

Mount Spurr Geothermal Lease Sale No. 3

Final Finding of the Director

Prepared by
Alaska Department of Natural Resources
Division of Oil and Gas
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A. Introduction

The Alaska Department of Natural Resources (ADNR) is offering 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, depicted in Figure 1, Mt. Spurr Geothermal Exploration Area. The area is located on the west side of Cook Inlet, northwest of Trading Bay, along the southern flank of Mount Spurr, and includes the east end of Chakachamna Lake and a portion of the Chakachamna River. The lease sale area, which is approximately 40 miles west of the village of Tyonek, lies entirely within the Kenai Peninsula Borough.

ADNR's Division of Oil and Gas (DO&G) initiated the proposal, which originally included a small portion of land within in the coastal zone as that term is defined at AS 46.40.210(4), subject to the Alaska Coastal Zone Management Program ("ACMP," AS 46.40 et .seq.). DO&G removed from its initial proposed lease sale area all land within the coastal zone (Figure 1) and created a new tract from the remainder of an original tract bisected by the coastal zone. As a result, the 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.

Geothermal energy is heat taken from the earth. Geothermal energy resources include underground reservoirs of hot water or steam. Geothermal hot water and steam can reach the earth's surface in the form of hot springs, geysers, mud pots, or steam vents. Geothermal resources also 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 indicative of geothermal sites. Alaska's approximately 140 volcanoes (one-third of which are active) and more than 90 hot springs provide tremendous potential for geothermal energy development, except that the vast majority of these sites are located far from population centers (USDOE, 2005). However, the site of Mount Spurr Geothermal Lease Sale No. 3 has an unusually close proximity to the Southcentral Alaska power grid that makes the lease sale area exceptionally viable as a geothermal energy production site.

Construction of geothermal power plants is capital intensive. On the other hand, like other renewable energy sources, geothermal plants have few additional long-term costs in comparison to fuel-based electric power plants. They bear no fuel costs or associated transportation costs, and operation and maintenance costs are relatively minor. Despite the high capital costs, a typical geothermal plant's lifetime operating costs are much less than that of a diesel-powered facility of equivalent capacity. This disparity of operating costs is especially true during times of high fossil fuel prices (Alaska Report, 2006).

ADNR held its first geothermal lease sale in the Mount Spurr area on May 17, 1983. 10,240 acres in 16 tracts were offered in Competitive Geothermal Lease Sale 1. One tract (Tract No. 9) received a bid. The lease for that tract was terminated in 1992.

On June 24, 1986, ADNR offered 2,640 acres in two tracts in the Mount Spurr area for geothermal exploration and development in Competitive Geothermal Lease Sale 2. Both tracts received bids. The lease for Tract 1 expired in 1996, and the lease for Tract 2 was terminated in 1990.

State resource evaluation officials indicate that one possible reason geothermal resources were never developed was the collapse of oil and gas prices in the mid-1980s, which made geothermal projects less attractive.

B. Call for Applications and Comments

DO&G issued a call for applications and comments for the proposed Mount Spurr Geothermal Exploration Area on April 9, 2007. DO&G received seven comments. The comments are summarized in Appendix A.

C. Authorities

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 mineral interests. AS 38.05.035(e) says that upon a written finding that the interests of the state will be best served, the director¹ may, with the consent of the ADNR commissioner (commissioner), approve contracts for the sale, lease, or disposal of available land, resources, property, or interests in them. This written finding is known as a best interest finding (BIF) and describes the lease sale area, analyzes the potential effects of the lease sale, describes measures to mitigate those effects, and constitutes the director's determination that the interests of the state will be best served by the disposal.

Geothermal disposal procedures are set out in regulation (11 AAC 84.700 – 11 AAC 84.790). To commence a call for applications for a disposal of geothermal resources, the commissioner designates a proposed geothermal disposal area comprised of individual tracts and invites applications for the tracts during a specified period. After reviewing available geologic information and the response to the call for applications, the 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 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 requirements are set out at 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

¹ The statutory Alaska Division of Lands (ADL) was originally given responsibility to manage all state land subject to AS 38. Almost all statutory powers and duties of the ADL "director" have been delegated to other divisions of the department. The Director of the Division of Oil and Gas has been delegated the authority to designate a geothermal area or portion of it a competitive geothermal area and to issue geothermal leases to the highest bidder by competitive bidding (AS 38.05.181).

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. Process

On December 27, 2007, DO&G issued a preliminary best interest finding (PBIF) concluding that the disposal would serve the best interests of the state. DO&G then provided opportunity for public comment on the proposed disposal for a period of 30 days. Eight comments were received and evaluated. Based in part upon comments received, DO&G revised the PBIF. Following review of comments on the PBIF and any additional available information, the director determined that the Mount Spurr Geothermal Lease Sale No. 3 is in the state’s best interest and issues this final finding and decision.

E. Best Interest Finding Scope of Review

The director’s determination is based upon a review of all facts and issues known, or made known, to the director, which enables him to arrive at a determination whether this disposal serves the best interests of the state. The review and finding address only reasonably foreseeable, significant effects of the uses proposed to be authorized by the disposal (AS 38.05.035(e)(1)(A)). 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 facts and issues are material to the decision;
- determining the reasonably foreseeable significant effects of the proposed lease sale.

Therefore, the scope of review and finding for the disposal is limited to applicable statutes and regulations and the material facts and issues known to the director that pertain to the reasonably foreseeable, significant effects of leasing. In preparing the written finding, the director is not required to speculate about possible future effects subject to future permitting that cannot reasonably be determined until the project or proposed use is more specifically defined. The effects of future exploration, development, or production will be considered at each subsequent stage, when various government agencies and the public review permit applications for the specific activities proposed at specific locations in the lease sale area. However, this final finding does discuss, in general terms, the potential effects that may occur from the lease sale.

F. Final Best Interest Finding

The director of DO&G is delegated the authority to designate a geothermal area or portion of it a competitive geothermal area and to issue geothermal leases to the highest bidder by competitive bidding (AS 38.05.181). The director signs the best interest finding and the commissioner consents to the director’s decision by co-signing the final written finding. A person who is eligible to file a request for the commissioner’s reconsideration and who is aggrieved by the final written finding of the director may, within 20 calendar days after issuance of the final written finding, request

reconsideration of the decision by the commissioner. A person is eligible to file a request for reconsideration if the person meaningfully participated in the process set out for receipt of public comment by either submitting written comments during the comment period or by presenting oral testimony at a public hearing, if a public hearing was held, and is affected by the final written finding (AS 38.05.035(i)).

A person may appeal a final written finding to the superior court, but only if the person was eligible to request, and did request, reconsideration of that finding at the agency level. In addition, the points on appeal are limited to those presented to the commissioner in the request for reconsideration (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 party's points on appeal before litigation. For the purposes of appeal, the burden is on the party seeking review to establish the invalidity of the finding (AS 38.05.035(m)).

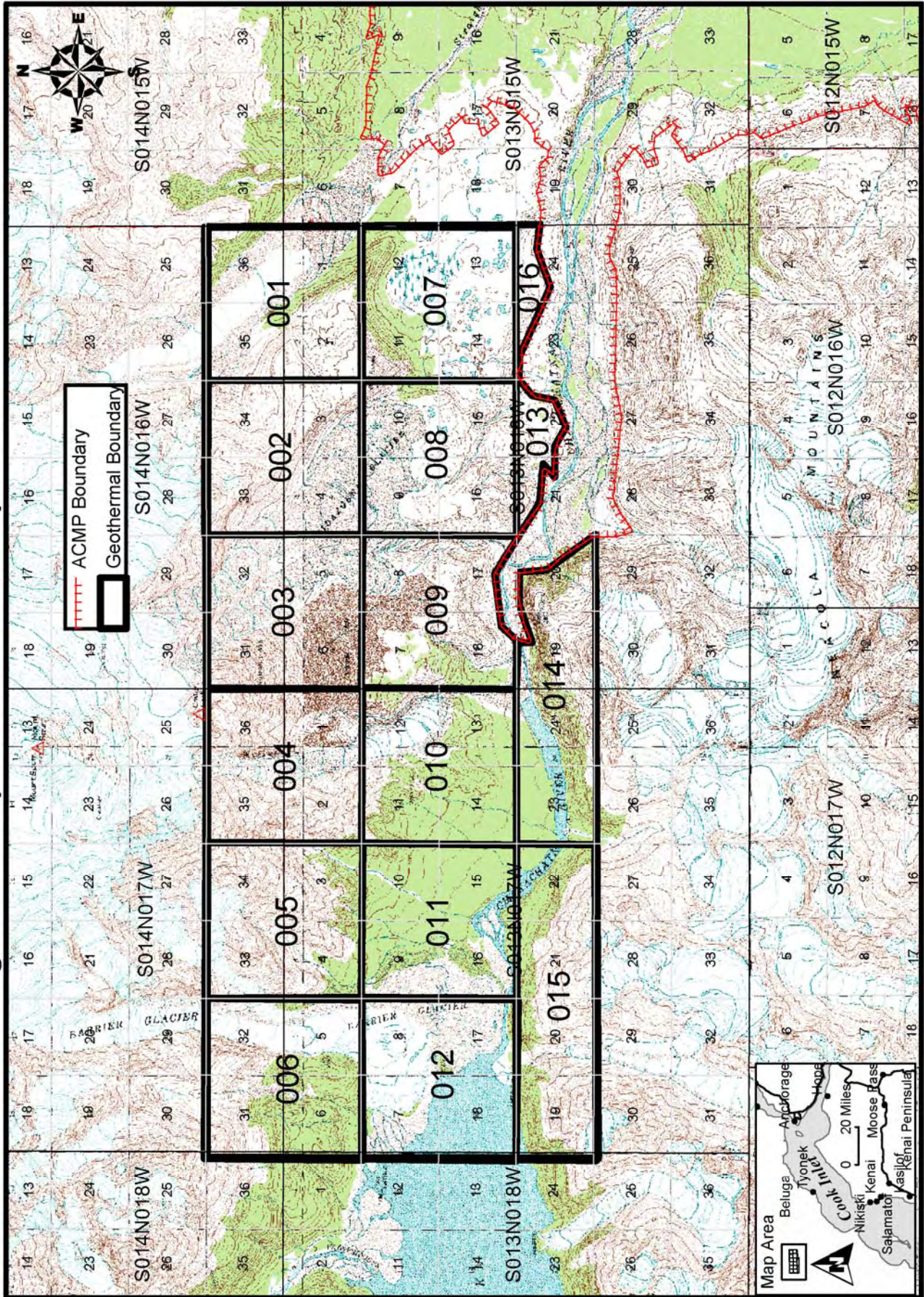
G. Description of the Lease Sale Area

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 lease 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 land within the lease sale area.

Included in the state-owned land is 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). This would be the site of the Chakachamna Hydroelectric Project, an application for which was filed with the Federal Energy Regulatory Commission on March 13, 2006. Under Section 24 of the Federal Power Act, the federal government may enter upon, occupy, and use any part of the state 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).

Lands to the west of the lease sale area are in Lake Clark National Park and Preserve. 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 lease sale area (OHMP, 2007).

Figure 1 Mt. Spurr Geothermal Exploration Area



NAD 1927 UTM Zone 5N
 Base Map: U.S.G.S. 63k Topo Quads; Tyonek A6, A7, B6, B7.
 ADNR 3/2008
 For Informational Purposes Only.

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 2 miles from the summit on Mount Spurr's south flank, was the site of the 1992 eruption and an eruption in 1953. It has been the active vent throughout most of the past 6,000 years (Waythomas and Nye, 2002).

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.

Active volcanoes can be substantial sources of geothermal energy. The potential for discovery and development of exploitable resources 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 previous two lease sales have offered acreage located only on Mount Spurr's southern flank. The area of the current lease sale includes acreage offered in the previous two lease sales as well as additional surrounding acreage.

There are a number of economic, technological, environmental, and resource-reserves issues that have changed since tracts on Mount Spurr were last offered for geothermal lease in 1986. In 1980 there were nearly 8-trillion cubic-feet of "stranded" natural gas reserves in the Cook Inlet basin that heated homes, generated electricity, made fertilizer, and were exported as liquefied natural gas at a relatively low price. Currently there are less than 1.5-trillion cubic-feet of reserves. Second, fossil fuels—coal, oil, and natural gas—are increasingly expensive and consumed in ever-increasing amounts, which changes the economic viability of many alternate sources. Third, oil and gas imports from foreign sources raise concerns over long-term energy security. Finally, burning fossil fuels releases carbon dioxide and other pollutants into the atmosphere. A combination of all these factors dictates that Alaska diversifies its energy portfolio. Geothermal is one of many viable alternatives that should be pursued.

