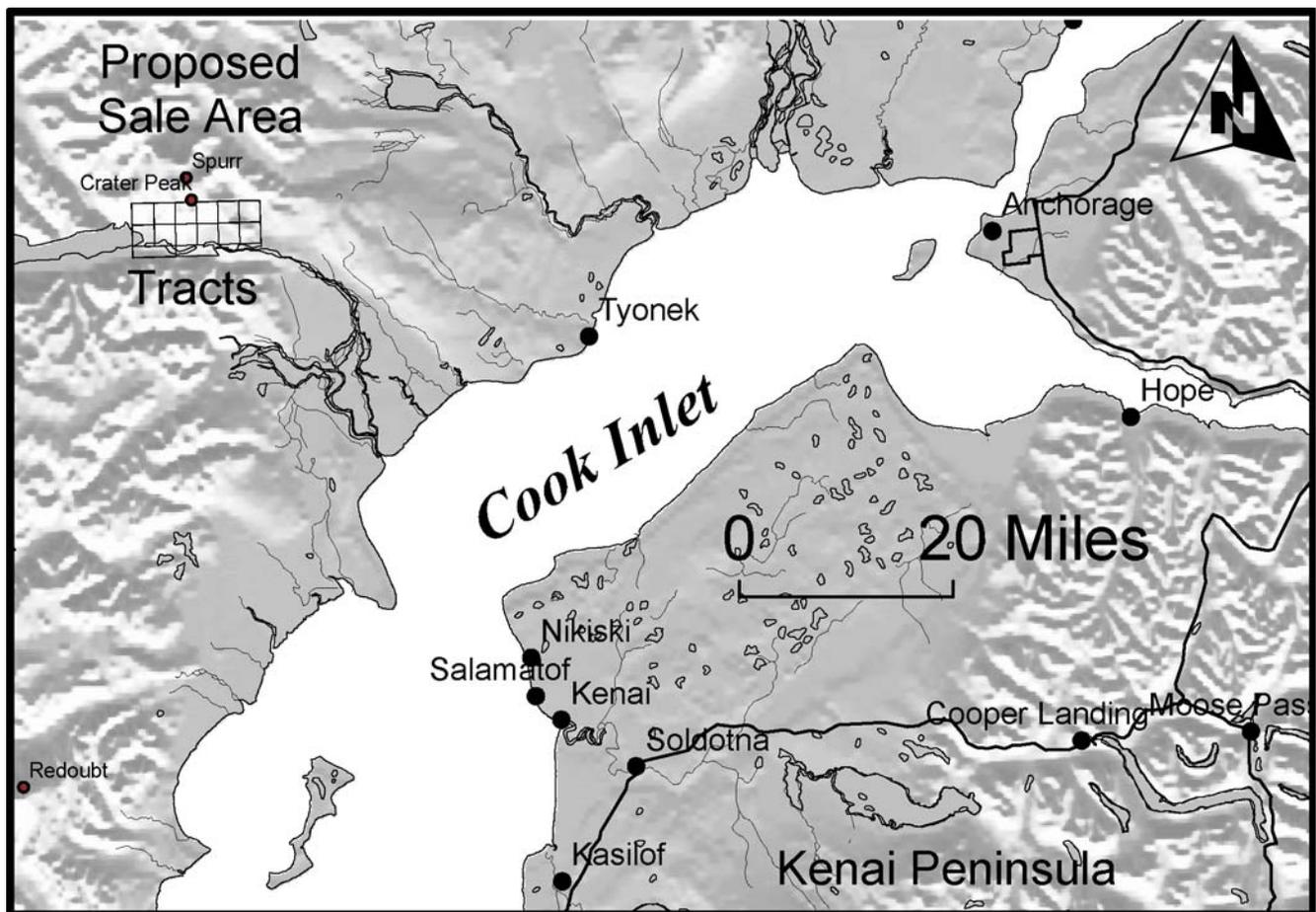


# Proposed Mount Spurr Geothermal Lease Sale No. 3 Preliminary Finding of the Director

December 27, 2007



Alaska Department of  
**NATURAL  
RESOURCES**  
DIVISION OF OIL & GAS



Proposed Mount Spurr Geothermal Lease Sale No. 3

Preliminary Finding of the Director

Prepared by  
Alaska Department of Natural Resources  
Division of Oil and Gas  
December 27, 2007



## Table of Contents

A.	Introduction .....	1
B.	Call for Applications and Comments .....	1
C.	Statutory Background .....	2
D.	Public Participation .....	2
E.	Best Interest Finding Scope of Review .....	3
F.	Final Best Interest Finding .....	3
G.	Description of the Sale Area .....	4
H.	Geology and Geophysics.....	6
I.	Habitat, Fish and Wildlife .....	6
J.	Current and Projected Use .....	7
K.	Reasonably Foreseeable Effects .....	11
L.	Transportation.....	13
M.	Geohazards .....	13
N.	Cumulative Effects.....	16
O.	Subsistence Use.....	18
P.	Economic Effects .....	21
Q.	Other Effects .....	21
R.	Mitigation Measures and Lessee Advisories.....	22
	<b>Mitigation Measures</b> .....	23
	1. Facilities and Operations .....	23
	2. Fish and Wildlife Habitat .....	25
	3. Subsistence, Commercial, and Sport Harvest Activities .....	26
	4. Fuel, Hazardous Substances, and Waste.....	27
	5. Access .....	28
	6. Prehistoric, Historic, and Archeological Sites.....	28
	7. Local Hire, Communication, and Training.....	29
	8. Definitions .....	29
	<b>Lessee Advisories</b> .....	30
	1. ADNR/OHMP .....	30
	2. ADEC .....	30
	3. ADLWD .....	31
	4. USCOE .....	31
	5. USFWS .....	31
	6. NMFS.....	32
S.	Bidding Method and Lease Terms .....	32
T.	Preliminary Decision .....	32
U.	Request for Comments.....	34

Appendix A: Summary of Comments and Responses (reserved for Final Finding) .....	36
Appendix B: Laws and Regulations Governing Geothermal Leasing and Development .....	37
Appendix C: Lease Contract (reserved for Final Finding) .....	38
Appendix D: References .....	39

### **Figures and Tables**

Figure 1 Mt. Spurr Geothermal Exploration Area .....	5
Figure 2 Land Status .....	8
Figure 3 Moose, Fish Habitat .....	9
Figure 4 Geese, Waterfowl .....	10
Figure 5 Existing and Proposed Development.....	14
Table 1. Annual Cycle of Seasonal Harvest Activities -- Tyonek, 1978-1982 .....	19

## **A. Introduction**

The State of Alaska proposes to offer approximately 36,057 acres in 16 tracts on the south flank of Mount Spurr for geothermal exploration and development in Mount Spurr Geothermal Lease Sale No. 3. (Figure 1). The proposed geothermal exploration area is located northwest of Trading Bay along the southern flank of Mount Spurr, including the east end of Chakachamna Lake and a portion of the Chakachatna River. The area lies entirely within the Kenai Peninsula Borough, approximately 40 miles west of the village of Tyonek.

Geothermal energy is heat taken from the earth. Geothermal energy resources include underground reservoirs of hot water or steam. Geothermal steam and hot water can reach the earth's surface in the form of hot springs, geysers, mud pots, or steam vents. These resources can be accessed by wells, and the heat energy used for generating electricity or for direct uses such as heating buildings, greenhouses, industrial processes, and aquaculture (BLM, 2007; Geothermal Resources Council, 2005). To be extractable, geothermal resources must be trapped in reservoirs near the surface of the earth.

Hot springs and fumaroles (vents in the earth's surface from which vapor and hot gas escape) are indicative of near-surface geothermal resources. Recently active volcanoes are also geothermal sites. Alaska's approximately 140 volcanoes (one-third of which are active) and more than 90 hot springs provide tremendous potential for geothermal development. The drawback is that many of the state's geothermal resources are far from population centers (USDOE, 2005). However, the proposed Mount Spurr geothermal lease sale's proximity to the Southcentral Alaska power grid makes it an exception.

Tracts in the Mount Spurr area were included in the state's first geothermal lease sale on June 22, 1982. Sixteen tracts were offered for lease the following year in Competitive Geothermal Lease Sale No. 1 (Mount Spurr). One tract (No. 9) received a bid. The lease for that tract was terminated in 1992.

On June 24, 1986, Competitive Geothermal Lease Sale No. 2 (Mount Spurr) was held. Two tracts totaling 2,640 acres were offered for competitive lease. The lease for Tract 1 expired in 1996, and the lease for Tract 2 was terminated in 1990.

## **B. Call for Applications and Comments**

The Alaska Department of Natural Resources (ADNR) issued a Call for Applications and Comments for the proposed Mount Spurr geothermal exploration area on April 9, 2007. The initial proposal included a small portion of land within in the Alaska Coastal Zone. ADNR has deleted all land within the coastal zone from its initial proposal (See Figure 1) and created a new tract from the remainder of an original tract bisected by the coastal zone. As a result, the proposed Mount Spurr Geothermal Lease Sale No. 3 is not subject to the policies of the Alaska Coastal Management Program (ACMP) or the Kenai Peninsula Borough Coastal Management Program (KPBCMP).

The ADNR Office of Habitat Management and Permitting submitted information on fish and wildlife in the proposed sale area and proposed mitigation measures. The Office of History and Archaeology asked to review all information pertaining to the proposed sale under the Alaska Historic Preservation Act. The Alaska Volcano Observatory provided information on Mount Spurr eruptions and seismic activity. The Homer Electric Association, Cook Inlet Keeper,

Michael O’Meara, and Susan Tierney submitted comments in support of exploration in the Mount Spurr area.

## **C. Statutory Background**

The Alaska Constitution provides that the state’s policy is “to encourage ... the development of its resources by making them available for maximum use consistent with the public interest” and that the “legislature shall provide for the utilization, development, and conservation of all natural resources belonging to the State ... for the maximum benefit of its people” (Alaska Constitution, Article VIII, §1 and 2). To comply with this provision, the Alaska State Legislature enacted Title 38 of the Alaska Statutes (AS 38) and directed ADNR to implement the statutes.

Alaska statutes govern the disposal of state-owned subsurface interests. Under AS 38.05.035(e), an ADNR director may not dispose of state land, resources, property, or interests, unless the director first determines in a written finding that such action will serve the best interests of the state. This written finding is known as a best interest finding and describes the sale area, analyzes the potential effects of the sale, describes mitigative measures, and constitutes the director’s determination that the disposal serves the state’s best interests.

Geothermal disposal procedures are set out in 11 AAC 84.700 – 11 AAC 84.790. To initiate a geothermal disposal, the state must designate tracts and issue a call for applications. After reviewing available geologic information and the response to the call for applications, the ADNR commissioner determines whether the tracts will be leased competitively or whether noncompetitive geothermal prospecting permits will be issued. Noncompetitive prospecting permits may be issued for tracts receiving only one application; tracts receiving two or more applications must be leased competitively. All tracts in the proposed Mount Spurr Geothermal Lease Sale No. 3 will be leased competitively.

All geothermal leases, whether awarded competitively or noncompetitively, are for a primary term of 10 years. Geothermal lease renewal and extension are set out in 11 AAC 84.745(a), which says:

If, at the expiration of the 10-year primary term of a geothermal lease, the lessee has begun operations necessary to drill a geothermal well using equipment located at the lease area of sufficient size and capacity to drill to the total depth proposed in the plan of exploration for the well, the commissioner will, in his discretion, extend the geothermal lease for one five-year term. In this subsection, “operations necessary to drill a geothermal well” includes drilling, re-drilling, sidetracking, or other techniques necessary to reach the bottom hole location proposed in the plan of exploration.

## **D. Public Participation**

Upon issuance of this preliminary best interest finding, ADNR will solicit public comments during a 30-day review period. This preliminary best interest finding is subject to revision based on comments received. Following review of comments on this document and any additional available information, the director will determine if the proposed Mount Spurr Geothermal Lease Sale No. 3 is in the state’s best interest and issue a final finding and decision. The final finding and decision is expected to be issued in March 2008.

