Chapter Five: Reasonably Foreseeable Effects of Licensing and Subsequent Activity

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Until discoveries are made, it is impossible to predict the actual level of gas-related activities and their effects. General mitigation measures and licensee advisories have been developed to minimize pollution, 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 particular exploration and development proposals if and when they are submitted for approval in plans of operation. Implementation of any exploration and development program must meet the requirements of regulatory agencies before approval. Despite these protective measures, impacts may occur. In this chapter, potential impacts are discussed and measures to mitigate these impacts are presented. (See Chapter Seven for general mitigation measures and licensee advisories.) These discussions focus on natural gas. However, even though the geology of the Healy area suggests that gas is the most likely resource present in economic quantities, there still exists a remote possibility of finding oil. If this were to occur, the licensee must shut down operations and contact the DO&G for additional determinations.

Strategies used to explore, develop, produce, and transport petroleum resources will vary, depending on factors unique to the proposed license area, licensee, operator, and discovery. If commercial quantities of oil and gas are located, construction of pipelines and other production and transportation facilities would be necessary. New roads may be required, and machinery, labor, and housing would be required to support project sites.

The state of Alaska as a whole, the Denali Borough, and local communities may experience the effects of gas development activities. A summary of possible effects of exploration, development and production are listed in Table 5.1 and are addressed in more detail below. All licensing activities are subject to applicable local, state, and federal statutes, regulations, and ordinances, and the mitigation measures presented in Chapter 7. Additional stipulations may apply as well, if identified as conditions of approval for specific permitted activities.

Table 5.1: Potential Effects of Oil and Gas Exploration

Erosion	Water quality changes
Use conflicts	Chemical/pollutant releases
Disturbance to wildlife	Impacts to human environment
Incidental oil spills	Air quality degradation
Alteration of hydrology	Siltation
Loss of fish and wildlife	Employment opportunities
Increased noise and traffic	Road, airstrip, sanitary & utilities construction
Habitat loss or change	State petroleum tax & royalty revenues
Environmental studies	Local gas property tax revenues

Section A of this chapter begins with a technical description of the post licensing phases of gas activities. Section B focuses on the fiscal effects of these later phases on the state and communities in the proposed license area, and the expected distribution of fiscal benefits to the state and local areas. Section C

focuses on other effects to local communities, such as fishing, infrastructure and land use. Section D focuses on potential cumulative effects on habitats, fish and wildlife, subsistence activities and the historic and cultural resources of the proposed license area.

A. Post Licensing Phases

License-related activities proceed in phases. Following the licensing, there are three phases of industrial activity: exploration, development, and production. Various activities may occur at each of these phases, depending on the specifics of a project, and each subsequent phase's activities depend on the initiation or completion of the preceding phase. Table 5.2 lists activities that may occur during these phases.

Table 5.2: Exploration, Development, and Production Phase Activities

Exploration	Development	Production
Permitting	Gravel pits, pads, and roads	Well work over (rigs)
Water usage	Bridge construction	Gravel pads and roads
Environmental studies	Drilling rigs	Produced water
Seismic tests	Pipelines	Air emissions
Exploratory drilling	Work camps	Pipeline maintenance
Land clearing	Permitting	Work camps
Use of drilling muds & discharges	Monitoring	Trucking
Gravel road beds	Well heads	
Work camp	Reinjection wells	
Increased air traffic	Air emissions	
Temporary gravel pads		
Research and analysis		
Air emissions		

1. Exploration

Exploration activities are designed to gather as much information about the petroleum potential of an area as possible. Exploration activities may include the following: examination of the surface geology; geophysical surveys; researching data from existing wells; performing environmental assessments; and drilling one or more exploratory wells. Surface analysis includes the study of surface topography or the natural surface features of the area, near-surface structures revealed by examining and mapping exposed rock layers, and geographic features such as hills, mountains and valleys.

a. Geophysical Exploration

Geophysical companies usually conduct seismic surveys under contract with license holders. Geophysical exploration activities are regulated under 11 AAC 96 and the Alaska Department of Natural Resources (ADNR) tailors each permit approval to the specifics of a proposed project. Restrictions on geophysical exploration permits depend on the duration, location, and intensity of the project. They also depend on the potential effects the activity may have on vegetation, fish, and wildlife resources or human use in the area. The extent of effects varies, depending on the survey method and the time of year the operation is conducted.

Geophysical surveys help reveal what the subsurface may look like. Before proceeding, companies must acquire one or more permits from the state, depending on the timing and extent of the proposed activity. Companies will gather two-dimensional (2-D) and possibly three-dimensional (3-D) seismic data. Two-

dimensional seismic programs usually have fewer crewmembers and employ less equipment than 3-D programs. Land-based seismic surveys are typically conducted in winter, and all seismic surveys must be individually permitted.

To gather seismic data, an energy source is required to generate energy waves that travel into the subsurface. Depending on the difference in densities of the rock layers beneath the surface, these energy waves are reflected back from the various rock layers and are received by vibration-sensitive devices called geophones. Impulses are recorded, processed on high-speed computers, and displayed in the form of a seismic reflection profile.

Geophysical companies use various methods of generating energy, depending on the terrain and conditions. Possible methods might include the use of explosives, Vibroseis equipment, or the dropping of weights, to name a few. Explosives may be placed into drill holes and detonated, or they may be suspended on stakes above the ground (Poulter method). If buried, drill holes are typically 15 to 25 feet deep with five pounds of explosive set at the bottom of the hole. The drill holes are either drilled with track-mounted drills or, if in remote or sensitive areas, slung into position by helicopters. Vibroseis equipment utilizes a vibrator as the energy source. The vibrating plate is attached to a low ground pressure tracked vehicle and creates a sinusoidal vibration of continuously varying frequency, typically lasting seven seconds or longer. Weight dropping can be accomplished with specially designed vehicles or with helicopters. Depending on the location, terrain and vegetation cover, several energy source techniques might be needed within the proposed license area.

Land-based surveys are typically conducted in winter from mobile camps comprising survey vehicles, fuel trucks, and modular camp units pulled by bulldozers. Once in the area of operation, these mobile camps are moved every few days to once a week, with fuel trucks making runs to resupply as necessary.

b. Exploration Drilling

When interpretation of the seismic data reveals gas prospects, exploratory drilling is conducted to determine whether a prospect contains commercial quantities of gas. Exploratory drilling generates information for the licensee, which will aid in the decision to proceed to the development phase. Drilling operations include the collection of core samples, well logs, cuttings, and various other forms of information. Cores may be cut at various intervals so that geologists and engineers can examine the sequences of rock that are being drilled. A well log is a record of one or more physical measurements as a function of depth in a borehole, and is achieved by lowering measuring instruments into the well bore.

If the exploratory well is successful, the operator may drill additional wells to delineate the extent of the discovery and gather more information about the field. The licensee needs to know the quantity of gas, and the quality of the rocks or coal in which it is found, to determine whether to proceed to the development phase.