I. Habitat, Fish and Wildlife

There are four cataloged anadromous fish streams that flow into Chakachamna Lake, the Neacola, Igitna, Chilligan and Nagishlamina. The headwaters of Straight Creek, water body number 247-10-10080-2010-3040, are in the lease sale area. An unnamed tributary of Straight Creek is water body number 247-10-10080-2010-3040-4010. Straight Creek and its unnamed tributary support spawning and rearing of chum, king, pink, sockeye and coho salmon, as well as Dolly Varden char. Another unnamed tributary of Straight Creek, water body number 247-1080-2010-3040-4010-5002, supports coho rearing (ADF&G, 2008).

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 (Figure 4); moose calving and overwintering areas (Figure 3); bear feeding areas; and salmon spawning and rearing habitat (Figure 3). Maintaining water quality is an important component of these habitats (OHMP, 2007).

Chakachamna Lake, water body number 247-10-10080-2010-0010, on the west side of the lease sale 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 lease sale 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 lease sale area. Their occurrence is probably restricted to lower-elevation alder thickets near the Chakachatna River. The lease sale area is located within Game Management Unit 16B. The moose population in this unit has been below management objectives and population levels have been insufficient to sustain normal harvest levels (ADF&G, 2008).

Although not likely present in large numbers, wolves are present in the Mount Spurr area. Even though wolves have been harvested from the West Cook Inlet in record numbers, high productivity has resulted in increasing wolf populations (ADF&G, 2008).

J. Current and Projected Uses

Tyonek, a coastal Dena'ina Athabascan community of 199 people, is approximately 40 miles west of Mount Spurr and is the nearest settlement (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 approximately 7 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 occasionally visited by small groups of people in summer and winter. An oil pipeline crosses the Chakachatna River

FIGURE 2 LAND STATUS

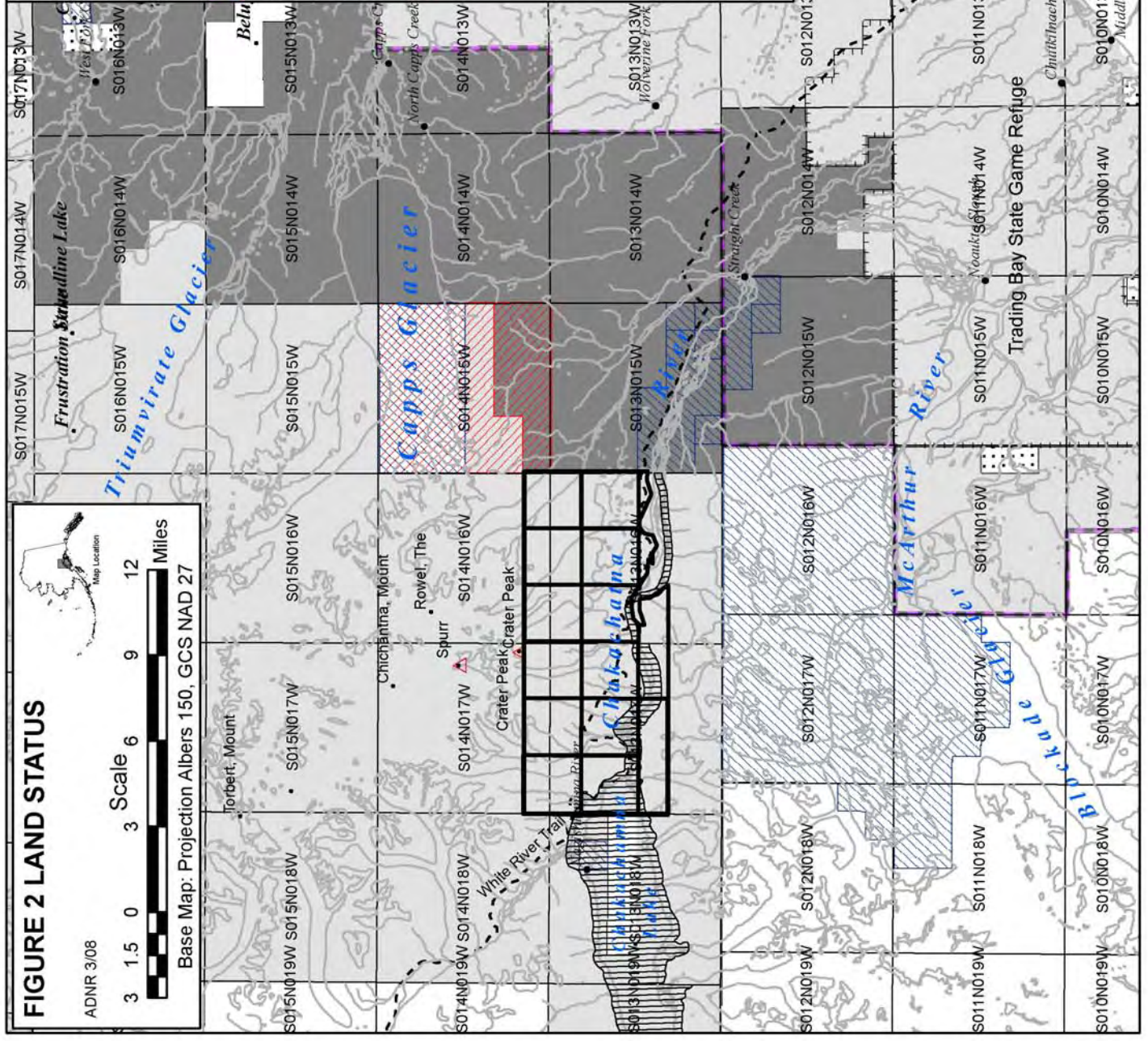
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Legend






- Mt. Spurr Geothermal Tracts
- Volcanoe Summit
- RS2477 Trails
- Power Site Classification 395
- Cook Inlet Areawide Sale Boundary
- State Wildlife, Park, Forest, and Other Multiple Use Areas
- State Selected (ANILCA Topplings included) (Land Administration System, March 2006)
- ANCSA Selected (Bureau of Land Management, March 2006)
- Municipal or Other Private Parcels (Bureau of Land Management, March 2006) (Land Administration System, March 2006)
- Both State and ANCSA Lands are Located Within a Section
- State Patented, Tentatively Approved or Other State Acquired Lands (Land Administration System, March 2006)
- ANCSA Patented or Interim Conveyed (Bureau of Land Management, March 2006)

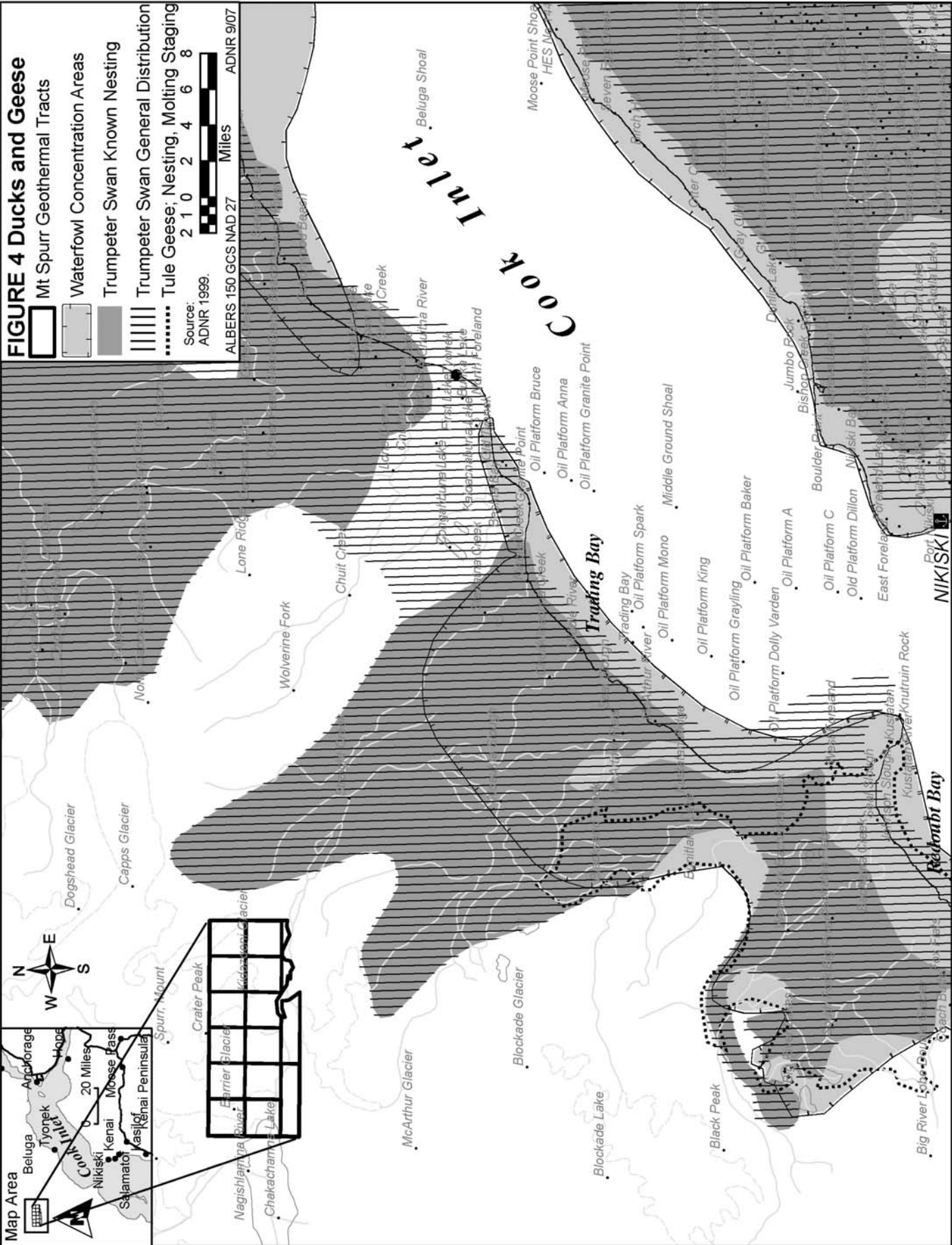
White
Bureau of Land Management Public Lands Source: Alaska DNR, LRIS.



Cook Inlet

FIGURE 4 Ducks and Geese

-  Mt Spurr Geothermal Tracts
 -  Waterfowl Concentration Areas
 -  Trumpeter Swan Known Nesting
 -  Trumpeter Swan General Distribution
 -  Tule Geese; Nesting, Molting Staging
- Source: ADNR 1999.
- ALBERS 150 GCS NAD 27 Miles ADNR 9/07



valley along the Cook Inlet coastline. Tyonek is located near the valley. Life and property are not at risk in the immediate vicinity of the volcano. (USGS, 2002)

The Mount Spurr region is not connected by permanent road to the Alaska highway system. 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 is located south of Tyonek. Airstrips are maintained at Beluga and Tyonek; lakes and river bars are also used for landing sites.

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. Some major proposed projects include:

Mining

- Pebble Mine Project (copper, gold, and molybdenum)
- Whistler (copper and gold)
- Lucky Shot (gold)
- Shulin Lake and Yenlo Hills (diamonds)
- Chuitna Coal Project
- Beluga Coal Fields (coal-to-liquids plant)

Oil and Gas

- State Oil and Gas Lease Sales (Cook Inlet Areawide held annually)
- Federal OCS oil and gas lease sales

Alternative Energy

- Chakachamna Hydroelectric Project

Other Natural Resources

- Kenai Peninsula State Timber Sales (11,465 acres for 2007-2011)

Transportation

- Knik Arm Crossing
- Port of Anchorage Expansion

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

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 mitigated by 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 measures that will be

imposed to mitigate adverse effects. The magnitude of lease sale effects will depend upon whether commercial geothermal resources are discovered and produced, the location of such resources, 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 geothermal energy source, the presence of exploitable geothermal resources 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.

The objectives of exploration are to locate geothermal resources; to estimate the depth, volume, temperature, and permeability of such resources; and to determine the chemical and physical nature of the resources. 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 resources. 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.

One type of commercial geothermal system is produced by numerous wells spaced over a hydrothermal 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. Geothermal resources provide steam or hot brine to create vapor to turn a turbine. Cooling towers eject the resultant heat. Until more information is gathered during the exploratory and development stages, 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) **Dry steam** power plants are 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. Only about 6 percent of the world's known geothermal resources are dry steam. Flashed steam and binary cycle are the most common technologies for new geothermal projects.