## **E. Best Interest Finding Scope of Review**

The best interest finding scope of review is based upon the facts and issues known, or made known, to the director of DO&G (director). The scope of the administrative review and finding may address only reasonably foreseeable, significant effects of the uses proposed to be authorized by the disposal (AS 38.05.035(e)(1)(A)). Legislative history indicates that for an effect to be “reasonably foreseeable”: (1) there must be some cause/result connection between the proposed disposal and the effect to be evaluated; (2) there is a reasonable probability that the effect will occur as a result of the disposal; and (3) the effect will occur within a predictable time after the disposal. These constraints eliminate speculation about potential but improbable future effects and focus the best interest finding on those effects most likely to occur as a result of the proposed disposal. For example, at the time ADNR prepares a best interest finding, it is impossible to predict whether, when and where development or production, or related facilities might result

A reasonably foreseeable effect must also be “significant.” Significant means a known and noticeable impact on or within a reasonable proximity to the area involved in the disposal.

Public input assists in providing a body of information for the best interest finding review and analysis that is as complete as possible. Information provided by agencies and the public assist the director in:

- reviewing all of the facts and issues;
- determining which are material to the decision of whether to issue a lease;
- establishing the scope of the review for that decision by determining the reasonably foreseeable, significant effects of leasing that arise from those material facts and issues; and
- balancing those effects to determine under what conditions, if any, issuing a lease for the area will serve the best interests of the state.

## **F. Final Best Interest Finding**

Therefore, the scope of review in this preliminary finding is limited to the applicable statutes and regulations, the material facts and issues known to the director that pertain to the issuance stage, and the reasonably foreseeable, significant effects of leasing. A discussion of the possible specific effects of unknown future exploration, development and production activities is not within the scope of this finding. The effects of future exploration, development, and production will be considered at each subsequent stage, when various government agencies and the public review permit applications for specific proposed activities at specific locations. However, this finding does discuss, in general terms, the potential effects that may occur with geothermal Final Best Interest Finding

After a final best interest finding is issued, an individual or organization may request reconsideration at the agency level in accordance with AS 38.05.035(i). A request for reconsideration of a best interest finding must be filed with the ADNR commissioner within 20 days after issuance of the final best interest finding. In order to file a request for reconsideration, a person must have “meaningfully participated” in the administrative review process and must be

affected by the final decision.<sup>1</sup> The term “meaningfully participated” means that the person (1) submitted written comment during a public comment period or (2) presented oral testimony at a public hearing (AS 38.05.035(i)), if held.

A person may appeal to the superior court only if the person was eligible to request and requested reconsideration at the agency level. In addition, only those points raised in the request for reconsideration may be appealed (AS 38.05.035(l)). By requiring a party to exhaust the administrative review and reconsideration process before appealing to the superior court, the agency is given full opportunity to review, analyze, and respond to the concerns before litigation. For the purposes of review, the person appealing has the burden of establishing the invalidity of the finding (AS 38.05.035(m)).

## **G. Description of the Sale Area**

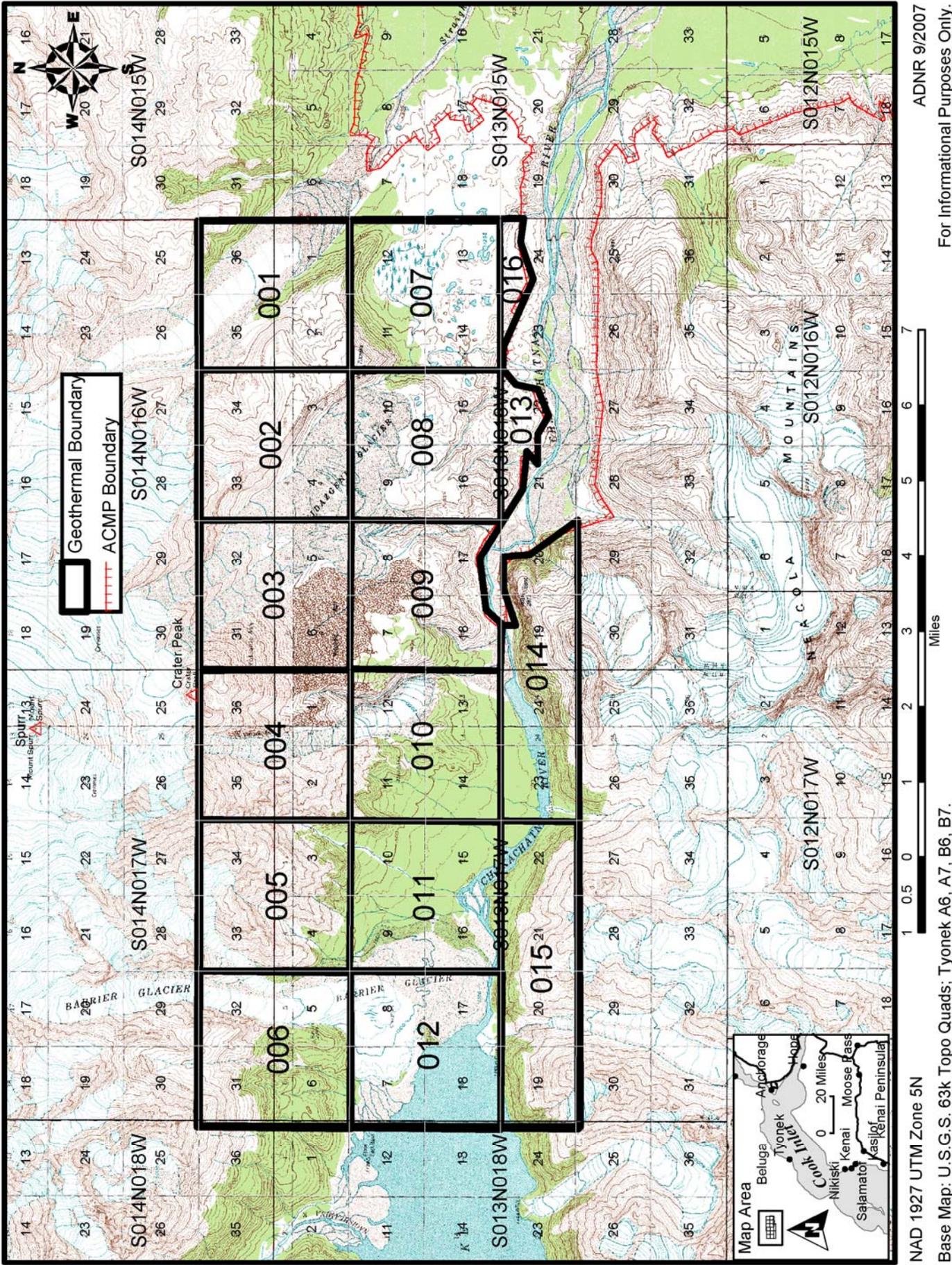
Located 80 miles from Anchorage on the west side of Cook Inlet, Mount Spurr (elevation 11,070 feet) is one of the northernmost peaks in the Aleutian Island-Alaska Peninsula volcanic arc. Much of the proposed sale area is currently or was recently glaciated; unglaciated portions comprise steep volcanic ash slopes. Lower elevations are usually gently sloping with thickets of alder. The state owns the sale area, including the lands in Power Site Classification (PSC) No. 395 (subject to Section 24 of the Federal Power Act of 1920), and the bed of the Chakachatna River (Figure 2). A hydroelectric application was filed with the Federal Energy Regulatory Commission on March 13, 2006. Section 24 of the Federal Power Act allows the federal government to enter upon, occupy, and use any part of the lands within the former classification for water power sites, water power development, or electrical transmission.

The Chakachamna Hydroelectric Project would be located at the existing Chakachamna Lake on the Chakachatna River. The proposed project would consist of a 49-foot-high, 600-foot-long rock-fill dam at the Chakachamna Lake outlet, a spillway, and a powerhouse containing four generating units with a total installed capacity of 330 megawatts. Two 230-kilovolt transmission lines, each approximately 42 miles long, would connect to existing power lines (FERC, 2006).

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<sup>1</sup> Alaska case law defines "a person affected by a decision" as someone who has a personal stake in the results of the decision. *Sisters of Providence v. Dept. of Health & Social Services*, 648 P. 2d 970, 974 (Alaska 1982).

**Figure 1 Mt. Spurr Geothermal Exploration Area**



ADNR 9/2007  
For Informational Purposes Only.

NAD 1927 UTM Zone 5N  
Base Map: U.S.G.S. 63k Topo Quads; Tyonek A6, A7, B6, B7.

Lands to the west of the sale area are in Lake Clark National Park and lands to the east are in Trading Bay State Game Refuge. The Bureau of Land Management and Cook Inlet Region Inc. own the remainder of land in the vicinity of the sale area (OHMP, 2007).

## **H. Geology and Geophysics**

Mount Spurr is an active snow- and ice-covered stratovolcano located on the west side of Cook Inlet; its most recent eruption occurred on September 16, 1992. Crater Peak, a small stratocone located about two miles from the summit on Mount Spurr's south flank, was the site of the 1992 eruption and a 1953 eruption and has been the active vent throughout most of the past 6,000 years (Waythomas and Nye, 2002).

Active volcanoes can be substantial sources of geothermal energy. The potential for discovery and development of exploitable reservoirs in the Mount Spurr area has long been considered worthy of further investigation, as witnessed by the previous geothermal exploration and development lease sales in 1983 and 1986, and by a multifaceted geophysical, geological, geochemical, and geothermal investigation in 1985. Because of persistent ice cover and the steep and dangerous topography at higher elevations, the prior two lease sales have offered acreage located only on Mount Spurr's southern flank. The proposed area for the current lease sale includes acreage offered in the previous two lease sales as well as additional surrounding acreage.

Geothermal energy potential is indicated by a discontinuous zone of weak thermal activity, including warm seeps, springs, and fumaroles, extending from south of Crater Peak to north of Mount Spurr (Wescott et al., 1985). Starting in 2004, increased heat flux at the summit of Mount Spurr began producing a melt-water lake. By March 2006, approximately 5.4 million cubic meters of melt-water volume had resulted from this increased heat flux in the area. This may be the result of non-eruptive shallow-level magmatic intrusion as recently as mid-2004 (Coombs et al., 2006).

In 1985, geophysical, geological, and geochemical surveys were conducted in the area of the current lease sale to explore for accessible geothermal energy resource prospects. Correlations between anomalous concentrations of mercury and helium in soil samples and self-potential and controlled-source audio-magnetotelluric resistivity (CSAMT) measurements were interpreted to mean that a geothermal reservoir having sufficient volume and temperature to warrant further investigation might exist (Wescott et al., 1988). One warm-spring and a series of seeps in a canyon on the southwest side of Crater Peak were first reported during this same study. The measured temperature of the warm spring and seeps was approximately 40°C. Total warm water flow for the entire valley bottom was estimated at 1,000 liters per minute (Wescott et al., 1988). Geothermal fluids were not directly sampled during this study and thermal spring waters from the flank of Crater Peak were too thoroughly mixed with meteoric water to permit estimation of reservoir temperature using standard chemical geothermometry.

## **I. Habitat, Fish and Wildlife**

The headwaters of Straight Creek, Stream No. 247-10-10080-2010-3040-4010, are in the sale area. Straight Creek is one of several clearwater tributaries to the glacially fed Chakachatna River (Stream No. 247-10-10080-2010). These clearwater streams support chinook salmon in the Chakachatna River drainage and sustain a small recreational chinook salmon fishery. The Chakachatna River system supports runs of five Pacific salmon species – coho, sockeye, chinook, pink, and chum – as well as Dolly Varden (ADF&G, 1994). The Chakachatna River is a major tributary of the MacArthur River. These rivers supply fresh water to the large tidal flat expanse

designated as Trading Bay State Game Refuge. This refuge was established to protect high-value waterfowl nesting, feeding, and migration areas; moose calving and overwintering areas; bear feeding areas; and salmon spawning and rearing habitat. Maintaining water quality is an important component of these habitats (OHMP, 2007).

Chakachamna Lake Stream No. 247-10-10080-2010-0010, on the west side of the lease area, provides spawning and rearing habitat for sockeye salmon. Sockeye salmon spawn in beach gravels as well as streambeds and juveniles typically rear in lake habitats for one to three years before out-migrating to salt water. Lake systems tend to be more productive than river systems for this species. Four cataloged anadromous streams outside the exploration area drain into Chakachamna Lake; salmon runs to these streams could be affected by changes in lake conditions (OHMP, 2007).