The drilling process is as follows:

- Special steel pipe, conductor casing, is bored into the soil.
- The bit rotates on the drill pipe to drill a hole through the rock formations below the surface and into the earth.
- Blowout preventers are installed on the surface and only removed when the well is plugged and abandoned. Blowout preventers are large, high-strength valves, which close hydraulically on the drill pipe to prevent the escape of fluids to the surface.

- Progressively smaller sizes of steel pipe, called casing, are lowered into the hole and cemented in place to keep the hole from caving in, to seal off rock formations, to seal the well bore from groundwater, and to provide a conduit from the bottom of the hole to the drilling rig.

- Depending upon the information obtained from exploratory drilling, the well is put into production, capped, or plugged and abandoned.

Byproducts of drilling activities may include muds and cuttings, produced water, and associated wastes. Drilling sometimes employs the use of carefully mixed fluids, called muds. Drilling muds are mostly water-based mixtures of clay and other earthen materials, such as almond husks, which are used to cool and lubricate the drilling bit, prevent the drill pipe from sticking to the sides of the hole and facilitate the drilling action, flush out cuttings within the well bore, seal off cracks in down-hole formations to prevent the flow of drilling fluids into these formations, and maintain reservoir pressure. Chemicals may be added to maximize the effectiveness of drilling and casing (see Table 5.3). Oil-based or synthetic-based muds may also be used depending on the well depth, well diameter, and subsurface formations (NRC 1983, Veil *et al.* 1996). Hazardous materials are not used in drilling muds. During drilling and after a well is in production, water comes to the surface mixed with cuttings, oil (if oil-based fluids are used), and gas and must be separated before further refining. Cuttings are small fragments of rock up to an inch across that are dislodged and carried to the surface by the drilling process, in the muds.

Table 5.3: Additives of Drilling Fluids

	Common additive	Use
Weighting material	Barite (barium sulfate ore)	Adds density and counters formation pressures
Viscosifiers	Bentonite clay (mostly sodium montmorillonite)	Removes cuttings, prevents fluid loss, helps seal wellbore
Natural & Synthetic Polymers	Bentonite and drilled clays, Corn and potato starch, modified starch, natural gums	Mud cake, prevent fluid loss, cuttings transport, hydraulics
Thinners	Plant tannins, polyphosphates, lignitic materials	Reduce temperature effects, reduce viscosity
pH and Ion Control	Soda ash, baking soda, sodium hydroxide	Control corrosion, remove harmful gas (H2S)
Lubricants	Natural and synthetic oil-based compounds	Reduce friction in wellbore
Bacteria Control Agents	Depends on ability to meet effluent guidelines	Mitigate fermentation of organics in drill system
Surfactants	Salts, soaps, fatty acid derivatives	Emulsifier, wetting agent, foamers, defoamers, reduce clay hydration

Source: NRC 1983

According to a 1993 Environmental Protection Agency (EPA) report, the use of water-based muds generates 7,000 to 13,000 barrels of waste per well, and depending on the depth and diameter of the well, 1,400 to 2,800 of those are cuttings (Veil *et al.* 1996). Volumes of oil-based muds are generally less than volumes of water-based muds because they are more efficient. Additionally, oil-based muds may be reconditioned, reused, and re-sold. Newer synthetic-based muds produce even less waste, improve drilling efficiency, are reusable, and have advantages in environmental protection over oil or water-based muds (Veil *et al.* 1996). Discharge of untreated oil-based muds into any water column violates federal and state pollution laws.

Produced water contains mostly natural substances, such as clay and sand, which is mixed with any oil, water, and gas found in the subterranean strata. Produced waters are usually saline with some level of hydrocarbons. Other production fluids include tank bottom sludge, brines associated with well work-overs, gas dehydration processes, tank wastewater, and other residues that are considered non-hazardous (low-toxicity) by the EPA. Like drilling muds, chemicals may be added to produced water to remove harmful bacteria, halt corrosion, break up solids, prevent scale build up, and break oil/water emulsions (EPA 1995).

The state discourages the use of permanent reserve pits, and most operators store drilling solids and fluids in tanks until they can be disposed, generally down the annulus of the well, in accordance with AOGCC regulations. Frozen cuttings may also be temporarily stored on the pad. In most circumstances, the cuttings are transported to a grind and inject facility.

If necessary, a flare pit may be constructed to allow for the safe venting of natural gas that may emerge from the well. If the exploratory well reveals a gas reservoir, it is likely that the pad used for the exploratory well will also be used for production testing operations. If an oil reservoir is discovered, all operations must cease, and the operator must immediately contact DO&G for further determinations, since the exploratory activity is conducted under a “gas only” exploration license.

2. Development and Production

The development and production phases are interrelated; therefore, this section discusses them together. During the development phase, operators evaluate the results of exploratory drilling and develop plans to bring the discovery into production. Production operations bring natural gas to the surface and prepares it for transport to the processing plant or compressor station. These phases can begin only after exploration has been completed and tests show that a discovery is economically viable (Gerding 1986).

After designing the facilities, the operator constructs permanent structures and drills production wells. The operator must build production structures that will last the lifetime of the field, and may have to design and add new facilities for enhanced recovery operations as production proceeds.

Production operations for natural gas generally consist of the following processes:

- Natural gas flows through a high-pressure separator system where any liquids (water, condensate, etc.) are removed. Produced oil, if any, goes through a separator to remove the natural gas from the oil.
- The gas is compressed if necessary.
- The gas is dehydrated to lower its water content.
- The gas is then metered (i.e. the amount of gas produced is measured).
- The gas is transported to a facility where it passes through a water precipitator to remove any remaining oil.

Gravel pads are semi-permanent structures used for production facilities and can be rehabilitated following field depletion. The development "footprint" of gravel pads has decreased in recent years as advances in drilling technology have led to smaller, more consolidated pad sizes (Figure 5.1). Figures 5.2 and 5.3 illustrate directional drilling, which results in recovering more product from a larger subsurface area (by increasing the drainage area) than would be possible from a single straight wellbore.