- 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 like 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 38.05.181, the commissioner may grant leases to explore for, develop, or use geothermal resources. Alaska statutes define geothermal resources as the natural heat of the earth at temperatures greater than 120 degrees Celsius, measured at the point where the highest-temperature resources encountered enter or contact a well or other resource extraction device (AS 41.06.060 (3)). If geothermal resources are discovered on Mount Spurr, the energy might be converted using a binary cycle, flashed steam, dry-steam plant, or another method depending on the temperature and other resource characteristics.

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 thus, 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.

M. Geohazards

Mount 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. 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 it is the reason why the river upstream of the center of Tract 014 is wider than the river downstream. Geologic evidence suggests that similar, larger dams have formed and failed in the past releasing water as floods. The floodplain of the Chakachatna River is at risk of similar floods following future eruptions (DGGS, 2007).

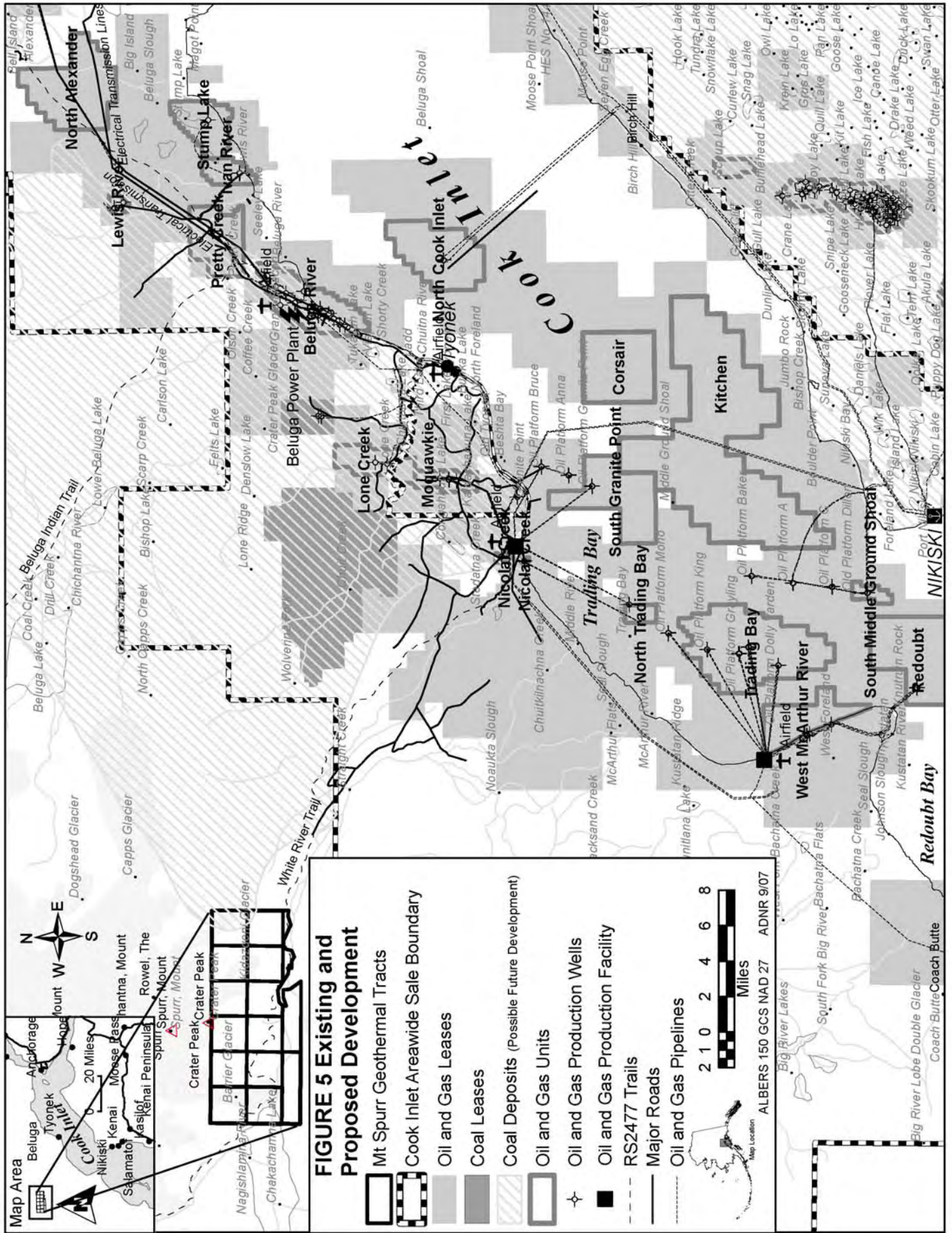
In 1992, three explosive eruptions occurred, separated by 4-7 weeks. These eruptions produced significant ash fall up to 700 km (400 miles) downwind, and produced drifting ash clouds that disrupted air traffic in the northeastern United States. In the Mount Spurr Geothermal Exploration Area, these eruptions 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 and anticipated level of volcanic activity is not expected to create conditions under which geothermal prospecting would be unduly hazardous. If prospecting were to be undertaken over a period of days or weeks, AVO has expressed a willingness 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 before 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 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 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 Exploration 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 DO&G, 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. Although land subsidence may occur due to the withdrawal of geothermal fluids, it is not because the reservoirs are commonly over-pressured. If all the geothermal fluids are not injected back into the geothermal reservoir, subsidence may occur as a result of a drop in reservoir pressure and changes in the pore space in the rock. 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 before 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 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

At the lease sale stage, DO&G cannot predict with a reliable degree of specificity the type, location, duration, timing, or level of any exploration or development activity that might occur. Therefore, the director cannot at this time predict the cumulative effects of all possible activities. General measures and licensee advisories have been developed to mitigate 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, most 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 (ADNR, 1986).

Geothermal wastewater could also be 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 the Clean Air Act and state air quality standards (18 AAC 50.010 – 18 AAC 50.990). 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. The probability of a geothermal well blowout and consequent geothermal fluid spills is low, but the state will still require in Lessee Advisory 2.a. that lessees submit and gain approval of a geothermal spill contingency plan from the Alaska Department of Environmental Conservation (ADEC). 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 lease 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 will not have a significant cumulative impact on air quality (BLM, 2007).

3) Noise. Noise impacts from geothermal exploration and development are caused by construction operations and subsequent operation of any geothermal facilities. The principal noise sources during construction would be construction equipment. New noise sources during operations could be vehicles and aircraft that would access the geothermal well sites and energy-generating facilities as well as noise from any turbines or other infrastructure. These noise sources would be an intensification of use on land primarily used at present for off-highway vehicle recreational use.

Well operations and energy generation could also cause increased noise levels. The principal operational noise source would be turbine. Mufflers can be used to reduce noise from geothermal operations. Any power plants would be sited in terrain designed to reduce noise and visual impacts to the greatest extent possible, which would 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 in the lease area. Although geothermal exploration could disturb moose, black bear, and other wildlife species, such disturbance would be temporary. However, geothermal development could result in permanent displacement of these animals from part of the lease 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 possibly displacing large mammals from the developed area. Mitigation Measure 1.c. prohibits facilities within 500 feet of all fish-bearing streams and water bodies, to the extent feasible and prudent. 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. Because 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 lease sale area, and because of the mitigation measures listed, any displacement from the developed areas would probably have a negligible effect on regional populations of animals (ADNR, 1986). Chakachamna Lake and Chakachatna River are important salmon habitat. If geothermal wastewater were to enter the Chakachamna-Chakachatna system, the fishery resource could be impacted. Mitigation Measure 1.c. restricts the siting of facilities within 500 feet of the Chakachatna River, to the extent feasible and prudent. 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 Uses

The fish, wildlife, and plant resources of the Cook Inlet area have been used for subsistence by area residents for centuries, including both Alaska Native populations and non-Natives (Fall et al. 2004). In the broad sense, subsistence refers to “any harvest or use of fish, wildlife, and wild plants for home use. It also incorporates the noncommercial exchange or sharing of resources...” (Fall et al. 2004). Under this general definition, detailed information about subsistence uses by residents of the

Cook Inlet area is available for only a few selected communities, but is not available for the broader Cook Inlet population.

The subsistence uses of wild resources by residents of the communities of Tyonek and Beluga were profiled in a 2005-2006 study. Tyonek is the nearest settlement to the lease sale area and could be the settlement most affected by geothermal exploration and development at Mount Spurr. Tyonek has a population of about 200 people, of which about 95 percent are Alaska Native or part Native (ADCED 2008b). Tyonek has a mixed cash and subsistence economy. Located a few miles north of Tyonek is much smaller community, Beluga, with a population of about 20, of which 25 percent are Alaska Native or part Native (ADCED 2008a). Although there are over 50 homes in Beluga, many of them are used only seasonally.

In the 2005-2006 study, Stanek et al. (2007) found that wild resources were used by 96 percent of Tyonek households and 94 percent of residents had harvested at least one type of fish, wildlife, or plant. 50 percent of Tyonek's residents harvested and processed fish, 17 percent trapped or hunted furbearers, 40 percent hunted birds and wild game, and over 60 percent participated in gathering plants. Based on self-reporting, the study indicated that about half the Tyonek residents relied on wild sources for over half the fish, meat, and birds they used annually and 26 percent estimated that over 75 percent came from wild sources. Some of the wild resources used by the community include Chinook salmon, rainbow trout, Dolly Varden, northern pike, eulachon, beluga whales, black bear, moose, beaver, muskrat, wolves, coyotes, marten, ruffed and spruce grouse, ptarmigan, migrating waterfowl such as ducks and geese, blueberries, currants, highbush cranberries, fireweed, cow parsnip, and bluebells (Stanek et al. 2007). Relative to a study conducted in 1983-1984, residents harvested about 17 percent less wild resources per person in 2005-2006 (Stanek et al. 2007).

The study also found that 95 percent of Beluga residents participated in at least one resource activity and that over 75 percent of residents participated in harvesting and processing fish, mammals, and game birds, and in gathering and processing plants. About half of Beluga households reported that more than half their supply of fish, meat, and birds came from wild sources (Stanek et al. 2007). Beluga residents used a variety of wild resources, including salmon, rainbow trout, pike, eulachon, brown and black bear, moose, beaver, red squirrels, ruffed and spruce grouse, ptarmigan, cranes, ducks, geese, berries, and plants (Stanek et al. 2007).

A second study, conducted in 2006, collected detailed information about historical subsistence uses of resources in the area by residents (Braund & Associates, 2007). Residents were interviewed concerning their uses of wildlife, fish, and plants over the last 20 years, from 1987-2006. The following summarizes findings from the study for Tyonek, the larger of the two communities.

Fish: Tyonek respondents harvest all five species of Pacific salmon (Chinook, coho, sockeye, chum, and pink) as well as other non-salmon fish species, including rainbow trout, Dolly Varden, and hooligan. Fishing activities generally occur year-round and are an important part of Tyonek residents' subsistence diet. Residents reported traveling along the road system to the Chuitna River, Nikolai Creek, and Beluga River, and fishing up and downriver from the bridges; some also reported fishing at the mouths of Beluga and Chuitna rivers (Braund & Associates, 2007).

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, hooligan, and clams are also important items of the Tyonek diet (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).

Marine Mammals: Federal regulations allow Tyonek residents to participate in traditional hunting of seal and beluga in Cook Inlet. However, Tyonek residents have been allowed a subsistence hunt of zero to two whales a year since 1999, due to the depletion of Cook Inlet beluga. 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 voluntarily agreeing to halt subsistence hunting of the animals in some years. (NOAA Fisheries, 2007). Tyonek residents hunt beluga in Cook Inlet primarily between the Susitna (also called “Big Su”) and Beluga rivers, encompassing an area that stretches from Granite Point to Little Susitna River (Braund & Associates, 2007).

Tyonek seal hunting areas extend from the Susitna River south past Harriet Point, with the majority of activity occurring in Cook Inlet between Tyonek and McArthur River and between the Beluga and Susitna Rivers. Residents generally hunt seals in the mouths of rivers or while traveling in open water by boat. However, some reported traveling to the shore or to riverbanks by vehicle and hunting seals from the land (Braund & Associates, 2007).

Bear: Tyonek residents reported hunting both black and brown bear. Respondents reported hunting bear in many of the same areas where they hunt moose during the fall season, along the McArthur River and on the local road system. Tyonek residents provided the locations of key bear habitat, primarily denning areas. The majority of observed bear dens were in the Bald Hills and Lone Ridge area. Tyonek respondents also indicated that upon emerging from their dens, bears are near salmon spawning streams and in areas abundant with moose (Braund & Associates, 2007).