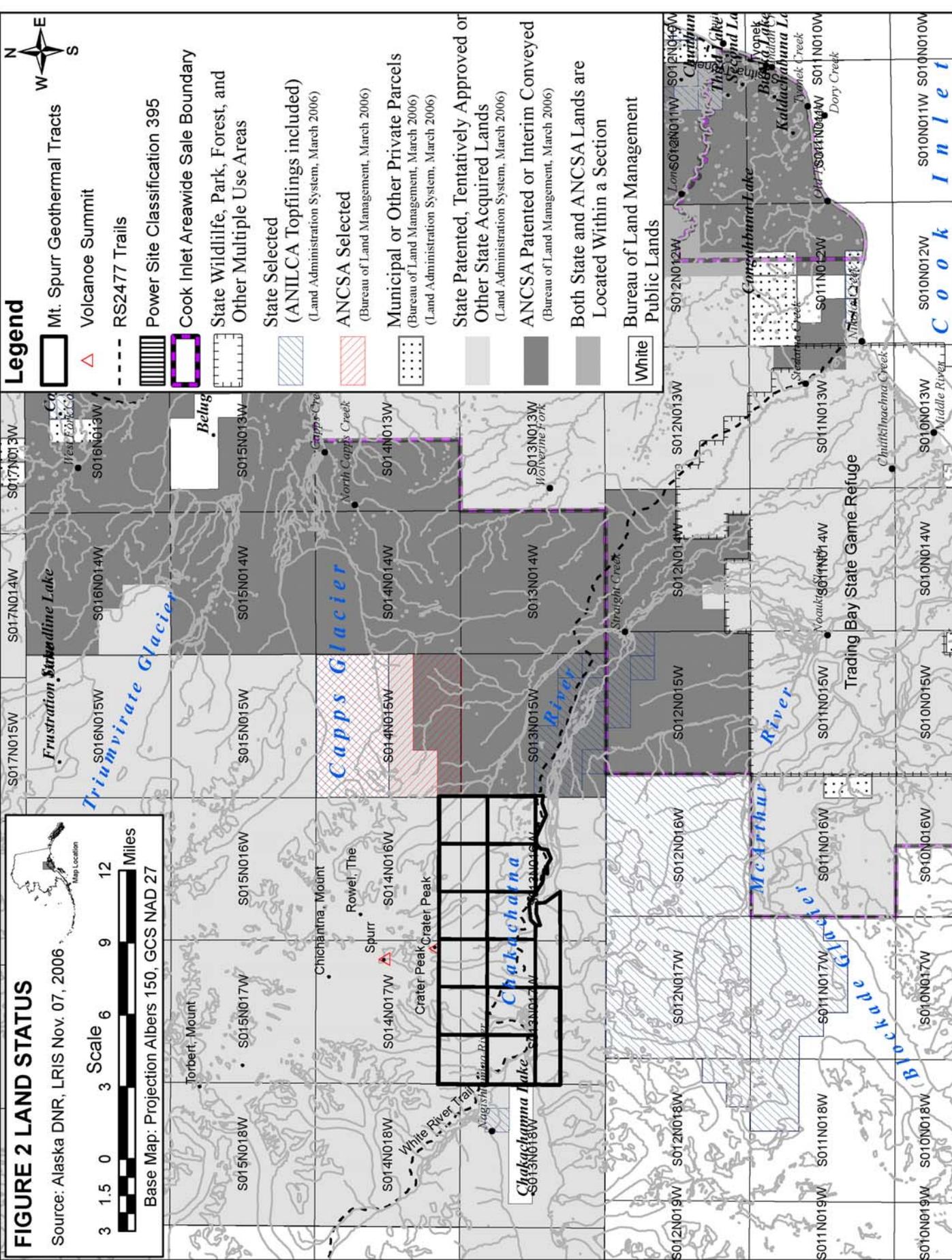
Black bear and moose are the most abundant large mammals in the sale area, and their occurrence is probably restricted to lower-elevation alder thickets near the Chakachamna River. The geothermal exploration area is located within Game Management Unit 16B. The moose population in this unit is subject to intense predation from brown and black bears and wolves and is managed in part for subsistence harvest by residents of Tyonek (Figure 3).

## **J. Current and Projected Use**

Tyonek, a coastal Dena'ina Athabascan community of 199 people, is the nearest settlement to Mount Spurr (CIS, 2006). Natural gas is being produced from 13 platforms in Cook Inlet, including locations at nearby Trading Bay and Granite Point. A gas-fired power plant, which provides electricity to Anchorage, is located seven miles northeast of Tyonek at Beluga. Commercially promising coal deposits are present between Mount Spurr and Tyonek, and coal development may occur within this decade

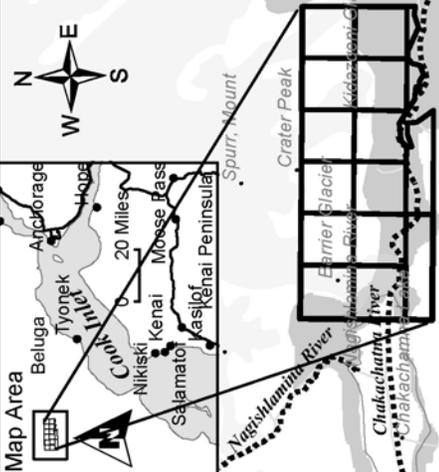
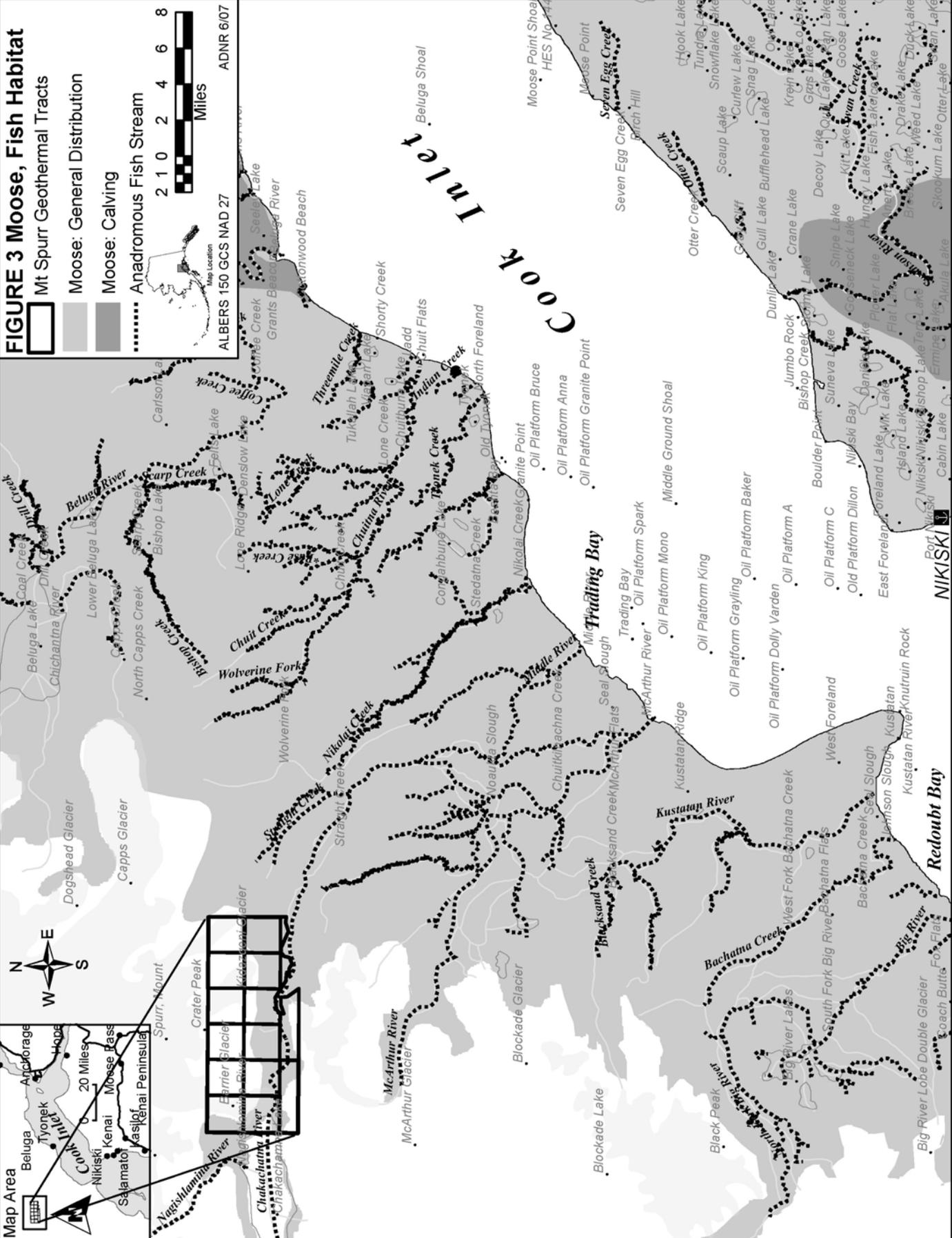
Most of the area around the Mount Spurr volcano is uninhabited wilderness. Recreational use of the area is minimal because of the remote location, although the area is visited by small groups of people in summer and winter. An oil pipeline crosses the Chakachamna River valley along the Cook Inlet coastline, and two villages, Tyonek and Shirleyville, are located near the valley. Life and property are not at risk in the immediate vicinity of the volcano. (USGS, 2002)

Although the Mount Spurr region is not connected by permanent road to the Alaska highway system, an extensive local road system exists within the region. A winter trail from Tyonek to the Parks Highway provides the only surface access route to Anchorage and other road-accessible parts of the state. Although nearshore Cook Inlet is shallow, the region is accessible by boat; a barge landing is present north of Tyonek and a lumber loading pier located south of Tyonek. Airstrips are maintained at Beluga and Tyonek; lakes and river bars are also used for landing sites.



**FIGURE 3 Moose, Fish Habitat**

-  Mt Spurr Geothermal Tracts
-  Moose: General Distribution
-  Moose: Calving
-  Anadromous Fish Stream





## **K. Reasonably Foreseeable Effects**

The director's decision that a geothermal lease sale best serves the state's interest is contingent upon analysis of the potential effects of the sale, both adverse and beneficial. Many of the potential adverse effects are avoidable, and the state imposes laws and regulations for this purpose. Some adverse effects are unavoidable. Of those, most can be lessened by mitigation measures imposed by the state; a few must be anticipated and balanced against the beneficial effects. This section of the director's best interest finding outlines the activities likely to occur as a result of this lease sale. It also discusses the potential environmental, social, and economic effects and the mitigation measures that will be imposed to reduce adverse effects. The magnitude of lease sale effects will depend upon whether commercial geothermal reservoirs are discovered and produced, the location of such reservoirs, the type and extent of facilities necessary for development, and the effectiveness of mitigation measures in negating undesirable impacts.

Although Mount Spurr is an active volcano and has potential as a substantial geothermal energy source, the presence of exploitable reservoirs remains unknown (Nye, pers. comm., 2007). Prediction of the activities resulting from this sale is difficult. Nonetheless, this discussion of potential effects will consider the effects of both exploration and development. Because Mount Spurr is remote, the likelihood that any geothermal resources would be used for space heating, ethanol production, or other direct uses is low. This discussion will assume that if development occurs, the geothermal energy produced will be converted to electricity.

The objectives of geothermal exploration are to locate hydrothermal reservoirs; to estimate the depth, volume, temperature, and permeability of such reservoirs; and to determine the chemical and physical nature of reservoir fluids. To meet these objectives, geothermal exploration uses geologic, hydrologic, geophysical, and geochemical techniques (ADNR, 1986).

Potential geothermal areas are first reconnoitered by geologic field crews. Prospective locations may be further explored using electrical and electromagnetic surveys. Passive seismic monitors that record seismic movements are often used to locate geothermal reservoirs. If a prospect remains attractive after reconnaissance, shallow holes are drilled to allow measurement of the temperature gradient. Such measurements indicate whether a heat source is present. Temperature gradient holes, which are typically 300-500 meters deep, can be drilled from portable, truck-mounted, or helicopter-lifted drill rigs. After surface exploration and shallow drilling have identified potentially commercial geothermal prospects, deep exploratory drilling is necessary. Only deep drilling, often of two or more wells, and well testing can prove the commercial viability of a geothermal system.

