal manifestations such as hot springs, eliminating the need for most exploration activities. Exploration activities in the past have often been limited to water temperature and chemistry analysis.

Looking to the future, it is likely that most direct use applications will not be able to draw from existing surface manifestations as they have in the past. Surface manifestations such as naturally occurring hot springs have become increasingly sought after with increases in population in the western US, increased recreational use, and more stringent regulations preserving such resources for their recreational, cultural or scenic value. In such cases where surface manifestations are not nearby or are not being utilized directly, exploration activities similar to those described above for indirect use would also apply for direct use.

Phase Two: Drilling

In applications where a surface manifestation is used directly, the resource development phase involves installing piping into that manifestation to withdraw the hot water. For applications requiring the drilling of a well, drilling activities would be the same as described above under Phase Two for indirect use.

Phase Three: Utilization

The utilization phase typically lasts for several decades, if not longer. Activities associated with the production phase are generally limited to maintenance and repair activities of all components of the collection, distribution and injection/use/disposal system.

As described above for indirect use, the drilling of production wells may be necessary. Drilling activities would be similar to that discussed above in the drilling phase. Some applications may inject the post-use geothermal fluids back into the ground, in which case an injection well would be drilled and connected via piping to the application. In other applications where the spent geothermal fluids are discharged to a surface water body or used for some other purpose, then discharge piping, collection systems or distribution systems may need to be constructed. For such systems where the waters are not reinjected into the geothermal reservoir but are rather discharged or otherwise used, treatment systems may need to be installed to reduce levels of any naturally occurring but toxic chemicals present within the geothermal waters, such as mercury, arsenic and boron to meet applicable health or environmental standards.

Operation and maintenance of existing facilities and production of geothermal energy would also take place during the production phase. Activities associated with operation and maintenance and energy production would involve managing waste generated by daily activities, managing geothermal water, landscaping, and the maneuvering of construction and maintenance equipment and vehicles associated with these activities.

Phase Four: Reclamation and Abandonment

As described above for indirect use, this phase involves abandoning the well after production ceases and reclaiming all disturbed areas in conformance with BLM and FS standards. Abandonment includes plugging, capping, and reclaiming

the wells. Reclamation includes removing all surface equipment and structures, regrading the site to predisturbance contours, and replanting native vegetation.

Areas of Disturbance from Direct Use Applications

Surface disturbances for direct use are generally much less than for indirect use since direct uses are more likely to be located near existing communities with less of a need for new access roads. Also, since direct use applications utilize the geothermal energy on-site, there is no need for the construction of electrical equipment and transmission lines, except for bringing in electricity from the existing grid to the facility being constructed. Surface disturbances can still be expected for well pad development, site access, and construction of the facility utilizing the resource, although in some cases the facility may already exist and may simply be shifting its heat source to geothermal.

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