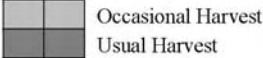
Moose: For the last 20 years (1987-2006), Tyonek residents reported hunting moose in an area extending from the Lewis River south to the McArthur River and west toward Lone Ridge and the foothills of Mount Spurr. A number of residents focus on hunting moose particularly in the area south of Tyonek, on roads that follow the Chakachatna River and extend toward the Bald Hills. A number of people set up camps near Chakachatna River and hunt moose further off-road by four-wheeler, as well as using tree stands built along the road system (Braund & Associates, 2007).

Factors that contribute to an important area to harvest moose include harvest success, family and cultural value of an area, distance from the village, and ease of access. Tyonek respondents explained their preferences for hunting areas such as the McArthur and Chakachatna Rivers, often pointing to their distance from human activity as a primary reason (Braund & Associates, 2007).

Furbearers and Other Small Land Mammals: Tyonek respondents reported hunting and trapping furbearers and small land mammals, including beaver, wolf, wolverine, mink, and marten. Residents also hunt beaver, porcupine, and hare for their meat. Hunting and trapping areas extend from the Lewis River to the McArthur River and inland toward the Bald Hills. Other residents reported hunting beaver with rifles, targeting them in streams and lakes along the road system, or along rivers while hunting moose. Residents commonly reported hunting beaver along the McArthur River during the fall moose hunting season (Braund & Associates, 2007).

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.

Waterfowl: Tyonek respondents reported hunting waterfowl in three main areas: Trading Bay, Chuitna River, and the flats west of Susitna River. A number of respondents reported harvesting waterfowl during fall moose hunting trips along the above mentioned waterways. Residents generally reported hiking substantial distances to harvest waterfowl. Tyonek subsistence users reported hunting both spruce grouse and ptarmigan throughout the year. Respondents indicated that they often hunt upland birds when they are available during other subsistence pursuits or when residents are traveling along the road system, rather than taking separate trips to harvest them.

Federal regulations allow Tyonek residents to participate in traditional spring and summer hunting of waterfowl. The season is open April 2nd until May 31st and again from August 1st to August 31st. The regular hunting season begins in September. September represents the highest number of waterfowl hunts, over twice as many as any other month.

Plants: 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.

Tyonek residents harvest a variety of berries each summer and fall, including blueberries, cranberries, cloudberries (locally called salmonberries), currants, crowberries (blackberries), and salmonberries (high bush salmonberries). Some respondents reported harvesting enough berries to last through the summer and into the winter. Residents reported harvesting berries close to the village, along the main road system, and on smaller logging and “seismograph” roads or trails.

Respondents reported harvesting berries during moose hunting trips along the road system, especially near the Chakachatna River, and on McArthur River. Residents pick berries primarily during the months of July and August, although some will pick into September and October (Braund & Associates, 2007).

Tyonek residents use a variety of plants including Hudson’s Bay tea, wild celery, wormwood, club moss, devil’s club, rose hips, mountain ash, spruce roots, alder branches (for the steam bath), wood, and fiddlehead ferns. Devil’s club, wormwood, wild celery and club moss have medicinal uses (Braund & Associates, 2007).

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 subsistence 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 lease 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 lease sale area. Such orientation should help increase understanding of community values, customs, and lifestyles and mitigate any negative effects.

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 provide partial relief.

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 Mount Spurr Geothermal Lease Sale No. 3 will not be achieved unless development occurs. If geothermal resource development occurs in the lease 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 geothermal 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 to the extent allowed by law.

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 lease sale area for activities such as hunting and fishing will depend on continued access. Under Mitigation Measure 5.c., public access to the lease 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 number 395 if a hydroelectric project is constructed.

2) Historic and archeological sites. The lease sale 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

AS 38.05.035(e) and the ADNR delegation of authority provide the 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.

Before conducting exploration, development, or production activities, lessees must first obtain the director's approval of a detailed plan of operations. 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 Alaska Department of Fish and Game (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), Kenai Peninsula Borough (KPB), National Marine Fisheries Service (NMFS), National Pollutant Discharge Elimination System (NPDES), Office of Habitat Management and Permitting (OHMP)², State Historic Preservation Officer (SHPO), U.S. Army Corps of Engineers (USCOE), U.S. Bureau of Land Management (BLM), U.S. Environmental Protection Agency (EPA), and U.S. Fish and Wildlife Service (USFWS).

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 and prudent, 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 important 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).

² The Office of Habitat Management and Permitting (OHMP) of the Alaska Department of Natural Resources will become the Division of Habitat, a part of the Alaska Department of Fish and Game (ADF&G), effective July 1, 2008, as a result of Executive Order 114.

- 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 lease sale area in relation to pipe elevation to ensure adequate clearance for wildlife. DO&G may, after consultation with OHMP, require additional measures to mitigate impacts to wildlife movement and migration.
- h.
 - i. The use of continuous-fill causeways is discouraged. 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/), or similar measures.
- l. Lessees must conduct a second order survey of the land surface before 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 lease sale area can be obtained from 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. Before 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 that 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 DO&G.
- d. If the parties cannot agree, then any of them may request the commissioner, 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 feasible and prudent. 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 stage 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 important 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 stage.
- c. Public access to, or use of, the lease sale 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. Before 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. To the extent authorized by law, 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 sale 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 local community groups that have expressed interest in the project to the lessee or the state.
- 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. ADNR/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, ADNR may, in approval of plans of operation, require that permanent structures be designed to be compatible with the aesthetics of the surrounding area.
- f. The director, in consultation with OHMP, may impose restriction on activities located in important moose calving and wintering area during the plan of operations approval stage.

2. ADEC

- a. A spill prevention control and countermeasure plan must be submitted to ADEC for approval before 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 and 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 sale 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 before 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 and essential fish habitat, 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 lease sale are largely unknown. Mount Spurr is considered a geothermal prospect primarily because it is an active volcano, close to infrastructure, with a few known surface “hot spots.” Whether there is geothermal reservoir near the surface will not be known until thermal gradient holes are drilled.

The minimum bonus bid is \$1 per acre. Leases will be awarded to the qualified bidder submitting the highest bonus bid per acre. In selecting the bidding method, ADNR considered and balanced 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), a geothermal lease shall be issued for a primary lease term of 10 years and may be renewed for an additional term of 5 years if the lessee is actively engaged in drilling operations. The initial 10-year term is sufficient to formulate environmentally sensitive, economically efficient, exploration strategies and commence drilling operations. Each geothermal lease shall be conditioned upon payment by the lessee of a royalty of 10 percent of the gross revenues derived from the production, sale, or use of geothermal resources under the lease (AS 38.05.181(g)).

A draft geothermal lease is included in Appendix C.

T. Final Finding of the Director

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 lease sale area are relatively few. There are few sport and no commercial harvests of fish and game; there are few recreational visits to the lease sale area. Some Tyonek residents may enter the lease sale area on subsistence hunting trips, but most Tyonek subsistence occurs outside of the lease sale area. Because few people enter the lease 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 long-term revenue or jobs, the sale could result in a source of energy for electrical generation for Southcentral Alaska. Although current electrical demand is largely 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. Additionally, introduction of a competing energy source in Southcentral Alaska may result in downward natural gas price pressure on local utilities.

If resources are discovered, development of geothermal resources at Mount Spurr will take many years. If geothermally generated electricity is to contribute to Southcentral Alaska's energy supply, exploration must begin soon. Finding and delineating the reservoir is the first step to development. Exploration resulting from this lease sale will indicate whether geothermal resources are present at Mount Spurr. Because of the long time needed to develop geothermal resources, it is important to lease now so that serious exploration may continue.

Development of the lease 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 could 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 stages 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. DO&G 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 mitigation measures presented in this final 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 lease 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, recreation, 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 final finding, I conclude that the potential benefits of the Mount Spurr Geothermal Lease Sale No. 3, as conditioned, outweigh the possible adverse impacts, and that the sale will best serve the interests of the state of Alaska.

A person affected by this decision who provided timely written comments may request reconsideration, in accordance with 11 AAC 02. Any reconsideration request must be received by July 7, 2008, and may be mailed or delivered to Thomas E. Irwin, Commissioner, Department of Natural Resources, 550 W. 7th Avenue, Suite 1400, Anchorage, Alaska 99501; faxed to 1-907-269-8918; or sent by electronic mail to dnr.appeals@alaska.gov. If reconsideration is not requested by that date or if the commissioner does not order reconsideration on his own motion, this decision goes into effect as a final order and decision on July 17, 2008. Failure of the commissioner to act on a request for reconsideration within 30 days after issuance of this decision is a denial of reconsideration and is a final administrative order and decision for purposes of an appeal to Superior Court. The decision may then be appealed to Superior Court within a further 30 days in accordance with the rules of the court, and to the extent permitted by applicable law. An eligible person must first request reconsideration of this decision in accordance with 11 AAC 02 before appealing this decision to Superior Court. A copy of 11 AAC 02 may be obtained from any regional information office of the Department of Natural Resources.

signed by Kevin R. Banks

Kevin R. Banks, Acting Director

June 16, 2008

Date

I concur with the director that the Mount Spurr Geothermal Lease Sale No. 3 is in the best interests of the state.

signed by Marty Rutherford for

Thomas E. Irwin, Commissioner

June 16, 2008

Date

Appendix A: Summary of Comments and Responses

- **Comments received in response to the Call for Applications and Comments issued April 9, 2007.**

M. O'Meara, Homer, AK, 5/11/2007

Comment: Supports geothermal exploration at Mount Spurr. Please focus on this area. The tracts lie relatively near the power grid and could be connected at minimal expense. The most stringent permitting process and regulatory oversight should govern exploration, development and operation of the facilities.

ADNR Response: Comment noted. DO&G has developed mitigation measures to minimize possible negative effects of geothermal development in the Mount Spurr area. Additional mitigation measures may be imposed at the plan of operations stage, when a specific project is proposed.

Homer Electric Association, Homer, AK, 5/9/2007

Comment: Urges the commissioner to open the Mount Spurr area to geothermal exploration. The development of geothermal power generation at Mount Spurr has the potential to greatly benefit Alaska. It could contribute a significant volume of low cost power, not just to the Kenai Peninsula, but throughout the entire Rail Belt. Strongly believes the application process should be followed by prospect permit or competitive bid. HEA has surveyed their members and they are firmly behind the efforts to secure a source of power from renewable energy resources.

ADNR Response: Comment noted.

Bob Shavelson, Cook Inlet Keeper, Homer, AK, 5/11/2007

Comment: Strongly supports exploration in the Mount Spurr region. The mountain sits close to existing infrastructure, and a geothermal facility could be linked more easily and economically to the rail belt grid. This region also possesses considerable hydroelectric and wind energy potential. Development of multiple energy projects in the area could create the economics of scale needed to make power transmission economically viable. Cook Inlet Keeper urges DNR to include rigorous salmon and beluga whale habitat protections into all necessary permits and authorizations.

ADNR Response: Comment noted. Mitigation measures and lessee advisories have been developed to minimize impacts to salmon habitat. Beluga whales are not present in the Mount Spurr Geothermal Lease Sale Area; however they are nearby in Cook Inlet. Lessees are advised they must comply with the provisions of the Marine Mammal Protection Act of 1972, as amended. USFWS shares authority for marine mammals with the NMFS.

Judith E. Bittner, State Historic Preservation Officer (SHPO), State of Alaska, Division of Parks and Outdoor Recreation, Office of History and Archaeology, Anchorage, AK, 5/14/2007

Comment: Requests that the Division of Oil and Gas forward all information to the Office of History and Archaeology for review under Section 41.35.070 of the Alaska Historic Preservation Act.

ADNR Response: Mitigation Measure 6. requires lessees to conduct an inventory of prehistoric, historic, and archeological sites within the area affected by an activity and submit it to the State Historic Preservation Officer. If new sites are discovered during permit/lease operations, 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.

Suzan Tierney, Willow, AK 5/12/2007

Comment: Provided an Area Development Plan written by Bruce Gaugler, Geologist. The plan suggests that Mount Spurr has a tremendous geothermal energy potential. They are convinced that there is enough geothermal energy to meet much of the future residential and commercial electrical heating needs.

ADNR Response: The potential for discovery and development of exploitable reservoirs in the Mount Spurr area has long been considered worthy of further investigation. Until the area is explored it is impossible to know for sure the geothermal potential of the area.

Scott Maclean, Office of Habitat Management & Permitting (OHMP), Anchorage, AK, 5/14/2007

Comment: Recommends that all spent fluids be disposed of by injection in order to minimize chemical and thermal impacts to surface waters that would affect fish and wildlife habitat. OHMP attached a 10 page document of Recommended Mitigation Measures Geothermal Leasing 2007.