A commercial geothermal system is produced by numerous wells spaced over the reservoir. Optimum spacing, which varies widely among sites, is determined by the porosity and permeability of the reservoir rocks. At The Geysers, a dry steam field in California, optimum well spacing is one well per 40 acres; at other producing sites, wells have been spaced as closely as one well per two acres (ADNR, 1986). Producing wells are connected by gathering lines to nearby power plants.

Electrical generation using geothermal resources can be accomplished in several ways depending upon the temperature, pressure, and amounts of steam and water in the geothermal system. Most geothermal electrical generating plants are of three types: (1) dry steam, (2) flashed steam, or (3) binary cycle. All three power plant types use the geothermal resource to produce

steam to drive turbines. They also employ cooling towers to condense the steam, injecting the geothermal fluids back into the reservoir after use. Until more information is gathered during the exploratory and development phases, the precise technology that would be used is unknown. The principal differences among these power plants are in the manner of producing the steam.

- 1) The **dry steam** power plant is suitable where the geothermal steam is not mixed with water. Production wells are drilled down to the aquifer and the superheated, pressurized steam (180 ° - 350 ° C) is brought to the surface at high speeds and passed through a steam turbine to generate electricity. In simple power plants, the low-pressure steam output from the turbine is vented to the atmosphere, but more commonly, the steam is passed through a condenser to convert it to water. This improves the efficiency of the turbine and avoids the environmental problems associated with the direct release of steam into the atmosphere. The wastewater is then re-injected into the field via re-injection wells. Dry-steam power plants are the simplest and most economical technology, and therefore are widespread. The technology is well developed and commercially available (Murdoch University).
- 2) **Flashed steam** technology is used where the hydrothermal resource is in a liquid form and is the most common type of geothermal power plant. The fluid is sprayed into a flash tank, which is held at a much lower pressure than the fluid, causing it to vaporize (or flash) rapidly to steam. The steam is then passed through a turbine coupled to a generator as for dry steam plants. To prevent the geothermal fluid flashing inside the well, the well is kept under high pressure. The majority of the geothermal fluid does not flash, and this fluid is re-injected into the reservoir or used in a local direct heat application. Alternatively, if the fluid remaining in the tank has a sufficiently high temperature, it can be passed into a second tank, where a pressure drop induces further flashing to steam. This steam, together with the exhaust from the principal turbine, is used to drive a second turbine or the second stage of the principal turbine to generate additional electricity (Murdoch University, 2006).
- 3) **Binary cycle** plants are used to generate electricity from low-temperature geothermal fluids or where corrosion or scaling problems prevent direct use. In a binary cycle, hot water from the wells is gathered and delivered to a heat exchanger located at the power plant site. The heat exchanger transfers heat from the hot water to a secondary fluid, such as iso-butane or iso-pentane. After flowing through the heat exchanger, the cooled geothermal water is sent to injection wells, where it is returned to the reservoir. The hot secondary fluid flashes into a vapor and passes through a turbine. Electricity is created from a generator attached to the turbine shaft. After passing through the turbine, the secondary fluid is condensed into a liquid, and the process is repeated (BLM, 2007).

Under AS 41.06.060, geothermally heated fluids are considered a leasable resource only if their temperature is above 120° Celsius. Only dry steam plants can use geothermal resources at that temperature. The flashed-steam and binary cycle plants are designed to exploit lower temperature resources. Thus, if geothermal resources as defined by AS 41.06.060 are discovered on Mount Spurr tracts, the energy would most likely be converted to electricity using a dry-steam plant.

Producing geothermal fields generally require little maintenance. With remote monitoring and control equipment, a small staff can operate power plants from a central location, and only a few people are needed to control and service the producing wells. At some geothermal fields, inorganic salts in the geothermal fluids cause scaling of the equipment, and greater maintenance requirements.

The following discussion of potential effects will identify those statutes and regulations (see Appendix B) that address the potential impacts of geothermal exploration and development in the Mount Spurr area. This discussion will also identify those stipulations and terms of sale that address potential impacts not explicitly covered by existing laws.

## **L. Transportation**

Geothermal energy is unique because it must be used or converted to electricity within a few miles of its recovery from the ground. Compared to other fuels, geothermal resources can only be transported a relatively short distance. It is likely that a power plant would be built near the geothermal heat source and a power line constructed to tie into the existing electrical grid. The gas-fired Beluga power plant, with transmissions lines to Anchorage, is located approximately seven miles northeast of Tyonek (Figure 5). Underwater cables in Cook Inlet carry power between Point MacKenzie and Point Woronzof in Anchorage.

## **M. Geohazards**

Spurr is an active volcano, with all or most eruptions in the past several thousand years coming from Crater Peak, a vent on the south flank of the volcano. In 1953, a single explosive eruption produced significant ash fall in the Anchorage area. The eastern half of the Mount Spurr Geothermal Exploration Area was heavily blanketed with ash. Also during that eruption, a slurry of mud, sand, gravel, and boulders descended the south flank of Crater Peak and dammed the Chakachatna River. That dam is still in place, and is why the river upstream of the center of Exploration Area Tract 014 is wider than the river downstream. Such dams sometimes impound great quantities of water, which are subsequently released as floods when the dams fail catastrophically. Geologic evidence suggests that similar, larger dams have formed and failed in the past. The floodplain of the Chakachatna River is at risk of similar floods following future eruptions (DGGS, 2007).

In 1992, three explosive eruptions occurred, separated by 4-7 weeks. These eruptions produced significant ash fall up to 700 km (400 miles) downwind, and produced drifting ash clouds that disrupted air traffic in the northeastern United States. In the Geothermal Exploration Area, these eruptions produced pyroclastic flows and lahars on the southern flanks of Crater Peak; a zone of impact of ballistic blocks (each tens of centimeters in diameter) that covered much of Tract 003; and thick local ash fall (DGGS, 2007).

In 2004, increased seismicity and heat flux at the summit of Mount Spurr (instead of the usual eruptive vent, Crater Peak) culminated in the melting of a large volume of ice and the formation of the first recorded crater lake at the summit of Mount Spurr. Significant volumes of



presumably magmatic gasses were emitted. This activity did not escalate into an eruption, and appears to be waning somewhat at present. However, significant seismic unrest continues. The Alaska Volcano Observatory (AVO) considers eruptions from Crater Peak or (less likely) Mount Spurr summit to be a virtual certainty in the more distant future (DGGs, 2007).

The current level of unrest probably does not presage conditions under which geothermal prospecting would be unduly hazardous. If prospecting were to be undertaken over a period of days or weeks, AVO would be willing to set up communications protocols with prospectors to keep them apprised of any significant changes in the status of the volcano. If a geothermal resource were to be discovered, then hazards from future eruptions should be considered prior to the development of infrastructure for the exploitation of that resource (DGGs, 2007).

These unique features of geothermal resource use influence the potential environmental effects, which include: landslides, subsidence, increased seismicity, thermal and chemical water pollution, air pollution, noise, and disturbance to fish and wildlife. These potential effects and the means to prevent or mitigate their impacts at Mount Spurr are discussed below.

1) Volcanic Hazards. Volcanic hazards include volcanic-ash clouds, volcanic-ash fallout and falling rock debris, lava flows and lahars. Lahars are formed when hot volcanic debris interacts with snow and ice to form fast-moving slurries of water, mud, rocks, and sand. Lahars, which typically follow streams and drainages, are expected to form during most future eruptions of Crater Peak and would be a hazard to people and facilities in the Chakachatna River valley. Pyroclastic flows typically travel along valleys and low-lying topography, but remain a significant hazard to people or facilities within close proximity to the volcano.

Additional, although less likely, hazards include debris avalanching wherein a rapidly moving mass of rock, initiated by a large-scale failure of the volcano flank, travels rapidly downhill. A large prehistoric debris avalanche occurred at Mount Spurr and extended approximately 20 kilometers beyond the base of the volcano, blocking the Chakachatna River. Directed blasts are lateral, rather than vertical, volcanic explosions usually initiated by a slope failure or landslide on the flanks of a volcano and remain a potential threat in the Mount Spurr vicinity. Volcanic gas venting can build to toxic levels in the absence of wind and migrate downhill, accumulating in valleys or along low points. Although unlikely, volcanic gases could pose a threat to people working in valleys or low points below the volcano. Finally, the potential for lava flows to travel a few kilometers from the Crater Peak vent remains a possible threat to any facilities or people in the area (Waythomas and Nye, 2002).

Gases are emitted by most active volcanoes because magma contains dissolved gases and boils off shallow ground water that is typically present within volcanoes. The most common volcanic gases are water vapor, carbon dioxide, carbon monoxide, sulfur dioxide, and hydrogen sulfide (USGS, 2002).

2) Landslides. Geothermal resources are often located under steep terrain, and development requires substantial excavation to prepare facility sites. As a consequence of excavation, erosion and landslides could occur. Slopes underlain by weak bedrock can be a serious engineering and environmental problem.

The Mount Spurr geothermal disposal area comprises steep slopes. Some slopes are composed of volcanic ash and could be unstable. Design and construction of all drill pads built as

a result of this disposal must be approved (via plans of operations) by ADNR, and sound engineering practices will be required to prevent poor siting of facilities.

3) Subsidence. In hydrothermal fields, land subsidence is a potential effect of development. Typically, hydrothermal fields are over-pressured, and the water in the reservoir supports the overburden. Unless pressures are maintained, subsidence could occur. Whether geothermal development at Mount Spurr would cause subsidence is unknown. If hydrothermal resources are discovered at Mount Spurr, lessees will be required by Mitigation Measure 1.1. to conduct a second order survey of the land surface prior to and during production to determine whether subsidence has occurred. If production results in subsidence, and if subsidence is hazardous to production operations or adjoining land uses, the lessee will be required, as necessary, to adjust production and injection rates or to suspend operations.

4) Induced Seismicity. Geothermal fields are typically located in seismically active areas or along active faults. Because geothermal resource extraction redistributes fluid pressure in the reservoir, earthquakes could be triggered. Mount Spurr is in an active seismic area, and seismic effects are possible. Increased seismicity could be hazardous to production operations and adjoining land uses. Therefore, the state may install seismographs or other instruments in producing fields to detect induced seismic activity. If geothermal production induces increased seismicity, and if induced seismicity could be hazardous, lessees will be required, as necessary, to adjust production and injection rates or to suspend operations under Mitigation Measure 1.m.

## **N. Cumulative Effects**

This geothermal lease sale is one of many developmental activities occurring in the Cook Inlet region (Figure 5). Ongoing activities include oil and gas exploration and development in Cook Inlet, construction of the Point MacKenzie Industrial Port, and gas-fired electric power generation at Beluga. Proposed projects include:

- Pebble Mine Project
- State oil and gas lease sales (Cook Inlet Areawide held annually)
- Federal OCS oil and gas lease sales
- Chuitna Coal Project
- Knik Arm Crossing
- Chakachatna Hydroelectric Project

Although it is unclear how many of these projects may actually occur, infrastructure developed for one project may make other projects more feasible.

At the lease sale phase, the Division of Oil and Gas cannot predict when any exploration or development activity might occur or the type, location, duration, or level. Therefore, it is impossible to predict the potential effects of all possible activities. General mitigation measures and licensee advisories have been developed to minimize pollution and habitat degradation, and disturbance to fish and wildlife species, subsistence users, and local residents. In addition, project-specific and site-specific mitigation measures will be applied to exploration and development proposals when submitted. Despite these protective measures, impacts may occur.

1) Water Quality. Pollution from most sources can be easily circumvented by requiring the proper care and disposal of offending substances. Per the Clean Water Act, disposal of produced waters will be by subsurface disposal techniques, and surface discharge of reserve pit

fluids will be prohibited unless authorized (Lessee Advisory 3.b). Solid waste disposal restrictions are addressed by Mitigation Measure 4. Except for non-condensable gases, substantially all chemical effluents are dissolved in geothermal wastewater. Effluents comprise many chemical species of which arsenic, mercury, radon, hydrogen sulfide, carbon dioxide, and silica could produce significant environmental impacts (ibid).