Figure 5.1: Evolving Consolidation of North Slope Production Pad Size

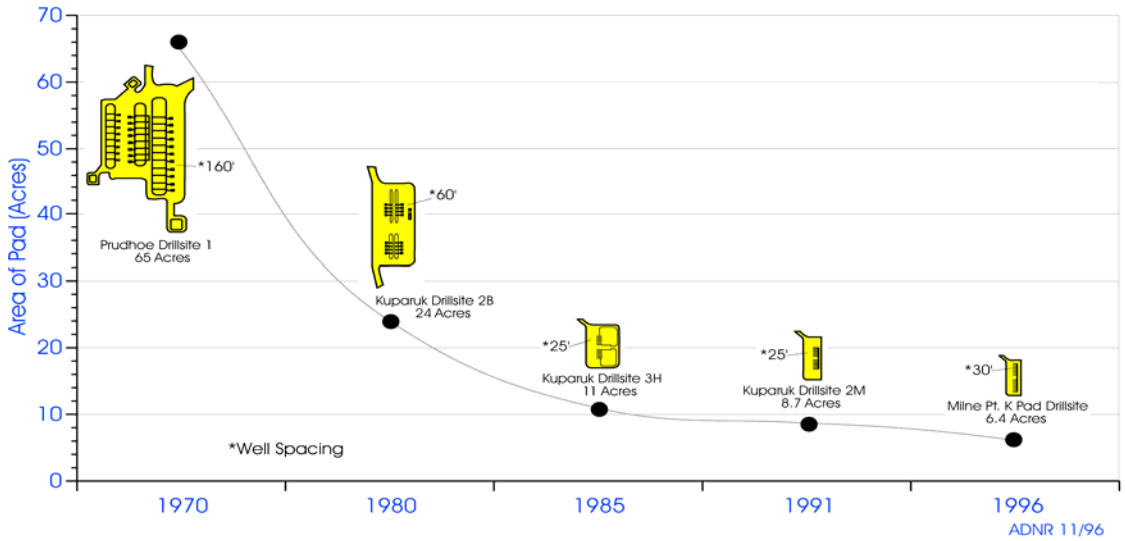


Figure 5.2: Drill Site Block Diagram

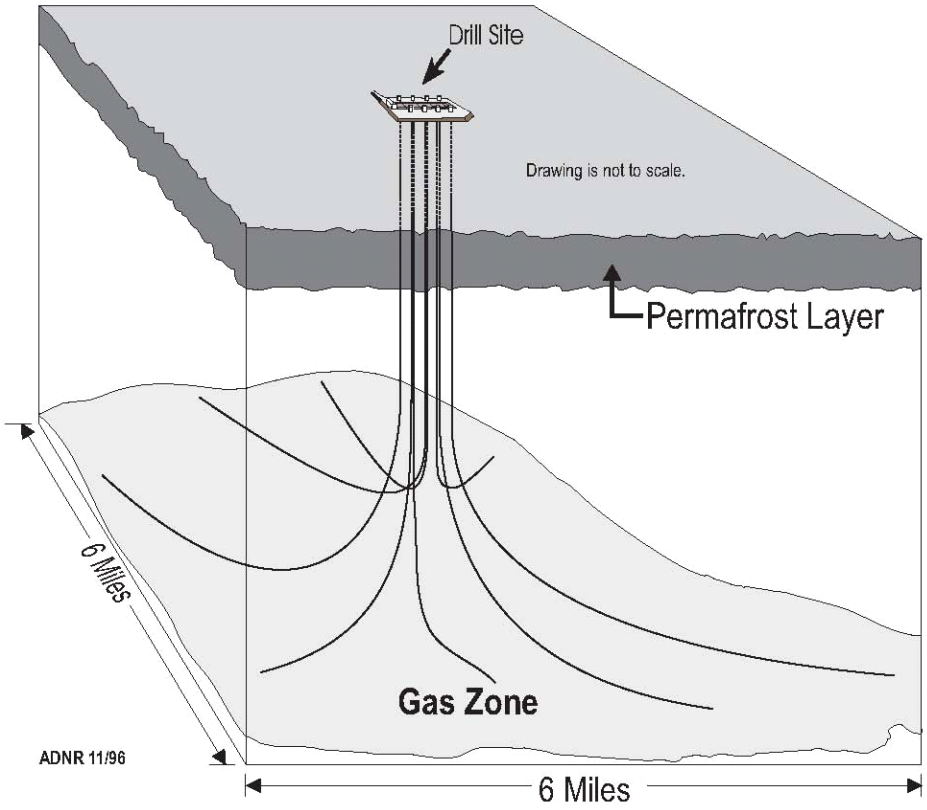
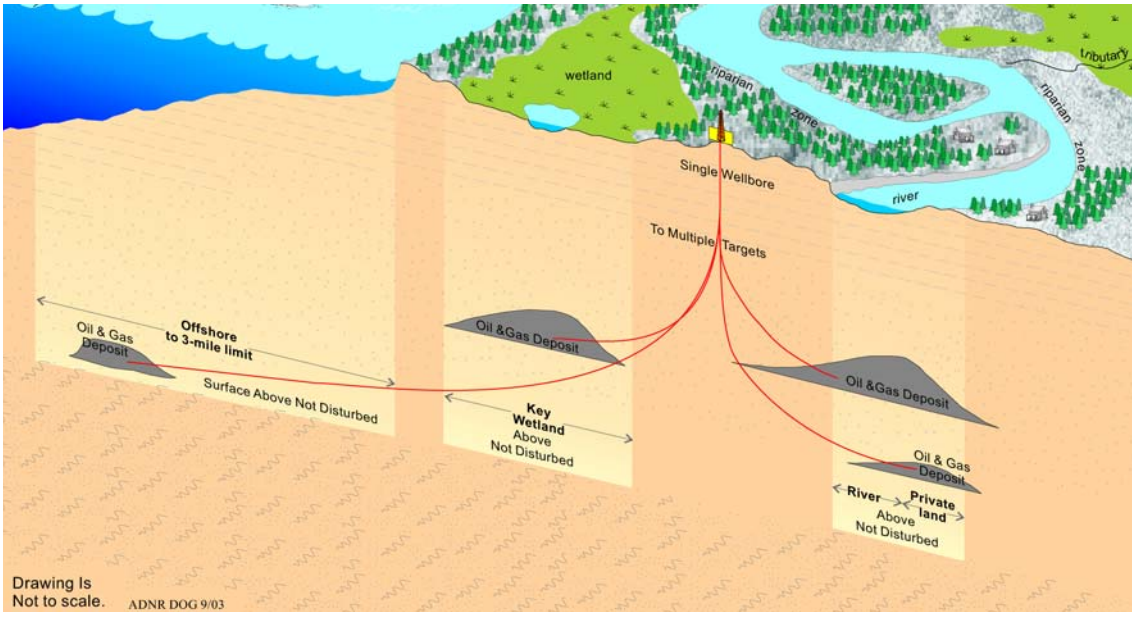


Figure 5.3: Directional Drilling Applications



In addition to exploring for and producing conventional gas, the proposed exploration license also allows a licensee to explore for nonconventional gas resources, such as coal bed methane (natural gas - CH_4) (CBM). CBM is a by-product of the transformation of decayed plant material into coal. There are two types: biogenic methane, produced during microbial decay of the peat (also called swamp gas) and thermogenic methane, produced by the thermal cracking of the organic molecules during the formation of higher ranks of coal. During the formation of coal, large quantities of methane-rich gas are generated and stored on its internal surfaces. Because coal has such a large internal surface area, it can store surprisingly large volumes of methane-rich gas; six or seven times as much gas as a conventional natural gas reservoir of equal rock volume. The amount of methane stored within the coal can reach up to 500 cubic feet per ton. Production of coal bed methane (CBM), a possible product in the proposed license area, is accomplished through both vertically and horizontally drilled wells, much like those described above.