ADNR Response: Lessees must comply with the provisions of the Clean water Act and ADEC statutes and regulations governing the disposal of fluids. Lessee Advisories 2c and 2d address the disposal of wastewater, produced waters, drilling muds, and pit fluids. 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.

Chris Nye, Alaska Volcano Observatory (AVO), AK, 5/17/2007

Comment: Mount Spurr is an active volcano. Explosive eruptions have occurred in 1953 and 1992. In 2004, there was increased seismicity and heat flux at the summit but did not escalate into an eruption. Even though significant seismic unrest continues, AVO does not believe that this unrest is precursory to an eruption in the immediate future. The current level of unrest probably does not presage conditions under which geothermal prospecting would be unduly hazardous. The AVO is willing to set up communication with prospectors to keep them apprised of any significant changes in the status of the volcano.

ADNR Response: Comment noted. This information has been incorporated into the finding.

- **Comments received in response to the Preliminary Best Interest Finding issued December 27, 2007.**

ADF&G, Division of Sport Fish, Amber Bethe, Habitat Biologist, dated and received January 28, 2008.

Comment: Anadromous Water Body Corrections: Straight Creek is water body number 247-10-10080-2010-304-; the unnamed tributary of Straight Creek is water body number 247-1010080-2010-3040-4010. Straight Creek and its unnamed tributary support spawning and rearing of chum, king, pink, sockeye and coho salmon, as well as Dolly Varden Char. Another unnamed tributary of Straight Creek, water body number 247-1080-2010-3040-4010-5002, supports coho rearing.

There are four cataloged anadromous fish streams that flow into Chakachamna Lake, the Neacola, Igitna, Chilligan and Nagishlamina.

Moose: The Board of Game has identified moose in Game Management Unit (GMU) 16B as important for providing high levels of harvest for human consumptive use. Although moose habitat in the lease area is likely limited to lower-elevation alder thickets, the moose population in GMU 16B has been below management objectives and population levels have been insufficient to sustain normal harvest levels.

Wolves: Although not likely present in large numbers, wolves are present in the Mount Spurr area. Even though wolves have been harvested from the West Cook Inlet in record numbers, high productivity has resulted in increasing wolf populations.

ADNR Response: This information has been incorporated into the final finding.

Mitigation Measures

Comment: Mitigation Measure 1.d. refers to “key wetlands”; however, definition 8.a.iii defines “important wetlands.” Suggest changes to make terms consistent.

ADNR Response: All references to “key wetlands” have been changed to “important wetlands.”

Comment: Mitigation Measure 1.h. refers to causeways. That causeways are generally not considered necessary in inland environments. Suggest deleting this mitigation measure.

ADNR Response: These are standard mitigation measures designed to apply anywhere a geothermal project may be proposed in the state. If they are not applicable to a certain local, it will be noted in the plan of operations.

Comment: Suggest deleting the word “offshore” in Mitigation Measure 3.b. because this is an inland project.

ADNR Response: See response above.

Lessee Advisories

Comment: The DNR/OHMP lessee advisory suggesting seasonal restrictions on activities in important moose calving and overwintering areas has been omitted. Suggest adding the following

advisory: “The director, in consultation with OHMP, may impose restriction on activities located in important moose calving and wintering area during the plan of operations approval stage.”

ADNR Response: Adopted as Lessee Advisory 1.f.

Cook Inlet Keeper, Bob Shavelson, Executive Director, dated January 28, 2008, received January 28, 2008.

Comment: That the reasonably foreseeable effects section of the preliminary best interest finding (PBIF) is cursory, and lacks basic details needed to understand potential impacts. For example, even at the best interest finding (BIF) stage, it would be helpful to understand potential road miles needed to develop the leases, including any habitat and/or fish and wildlife impacts that could occur from road development and habitat fragmentation. That it would be helpful to understand what project-related effects might reasonably befall the species listed in the subsistence harvest data in Table 1 (PBIF, p. 19).

ADNR Response: The potential road miles needed to develop leases and the effects on habitat are not known at this time. These will be considered at the plan of operations stage when a specific project is proposed. The PBIF discussed the likely effect of disturbance to fish and wildlife and imposed mitigation measures to minimize these effects.

Comment: That the cumulative effects section lists known and/or anticipated projects, but does not analyze whether cumulative or synergistic effects might constitute a significant effect. That one important omission from this list is the proposed Port of Anchorage expansion. That another omission includes the effects of climate change. That’s because Alaska is experiencing a rapid warming trend, DNR should include climate implications in all its BIF documents.

ADNR Response: The Port of Anchorage expansion has been added to the list of proposed projects in the current and projected uses section. A discussion of the implications of this project on global climate would be speculative.

Comment: Under the discussion on water quality, page 18 of the PBIF states: “Mitigation Measure 1.c. prohibits facilities within 500 feet of all fish-bearing streams and water.” That the mitigation measure cited later in the document does not provide for a blanket preclusion, and the BIF should reflect the actual mitigation measure language.

ADNR Response: “To the extent feasible” has been added to reflect the actual mitigation measure language.

Comment: That ADNR should expand the potential for geothermal energy development by supporting statutory changes to AS 41.06.

ADNR Response: Comment noted.

Department of the Army, U. S. Army Engineer District, Alaska, Serena Sweet, Project Manager, Dated January 29, 2008, and received January 30, 2008.

Comment: It appears that no Section 10 waters will be affected by the proposed project. However, it appears that as currently proposed the project may involve work under Section 404. Therefore, a Department of the Army permit may be required.

ADNR Response: All federal laws including the Clean Water Act must be followed. Lessees must apply for a Section 404 permits if applicable.

Homer Electric Association, Inc., Bradley P. Janorschke, General Manager, dated January 25, 2008, and received January 29, 2008.

Comment: Homer Electric strongly believes a review of all the facts and issues, including these public comments, should be followed by an affirmative BIF and a subsequent competitive lease sale offered to all eligible applicants.

ADNR Response: Comment noted.

Dave Johnston (received from Cari Sayre's email account), dated and received January 28, 2008.

Comment: That the state needs broad view, multi-resource, multi-agency comprehensive planning. That ADNR should not allow the exploration companies to stage on east shore of Chakachamna Lake. That they should be made to stage in the alder patch, north of the Chakachatna River, in tracts 008, 007, 013, and 016.

ADNR Response: The "Kenai Area Plan," which includes the Mount Spurr Geothermal Lease Sale Area, was adopted on January 7, 2000. The plan determines the management intent, land use designations, and management guidelines that apply to state land in the area. The plan is the product of over 8 years of work by state and federal agencies, other landowners, local governments, interest groups, and the public. This BIF goes into greater depth than the plan about the area and the lease sale. The BIF process includes soliciting information and comments from multiple agencies and the public. Specifics such as staging areas and access will be determined when an actual project is proposed and applications for permits are submitted.

Comment: That a trail cut by USGS from Tyonek over Merrill Pass in the late 20's or 1930 may pass through tracts 015 and 014 and may be of historical significance.

ADNR Response: Under Mitigation Measure 6, lessees must conduct an inventory of historic sites and submit it to the SHPO. The lessee must make reasonable efforts to preserve and protect a discovered site or object from damage until the director, after consultation with the SHPO and the KPB, has directed the lessee on the course of action to take for its preservation.

Thomas E. Meacham, dated and received January 28, 2008.

Comment: That to the greatest extent possible, the Division of Oil and Gas should recognize and protect the remote, pristine values of this area when it considers offering the area for geothermal exploration and possible development. That this means planning and permitting the transportation, surface development, and exploration and exploitation infrastructure in ways that do not significantly or permanently alter the existing character of this area, or preclude it from future active use as a wilderness recreation destination. That this will require formal planning and wide-ranging management goals and implementation for wilderness recreation as well as geothermal uses—not ad hoc decisions on individual exploration permit applications without the backdrop of a formal, well-considered land use plan.

ADNR Response: As noted above, the Mount Spurr Geothermal Lease Sale Area is covered by the "Kenai Area Plan." The lease sale area is located in Region 11 of the plan; Units 307, 307A, and 308. The plan designates Unit 307, the higher elevations around Chakachatna River and Chakachamna Lake, and Unit 307A, Mount Spurr, for general use. The plan designates Unit 308, Chakachatna River and Chakachamna Lake, dispersed use public recreation and tourism. Nothing in the area plan prohibits the lease sale, although detailed decisions cannot be made until an application for a permit is submitted. Any decision on that application will be made with the backdrop of the formal, well-considered "Kenai Area

Plan.”

This sale is consistent with the management of state lands under the constitutionally based principle of concurrent multiple use. ADNR considered all identified uses and resource values in the lease sale area, and measures to balance protection of the environment, the various public uses, and geothermal exploration and development consistent with multiple use principles. Based on review of information available at this time, ADNR foresees no adverse impact on other uses in the lease sale area at the lease sale stage. If this lease sale results in leasing of sites that are considered for exploration or development at a later stage of this project, ADNR believes adequate protection can be achieved through the multi-agency permitting process and application of mitigation measures; existing federal, state, and local government restrictions; and site-specific project review.

Northern Alaska Environmental Center, David van den Berg, Executive Director, dated January 22, 2008, received January 28, 2008.

Comment: Surface access, as well as transmissions lines, to any future geothermal plant will need to be carefully planned to minimize the impact on local habitat and wildlife. Northern Alaska Environmental Center assumes from the description of the lease sale area on page 4 of the PBIF that future geothermal development would be able to share access and transmission to a large extent with any Chakachamna Hydroelectric Project, thus reducing its independent impact. Depending on factors such as slope, soil porosity, and hydrology, it may be important to increase the minimum required distance between sighting of developments and fresh water bodies.

ADNR Response: This will be addressed in the future when a specific project is proposed. It is possible that no development will occur on either project.

Comment: Available technologies should be used to diminish atmospheric emissions and spent fluids should be reinjected.

ADNR Response: Lessees must comply with the Clean Air Act and the Clean Water Act and state air and water quality standards. Disposal of produced waters will be by subsurface disposal techniques. ADEC may permit alternate disposal techniques if the lessee demonstrates that subsurface disposal is not feasible or prudent.

Comment: The final paragraph on page 12 of the PBIF makes the erroneous statement “only dry steam plants can use geothermal resources at [temperatures of 120 C or greater].” The US DOE website states that binary cycle plants require resources of 107-182 C while flashed steam plants use sources of greater than 182 C and sources suitable for dry steam are uncommon in the United States, though are generally above 235 C.

ADNR Response: This has been corrected in the final finding.

ORMAT Nevada, Daniel Schochet, Vice President, Dated January 23, 2008, and received January 28, 2008.

Comment: Who owns all the surface rights?

ADNR Response: The State of Alaska owns the land estate of the entire lease sale area.

G. Description of the Lease Sale Area:

Comment: That it appears that BLM lands surround the state lands proposed for lease. That

BLM may want to consider leasing its lands and, include the acreage in the programmatic environmental impact statement currently underway for BLM's consideration of leasing lands in the western U.S., including Alaska.

ADNR Response: Comment noted.

J. Current and Projected Use:

***Comment:** The second paragraph **describes** the area as "uninhabited wilderness." Does any of the proposed area actually have official wilderness status?*

ADNR Response: None of the area has official wilderness area status.

K. Reasonable Foreseeable Effects:

***Comment:** ORMAT suggests the following corrections of the descriptions of geothermal power plants starting at paragraph 6:*

***Correction #1:** PBIF text—"Most geothermal electrical generating plans are of three types: (1) dry stream, (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 reservoirs after use."*

ORMAT's suggested language—Geothermal plants use geothermal resources to provide steam or the hot brine to create a vapor to turn a turbine. The cooling towers eject heat from the condensed steam or hot brine used in the power cycle.

***Correction #2:** PBIF text—"Dry-steam power plants are the simplest and most economical technology, and, therefore, are widespread."*

ORMAT's suggested language—Dry steam resources are not widespread. Only about 6 percent of the world's known geothermal resources are dry-steam. In fact, this statement contradicts the correct one made below that flashed steam plants are most common. Flashed steam and binary-cycle are the most common technologies for new geothermal projects.

***Correction #3:** PBIF text—"Under AS 41.06.060, geothermally heated fluids are considered a leasable resource only if their temperature is above 120 degrees Celsius. Only dry steam plants can use geothermal 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 41.06.600 are discovered on Mount Spurr tracts, the energy would most likely be converted to electricity using a dry-steam plan."*

ORMAT's suggested language—Only binary cycle plants can utilize temperatures as low as 120 degrees Celsius. The above statement contradicts your contention that dry steam plants use temperature between 180 degrees – 350 degrees C. There is no way to know at this time whether Mount Spurr is a dry steam resource.