Geothermal wastewater is also hot, and disposal to surface waters could cause thermal pollution (ADNR, 1986). Lessee Advisory 2.b.iii. requires that all produced waters be disposed by subsurface techniques, thus the potential impacts of disposing of geothermal wastewater into surface waters will be prevented. Geothermal drilling and conservation regulations will also help prevent pollution by setting standards for geothermal drilling procedures, including selection of casing, cementing and blowout prevention.

Although non-condensable gases, primarily carbon dioxide, form a negligible part of the steam produced from geothermal wells, hydrogen sulfide may be present in hazardous concentrations (ADNR, 1986). Geothermal producers must comply with state air quality standards (18 AAC 50.010 – 18 AAC 50.990), and any geothermal power plants built in the Mount Spurr area as a result of this sale will be required to use sulfur abatement technologies. Current regulations and abatement technologies should be adequate to prevent significant deterioration of air quality in the Mount Spurr area if geothermal development occurs.

Loss of well control from blowouts could result in geothermal fluid spills. However, lessees will be required by regulation 11 AAC 87.130 to use blowout prevention equipment, which will reduce the probability of spills. While the probability of a geothermal well blowout and consequent geothermal fluid spills is low, the probability is not zero; thus, the state will require in Lessee Advisory 2.a. that lessees submit and gain approval of a geothermal spill contingency plan from the Department of Environmental Conservation. Contingency plans must detail how lessees will prevent, control, and clean up accidental releases of geothermal fluids. Such plans should decrease the risk of a geothermal fluid spills in the sale area.

2) Air Quality. While geothermal energy generates minimal emissions compared to fossil fuels, exploration, development, and operation of this renewable resource would be responsible for minor amounts of air pollutants. Diesel exhaust from construction and drilling equipment and dust from road and well pad construction and use would contribute air pollutants to the region. However it is expected that any incremental increases in pollution not have a significant cumulative impact on air quality (BLM, 2007).

3) Noise. Noise impacts associated with the geothermal exploration and development would be related to noise generated during construction and subsequent operation of the proposed geothermal facilities. The principal noise sources during construction would be construction equipment. New noise sources during operations would be vehicles and aircraft that would access the geothermal well sites and energy-generating facilities as well as noise from the turbines and other infrastructure. These noise sources would be an intensification of use on land primarily used for off-highway vehicle recreational use.

Well operations and energy generation would also contribute to increased noise levels. The principal noise sources would be turbine. Mufflers can be used to reduce noise from geothermal operations. The potential power plants would be sited in terrain designed to reduce noise and visual impacts to the greatest extent possible, which could further reduce noise levels (BLM, 2007).

Under Mitigation Measure 1.a., the plan of operations must describe the lessee's efforts to minimize impacts on residential, commercial, and recreational areas. Mitigation Measure 1.b. requires lessees to minimize sight and sound impacts for new facilities sited in areas of high commercial, recreational, and subsistence use and important wildlife habitat.

4) Disturbances to Fish and Wildlife. Because the tracts are located at relatively high elevations, few animals reside there. Although geothermal exploration could disturb moose, black bear, and other wildlife species, such disturbance would be temporary. Geothermal development, however, could result in permanent displacement of these animals from part of the sale area because development may affect many acres (ADNR, 1986).

Geothermal well spacing can be dense — up to one well per two acres, and wells are connected by gathering lines to power plants. Development could therefore present a maze of well pads and pipelines, and large mammals could be displaced from the developed area. Mitigation Measure 1.c. prohibits facilities within 500 feet of all fish-bearing streams and water bodies. Mitigation Measure 1.g. is designed to allow free movement and safe passage of mammals. Temporary wildlife displacement may occur due to power line construction should a geothermal development yield marketable quantities of electricity. Since drilling rigs and other facilities would require gravel bases, Mitigation Measure 1.i. prohibits gravel mining within active river floodplains and restricts upland sites to the minimum necessary.

Because few large mammals reside in the sale area, and because of the mitigation measures listed, any displacement from geothermal development areas would probably have a negligible effect on regional populations of animals (ADNR, 1986). Chakachamna Lake and Chakachamna River are important salmon habitat. If geothermal wastewater were to enter the Chakachamna-Chakachamna system, the fishery resource could be impacted. Mitigation Measure 1.c. restricts the siting of facilities within 500 feet of the Chakachamna River. Lessee Advisory 2.b. prohibits discharge of produced waters into freshwater bodies and disposal of produced waters will be by subsurface disposal techniques. Lessee Advisory 2.a. requires that lessees have an approved geothermal discharge prevention plan.

## **O. Subsistence Use**

Tyonek is the nearest settlement to the sale area. Because of its proximity, Tyonek will be the settlement most affected by geothermal exploration and development at Mount Spurr. Tyonek has a mixed cash-and-subsistence economy.

Residents of Tyonek harvest fish, wildlife, and vegetation from the Susitna River south to Tuxedni Bay, with harvest effort concentrated in areas west and south of Tyonek. Although Tyonek residents harvest a wide variety of subsistence resources, moose and salmon are the most important. Traditionally, beluga whales have also been harvested, though declining beluga numbers in Cook Inlet in recent years have led to proposals to list Cook Inlet belugas under the federal Endangered Species Act. In 2007, Tyonek residents joined efforts to help Cook Inlet beluga stocks regenerate by agreeing to halt subsistence hunting of the animals (NOAA Fisheries, 2007). Other plants and animals harvested for subsistence include waterfowl, grouse, black bear, clams, hooligan, seal, porcupine, berries, celery, and rhubarb. The annual round of harvests by Tyonek residents is depicted in Table 1.

**Table 1: Annual Cycle of Seasonal Harvest Activities – Tyonek, 1978-1982**

	Spring		Summer			Fall		Winter				
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
King Salmon												
Red Salmon												
Chum Salmon												
Pink Salmon												
Silver Salmon												
Hooligan												
Herring												
Rainbow trout												
Dolly Varden												
Tomcod												
Razor Clam												
Butter Clam												
Redneck Clam												
Cockle												
Beluga												
Harbor Seal												
Brown bear												
Black bear												
Moose												
Porcupine												
Snowshoe hare												
Beaver												
Mink												
Fox												
Otter												
Coyote												
Marten												
Spruce Grouse												
Ptarmigan												
Ducks												
Geese												
Berries												
Edible Plants												
Medicinal Plants												
Coal												
Wood												



Occasional Harvest  
Usual Harvest

Source: Fall, Foster, and Stanek 1983: Figure 3; Fall 1983: Figure 37; Foster 1982b: Figure 20.  
Stephen R. Braund & Associates, 2006.

A subsistence set-gillnet fishery provides for the harvest of salmon. Chinook salmon are an important part of the subsistence harvest because of their early arrival and large size. Coho salmon are harvested for both subsistence and commercial sale, whereas sockeye, pink, and chum salmon are harvested mostly for commercial sale. Twenty residents hold commercial fishing permits (DCED, Community Database 2007). Dolly Varden, char, rainbow trout, eulachon (hooligan), and clams are also important items of the Tyonek diet. Black bear, porcupine, grouse, ptarmigan, waterfowl, and marine mammals are harvested on an opportunistic basis during fall hunts (ADNR, 1999).

Fishing for coho salmon continues into September. Dolly Varden and rainbow trout are caught throughout the summer from local streams, using rod and reel (ADF&G, 1985).

In September, harvest efforts concentrate on moose. Access to moose hunting areas is through a network of local logging roads or by boat to nearby river drainages. Fall moose hunts frequently combine fishing and gathering activities.

Firewood is gathered throughout the year, but wood gathering intensifies around October. Gathering of edible plants such as wild celery, wild rhubarb, and rosehips occurs during the summer. Berries picked in season include high- and low-bush cranberries, salmonberries, blueberries, and crowberries (ADNR, 1999).

Winter is a time of relatively low activity in the annual cycle of subsistence life for West Cook Inlet residents. Hunting for ptarmigan, spruce grouse, and hare continues through the winter, and trout are caught through the ice. A few Tyonek residents trap furbearers beginning in mid-November and continuing throughout the winter months. Trapping for beaver continues into March (ADNR, 1999).

Social relationships, especially kinship, shape harvest and processing activities as well as distribution and exchange of fish and game resources in Tyonek. Facilities and equipment such as fish camps, nets, vehicles, and smokehouses are commonly shared, and wildlife resources are widely distributed throughout the village. Distribution of products occurs from the harvester to recipients, such as the elderly or sick, who do not have the means to produce the products themselves (ADNR, 1999). Resources are also shared at potlatches during special social events such as weddings, birthdays, and funerals (ADNR, 1999).

Most households participate in several subsistence activities. Since contact with outside cultures, Native subsistence lifestyles have been offset by cash economy. Currently, employment in Tyonek is seasonal and limited to commercial fishing, government-subsidized jobs, and recreational hunting and fishing guide services. To a large extent, Tyonek residents have remained dependent on local fish and game for food, and this dependence is culturally important. Sharing of food gathered in Tyonek subsistence harvests is well documented (Stickney 1980; Stanek and Foster 1980). This sharing reaffirms social relationships among villagers, and is a primary reason Tyonek culture has retained its Tanaina character (ADNR, 1999). Continued subsistence will be critical to Tyonek wellbeing.

Most Tyonek subsistence activities occur near the coast and in the McArthur River floodplain. A few moose, black bear, and brown bear are harvested from the Mount Spurr area; however, the sale area is outside of important subsistence hunting zones. Therefore, Tyonek subsistence should not be directly affected by geothermal development at Mount Spurr. Geothermal development could indirectly affect Tyonek subsistence if new Mount Spurr residents hunt in areas currently used for that purpose. Roads between Tyonek and the Chakachatna River would likely be improved if geothermal development occurs. While improved access could provide greater hunting opportunities for Tyonek residents, improved access, in conjunction with increased regional population, could also increase competition for wildlife. Despite more than 200 years of outside influence, Tyonek culture retains its Tanaina heritage. Geothermal development and support facilities will likely be 30 to 40 miles from Tyonek, and contact between Tyonek residents and geothermal employees should be minimal (ADNR, 1986). Further, Mitigation Measure 7.c. requires lessees' employees to be informed of the environmental, social, and cultural concerns of the sale area. Such orientation should help increase understanding of community values, customs, and lifestyles.

## **P. Economic Effects**

Programs to explore, locate, and develop leasable minerals and energy sources that may provide new state revenue sources are essential to the development of a diversified state economic base. This lease sale is part of such a program. If geothermal development occurs as a result of this sale, the growth of other industries could be stimulated by geothermally-generated electricity and by geothermal-related infrastructure.

Geothermal development at Mount Spurr could also help satisfy the increasing demand for electricity in the Southcentral Alaska. Currently, most Southcentral electrical demand is met by natural-gas fired power plants. However, natural gas reserves in the Cook Inlet region are finite. Thus, Southcentral Alaska must eventually look to other energy sources to satisfy future demand, and geothermal development at Mount Spurr could be such a source.

Because the geothermal industry is relatively new to Alaska, state revenues invested to promote geothermal resource development will probably not be recouped until the industry matures. Direct economic benefits from the Mount Spurr geothermal lease sale will not be achieved unless development occurs. If geothermal resource development occurs in the sale area, revenues from lease rentals, production royalties, and taxes will accrue to the state. Taxes will also accrue to the Kenai Peninsula Borough, although compared to oil and gas revenues, geothermal revenues will likely be a modest addition to state and borough funds. Employment opportunities associated with Mount Spurr development will probably be limited. As previously stated, producing geothermal fields require little maintenance. With remote monitoring and control equipment, a small staff can operate power plants from a central location, and only a few people are needed to control and service the producing wells. Thus, geothermal development at Mount Spurr will create few long-term jobs. However, construction activities would temporarily employ a greater number of people. Mitigation Measure 7.a. encourages lessees to employ local and Alaska residents.

In addition to addressing the immediate energy needs of local communities, geothermal energy also offers the potential for communities to expand their industrial and employment base by providing a stable source of competitive electric energy to energy-intensive users (USDOE, 2005).