In addition, much of the coal, and thus much of the methane, lies at relatively shallow depths, making these wells easy to drill and inexpensive to complete. The amount of gas that can be produced from a given coal bed depends on the following factors:

- The thickness, lateral continuity and rank of the coal;
- The permeability of the coal, controlled by the amount of fracturing or cleats;
- Depth of burial and other barriers, such as impermeable geologic layers, structures, and faults or folds, that keep the gas trapped within the coal seam.

Coal bed methane exploration and production also involves a technique called “fracturing” the coal. This involves sending highly pressured materials into the coal seam to create fractures to facilitate the movement of gas to the wells.

At the license issuance phase, it is impossible to predict what a full development scenario would entail. The final project parameters will depend on the surface location, size, depth, and geology of a specific commercial discovery. Scientific understanding of and production experience with CBM are both in the early stages. Much is yet to be learned about what controls the occurrence and recoverability of CBM. The only

recent CBM exploration and pilot project in Alaska is that of Evergreen Resources in the Matanuska-Susitna (Mat-Su) Valley, which was abandoned. To date, there has not been an economical CBM development in Alaska, so there is no model of what a potential development might look like in the Healy area if CBM is found, or the subsequent level of CBM activities and their potential effects. Therefore, a potential development scenario must be drawn from the combination of the CBM pilot project in the Mat-Su Valley and the existing developments in the Raton Basin of Colorado and New Mexico, and the Powder River Basin of Montana and Wyoming, though there are important differences in the depth of both coal and water resources, between Alaska and other states, which must be considered. See Appendix G for more information on CBM wells.

Enforceable standards for CBM development within the Mat-Su Borough were developed by the department in 2004 (ADNR 2004). Similar standards, tailored to the conditions of the proposed Healy license area, are included in the mitigation measures in Chapter 7. Implementation of any CBM exploration and development program must meet the requirements of regulatory agencies prior to approval. Permit requirements will be evaluated in light of the particular activity proposed, and plans of operation must be approved with appropriate project-specific and site-specific safeguards. Generally, the process for evaluating exploration results is lengthy, involving shallow geophysical surveys, core hole test wells, pilot projects, water disposal plans, proposed field development, gas transportation, and cumulative effects.

B. Statewide and Local Fiscal Effects

1. Statewide Fiscal Effects

Alaska's economy depends heavily on revenues related to oil and gas production and the resulting government spending. The following statistics illustrate various ways in which the licensing program could generate income to state government.

License Fees. The recipient of the license pays a $1 per acre license fee. As of January 2005 the state has issued six exploration licenses: Copper River Basin, Nenana Basin, Susitna Basin I, and Susitna Basin II for a total of 1,739,068 acres. License fees, therefore, have totaled $1,739,068. At 208,630 acres, this proposed license, if issued, would result in a fee of $208,630.

Rentals. During the term of the exploration license, no rentals are due. Once the work commitment has been met, any portion of the proposed license area may be converted to gas leases. The term of the leases will be for 10 years. There is a standard annual rental fee for leases of one dollar per acre for the first year, increasing to a maximum of three dollars per acre after the fourth year.

Royalties. Royalties represent the state's share of the production as the mineral interest owner. The royalty rate varies from five percent to sixty percent based on the terms of the lease, but most often is twelve and one-half percent. Royalty is paid based on the agreed value of the oil or gas removed from the lease, the volume removed and the lease's royalty rate. Royalties from statewide oil and gas development provided over $1 billion in revenue to the state in fiscal year (FY) 2004 (ADOR 2004). Given the probability for coal bed shallow natural gas in the Healy area, the state could realize revenue income from royalties, the amount of which is dependent on production levels.

Severance Taxes. Production taxes must be paid by producers on all taxable oil and gas produced from each lease or property in the state. The taxes are paid on a percentage of gross value basis. Unrestricted oil and gas production taxes were approximately $652 million for FY 2004 (ADOR 2005). Production from the Healy area is estimated to be several years downstream, if it occurs. The level of tax income to the state would depend on the amount of gas production achieved.

Income taxes. All corporations in the state must pay corporate income tax for all taxable income derived from sources within the state. Special provisions apply to apportioning total income worldwide for corporations involved in producing or transporting oil and gas. Most, if not all, producers and transporters of oil and gas in Alaska are corporations. For FY 2004, total oil and gas corporation taxes were approximately $299 million (ADOR 2004). As noted above, gas production from the Healy area is estimated to be several years downstream, if it occurs. The level of resulting income tax revenue to the state would depend on the amount of gas production achieved.

Oil & Gas Property Taxes. An annual tax is levied each year on the full and true value of property taxable under AS 43.56. This includes exploration property, production property, and pipeline transportation property. Property taxes amounted to approximately $47.3 million in FY 2004 (ADOR 2005). Again, the level of state revenue from gas property taxes depends on the amount of taxable property generated during exploration, development, and production, if they occur.

Together, the revenues derived from oil and gas exploration, development, and production comprised approximately 87 percent of the state's general fund unrestricted revenue in FY 2004, and are expected to provide at least 80 percent of forecasted Unrestricted General Purpose Revenue through FY 2008 (ADOR 2005). Such revenues finance the state's revenue sharing, municipal assistance, education funding, operating budget and capital budget. State spending supports nearly one out of every three jobs, and three of every ten dollars of personal income result from state spending. Nearly one of every two local government jobs (including school district jobs) in Alaska relies on state funding (ISER 1990). Oil and gas royalties and revenues also contribute to the Alaska Permanent Fund, which pays significant dividends each year to every qualified state resident. Given the estimated high potential for shallow coal bed gas in the Healy area, it is possible that this project will be able to contribute to these state revenues. The level of that contribution, however, is unknown and depends on success at every project phase, and ultimately on levels of gas production. However, in comparison to the state's total revenue from oil and gas activities, the anticipated revenue from the Healy Exploration License is unlikely to cause a significant percentage increase.

2. Local Fiscal Effects

The region's economic structure consists of communities with seasonal economies, with employment peaking during the summer months. The fiscal effects of licensing may extend far beyond the proposed license area and affect the regional economy. Communities in the Healy region include: Anderson, Cantwell, Ferry, Healy, and McKinley Park Village. (See Chapter Four for community profiles.)

a. Employment

The Alaska Department of Labor (ADOL) collects and reports employment data for those jobs that are subject to employment regulation. As discussed in Chapter 4, tourism in and adjacent to Denali National Park plays an important role in the local economy. The accommodation tax was raised in 1996 from three percent to seven percent. Revenue from this tax makes up nearly 86 percent of the borough's revenue (ADOL 2001). Although the park is important to the local economy, jobs provided by the Usibelli Coal Mine, Clear Air Force Station, and public service jobs provide stable employment to many of the year-round residents (see Table 5.4).