ORMAT's suggested re-write with its changes in underlined text:

Under AS 41.06.060, geothermally heated fluids are considered a leasable resource only if their temperature is above 120 degrees Celsius. Only a binary-cycle plant could utilize temperatures below 120 degree Celsius. However, If geothermal resources as defined by

AS 41.06.060 are discovered on Mount Spurr tracts, the energy might be converted using a binary cycle, flashed steam, or dry-steam plant, depending on the temperature and other resource characteristics.

ADNR Response: The suggested changes have been made in the final finding.

M. Geohazards

3) Subsidence

Comment: *That although land subsidence may occur due to the withdrawal of geothermal fluids, it is not because the reservoirs are commonly over-pressured. That if all the geothermal fluids are not injected back into the geothermal reservoir, subsidence may occur as a result of a drop in reservoir pressure and changes in the pore space in the rock.*

ADNR Response: These corrections have been incorporated into the final finding.

4) Seismicity and Mitigation Measure 1.m.

Comment: *That given that the project is on the side of an active volcano, it is doubtful that geothermal activity would induce seismicity that would impact the area given the nearest community is 40 miles away. ORMAT suggests that the state install a seismic monitoring system before exploration to collect background data on the area. That it appears that the proposed mitigation is based on information from The Geysers, a dry steam resource that does have induced micro seismicity from injection. That given that there are no communities in the area, threatening suspension of operations before leasing appears to be extreme.*

ADNR Response: As stated in Mitigation Measure 1.m., the state may install seismographs or other instruments in producing fields to detect induced seismic activity. The mitigation measure only requires lessees to adjust production and injection rates or to suspend operations where induced seismicity is determined to be hazardous to geothermal operations or adjoining land uses.

N. Cumulative Effects

1) Water Quality

Comment: *That geothermal waste, including drilling mud and cuttings, is considered non-hazardous under the Resource Conservation Recovery Act (40 CFR 261.4(b)(5)). Geothermal brines, called produced water in the PBIF, are usually injected back into the geothermal reservoir. That geothermal injections wells are Class V wells under the Underground Injection Control Program.*

ADNR Response: If authorized by ADEC and EPA, disposal of produced waters in upland areas will be by subsurface disposal techniques. On-pad temporary cuttings storage will be allowed as necessary to facilitate annular injection and or backhaul operations in accordance with 18 AAC 60.

Comment: *3rd paragraph—that hydrogen sulfide, not sulfur, is abated. That sulfur is a by-product of hydrogen sulfide abatement under the Stretford and Lo-Cat processes. That the need for hydrogen sulfide abatement is not a given and is usually determined after the chemistry of the resource is known, the design of power plant is decided, and, if needed, air quality modeling is completed to determine if there will be an impact to ambient air quality standards.*

ADNR Response: This has been corrected in the final finding.

3) Noise

Comment: Section 3, 3rd paragraph—proposed Mitigation Measures 1.a. and 1.b. require the plan of operations to describe the lessee’s efforts to minimize impacts on residential, commercial, and recreational areas even though the area is described as having no residential area within 40 miles of the lands to be leased.

ADNR Response: If there are no residential areas affected then it will simply be noted in the plan of operations.

4) Disturbances to Fish and Wildlife

Comment: Section 4, 2nd paragraph—proposed Mitigation Measure 1.i. prohibits gravel mining within active river floodplains and restricts upland sites to the minimum necessary. Are there other sources of gravel for well pads nearby?

ADNR Response: Gravel mining within active river floodplains is prohibited whether or not there are other sources of gravel nearby. It is unknown at this time if there are other sources of gravel nearby.

P. Economic Effects

Comment: ORMAT suggests a review of the Geothermal Energy Associations’ (GEA) October 2006 publication “A Handbook on the Externalities, Employment, and Economics of Geothermal Energy” that can be found at the GEA’s website, www.geo-energy.org/publications/reports. ORMAT believes that the employment estimates and economic benefit to the community are understated in the PBIF.

ADNR Response: The GEA handbook references a U.S. Department of Energy web site that cites a 1994 study. Through the economic [multiplier effect](#)¹, wages and salaries earned by industry employees generate additional income and jobs within their local and regional economies. The study assumes the operation and maintenance (O&M) of a 7,000 megawatt capacity geothermal plant will generate \$525 million. This equals 10,500 jobs associated with the plants themselves and 15,500 jobs associated with O&M equipment and services. However, until exploration takes place it is impossible to predict the megawatt capacity of any Mount Spurr development.

R. Mitigation Measures and Lessee Advisories

Comment: Proposed Mitigation Measure 1.g. requires pipelines to be buried. That geothermal pipelines are not usually buried except for road crossings. That due to the expansion and contraction of the pipelines, which are designed to ASME (American Society of Mechanical Engineers) standards for pressured piping, they are usually above ground and insulated and can be designed to accommodate wildlife movements, snow, etc.

ADNR Response: Mitigation Measure 1.g. requires pipelines to be buried where soil and

¹ The multiplier effect is sometimes called the *ripple effect* because a single expenditure in an economy can have repercussions throughout the entire economy. The multiplier is a measure of how much additional economic activity is generated from an initial expenditure.

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

***Comment:** Mitigation Measure 4.g.: Is secondary containment considered an acceptable technology for a permanent storage facility in lieu of a water quality monitoring program?*

ADNR Response: ADEC may approve an alternative acceptable technology. This will be determined on a site specific, case-by-case basis at the plan of operations stage of development.

***Comment:** That proposed Mitigation Measure 6.a. appears to be recommending an ethnographic study be completed before any geothermal work at Mount Spurr. Given the time and cost to complete this type of study, and its potential impact on the location for geothermal activities, could the state begin this study now?*

ADNR Response: Conducting an inventory now would be premature. The inventory is only required before the construction or placements of any structure, road or facility resulting from exploration, development, or production activities within the area affected by that activity.

***Comment:** That Mitigation Measure 6.b.: Has the state initiated discussion with the SHPO concerning this proposal? That the SHPO's input on the leasing and possible development may help alleviate future concerns with geothermal development in the area.*

ADNR Response: Yes, see the SHPO's comments above received in response to the Call for Applications and Comments issued April 9, 2007. Standard mitigation measures designed to protect prehistoric, historic, and archeological sites for oil and gas lease sales and exploration licenses have been adopted for the Mount Spurr geothermal lease sale. Under Mitigation Measure 6, lessees must conduct an inventory of historic sites and submit it to the SHPO. The lessee must make reasonable efforts to preserve and protect a discovered site or object from damage until the director, after consultation with the SHPO, and the Kenai Peninsula Borough, has directed the lessee on the course of action to take for its preservation.

***Comment:** Lessee Advisory 2: That geothermal waste, including drilling mud and cutting, is considered non-hazardous under the Resource Conservation Recovery Act (40 CFR 261.4(b)(5)). That geothermal brines, called produced water in the document, are usually injected back into the geothermal reservoir. That it is not uncommon in the geothermal industry to bury dried mud and cuttings on site at the end of a drilling operation. That the geothermal industry does not practice annular injection and/or backhaul operations because the casing is usually cemented from the casing shoe to the surface.*

ADNR Response: 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.

S. Bidding Method and Lease Terms

***Comment:** ORMAT understands that royalties are based on statutory guidelines; however the interpretation of those statutes has not been clarified. Will the royalty calculation be similar to the options provided by the BLM? ORMAT is concerned about the economics of the project if the royalty rate is too high.*

ADNR Response: The minimum bonus bid is \$1 per acre. Leases will be awarded to the qualified bidder submitting the highest bonus bid per acre. The annual rental fee is \$3 per acre in accordance with AS 38.05.181(e). Under AS 38.05.181(f), a geothermal lease shall be issued for a primary lease term of 10 years and may be renewed for an additional term of 5 years if the lessee is actively engaged in drilling operations. Each geothermal lease shall be conditioned upon payment by the lessee of a royalty of 10 percent of the gross revenues derived from the production, sale, or use of geothermal resources under the lease (AS 38.05.181(g)). See Section S of the final finding.

T. Preliminary Decision

Comment: Could you explain which permits referred to in paragraph 6 have public comment periods and whether the periods run concurrently with the state's approval of the operating plan provided that the permit applications are submitted concurrently to the respective agencies?

ADNR Response: All authorizations involving a disposal of an interest in state land have public comment periods. A typical permit process would begin with a pre-application meeting where the agencies assist the applicant in identifying the permits that would be required for the proposed activity. Usually the applicant has done advance work with the agencies on the proposal. Once the permits are identified, the various requirements and timelines for those requirements can be made, including those for public notice. However, there is no guarantee that public comment periods on applications, some of which may have different notice requirements, will run concurrently.

The ADNR Office of Project Management and Permitting is available to coordinate reviews of large-scale projects. A project coordinator is assigned to each project in order to facilitate interagency coordination and a cooperative working relationship with the developer of the project.

Marvin L. Yoder, dated and received January 21, 2008.

P. Economic Effects

Comment: Because a geothermal power project of this magnitude is new in Alaska, Mr. Yoder suggests that an applicant's past experience with geothermal projects should add points to the applicant's score or ranking. That the state needs to consider the capacity of the applicant in awarding the leases. That a quantitative value should be put on similar project experience.

ADNR Response: Leases will be awarded to the qualified bidder submitting the highest bid per acre in accordance with AS 38.05.181(d).

Comment: That to insure local hire goals are met, special attention should be paid to applicants that are partnered with an Alaskan firm.

ADNR Response: Mitigation Measure 7.a. says in part, "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."

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
AS 44.46.028
AS 44.81.350
AS 46.03.299
AS 46.03.900
11 AAC 05.010
11 AAC 55.075
11 AAC 82.605
11 AAC 84.700–11 AAC 84.950
11 AAC 84.725–11 AAC 84.730
11 AAC 87.010–11 AAC 87.290

Appendix C: Draft Lease

Competitive Geothermal Resources Lease
Form No. DO&G 200805GL

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
Competitive Geothermal Resources Lease ADL NO.

THIS LEASE is entered into _____, 200____, between the State of Alaska, "the state," and _____, "the lessee," whether one or more, whose sole address for purposes of notification is under Paragraph 25.

The state and the lessee agree as follows:

1. GRANT. (a) For and in consideration of a cash bonus and the first year's rental, the receipt of which is hereby acknowledged, and of the rentals, royalties, covenants, and conditions herein contained on the part of the lessee to be paid, kept and performed, and subject to the conditions and reservations herein contained, the state does hereby grant and lease unto the lessee, exclusively, for the sole and only purposes of exploration, development, production, processing, drilling, and marketing of geothermal resources, the following described tract of land in Alaska:

containing approximately _____ acres, more or less (referred to in this lease as the "leased area");

(b) The right to erect, construct, install, maintain, and use structures, buildings, plants for processing and power generation, roads, pipelines, powerlines, reservoirs, storage tanks, production equipment, metering equipment, electrical transmission lines, pumping stations and other improvements, and to house and board employees, as may be necessary or convenient in the development and production of geothermal resources from the leased area, subject to the lessee obtaining the required federal, state, borough and municipal agency approvals, as required by law, such approval not to be unreasonably withheld. The rights granted by this lease are to be exercised in a manner which will not

unreasonably interfere with the rights of any permittee, lessee or grantee of the state consistent with the principle of reasonable concurrent uses as set out in Article VIII, Section 8 of the Alaska Constitution.

(c) For the purposes of this lease, the leased area contains the legal subdivisions as shown on the attached plat marked Exhibit A.

(d) If the leased area is described by protracted legal subdivisions and, after the effective date of this lease, the leased area is surveyed under the public land rectangular survey system, the boundaries of the leased area are those established by that survey, when approved, subject, however, to the provisions of applicable regulations relating to those surveys. If for any reason the total leased area includes more acreage than the maximum permitted under applicable law (the "rule-of-approximation" authorized in AS 38.05.145 and defined in AS 38.05.965(19), this lease is not void and the acreage included in the leased area must be reduced to the permitted maximum. If the state determines that the leased area exceeds the permitted acreage and notifies the lessee in writing of the amount of acreage that must be eliminated, the lessee has 60 days after that notice to surrender one or more legal subdivisions included in the leased area comprising at least the amount of acreage that must be eliminated. Any subdivision surrendered must be located on the perimeter of the leased area as originally described. If a surrender is not filed within 60 days, the state may terminate this lease as to the acreage that must be eliminated by mailing notice of the termination to the lessee describing the subdivision eliminated.