## **Q. Other Effects**

1) Public Access. Continued use of the sale area for activities such as hunting and fishing will depend on continued access. Under Mitigation Measure 5.c., public access to the sale area may not be restricted except within 1,500 feet of drill sites, buildings, or other related facilities. Additionally, no facilities or operations may be located where they would block public access to or along navigable and public waters as defined in AS 38.05.965(13) and AS 38.05.965(18). If facilities are to be located near public waters, an easement will be reserved under AS 38.05.127 and 11 AAC 51.045 to ensure the right of public access. However, the Federal Energy Regulatory Commission may restrict access within power-site classification No. 395 if a hydroelectric project is constructed.

2) Third-Party Interests. Surface and subsurface interest holders other than lessees will be protected by AS 38.05.130, which provides for compensation if geothermal exploration or development damages the other interest owners. If only the subsurface estate is owned by the state, or if the surface is owned by the state but subject to third-party interests, the lessee must not

enter upon such land until the lessee makes a good-faith effort to agree with the surface interest holder on settlement of damages that may be caused by lease activities.

3) Historic and archeological sites. The disposal area contains no documented historic or archeological sites, and has a low potential for containing other cultural resources. However, if a site, structure, or object of prehistoric, historic, or archaeological significance is discovered during permit/lease operations, the lessee must report the discovery to the director as soon as possible and take steps to protect it under Mitigation Measure 6.

## **R. Mitigation Measures and Lessee Advisories**

Alaska Statute (AS) 38.05.035(e) and the departmental delegation of authority provide the director, Division of Oil and Gas (DO&G) [“director”], with the authority to impose conditions or limitations, in addition to those imposed by statute, to ensure that a resource disposal is in the state’s best interests. Consequently, to mitigate the potential adverse social and environmental effects of specific permit/lease-related activities, DO&G has developed mitigation measures and will condition plans of operation, exploration, or development and other permits based on these mitigation measures.

Lessees must obtain approval of a detailed plan of operations from the director before conducting exploration, development, or production activities. A plan of operations must identify the sites for planned activities and the specific measures, sequence, and schedule of operations, design criteria, transportation activities, construction methods and operational standards to be employed to comply with the restrictions listed below. It must also address any potential geophysical hazards that may exist at the site.

These measures were developed after considering terms imposed in earlier geothermal disposals, competitive oil and gas lease sales, and comments and information submitted by the public, local governments, environmental organizations, and other federal, state, and local agencies. Additional measures will likely be imposed when lessees submit a proposed plan of operations.

Lessees must comply with all applicable local, state, and federal codes, statutes and regulations, as amended; all current or future ADNR area plans and recreation rivers plans; and ADF&G game refuge plans, critical habitat area plans, and sanctuary area plans within which a permit/lease area is located.

The director may grant exceptions to these mitigation measures. Exceptions will only be granted upon a showing by the lessee that compliance with the mitigation measure is not feasible and prudent or that the lessee will undertake an equal or better alternative to satisfy the intent of the mitigation measure. Requests and justifications for exceptions must be included in the plan of operations. The decision whether to grant an exception will be made during the public review of the plan of operations.

Abbreviations mean: Alaska Department of Environmental Conservation (ADEC), Alaska Department of Fish and Game (ADF&G), Alaska Department of Labor and Workforce Development (ADLWD), Alaska Department of Natural Resources (ADNR) ADNR commissioner (commissioner), Division of Forestry (DOF), Division of Mining, Land and Water (DMLW), Division of Oil and Gas (DO&G), Division of Parks and Outdoor Recreation (DPOR), Kenai Peninsula Borough (KPB), National Marine Fisheries Service (NMFS), Office of Habitat Management and Permitting (OHMP), Office of Project Management and Permitting (OPMP);

State Historic Preservation Officer (SHPO), U.S. Army Corps of Engineers (USCOE), and U.S. Fish and Wildlife Service (USFWS), and U.S. Bureau of Land Management (BLM).

## **Mitigation Measures**

### **1. Facilities and Operations**

- a. A plan of operations must be submitted and approved before conducting exploration, development, or production activities, and must describe the lessee's efforts to minimize impacts on residential, commercial, and recreational areas, Native allotments and subsistence use areas. At the time of application, the lessee must submit a copy of the proposed plan of operations to the KPB and all surface owners whose property will be entered.
- b. Facilities must be designed and operated to minimize sight and sound impacts in areas of high commercial, recreational, and subsistence use and important wildlife habitat. Methods may include providing natural buffers and screening to conceal facilities, sound insulation of facilities, or by using alternative means approved by the Director, in consultation with OHMP.
- c. To the extent feasible, the siting of facilities will be prohibited within 500 feet of all fish-bearing streams and water bodies and 1,500 feet from all current surface drinking water sources. Facilities may be sited within these buffers if the lessee demonstrates to the satisfaction of the director, in consultation with OHMP, that site locations outside these buffers are not feasible and prudent or that a location inside the buffer is environmentally preferred. Road, utility, and pipeline crossings must be consolidated and aligned perpendicular or nearly perpendicular to watercourses.
- d. Measures will be required, in consultation with OHMP and ADEC, to minimize the impact of industrial development on key wetlands. Lessees must identify on a map or aerial photograph the largest surface area, including reasonably foreseeable future expansion areas, within which a facility is to be sited, or an activity will occur. The map or photograph must accompany a plan of operations. DO&G will consult with OHMP and ADEC to identify the least sensitive areas within the area of interest. To minimize impacts, the lessee must avoid siting facilities in the identified sensitive habitat areas. Further, all activities within wetlands require permission from the U.S. Army Corps of Engineers (see Lessee Advisories).
- e. With the exception of drill pads, airstrips, and roads permitted under Mitigation Measure 5.a., exploration facilities must be consolidated, temporary, and must not be constructed of gravel unless the director determines that no feasible and prudent alternative exists. Reuse of abandoned gravel structures may be permitted on a case-by-case basis by the director, after consultation with the director, DMLW, and OHMP. Approval for use of abandoned structures will depend on the extent and method of restoration needed to return these structures to a usable condition.
- f. Where feasible and prudent, onshore pipelines must be located on the upslope side of roadways and construction pads, unless the director of DMLW determines that an alternative site is environmentally acceptable. All pipelines must be designed, constructed

and maintained to assure integrity against climatic conditions, tides and current, geophysical hazards, corrosion, and other hazards as determined on a case-by-case basis.

- g. Wherever possible, onshore pipelines must utilize existing transportation corridors and be buried where soil and geophysical conditions permit. In areas where pipelines must be placed above ground, pipelines must be sited, designed, and constructed to allow free movement of large mammals. Lessees shall consider increased snow depth in the sale area in relation to pipe elevation to ensure adequate clearance for wildlife. ADNR may, after consultation with OHMP, require additional measures to mitigate impacts to wildlife movement and migration.
- h. The State of Alaska discourages the use of continuous-fill causeways. Environmentally preferred alternatives for field development include use of buried pipelines, onshore directional drilling, or elevated structures. Approved causeways must be designed, sited, and constructed to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics (e.g., salinity, temperature, suspended sediments) that result in exceedances of water quality criteria, and must maintain free passage of marine and anadromous fish.
  - ii. Causeways and docks shall not be located in river mouths or deltas. Artificial gravel islands and bottom-founded structures shall not be located in river mouths or active stream channels on river deltas, except as provided for in (iii).
  - iii. Each proposed structure will be reviewed on a case-by-case basis. Causeways, docks, artificial gravel islands and bottom-founded structures may be permitted if the director, in consultation with OHMP, ADEC, and the KPB determines that a causeway or other structures are necessary for geothermal development and that no feasible and prudent alternatives exist. A monitoring program may be required to address the objectives of water quality and free passage of fish, and mitigation shall be required where significant deviation from objectives occurs. (See also Lessee Advisories regarding U.S. Army Corps of Engineers requirements.)
- i. Gravel mining within an active floodplain is prohibited. Gravel mining in upland sites will be restricted to the minimum area necessary to develop the field in an efficient manner.
- j. Dismantlement, Removal and Rehabilitation (DR&R): Upon abandonment of material sites, drilling sites, roads, buildings or other facilities, such facilities must be removed and the site rehabilitated to the satisfaction of the director, unless the director, in consultation with DMLW, OHMP, ADEC, and any affected local borough, and any non-state surface owner, determines that such removal and rehabilitation is not in the state's interest.
- k. Wherever possible, transmission lines must utilize existing transportation corridors and must be designed and constructed so as to minimize impacts to fish and wildlife movement. Minimizing impacts may include burying lines, consolidating stream crossing structures, using building standards contained in "2006 Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006" produced by the Avian Power Line Interaction Committee (available at [www.aplic.org/](http://www.aplic.org/)), or similar measures.

- l. Lessees must conduct a second order survey of the land surface prior to and during hydrothermal resources production to determine any elevation changes. If production results in subsidence and if subsidence is determined to be hazardous to geothermal production operations or adjoining land uses, the director, will require lessees adjust production and injection rates or to suspend operations.
- m. The state may install seismographs or other instruments in producing geothermal fields to detect induced seismic activity. If geothermal production induces increased seismicity and if induced seismicity is determined to be hazardous to geothermal production operations or adjoining land uses, the director, will require lessees adjust production and injection rates or to suspend operations.

## **2. Fish and Wildlife Habitat**

- a. Use of explosives will be prohibited in open water areas of fish-bearing streams and lakes. Explosives must not be detonated beneath, or in close proximity to fishbearing streams and lakes if the detonation of the explosive produces a pressure rise in the waterbody greater than 2.7 pounds per square inch (psi) unless the water body, including its substrate, is solidly frozen. Explosives must not produce a peak particle velocity greater than 0.5 inches per second (ips) in a spawning bed during the early stages of egg incubation. Blasting criteria have been developed by ADF&G and are available upon request from ADF&G or OHMP. The location of known fish-bearing waters within the project area can be obtained from the OHMP.
- b. Removal of water from fish-bearing rivers, streams, and natural lakes shall be subject to prior written approval by DMLW and OHMP.
- c. Water intake pipes used to remove water from fish-bearing water bodies must be surrounded by a screened enclosure to prevent fish entrainment and impingement. Screen mesh size shall be no greater than 0.1 inches and the maximum water velocity at the surface of the screen enclosure may be no greater than 0.2 feet per second unless another size or velocity has been approved by OHMP. Screen material must be corrosion resistant, and must be adequately supported to prevent excessive sagging which could result in unusable intake surface. The intake structure must be designed and installed to avoid excessive fouling from floating debris, and a minimum of eight square feet of effective wetted screen surface must be provided for each multiple of a 450-gallon per minute (one cubic foot per second) pumping rate. The pump intake opening must be placed equidistant from all effective wetted screen surfaces.
- d. Compaction or removal of snow cover overlying fish bearing rivers, streams and natural lakes shall be prohibited, except for approved crossings. If ice thickness is not sufficient to facilitate a crossing, ice or snow bridges may be required.
- e. Surface entry will be prohibited within one-quarter mile of trumpeter swan nesting sites April 1 through August 31. The siting of permanent facilities, including roads, material sites, storage areas, power lines, and above-ground pipelines will be prohibited within one-quarter mile of known nesting sites. Location of trumpeter swan nesting sites can be obtained from ADF&G.

- f. Bears:
- i. Before commencement of any activities, lessees shall consult with ADF&G to identify the locations of known bear den sites that are occupied in the season of proposed activities. Exploration and development activities between November 15 and March 31 must not be conducted within one-half mile of occupied brown bear dens, unless alternative mitigation measures are approved by ADF&G. A lessee who encounters an occupied brown bear den not previously identified by ADF&G must report it to the Division of Wildlife Conservation, ADF&G, within 24 hours. Mobile activities shall avoid such discovered occupied dens by one-half mile unless alternative mitigation measures are approved by the director, with concurrence from ADF&G. Non-mobile facilities will not be required to relocate.
  - ii. For projects in close proximity to areas frequented by bears, lessees are required to prepare and implement bear interaction plans to minimize conflicts between bears and humans. These plans should include measures to:
    - A. Minimize attraction of bears to drill sites.
    - B. Organize layout of buildings and work areas to minimize interactions between humans and bears.
    - C. Warn personnel of bears near or on facilities and the proper procedures to take.
    - D. If authorized, deter bears from the facilities.
    - E. Provide contingencies in the event bears do not leave the site.
    - F. Discuss proper storage and disposal of materials that may be toxic to bears.
    - G. Provide a systematic record of bears on site and in the immediate area.
- g. The director, in consultation with OHMP, shall restrict or modify lease-related activities if scientific evidence documents the presence of Steller's eider from the Alaska breeding population in the area and it is determined that geothermal activities will impact them or their overwintering habitat in the nearshore waters of Cook Inlet.