Table 5.4: Denali Borough Average Monthly Employment, 2003

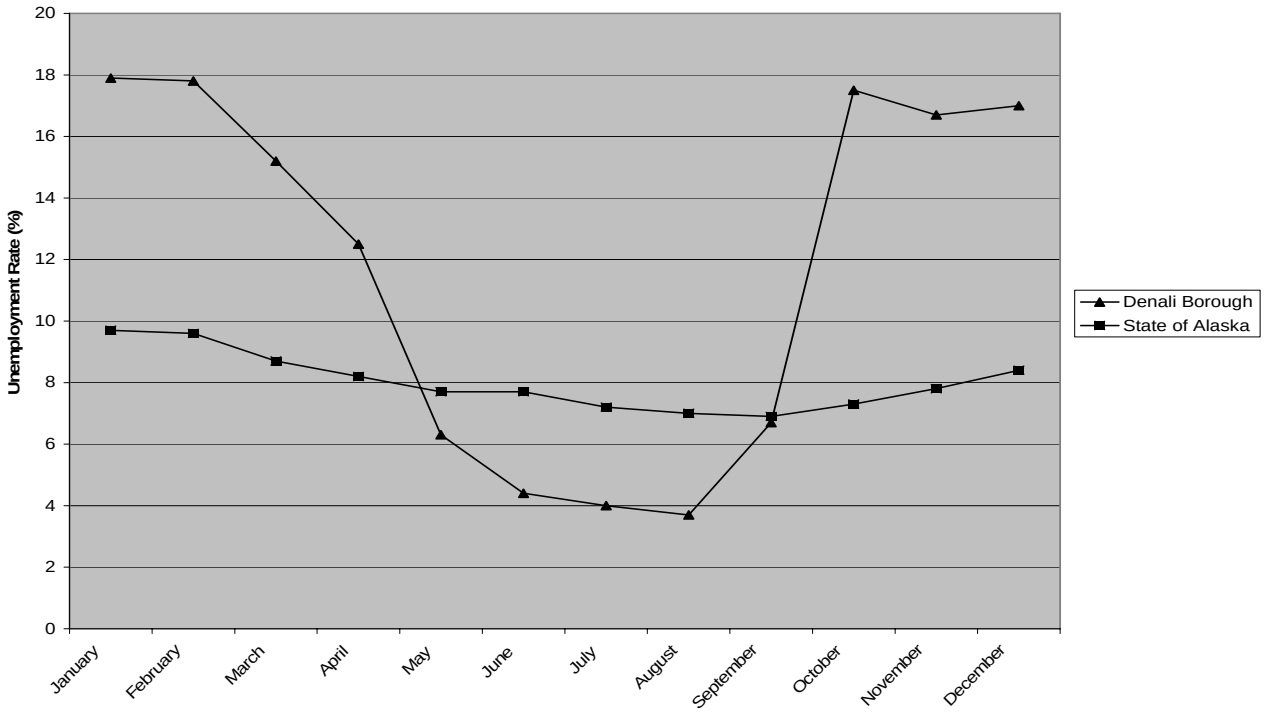
Industry	Average Number of Workers per Month		
	Jan – Apr, Nov-Dec	May - Oct	Annual Monthly Average
Federal Government	167	255	211
State Government	20	27	23
Local Government	121	93	107
Natural Resources & Mining	84	88	86
Construction	12	25	19
Manufacturing	1	1	1
Trade, Transportation & Utilities	190	653	421
Information Services	1	1	1
Professional & Business Services	184	206	195
Educational & Health Services	11	11	11
Leisure & Hospitality	201	1,476	839
Other Services	6	11	9

Source: ADOL 2003

Average annual unemployment rates are higher for the Denali Borough than for the state as a whole. The 2003 average annual unemployment rate was 11.8 percent; the statewide average annual unemployment rate was 7.0 percent. However, average annual unemployment disguises seasonal variations that tend to be significant for the region (Figure 5.4). The unemployment rate dips well below the statewide average during the tourist season.

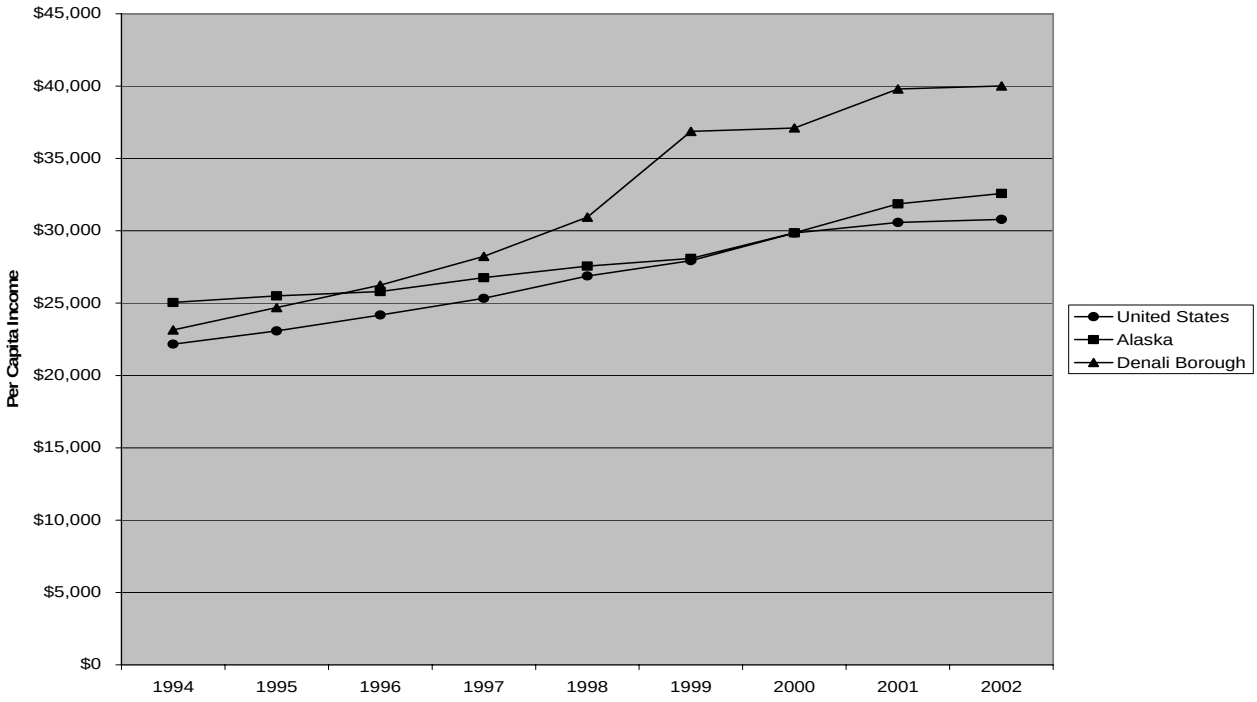
The Denali Borough per capita income has been higher than both the state and the national per capita incomes since 1996 (ADOL 2004b). Figure 5.5 presents the per capita income of the Denali Borough, the State of Alaska, and the United States from 1994 to 2002.

Figure 5.4: Average Monthly Unemployment Rate, 2003



Source: ADOL 2004a

Figure 5.5: Per Capita Income 1994-2002



Source: ADOL 2004b

An exploration license may create new employment opportunities in the gas, service, transportation, utilities, and retail sectors of the local economy. Short-term job opportunities could arise during the exploration phase. The long-term employment benefits of the proposed license on the Denali Borough and local communities will depend on the subsequent production of commercial quantities of gas.