(e) The state makes no representations or warranties, express or implied, as to title, or access to, or quiet enjoyment of, the leased area. The state is not liable to the lessee for any deficiency in title to the leased area, nor is the lessee or any successor in interest to the lessee entitled to any refund due to deficiency in title for any rentals, bonuses, or royalties paid under this lease.

2. RESERVED RIGHTS. (a) The state, for itself and others, reserves all rights not expressly granted to the lessee by this lease. These reserved rights include, but are not limited to:

(1) The right to conduct geological and geophysical surveys within the leased area;

(2) The right to explore for, develop, and remove natural resources other than geothermal resources on or from the leased area;

(3) The right to establish or grant easements and rights-of-way upon, through, or within the lease area for any lawful purpose necessary or appropriate for the working of the leased area or other lands for natural resources other than geothermal resources;

(4) The right to dispose of land within the leased area for well sites and well bores of wells drilled from or through the leased area to explore for or produce geothermal resources in and from lands not within the leased area; and

(5) The right otherwise to manage and dispose of the surface of the leased area or interests in that land by grant, lease, permit, or otherwise to third parties;

(b) The rights reserved under 2(a) above shall not be exercised in any manner that unreasonably interferes with the lessee's enjoyment of this lease or that endangers the lessees' operations under the lease.

3. TERM. This lease is issued for a primary term of ten (10) years from the effective date of this lease. The term may be renewed or extended as provided in Paragraph 4 below.

4. RENEWAL AND EXTENSION. (a) After the expiration of the primary term, this lease may be renewed for one additional term of five years if, at the end of the primary term, the lessee is diligently conducting operations necessary to drill a geothermal well, with equipment at the lease area of sufficient size and capacity to drill to the total depth proposed for the well.

(b) This lease will be extended if and for so long as there is commercial production of geothermal resources from the leased area.

(c) This lease will be extended beyond its primary term for so long as it is producing in commercial quantities.

(d) If the state issues a written direction to suspend operations or production from the leased area or issues a written approval of such action, a period of time equivalent to the period of suspension will be added to the lease term.

(e) If the state determines that the lessee has been prevented by force majeure, after efforts made in good faith, from performing any act that would extend the lease, it will not expire during the period of force majeure and the state will grant a reasonable extension of time which may be different than the period of force majeure.

(f) Nothing in subparagraph (d) or (e) suspends the obligation to pay royalties or other production or profit-based payments to the state from operations on the leased area that are not affected by any suspension or force majeure, or suspends the obligation to pay rentals.

5. RENTALS. (a) The lessee shall pay annual rental to the state in the amount of \$3.00 per acre or fraction of an acre, provided that the state may adjust the annual rental rate as provided by applicable law beginning 20 years after the commencement of production in commercial quantities and at ten year intervals thereafter.

(b) The lessee shall pay the annual rental to the state in advance, on or before the annual anniversary date of this lease. The state is not required to give notice that rentals are due by billing the lessee. If the state's (or depository's) office is not open for business on the annual anniversary date of this lease, the time for payment is extended to include the next day on which that office is open for business. If the annual rental is not paid timely, this lease automatically terminates as to both parties at 11:59 p.m., Alaska Standard Time, on the date by which the rental payment was to have been made.

(c) The rental for a year may be credited against royalties accruing for that year.

6. RECORDS. The lessee shall maintain records showing the development and production (including records of development and production expenses) and disposition (including records of sales prices, volumes, and purchasers) of all geothermal resources produced from the leased area. The lessee shall permit the state or its agent to examine these records at all reasonable times, and to make copies of those records. Upon request by the state, the lessee's records shall be made available to the state at the state office designated by the state. Upon the lessee's request, the state will keep all information under this paragraph confidential in accordance with AS 38.05.035(a)(8). The lessee's records of development, production, and disposition must employ methods and techniques that will ensure the most accurate

figures reasonably available. The lessee shall use generally accepted accounting principles (GAAP) consistently applied for its financial accounting records. The state is entitled to review all other relevant documents including those not subject to GAAP.

7. PAYMENTS. All payments to the state under this lease must be made payable to the State of Alaska, Department of Natural Resources in the manner directed by the state, and unless otherwise specified, must be tendered to the state at:

DEPARTMENT OF NATURAL RESOURCES
ATTENTION: FINANCIAL SERVICES SECTION
550 West 7th Avenue, Suite 1410
Anchorage, Alaska 99501-3561

or in person at either of the Department's Public Information Centers located at:

550 W. 7th Avenue, Suite 1260
Anchorage, Alaska

3700 Airport Way
Fairbanks, Alaska

or to any depository designated by the state with at least 60 days notice to the lessee.

8. PLAN OF OPERATIONS. (a) Except as provided in (b) of this section, a plan of operations for all or part of the leased area must be approved by the state before any operations may be undertaken on or in the leased area.

(b) A plan of operations is not required for activities that would not require a land use permit under AS 38.05 and 11 AAC.

(c) The lessee shall meet with the state annually to discuss lessee's ongoing operations, and any plans for future exploration, development and operation, as such operations or plans relate to the leased or unitized area.

9. PLAN OF EXPLORATION. Within one year after the issuance of this lease, the lessee shall submit to the state for approval a proposed plan of exploration that describes the lessee's plans for exploring the leased area, as set out in 11 AAC 84. No exploration of the leased area may occur until a plan of exploration has been approved by the state.

10. PLAN OF DEVELOPMENT. Before commencing development activities, the lessee shall submit to the state for approval a proposed plan of development that describes the lessee's plans for developing the leased area, as set out in 11 AAC 84. No development of the leased area may occur until a plan of development has been approved by the state. The plan of development shall be submitted by the ninth anniversary of the lease.

11. INFORMATION ACQUIRED FROM OPERATIONS. (a) The lessee shall furnish the state paper and digital copies in a format required by the state of all physical and factual exploration results, logs, surveys and any other derivative data resulting from operations on the leased area or unitized area,

including any surveys, logs, tests or experiments conducted on the leased area by the lessee or by any person or entity acting on behalf of the lessee.

(b) The lessee shall also supply to the state all results, in paper and digital form, for all geological, geophysical, engineering, and geochemical tests, experiments, reports and studies, interpretive or factual, including reservoir studies, profiles, computer modeling work and tests, experiments, reports or studies relating to injection, production testing, or reservoir depletion on the eased area or unitized area, irrespective of whether the results of such tests, experiments, reports or studies contain sensitive proprietary or confidential information or trade secrets. The lessee shall also file a plat showing the exact location of each well. All of the aforementioned data and results shall be supplied to the state within thirty (30) days of completion of any recorded portion of the operation, test, experiment, report or study from which the data or results are obtained.

(c) Any information filed by the lessee with the state in connection with this lease will be available at all times for the use of the state and its agents and contracting personnel, subject to the duty to keep qualifying information confidential as provided in AS 38.05.035(a)(8) and applicable regulations.

(d) With each production royalty payment, lessee shall submit to the state a statement of the geothermal resources produced, processed, used, shipped, or sold, including geothermal resources converted to other forms of energy, together with the price obtained or, where the substances are used without sale, an accounting of the alternate uses of the energy with evidence of their fair market value, and such other information relating to valuation as the state may require.

12. **DIRECTIONAL DRILLING.** This lease may be maintained in effect by directional wells whose bottomhole location is within the leased area but that are drilled from locations on lands outside of this lease. In those circumstances, drilling will be considered to have commenced on the leased area when actual drilling is commenced on those other lands for the purpose of directionally drilling into the leased area. Production of geothermal resources from the leased area through any directional well surfaced on those other lands, or drilling or reworking of that directional well, will be considered production or drilling or reworking operations on the leased area for all purposes of this lease. Nothing contained in this paragraph is intended or will be construed as granting to the lessee any interest, license, easement, or other right in or with respect to those lands in addition to any interest, license, easement, or other right that the lessee may have lawfully acquired from the state or from others.

13. **DILIGENT AND SAFE DEVELOPMENT AND PREVENTION OF WASTE.** (a) All operations on or into the leased area shall be carried on in a safe and workmanlike manner; in compliance with all state, federal, borough or municipal permits and authorizations; in accordance with generally accepted, good engineering practice; with due regard for the protection of life and property, preservation of the environment and conservation of natural resources; and in such a manner as to avoid damage to and waste of geothermal and non-geothermal natural resources. The lessee shall carry out at the lessee's expense all orders and requirements of the state relative to the prevention of waste and to the preservation of the leased area. If the lessee fails to carry out these orders, the state will have the right but not the obligation, together with any other available legal recourse, to enter the leased area to repair damage or prevent waste at the lessee's expense.

(b) The lessee shall exercise reasonable diligence in drilling, producing, and operating wells on the leased area unless consent to suspend operations temporarily is granted by the state.

(c) All drilling, redrilling, perforation or work-over operations on wells drilled into the leased area within a geothermal system shall be done with an approved circulating medium.

(d) Metering equipment shall be maintained and operated so that it will meet acceptable standards of accuracy in order to measure production from the leased area. Use of such equipment shall be discontinued at any time the state determines that acceptable standards of accuracy are not being maintained. Production shall be stopped until measurement accuracy has been obtained.

(e) Upon development of a geothermal resource on the leased area, the lessee or his agent shall determine whether methods to enhance energy recovery are feasible. The lessee shall conduct studies that evaluate reinjection of spent geothermal liquids, injection of source water or brine for the purpose of energy extraction or means of enhancing energy recovery by improvement of producibility. Results of such evaluations shall be included in the lessee's Plan of Development, and reports, evaluations and conclusions shall be filed with the state.

(f) The lessee must obtain approval from the state under 11 AAC 87 and the terms of this lease before the exploration of geothermal systems and the drilling of all geothermal wells.

14. **OFFSET WELLS.** In the event any well is completed or in commercial production after the effective date of this lease on other than state land, with any part of its producing interval within 1000 feet from the exterior boundary of this lease and within the same geothermal system, or if drainage is a material risk, then the state may notify the lessee in writing to commence drilling an offset well, and within reasonable time, not to exceed 120 days, the lessee shall commence operations for drilling an offset well on the leased area or shall unitize with the well that is draining state land or pay compensatory royalty to the state. An offset well shall mean a well in which the producing interval is situated in the leased area within 1000 feet of the exterior boundary of the lease nearest to the producing interval of the well to be offset. Wells drilled into an approved geothermal unit shall not create an obligation to drill an offset well as to any portion of the leased area that is included within such unit and participating in the revenue.

15. **INSPECTION.** The lessee shall keep open at all reasonable times, for inspection by any duly authorized representative of the state, the leased area, all wells, improvements, machinery, and fixtures on the leased area, and all reports and records relative to operations and surveys or investigations on or with regard to the leased area or under this lease. Upon request, the lessee shall furnish the state with copies of and extracts from any such reports and records.

16. **UNITIZATION.** (a) The lessee may unite with others, jointly or separately, in collectively adopting and operating under a cooperative or unit agreement for the exploration, development, or operation of the pool, field, or like area or part of the pool, field, or like area that includes or underlies the leased area or any part of the leased area whenever the state determines and certifies that the cooperative or unit agreement is in the public interest.

(b) Except as otherwise provided in this subparagraph, where only a portion of the leased area is committed to a unit agreement approved or prescribed by the state, that commitment constitutes a severance of the lease as to the unitized and non-unitized portions of the leased area. The portion of the

leased area not committed to the unit will be treated as a separate and distinct lease having the same effective date and term as originally provided in this lease and the severed portion may be maintained only in accordance with the terms and conditions of this lease, statutes, and regulations. Any portion of the leased area not committed to the unit agreement will not be affected by the unitization or pooling of any other portion of the leased area, by operations in the unit, or by suspension approved or ordered for the unit.

17. **SUSPENSION.** The state may from time to time direct or approve in writing suspension of production or other operations under this lease.

18. **ASSIGNMENT, PARTITION, AND CONVERSION.** This lease, or an interest in this lease, may, with the approval of the state, be assigned, subleased, or otherwise transferred to any person or persons qualified to hold a lease. No assignment, sublease, or other transfer of an interest in this lease, including assignments of working or royalty interests and operating agreements and subleases, will be binding upon the state unless approved by the state. The lessee shall remain liable for all obligations under this lease accruing prior to the approval by the state of any assignment, sublease, or other transfer of an interest in this lease.