### **3. Subsistence, Commercial, and Sport Harvest Activities**

- a. Exploration, development, and production operations shall be conducted in a manner that prevents unreasonable conflicts between lease-related activities and subsistence activities. Lease-related use will be restricted when the director determines it is necessary to prevent conflicts with local subsistence, commercial, and sport harvest activities. In enforcing this term, DO&G will consult with other agencies, the affected local borough(s), and the public to identify and avoid potential conflicts. In order to avoid conflicts with subsistence, commercial, and sport harvest activities, restrictions may include alternative site selection, requiring directional drilling, seasonal drilling restrictions, and other technologies deemed appropriate by the director.
- b. Prior to submitting a plan of operations for either onshore or offshore activities which have the potential to disrupt subsistence activities, the lessee shall consult with the potentially affected subsistence communities and the KPB (collectively "parties") to discuss the siting, timing, and methods of proposed operations and safeguards or mitigating measures which could be implemented by the operator to prevent unreasonable conflicts. The parties shall also discuss the reasonably foreseeable effect on subsistence activities of any other operations in the area that they know will occur during the lessee's

proposed operations. Through this consultation, the lessee shall make reasonable efforts to assure that exploration, development, and production activities are compatible with subsistence hunting and fishing activities and will not result in unreasonable interference with subsistence harvests.

- c. A discussion of agreements reached or not reached during the consultation process and any plans for continued consultation shall be included in the plan of operations. The lessee shall identify who participated in the consultation and send copies of the plan to participating communities and the KPB when it is submitted to the division.
- d. If the parties cannot agree, then any of them may request the commissioner of ADNR, or his/her designee, to intercede. The commissioner may assemble the parties or take other measures to resolve conflicts among the parties.
- e. The lessee shall notify the director of all concerns expressed by subsistence hunters during operations and of steps taken to address such concerns.
- f. Traditional and customary access to subsistence areas shall be maintained unless reasonable alternative access is provided to subsistence users. "Reasonable access" is access using means generally available to subsistence users.

#### **4. Fuel, Hazardous Substances, and Waste**

- a. Secondary containment shall be provided for the storage of fuel or hazardous substances.
- b. Containers with an aggregate storage capacity of greater than 55 gallons that contain fuel or hazardous substances shall not be stored within 100 feet of a water body or within 1,500 feet of a current surface drinking water source.
- c. During equipment storage or maintenance, the site shall be protected from leaking or dripping fuel and hazardous substances by the placement of drip pans or other surface liners designed to catch and hold fluids under the equipment, or by creating an area for storage or maintenance using an impermeable liner or other suitable containment mechanism.
- d. During fuel or hazardous substance transfer, secondary containment or a surface liner must be placed under all container or vehicle fuel tank inlet and outlet points, hose connections, and hose ends. Appropriate spill response equipment, sufficient to respond to a spill of up to five gallons, must be on hand during any transfer or handling of fuel or hazardous substances. Trained personnel shall attend transfer operations at all times.
- e. Vehicle refueling shall not occur within the annual floodplain, except as addressed and approved in the plan of operations. This measure does not apply to waterborne vessels.
- f. All independent fuel and hazardous substance containers shall be marked with the contents and the lessee's or contractor's name using paint or a permanent label.
- g. A freshwater aquifer monitoring well, and quarterly water quality monitoring, is required down gradient of a permanent storage facility, unless alternative acceptable technology is approved by ADEC.

- h. Waste must be reduced, reused, or recycled to the maximum extent practicable. Garbage and domestic combustibles must be incinerated whenever possible or disposed of at an approved site in accordance with 18 AAC 60. (See Lessee Advisories, ADEC.)
- i. New solid waste disposal sites will not be approved or located on state property during the exploratory phase of lease activities. Disposal sites may be provided for drilling waste if the facility complies with 18 AAC 60. (See Lessee Advisories, ADEC.)
- j. Impermeable lining and diking, or equivalent measures, such as double-walled tanks, will be required for sewage ponds and sumps. Additional site-specific measures may be required as determined by ADNR, with the concurrence of ADEC, and will be addressed in the existing review of project permits or C-Plans. Buffer zones of not less than 500 feet will be required to separate sewage ponds from marine waters and freshwater supplies, streams and lakes, and key wetlands.
- k. Proper disposal of garbage and putrescible waste is essential to minimize attraction of wildlife. The lessee must use the most appropriate and efficient method to achieve this goal.

## **5. Access**

- a. Onshore activities must be supported by air service, an existing road system or port facility, ice roads, or by vehicles that do not cause significant damage to the ground surface or vegetation. Unrestricted surface travel may be permitted by the director and the director of DMLW, if an emergency condition exists, or if it is determined, after consulting with OHMP, that travel can be accomplished without damaging the ground surface or vegetation.
- b. Construction of temporary roads may be allowed. Temporary means that a road must be removed to the extent that it is rendered impassable or is otherwise rehabilitated in a manner such that any placed gravel remaining approximates surrounding natural features. Construction of permanent roads will be prohibited during the exploration phase.
- c. Public access to, or use of, the lease area may not be restricted, except within 1,500 feet of drill sites, buildings, and other related facilities. Areas of restricted access must be identified in the plan of operations. Lease facilities and operations shall not be located so as to block access to or along navigable or public waters, as defined in AS 38.05.

## **6. Prehistoric, Historic, and Archeological Sites**

- a. Prior to the construction or placement of any structure, road, or facility resulting from exploration, development, or production activities, the lessee must conduct an inventory of prehistoric, historic, and archeological sites within the area affected by an activity. The inventory must include consideration of literature provided by the KPB, nearby communities, Native organizations, and local residents; documentation of oral history regarding prehistoric and historic uses of such sites; evidence of consultation with the Alaska Heritage Resources Survey and the National Register of Historic Places; and site surveys. The inventory must also include a detailed analysis of the effects that might result from the activity.

- b. The inventory of prehistoric, historic, and archeological sites must be submitted to the director and to SHPO, who will coordinate with the KPB for review and comment. If a prehistoric, historic, or archeological site or area could be adversely affected by a permit/lease activity, the director, after consultation with SHPO and the KPB, will direct the lessee as to the course of action to take to avoid or minimize adverse effects.
- c. If a site, structure, or object of prehistoric, historic, or archaeological significance is discovered during permit/lease operations, the lessee must report the discovery to the director as soon as possible. The lessee must make reasonable efforts to preserve and protect the discovered site, structure, or object from damage until the director, after consultation with the SHPO and the KPB, has directed the lessee as to the course of action to take for its preservation.

## **7. Local Hire, Communication, and Training**

- a. Lessees are encouraged to employ local and Alaska residents and contractors, to the extent they are available and qualified, for work performed in the lease area. Lessees shall submit, as part of the plan of operations, a proposal detailing the means by which the lessee will comply with the measure. The proposal must include a description of the operator's plans for partnering with local communities to recruit, hire, and train local and Alaska residents and contractors. The lessee is encouraged, in formulating this proposal, to coordinate with employment and training services offered by the State of Alaska and local communities to train and recruit employees from local communities.
- b. A plan of operations application must describe the lessee's past and prospective efforts to communicate with local communities and interested local community groups.
- c. A plan of operations application must include a training program for all personnel, including contractors and subcontractors. The program must be designed to inform each person working on the project of environmental, social, and cultural concerns that relate to that person's job. The program must use methods to ensure that personnel understand and use techniques necessary to preserve geological, archeological, and biological resources. In addition, the program must be designed to help personnel increase their sensitivity and understanding of community values, customs, and lifestyles in areas where they will be operating.

## **8. Definitions**

- a. In this document:
  - i. "Facilities" means any structure, equipment, or improvement to the surface, whether temporary or permanent, including, but not limited to, roads, pads, pits, pipelines, power lines, generators, utilities, airstrips, wells, compressors, drill rigs, camps and buildings.
  - ii. "Feasible and prudent" means consistent with sound engineering practice and not causing environmental, social, or economic costs that outweigh the public benefit to be derived from compliance with the standard.
  - iii. "Important wetlands" means those wetlands that are of high value to fish, waterfowl, and shorebirds because of their unique characteristics or scarcity in the region or that have been determined to function at a high level using the hydrogeomorphic approach.

- iv. “Minimize” means to reduce adverse impacts to the smallest amount, extent, duration, size, or degree reasonable in light of the environmental, social, or economic costs of further reduction.
- v. “Plan of operations” means a lease plan of operations under 11 AAC 83.158 and a unit plan of operations under 11 AAC 83.346.
- vi. “Secondary containment” means an impermeable diked area or portable impermeable containment structure capable of containing 110 percent of the volume of the largest independent container plus 12 inches of freeboard. Double walled tanks do not qualify as secondary containment unless an exception is granted for a particular tank.
- vii. “Temporary” means no more than 12 months.

## **Lessee Advisories**

Lessee advisories are intended to alert lessees to possible additional restrictions that may be imposed at the permitting stage of a proposed project or activity within permit/lease areas, especially where entities other than DO&G have permitting authority.

### **1. ADNOR/OHMP**

- a. Under the provisions of Title 41 of the Alaska Statutes, the measures listed below may be imposed by OHMP below the ordinary high watermark to protect designated anadromous fish-bearing lakes and streams and to ensure the free and efficient passage of fish in all fish-bearing water bodies. Exceptions to these requirements, including exceptions for the use of spill containment and recovery equipment, may be allowed on a case-by-case basis. Specific information on the location of anadromous water bodies in and near the area may be obtained from OHMP.
  - i. Alteration of riverbanks may be prohibited.
  - ii. The operation of equipment within riparian habitats will be prohibited. The operation of equipment, excluding boats, in open water areas of rivers and streams will be prohibited.
  - iii. Bridges or non-bottom founded structures may be required for crossing fish spawning and important rearing habitats.
  - iv. Culverts or other stream crossing structures must be designed, installed, and maintained to provide free and efficient passage of fish.
- b. Removal of water from fish-bearing water bodies requires prior written approval by DMLW and OHMP.
- c. Forest clearing must be approved by the director, after consultation with DOF and OHMP.
- d. The director, in consultation with OHMP, may impose seasonal restrictions on activities located in and adjacent to important waterfowl and shorebird habitat during the plan of operations approval stage.
- e. In populated areas where there is no local planning and zoning, ADNOR may, in approval of plans of operation, require that permanent structures be designed to be compatible with the aesthetics of the surrounding area.

### **2. ADEC**

- a. A spill prevention control and countermeasure plan must be submitted to the Alaska Department of Environmental Conservation for approval prior to geothermal drilling

operations. In addition to addressing the prevention of geothermal effluents, the plan must describe how a spill response would occur, a prevention plan to describe the spill prevention measures taken at the facility, and supplemental information to provide background and verification information.

- b. Wastewater (per Clean Water Act, 33 U.S.C. 1251 et seq):
  - i. Unless authorized by NPDES and/or state permit, disposal of wastewater into intertidal areas, estuarine waters, or freshwater bodies, including Class III, IV, VI and VIII wetlands, is prohibited.
  - ii. Unless authorized by an ADEC permit, disposal of produced waters into freshwater bodies, intertidal areas, and estuarine waters is prohibited.
  - iii. If authorized by ADEC and EPA, disposal of produced waters in upland areas, including wetlands, will be by subsurface disposal techniques. ADEC may permit alternate disposal methods if the lessee demonstrates that subsurface disposal is not feasible or prudent.
  - iv. Surface discharge of reserve pit fluids will be prohibited unless authorized in a permit issued by ADEC or EPA and approved by DMWL.
  
- c. Discharge of drilling muds and cuttings into lakes, streams, rivers, and high-value wetlands is prohibited. Surface discharge of drilling muds and cuttings into reserve pits shall be allowed only when it is determined that underground injection is not technically achievable. A solid-waste disposal permit must be obtained from ADEC. If use of a reserve pit is proposed, the operator must demonstrate the advantages of a reserve pit over other disposal methods, and describe methods to be employed to reduce the disposed volume. On-pad temporary cuttings storage will be allowed as necessary to facilitate annular injection and/or backhaul operations in accordance with 18 AAC 60.