Local communities may provide some labor needs if projects are proposed, approved, and developed within a reasonable commuting distance. Locally owned and operated companies may also provide services to the licensee or operators and may hire additional staff to meet the increased workload. Local contracts for resources and services, such as gravel and road construction, might also contribute to the local economy.

Labor supplies in the local communities may not be able to meet demands for some technical positions. As a result, these jobs may be filled by workers from the service support industry that is active in other regions of the state, or outside Alaska. However, licensees and their contractors are encouraged to hire local and Alaska residents to the extent they are qualified and available. Plans of operation must include a proposal detailing the means by which the licensee will comply with this measure.

Local businesses, such as charter operators, heavy equipment operators, welders, plumbers and pipe fitters, carpenters, vendors, food service providers, and air carriers could provide support for gas activities. Competition for available labor would be highest in the transportation, retail, wholesale, and service sectors of the regional economy during the summer months when tourism, sport fishing, and commercial fishing industries are most active and employing workers for the season. Construction activities could occur during both summer and winter months.

b. Cost of Living

Four times a year, the University of Alaska Fairbanks Cooperative Extension Service surveys the cost of food at a home for a week in 20 Alaska communities and Portland, Oregon (Luick & Bersamin 2004). Although the surveys cannot be used as a proxy for cost of living, they do make the important point that living outside of an urban community makes standard goods more expensive to attain.

Most residents of the Healy area drive to Fairbanks for goods and supplies. For the March 2004 survey, food costs were five percent higher in Fairbanks than in Anchorage (Luick & Bersamin 2004). Not only are goods themselves more expensive, but the expenditures on gas and travel time are also greater for communities in the Healy area, as Healy is located 78 miles south of Fairbanks.

C. Municipal and Community Effects

a. Infrastructure

New exploration and development activities will require labor and may require capital-intensive infrastructure. The presence of workers will likely increase the demand for some public services, like housing or sanitation. New exploration and development projects undertaken in areas away from existing infrastructure would have to be self-sufficient. If located near existing communities, such activities might place additional burdens on nearby community facilities. Since the existence of new developments is unknown at this time, it is not possible to predict the impact on community services.

Some gas projects may require a source of electricity or water. A licensee may provide their own water or electricity or may utilize those of a local community. The suitability of an existing community utility would depend on the specific project proposed, its location, and the existing supply and demand for the service. It would also depend on the ownership structure of the utility and whether the facility had the capacity to accommodate industrial demand.

One possibility for an energy source is the Healy Clean Coal Power Plant. The $274 million Healy Clean Coal Power Plant was completed in November 1997, but has sat idle since 2000. To lower the costs per kilowatt hour and be economically viable, the plant needs retrofits and modifications costing another $50 to $80 million. The plant is owned by the Alaska Industrial Development and Export Authority, an independent State corporation.

b. Health Services

The majority of health services are provided by the Interior Community Health Center (ICHC), a qualified emergency care center in Healy. ICHC provides medical, dental, preventive, and educational health services. The Tri Valley Fire Department (TVFD) provides auxiliary health services, and is also based out of Healy. TVFD is the main responding ambulance service for the Denali National Park, and has personnel trained in swift water rescue, technical rope rescue, aeromedical transport, and wildland firefighting. The nearest hospital is located in Fairbanks. Specialized care available in the area includes Railbelt Mental Health & Addictions, and the Healy Senior Center.

The development of gas resources in the area may place an additional burden on existing health services. In addition to the influx of employees, an increase in air charters and other activities associated with exploration and development increase the potential need for health services. Gas development may also generate additional local revenues that could result in an improvement to existing health services.

c. Land Use

Proximity to existing transportation, storage, and refining facilities is a major consideration in petroleum development planning, especially if a discovered field is considered economic. Logistical constraints and environmental parameters also affect decisions on locating post-exploration phase operations. Field development would take place relatively close to discoveries, and facilities would likely be sited near wells. Exploration and development activities, including construction, probably would not be readily visible outside of the area.

Communities closest to exploration activities may experience increased use of transportation systems, such as air charter services, airstrips, or roads for movement of personnel or construction equipment. Some portions of the area could be developed from existing roads or access routes; however, much of the acreage is remote from existing infrastructure. Larger reserves are required to justify the additional expense of providing necessary transportation to remote sites.

Development of the area could adversely affect human uses of the area and its biological resources if access to hunting, fishing, or trapping areas were restricted or if industry activities occurred at the same place and time as these activities. To avoid this conflict, use of the area by local residents will be unrestricted, except when required within the immediate vicinity of drill sites, buildings, and other related facilities. Areas of restricted access must be identified in the plan of operations.

It is also possible that a proposed activity, such as the building of permanent roads, could allow for easier access to property within or near the proposed license area. The increase in human presence on these lands could have negative impacts on subsistence and recreational use. Conversely, development of the area could increase access for users of the area's resources. If roads were constructed across general state lands, they would be open to the public and available for multiple use activities. If development occurs, consolidation of petroleum facilities is intended to reduce conflicts with recreational uses of the area. A plan of operations must include an analysis of road and access issues associated with site development. All aspects of transportation related to the proposed activity and possible effects on existing uses, and implementation of mitigation measures, must be considered.

D. Cumulative Effects

The potential negative effects of industry activities include loss of fish and wildlife habitat; environmental degradation; and restriction of access for fishing, hunting, and other subsistence uses. Potential positive effects include increased understanding of the environment and infrastructure to support continued access and use of local resources.

1. Effects on Water Quality

The federal Clean Water Act established the National Pollutant Discharge Elimination System (NPDES) to permit discharges of pollutants into United States waters by "point sources" such as industrial and municipal facilities. In Alaska, the EPA issues NPDES permits, designed to maximize treatment and minimize harmful effects of discharges on water quality as technological improvements are made. ADEC certifies that these discharge permits will not result in violations of Alaska Water Quality Standards.

The greatest potential for water quality impacts from winter seismic surveys is through thermokarst erosion and snow compaction (BLM 2005). Thermokarst results from impacts to the insulating vegetative layer, which allows the underlying permafrost to melt, resulting in soil erosion that impacts adjacent surface waters. Other potential impacts include snow removal and compaction, which increase the depth of frozen ice on surface waters, and in turn increase the salinity of the unfrozen water in lakes and streams. Under standard

ADNR permit conditions for winter seismic exploration, tracked vehicles are used to mitigate potential environmental damage, and the use of ground-contact vehicles for off-road travel is limited to areas where adequate ground frost and snow cover prevent damage to the vegetation and ground surface. Equipment other than boats must not enter open water areas of a watercourse during winter, and any roads, bridges, or approach ramps constructed near river, slough, or stream crossings must be free of extraneous material before break-up. Alteration of the banks of a watercourse is prohibited. Adherence to these conditions avoids or minimizes post-seismic increases in erosion, turbidity, and suspended solids in a drainage area.