19. **SURRENDER.** The lessee may at any time file with the state a written surrender of all rights under this lease or any portion of the leased area comprising one or more legal subdivisions with the consent of the state. That surrender will be effective as of the date of filing, subject to the continued obligations of the lessee to make payment of all accrued royalties and to place all wells and surface facilities on the surrendered land in condition satisfactory to the state for suspension or abandonment. After that, the lessee will be released from all obligations under this lease with respect to the surrendered lands.

20. **TERMINATION FOR DEFAULT.** Failure of the lessee to perform timely its obligations under this lease, or the failure of the lessee otherwise to abide by all express and implied provisions of this lease, is a default of the lessee's obligations under this lease. The state may terminate this lease in an administrative proceeding whenever the lessee fails to comply with any of the provisions of this lease within 60 days after written notice of that default to begin and diligently prosecute operations to remedy that default. Leases that expire pursuant to paragraphs 3 or 4 is not subject to this paragraph 21. Failure to submit a plan of exploration or plan of development for approval in a timely fashion may result in termination.

21. **RIGHTS UPON TERMINATION.** Upon the expiration or earlier termination of this lease as to all or any portion of the leased area, the lessee will be directed in writing by the state and will have the right at any time within a period of one year after the termination, or any extension of that period as may be granted by the state, to remove from the leased area or portion of the leased area all machinery, equipment, tools, and materials. Upon the expiration of that period or extension of that period and at the option of the state, any machinery, equipment, tools, and materials that the lessee has not removed from the leased area or portion of the leased area become the property of the state or may be removed by the

state at the lessee's expense. At the option of the state, all improvements such as roads, pads, and wells must either be abandoned and the sites rehabilitated by the lessee to the satisfaction of the state, or be left intact and the lessee absolved of all further responsibility as to their maintenance, repair, and eventual abandonment and rehabilitation. Subject to the above conditions, the lessee shall deliver up the leased area or those portions of the leased area in good condition.

22. **DAMAGES AND INDEMNIFICATION.** (a) No rights under this lease may be exercised by the lessee until the lessee has provided to pay the owner of another estate in the land subject to this lease, his lessees and permittees, full payment for all damages that may be sustained by the owner by reason of the exercise of the rights granted by this lease. If the owner for any reason does not settle the damages, the lessee may enter the land after posting a surety bond determined by the state, after notice and an opportunity to be heard, to be sufficient as to form, amount, and security to secure to the owner, his lessees and permittees, payment for damages, and may institute legal proceedings in a court of competent jurisdiction where the land is located to determine the damages which the owner of the land may suffer. The lessee agrees to pay for any damages that may become payable under AS 38.05.130 and to indemnify the state and hold it harmless from and against any claims, demands, liabilities, and expenses arising from or in connection with such damages. The furnishing of a bond in compliance with this paragraph will be regarded by the state as sufficient provision for the payment of all damages that may become payable under AS 38.05.130 by virtue of this lease.

(b) The lessee shall indemnify the state for, and hold it harmless from, any claim, including claims for loss or damage to property or injury to any person caused by or resulting from any act or omission committed under this lease by or on behalf of the lessee. The lessee is not responsible to the state under this subparagraph for any loss, damage, or injury caused by or resulting from the sole negligence of the state.

(c) The lessee expressly waives any defense to an action for breach of a provision of this lease or damages resulting from any harm to the environment that is based on an act or omission committed by an independent contractor in the lessee's employ. The lessee expressly agrees to assume responsibility for all actions of its independent contractors.

23. **BONDS.** (a) If required by the state under 11 AAC 84.790(a), the lessee shall furnish a bond prior to the commencement of lease operations in an amount established by the state and must maintain that bond as long as required by the state.

(b) The state may, after notice to the lessee and a reasonable opportunity to be heard, require a bond in a reasonable amount greater than the amount specified in subparagraph (a) above where a greater amount is justified by the nature of the surface and its uses, the degree of risk, and the nature of the activity involved in the types of operations being or to be carried out under this lease. A statewide bond will not satisfy any requirement of a bond imposed under this subparagraph, but will be considered by the state in determining the need for and the amount of any additional bond under this subparagraph.

24. **AUTHORIZED REPRESENTATIVES.** The Director of the Division of Oil and Gas, Department of Natural Resources, State of Alaska, and the person executing this lease on behalf of the

27. INTERPRETATION. This lease is to be interpreted in accordance with the law of the State of Alaska. The paragraph headings are not part of this lease and are inserted only for convenience. The state and the lessee expressly agree that any judicial proceeding affecting this lease shall be conducted in the state Superior Court, Third Judicial District, at Anchorage.

28. INTEREST IN REAL PROPERTY. It is the intention of the parties that the rights granted to the lessee by this lease constitute an interest in real property in the leased area.

29. WAIVER OF CONDITIONS. The state reserves the right to waive any breach of a provision of this lease, but any such waiver extends only to the particular breach so waived and does not limit the rights of the state with respect to any future breach; nor will the waiver of a particular breach prevent cancellation of this lease for any other cause or for the same cause occurring at another time. Notwithstanding the foregoing, the state will not be deemed to have waived a provision of this lease unless it does so in writing.

30. SEVERABILITY. If it is finally determined in a judicial proceeding that any provision of this lease is invalid, the state and the lessee may jointly agree by a written amendment to this lease that, in consideration of the provisions in that written amendment, the invalid portion will be treated as severed from this lease and that the remainder of this lease, as amended, will remain in effect.

31. CONDITIONAL LEASE. If all or a part of the leased area is land that has been selected by the State of Alaska under laws of the United States granting lands to the State of Alaska, but the land has not been patented to the State of Alaska by the United States, then this lease is a conditional lease as provided by law until the patent becomes effective. If for any reason the selection is not finally approved, or the patent does not become effective, any rental, royalty, or other production or profit-based payments made to the state under this lease will not be refunded.

32. NONDISCRIMINATION. The lessee and the lessee's contractors and subcontractors may not discriminate against any employee or applicant because of race, religion, marital status, change in marital status, pregnancy, parenthood, physical handicap, color, sex, age, or national origin as set out in AS 18.80.220. The lessee and its contractors and subcontractors must, on beginning any operations under this lease, post in a conspicuous place notices setting out this nondiscrimination provision.

33. ROYALTY ON PRODUCTION. (a) The state's royalty share of production from the lease is not subject to lien and shall be paid to the state, free and clear of all costs including but not limited to costs incurred for exploration, production, transmission, or transportation, regardless of whether the costs are unit or lease costs and regardless of whether the costs are incurred on or off the lease or unit.

(b) The lessee shall pay to the state as a royalty ten (10) percent in amount or value of:

(1) the gross revenues derived from the production, sale or use of geothermal resources from the leased area that are sold in a bona-fide arm's length transaction between independent parties;

(2) the market value of the geothermal resources that are sold in other than a bona fide arm's length transaction between independent parties;

(3) the market value of the geothermal resources consumed by the lessee.

(c) The state may adjust the royalty rates set out in subparagraph (b) above 20 years after the commencement of commercial production, and at intervals of not less than ten years thereafter.

34. ROYALTY IN VALUE. (a) Except to the extent that the state elects to receive all or a portion of its royalty in kind as provided in Paragraph 35, the lessee must pay to the state royalty at the rates provided in paragraph 33. All royalty that may become payable in money to the State of Alaska must be paid on or before the last federal banking day of the calendar month following the month in which the geothermal resources are produced. The amount of all royalty in value payments which are not paid when due under this lease or which are subsequently determined to be due to the state as the result of a redetermination will bear interest from the last federal banking day of the calendar month following the month in which the geothermal resources were produced, until the obligation is paid in full. Interest shall accrue at the rate provided in AS 38.05.135(d) or as may later be amended.

35. ROYALTY IN KIND. (a) At the state's option, which may be exercised from time to time upon not less than six months notice to the lessee, the lessee must deliver all or a portion of the state's royalty on geothermal resources produced or used from the leased area in kind. Delivery must be on the leased area or at a place mutually agreed to by the state and the lessee, and must be delivered to the State of Alaska or to any individual, firm, or corporation designated by the state.

(b) Royalty geothermal resources taken in kind must be delivered in good and merchantable condition.

(c) After having given notice of its intention to take, or after having taken its royalty on geothermal resources in kind, the state, at its option and upon six months notice to the lessee, may elect to receive a different portion or none of its royalty in kind. If, under federal regulations, the taking of royalty geothermal resources in value by the state creates a supplier-purchaser relationship, the lessee hereby waives its right to continue to receive royalty geothermal resources under the relationship, and further agrees that it will require any purchasers of the royalty geothermal resources likewise to waive any supplier-purchaser rights.

(d) If a state royalty purchaser refuses or for any reason fails to take delivery of geothermal resources, or in an emergency, and with as much notice to the lessee as is practical or reasonable under the circumstances, the state may elect without penalty to underlift for up to six months all or a portion of the state's royalty on geothermal resources produced from the leased or unit area and taken in kind. The state's right to underlift is limited to the portion of royalty geothermal resources that the royalty purchaser refused or failed to take delivery of, or the portion necessary to meet the emergency condition. Underlifted geothermal resources may be recovered by the state at a daily rate not to exceed ten (10) percent of its royalty interest share of daily production at the time of the underlift recovery.

36. REDUCTION OF RENTAL AND ROYALTY. The state may, at its discretion, after public hearing, reduce the lessee's obligation to pay royalty on all of the leased area or on any tract or portion of the leased area segregated for royalty purposes whenever the state determines that it is necessary to do

so to promote development, or that the lease cannot be successfully operated under its terms. The state may also waive, suspend, refund or reduce the rental on all or any portion of the leased area in accordance with the applicable statutes and regulations.

37. BINDING EFFECT. The state and the lessee agree that this lease, including all attachments and documents that are incorporated in this lease by reference, contains the entire agreement between the parties, and each of the covenants and conditions in this lease including any attachments will be binding upon the parties and upon their respective heirs, administrators, successors and assigns. The state and the lessee further agree that this lease is conditioned upon satisfactory performance of all covenants and conditions contained in this lease. The lessee is aware of the provisions of Title 38 Alaska Statutes, Title 11, Alaska Administrative Code, and other applicable laws, regulations, and ordinances, and fully understands the duties and obligations of the lessee under this lease, and the rights and remedies of the state.

38. DEFINITIONS. All words and phrases used in this lease are to be interpreted where possible in the manner required in respect to the interpretation of statutes by AS 01.10.040. However, the following words have the following meanings unless the context unavoidably requires otherwise:

(1) "drilling" means the act of boring a hole to reach a proposed bottom hole location through which geothermal resources may be produced if encountered in commercial quantities, and includes redrilling, sidetracking, deepening, or other means necessary to reach the proposed bottom hole location, testing, logging, plugging, and other operations necessary and incidental to the actual boring of the hole;

(2) "force majeure" means war, riots, acts of God, unusually severe weather, or other acts of nature;

(3) "geothermal system" means a stratum, pool, reservoir, or other geologic formation containing geothermal resources;

(4) "commercial quantities" means quantities sufficient to yield a return in excess of operating costs, even if drilling and equipment costs may never be repaid and the undertaking considered as a whole may ultimately result in a loss;

(5) "commercial production" means production of geothermal resources in commercial quantities.

39. EFFECTIVE DATE. This lease takes effect on _____, 200____.

BY SIGNING THIS LEASE, the state as lessor and the lessee agree to be bound by its provisions.

LESSEE

By: _____

Title: _____

By: _____

Title: _____

STATE OF ALASKA

By: _____

Title: _____

STATE OF ALASKA)
)SS.
Third Judicial District)

This is to certify that on _____, 200____, before me appeared _____,
of the Division of Oil and Gas of the State of Alaska, Department of Natural Resources, and who
executed this lease and acknowledge voluntarily signing it on behalf of the State of Alaska as lessor.

Notary public in and for Alaska
My commission expires:_____

INSERT NOTARY AND ACKNOWLEDGEMENT STATEMENT OF LESSEES HERE.

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
- 2008a Alaska Community Database Community Information Summaries: Beluga.
<http://www.dced.state.ak.us/dca/commdb/CIS.cfm>
- 2008b Alaska Community Database Community Information Summaries: Tyonek.
<http://www.dced.state.ak.us/dca/commdb/CIS.cfm>
- 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.
- Alaska Report
- 2006 An Introduction to Geothermal Energy, Could it Power Alaska Communities? October 9.
- AVO (Alaska Volcano Observatory)
- 2007 Spurr description and statistics:
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- 2007 Draft Environmental Impact Statement for the Truckhaven Geothermal Leasing Area, Imperial County, California, February.
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- DGGS (Division of Geological and Geophysical Surveys)

- 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.
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 2005 <http://www.geothermal.org/>
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 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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