### **3. ADLWD**

- a. The lessee shall facilitate Alaska resident hire monitoring by reporting project wages on a quarterly basis for each individual employed by the permittee/lessee in the permit/lease area, through electronic unemployment insurance reporting, and by requiring the same of the lessee's contractors and subcontractors.

### **4. USCOE**

- a. Any activity involving wetland-related dredge or fill activities, or construction in navigable waters of the United States, requires a permit from the USCOE.

### **5. USFWS**

- a. The lessee is advised that the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 et seq.), protects endangered and threatened species and candidate species for listing that may occur in the lease area. Lessees shall comply with the Recommended Protection Measures developed by the USFWS to ensure adequate protection for all endangered, threatened, and candidate species.
  
- b. Lessees are advised of the need to comply with the Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703), which is administered by the USFWS. Under the Migratory Bird Treaty

Act, it is illegal to “take” migratory birds, their eggs, feathers or nests. “Take” is defined (50 CFR 10.12) to include “pursuing, hunting, shooting, wounding, killing, trapping, capturing, or collecting.” The MBTA does not distinguish between “intentional” and “unintentional” take. Migratory birds include songbirds, waterfowl, shorebirds, and raptors. In Alaska, all native birds except grouse and ptarmigan (which are protected by the State of Alaska) are protected under the MBTA.

In order to ensure compliance with the MBTA, it is recommended that lessees survey the project area prior to construction, vegetation clearing, excavation, discharging fill or other activities which create disturbance, and confirm there are no active migratory bird nests. It is recommended that lessees contact the USFWS for assistance and guidance on survey needs, and other compliance issues under the Migratory Bird Treaty Act. While the USFWS can recommend methods (such as surveys and timing windows) to avoid unintentional take, responsibility for compliance with the MBTA rests with lessees.

- c. Lessees are advised that they must comply with the provisions of the Marine Mammal Protection Act of 1972, as amended (16 USC 1361-1407). USFWS shares authority for marine mammals with the NMFS.
- d. Lessees are advised that they must comply with the provisions of the Bald Eagle Act of 1940, as amended.

## **6. NMFS**

- a. NMFS shares authority for marine mammals with the USFWS, per the Marine Mammals Protection Act of 1972 (16 USC 1361-1407).

## **S. Bidding Method and Lease Terms**

The economic and geologic parameters of this geothermal lease sale are largely unknown. Mount Spurr is considered a geothermal prospect primarily because it is an active volcano with a few known surface “hot spots.” Whether there is a geothermal reservoir near the surface will not be known until thermal gradient holes are drilled.

Leases will be awarded to the qualified bidder submitting the highest bonus bid per acre. In selecting the bidding method ADNR will consider and balance the following state interests: protecting the state’s ownership interest in geothermal resources; promoting competition among individuals seeking to explore and develop the area; encouraging orderly and efficient exploration and development; and generating revenue for the state for the use of state geothermal resources. The annual rental fee is \$3 per acre in accordance with AS 38.05.181(e). Under AS 38.05.181(f), the initial lease term is ten years. This time period is sufficient to formulate environmentally sensitive, economically efficient exploration strategies and commence drilling operations. The minimum bonus bid per acre and royalty will be disclosed in the sale announcement.

## **T. Preliminary Decision**

Before a lease sale may be held, the director must determine that the sale best serves the interests of the state after considering the sale’s effects, both adverse and beneficial. The director must also consider the effectiveness of lease terms and stipulations in mitigating potential adverse effects. If the sale could result in one or several unmitigable adverse effects, the director may still

conclude that the sale serves the state's best interests if the potential benefits will outweigh the potential impacts.

Known human activities in the sale area are currently few. There are few sport and no commercial harvests of fish and game; there are few, if any, recreational visits to the sale area. Some Tyonek residents may enter the sale area on subsistence hunting trips, but most Tyonek subsistence use occurs outside of the sale area. Because few people enter the sale area, lease activities should not significantly affect current human activities in the Mount Spurr area.

The state's geothermal minerals program is designed to promote the orderly development of the state's natural resources. Mount Spurr is a promising geothermal resource and is near an existing electrical transmission system. Because geothermal energy must be usable or convertible to a usable form at the site, the presence of transmission lines will greatly increase the logistic and economic feasibility of developing any geothermal resources discovered at Mount Spurr. Although this lease sale probably will not produce significant revenue or jobs, the sale could result in a source of energy for electrical generation for Southcentral Alaska. Although current electrical demand is met by natural gas, gas reserves are finite and eventually Southcentral Alaska will have to find another energy source. Geothermal development resulting from this lease sale could contribute to the area's future energy supplies.

If resources are discovered, development of geothermal resources at Mount Spurr will take many years. If geothermally generated electricity is to provide part of the Cook Inlet region's energy supply as natural gas reserves are depleted, exploration must begin soon. Finding and delineating the reservoir is the first step to development. Exploration resulting from this lease sale will indicate whether a geothermal reservoir is present at Mount Spurr. Because of the long time needed to develop a geothermal field, it is important to lease now so that serious exploration may continue.

Development of the sale area alone will have the potentially limited impacts discussed in this document. The director must also consider sale impacts within the context of prior and projected western Cook Inlet development projects. Because Mount Spurr has an unknown geothermal potential and is adjacent to a major power plant at Beluga, the incremental impact of this geothermal lease sale is likely to be small. However, this lease sale will add to the cumulative impacts of all past and future Cook Inlet development.

No activity may occur without further review and proper authorization from the appropriate permitting agency. Lessees are required to submit plans of operation, exploration and development for approval before different phases of the project begin. When lessees propose specific activities, more detailed information such as site, type, and size of facilities will be known, in addition to the historical project data. Except for some very limited types of proprietary information, permit applications are public information and most permitting processes include public comment periods. The department may impose additional terms in any subsequent permits when applied for if additional issues are identified at that time.

Developing the state's geothermal resources may benefit the state's economy and the well being of its citizens. With the proposed mitigation measures presented in this preliminary finding imposed on leases and plans of operation, and additional project-specific and site-specific mitigation measures imposed in response to specific proposals, the geothermal resources of the sale area can likely be explored and developed without significantly affecting fish and wildlife populations or traditional human uses. The state has sufficient authority through general constitutional, statutory and regulatory empowerments, the terms of the sale, the lease contract,

and plan of operations permit terms to ensure that lessees conduct their activities safely and in a manner that protects the integrity of the environment and maintains opportunities for subsistence and all other concurrent uses.

On the basis of the facts and issues presented at this time, the foregoing findings, applicable laws and regulations, and the documents reviewed during preparation of this preliminary finding, I conclude, as a preliminary matter, that the potential benefits of the sale, as conditioned, outweigh the possible adverse impacts, and that the Mount Spurr Geothermal Lease Sale 3 will best serve the interests of the state of Alaska.

## U. Request for Comments

Government agencies, members of the public, environmental organizations, and industry are invited to comment on any part of this document. In commenting on this preliminary finding please be as specific as possible. Deletion of any tract or land within a tract does not constitute a significant change to the proposed offering and therefore does not require additional public notice. **Comments must be received by January 28, 2008 in order to be considered and must be sent to the following address:**

**Division of Oil and Gas  
550 W. 7th Ave. Suite 800  
Anchorage, AK 99501-3560  
ATTN: Greg Curney**

Comments must be in writing and may be submitted by mail, in person, via courier (Suite 800, 550 W. 7th Ave, Anchorage), by FAX (907-269-3484), or by e-mail to [greg.curney@alaska.gov](mailto:greg.curney@alaska.gov)

Following review of comments on this document and any additional available information, the Director will determine if the proposed lease sale is in the state's best interests and issue a final finding and decision. If a finding is made that the proposed lease sale serves the best interests of the state, the final finding and decision document will list mitigation measures to be imposed on the lessees and indicate the terms of the lease sale.

Any decision regarding whether to hold the proposed sale will be made with the advance knowledge and concurrence of the Commissioner, ADNR.

In accordance with AS 38.05.035, a person is eligible to file a request for reconsideration and subsequently an appeal to the superior court of a best interest finding decision if the person has meaningfully participated in the process by submitting written comment during the public comment period.

*Signed by:*

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Kevin R. Banks, Acting Director

December 27, 2007



**Appendix A Summary of Comments and Responses**

*Reserved for Final Finding*

**Appendix B: Alaska Statutes and Regulations Governing Geothermal Leasing and Development**

AS 38.05.130 –38.05.145	
AS 38.05.181 – AS 38.05.182	
AS 38.05.965	
AS 41.06.010 – AS 41.06.060	
AS 41.08.020	
44.81.350	
AS 44.46.028	
AS 46.03.299	
AS 46.03.900	
11 AAC 05.010	
11 AAC 87.010 – 11 AAC 87.290	
11 AAC 55.075	
11 AAC 82.605	
11 AAC 84.700–11 AAC 84.950	
11 AAC 84.725–11 AAC 84.730	

**Appendix C: Lease Contract**  
*Reserved for Final Finding*

## Appendix D: References

- ADCED (Alaska Department of Community and Economic Development)  
2007 Community Database Online  
[http://www.dced.state.ak.us/dca/commdb/CF\\_COMDB.htm](http://www.dced.state.ak.us/dca/commdb/CF_COMDB.htm)
- ADF&G (Alaska Department of Fish and Game)  
1985 Alaska Habitat Management Guide, Southcentral Region Volume II, Distribution, Abundance, and Human Use of Fish and Wildlife.  
1994 Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area Management Plan, July 1994
- ADNR (Alaska Department of Natural Resources)  
2007 Memorandum from Scott Maclean, Habitat Biologist, Office of Habitat Management & Permitting, to Allison Iversen, Division of Oil and Gas, Regarding Mt. Spurr and Augustine geothermal leasing, May 14.  
1999 Final Finding of the Director, Cook Inlet Areawide 1999 Oil and Gas Lease Sale, January 20.  
1986 Final Analysis of the Director Regarding Competitive Geothermal Lease Sale 2, Mount Spurr.
- AVO (Alaska Volcano Observatory)  
2007 Spurr description and statistics:  
<http://www.avo.alaska.edu/volcanoes/volcinfo.php?volcname=Spurr>
- BLM (Bureau of Land Management)  
2007 Draft Environmental Impact Statement for the Truckhaven Geothermal Leasing Area, Imperial County, California, February.
- CIS (Alaska Community Database Community Information Summaries)  
2006 [http://www.commerce.state.ak.us/dca/commdb/CIS.cfm?Comm\\_Boro\\_Name=Tyonek](http://www.commerce.state.ak.us/dca/commdb/CIS.cfm?Comm_Boro_Name=Tyonek)
- Coombs, Coombs, M.L., Neal, C.A., Wessels, R.L., and McGimsey, R.G.,  
2006 Geothermal disruption of summit glaciers at Mount Spurr volcano, 2004-6: an unusual manifestation of volcanic unrest: U.S. Geological Survey Professional Paper 1732-B.
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2007 Memorandum from Christopher J. Nye, Chief Volcanology Section, DGGS to Kathy Means, Division of Oil and Gas regarding comments on Mt. Spurr Proposed Geothermal Exploration Area.
- FERC (Federal Energy Regulatory Commission)  
2005 Application for Preliminary Permit, Chakachamna Hydroelectric Project.
- Geothermal Resources Council  
2005 <http://www.geothermal.org/>
- Murdoch University  
2006 Geothermal Energy Systems,  
<http://wwwphys.murdoch.edu.au/rise/reslab/resfiles/geo/text.html>

NOAA Fisheries (National Marine Fisheries Service)

2007 Management and Recovery of Cook Inlet Beluga Whales

<http://www.fakr.noaa.gov/protectedresources/whales/beluga/management.htm#ip>

Nye, Christopher J.

2007 Personal communication between Christopher J. Nye, Chief Volcanology Section, Division of Geological and Geophysical Surveys and Tom Bucceri, Division of Oil and Gas, May 24.

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2005 Geothermal Technologies Program, Alaska.

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2002 Preliminary Volcano-Hazard Assessment for Mount Spurr Volcano, U.S. Geological Survey, open File Report 01-482.

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1988 Exploration for geothermal energy resources at Mt. Spurr, Alaska: Geothermal Resources Council.

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