Water withdrawals from lakes and ponds is required for the construction of any ice roads and pads, for blending drilling muds in exploratory and production drilling activities, and for potable and domestic water uses at drilling camps. Withdrawals have the potential to affect water quality through changes in water chemistry and decreased circulation in shallow lakes affecting dissolved oxygen levels (BLM 2005). The construction of ice roads and pads may impact water quality by adding slightly saline water during spring melt to shallow lakes and diverting stream or lake flow, which can cause bank erosion and sedimentation (*ibid*.).

Gravel mining for the construction of permanent roads and pads may impact water quality both during the gravel mining operation and after construction through thermokarst and upslope impoundment. Gravel mining may be permitted within the active floodplain only if the Division of Mining, Land and Water (DMLW) and the Office of Habitat Management and Permitting (OHMP) determine that there are no feasible or prudent alternatives and that a floodplain mine site would enhance fish or wildlife habitat after mining operations are completed and the site is reclaimed and closed (McLean 2004). Dust blown off of gravel roads and pads darkens vegetation, increasing the heat absorption of the ground surface, melting permafrost and causing thermokarst. Thermokarst may impact water quality by altering water chemistry or by eroding mineral soil layers under the peat mat. Dust and thermokarst may increase the turbidity of surface waters adjacent to gravel pads and roads (BLM 2004).

Water quality impacts from spills may occur during all phases of post-licensing activity. The extent and duration of water quality degradation resulting from accidental spills depends on the type of product, the location of the spill, volume spilled, season, duration of the spill or leak and the effectiveness of clean-up response. Heavy equipment such as trucks, tracked vehicles, aircraft, and tank trucks commonly use diesel fuel, gasoline, jet fuel, motor oil, hydraulic fluid, antifreeze, and other lubricants. Spills or leaks could result from accidents during normal operations such as refueling, or from corrosion of lines. Under standard ADNR permit conditions for off-road activity, fuel and hazardous substances must have secondary containment apparatus. A secondary containment or surface liner is required under all container or vehicle fuel tank inlet and outlet points. Appropriate spill response equipment is required during any transfer or handling of fuel or hazardous substances. Vehicle refueling is prohibited within annual floodplains (ADGC 1995).

In addition to spills, there is the potential for a well blowout during exploration and production activities; however, as previously noted, a well blowout is considered highly unlikely. Further, as addressed in Appendix G, coal bed methane wells include installation of blowout preventers during the drilling of the well. Nonetheless, if a blowout were to occur, it could have effects on water quality. Fires associated with blowouts, either unintentional or as a cleanup technique, will produce additional air contaminants that can settle and affect surface water quality. These emissions include NO_X, CO, SO_2 and particulate matter (BLM 2005).

During the exploration and production phases, byproducts such as drilling muds and cuttings, produced water, and associated wastes are generated. The Alaska Oil and Gas Conservation Commission (AOGCC) requires proper and safe handling and disposal of drilling wastes. The AOGCC is the regulatory agency that oversees the underground operation of the Alaska oil and gas industry on private and public lands and waters. The AOGCC administers the Underground Injection Control (UIC) program for oil and gas wells,

acts to prevent waste of oil and gas resources and ensure maximum recovery, and protects subsurface property rights.

AOGCC regulates annular disposal of drilling waste, and a permit is required prior to injecting any fluid into a well annulus. During the permitting process, AOGCC considers the volume, depth and other physical and chemical characteristics of the formation designated to receive the waste. Annular disposal is only permitted for wastes incidental to the drilling of a well (*e.g.* muds and cuttings), and is not permitted into water-bearing zones where dissolved solids or salinity concentrations fall below predetermined threshold limits. Waste fluids are recycled, filtered and treated before reinjection or disposal. Produced water is treated to remove hydrocarbons, and then is reinjected either into an approved disposal well or into the hydrocarbon-bearing formation to maintain pressure and enhance recovery. Disposal of cuttings is either through on-site grinding and injecting, or through transport to an approved disposal site. Wastewater, including sanitary and domestic graywater, is also treated to meet effluent guidelines before discharge.

CBM development has the potential to affect water resources through groundwater drawdown from the dewatering process and surface disposal of co-produced water. A BLM computer modeling program for CBM development in the Powder River Basin, Wyoming simulated maximum groundwater drawdown over a 15-year period to range from 300 to 550 feet at the wellsite and affecting groundwater levels up to 20 miles away (Flores *et. al*. 2001). The majority of Healy residents use groundwater from individual wells, and the Usibelli mine and Healy Clean Coal Project have individual water well systems (ADCED 2004a). Approximately 75 percent of households in Ferry haul water from surface sources, with the remaining homes having individual water wells (*ibid.*). In addition, coal bed methane development could result in fracturing materials contacting ground water sources. To address the risk of drinking well drawdown or contamination, AOGCC is required to have an operator conduct baseline testing of potentially affected wells and establish a monitoring program.

Produced water may be disposed through discharge into surface waters or drainages or reinjection into other geologic formations; however, a NPDES permit is required and permission from ADNR would be required for the discharge of produced water into surface waters or drainages in the proposed license area. Potential water quality parameters affected by discharging produced water include total dissolved solids, pH, chloride and sulfates. In addition to possible effects on water quality, surface disposal of produced water also has the potential to cause erosion and drowning of vegetation along drainage banks (*ibid*.).

The following are examples of applicable mitigation measures and licensee advisories from Chapter Seven, or those routinely applied in activity-specific permitting, that are designed to mitigate the potential impacts to water quality identified above. Site-specific and activity-specific mitigation measures are routinely imposed when activities such as water withdrawals or seismic exploration are permitted.

- Water withdrawals may be allowed up to a maximum of 15 percent of the below-ice volume from fish-bearing lakes seven feet or deeper. Greater than 15 percent of below-ice volume may be withdrawn and lakes shallower than seven feet may be used for water withdrawals if fish are not present and the lake is not connected to a fish-bearing waterbody (BLM 2005).

- During winter seismic and exploration activities, tracked vehicle passage and ice/snow roads should be located at least one trail-width off during subsequent seasons to limit impacts to tundra. Passage should be avoided on fish-bearing water bodies to reduce snow compaction. Seismic activities are individually permitted (*ibid.*).

- The siting of permanent facilities will be prohibited within one-half mile of the banks of the Nenana River. The siting of temporary and permanent facilities will be prohibited within 500 feet of all fish bearing waterbodies.

- Gravel mining within an active floodplain may be prohibited. Upland sites will be restricted to the minimum area necessary to develop the field in an efficient manner.

- Drilling muds and cuttings cannot be discharged into lakes, streams, rivers, or important wetlands. Temporary cuttings storage will be allowed on pads. Impermeable lining and diking, or equivalent measures, will be required for reserve pits. Unless authorized by NPDES and state permits, disposal of wastewater into freshwater bodies is prohibited.

- Plan of operations approvals will include monitoring requirements to mitigate potential impacts on water quality. The monitoring requirements will be tailored to the specific situation and potential impacts.

- The AOGCC requires the operator to design and implement a water well testing program to provide baseline data on water quality and quantity, and make the results available to the public.

- Pursuant to regulations administered by ADEC, AOGCC must determine that evidence obtained through evaluation of exploration data demonstrates with reasonable certainty that the exploration wells will not penetrate a formation capable of flowing oil to the ground surface. If that determination cannot be made, the licensee is required to have an approved oil discharge prevention and contingency plan (C-Plan) and determination of financial responsibility prior to commencing operations.

- Pipeline gravel pads must be designed to facilitate the containment and cleanup of spilled fluids.

- Containers with an aggregate storage capacity of greater than 55 gallons that contain fuel or hazardous substances cannot be stored within 100 feet of a waterbody.

- Secondary containment is required during equipment storage or maintenance and during fueling and fuel or hazardous substance transfer and storage.

- The plan of operations will include an emergency preparedness and response plan for potential emergencies that may be associated with the operation of facilities. This may include explosions, fires, gas or water pipeline leaks or ruptures, earthquake or flood events, or hazardous material spills.

2. Effects on Air Quality

The Clean Air Act of 1970 established air quality programs to regulate air emissions from stationary, mobile, and other sources that pose a risk to human health and the environment. Ambient concentration limits for the protection of human health were established for six criteria pollutants: carbon monoxide, nitrogen dioxide, ozone, sulfur dioxide, lead, and particulate matter (two particulate sizes are regulated: less than 2.5 and less than 10 micrometers). These six criteria pollutants are used as indicators of air quality, as they tend to show up wherever air quality is poor (EPA 2005a). There are no areas within the Healy basin designated by the EPA as a non-attainment area for any of these pollutants.

EPA's Air Toxics program regulates an additional 188 air pollutants that are known or suspected to cause cancer or other serious health effects. These pollutants come from a variety of sources, including benzene, which is found in gasoline, and methylene chloride, which is used as a solvent. EPA has issued regulations for many of the commercial and industrial sources, including oil and natural gas production, to reduce air toxics emissions.

ADEC's Air Quality Maintenance program controls significant, stationary sources of air contaminants to protect and enhance air quality and to abate impacts on public health and the environment. ADEC monitors compliance with regulations and air quality standards through annual inspections and uniform enforcement procedures. The agency issues operating permits to existing major facilities incorporating all applicable requirements, and issues construction permits to new, large facilities and for expansions of existing facilities. The Alaska State Air Quality Control Plan and state regulations address air emissions within Alaska. The Healy area is classified as Class II and an air quality attainment area. The Class II designation allows a moderate incremental decrease in the air quality of the area. Baseline concentrations of pollutants and portions of the increments already consumed are determined by the EPA and the State of Alaska prior to issuing air quality permits.

Immediately adjacent to the proposed license area is Denali National Park and Preserve, which is designated a Class I area. Denali National Park and Preserve is the only Class I area in the state that is easily accessible, connected to the road system, and accommodates a wide variety of visitor uses. As a Class I area, air quality in Denali National Park and Preserve falls under EPA Regional Haze Rule (40 CFR Part 51). Contributors to reduced visibility in Denali National Park and Preserve include smoke and emissions from stationary sources (ADEC 2002). ADEC is currently working to develop a State Implementation Plan (SIP) to address EPA's regional haze requirements, and is drafting a smoke management plan to help determine how to manage smoke-related issues impacting air quality. It is difficult to distinguish emissions of international industrial sources from similar emissions generated in Alaska; however the potential for industrial sources within Alaska to contribute to Arctic haze must be examined, as well as any potential mitigation to improve visibility (ADEC 2002).

Emissions from routine activities during gas exploration, development, and production are likely to affect air quality. Specific sources of emissions include vehicular traffic, heavy equipment, drill rig engines, camp generator engines, steam or propane generators, waste oil burners, hot-air heaters, incinerators, and well test flaring equipment. Airborne emissions would be temporarily elevated during the construction phase due to increased construction and vehicular traffic; it is anticipated that these elevated levels would diminish after the construction phase is complete.

Other sources of air pollution include evaporative losses of volatile organic compounds (VOCs) from oil/water separators, pump and compressor seals, valves, and storage tanks. Venting and flaring could also be an intermittent source of VOC and sulfur dioxide emissions. Additionally, any release of oil or gas to the environment would be a source of VOC emissions. This includes evaporation and burning, both intentional, as a spill response technique, and non-intentional.

It is not possible to predict at the licensing stage the amount of pollutants that may be produced, but all industrial emissions must comply with the Clean Air Act (42 USC §§ 7401-7642) and state air quality standards. State regulations provide for air quality control including permit requirements, permit review criteria, and regulation compliance criteria. State regulations designate air quality standards for the construction, operation, or modification of gas facilities. Additionally, regulations designate two visibility special protection areas in the vicinity of the proposed license area: Mt. Deborah and the Alaska Range East, as viewed from approximately the Savage River Campground area; and Mt. McKinley, Alaska Range, and the Interior lowlands, as viewed from the vicinity of Wonder Lake. Routine mitigation measures include the use of best available technology during all phases of exploration, development and production to control emissions.

3. Effects on Fish and Wildlife Habitat and Populations and Their Uses

a. Terrestrial Habitat

Various activities associated with gas exploration and development in the proposed license area have the potential to impact terrestrial habitat through the disturbance of soils and vegetation during clearing activities. These include seismic operations, exploratory drilling, ice/snow road and pad construction, gravel road and pad construction, and pipeline construction. Clearing activities are necessary for gas exploration, particularly in portions of the proposed license area dominated by woody vegetation. Clearing involves chipping vegetation or felling and removing trees and undergrowth from an area; grubbing involves removal of roots and other vegetation within the same area. Any clearing or grubbing activities related to gas exploration and development must receive prior approval from the director of DO&G. During clearing and grubbing activities, proper disposal of slash is necessary to reduce the risks of fire, infestation, and disease.

Wetlands provide many key ecological functions within the proposed license area, including floodwater storage, sediment and pollutant filtration, erosion control, nutrient production, and fish and wildlife habitat. Degradation or isolation of wetland areas may detrimentally affect entire watersheds and associated organisms. Although efforts are made to avoid wetlands during exploration and development, it may become necessary to develop certain wetlands. The discharge of dredge or fill material affecting wetlands requires a Clean Water Act (CWA) Section 404 permit from the United States Army Corps of Engineers (USCOE) and, depending on the activity, may also require additional action from the EPA and the state.

Seismic surveys are typically conducted in the winter to minimize environmental impacts. Seismic trails, camp move trails, and trails made by vehicles traveling to and from the camp have the potential to impact vegetation depending on snow depth, vehicle type, traffic pattern, and vegetation type. By conducting land-based seismic surveys in the winter, the frozen ground and snow pack reduce the impact to vegetation. However, winter seismic trails do have the potential to compress microtopography, resulting in an overall wetter environment (Best 2003). Such a change in hydrology can impact resident species, forcing a change to more water-tolerant species (*ibid*.).

Modern seismic surveys also use satellite and navigational technology such as the global positioning system (GPS) to minimize impacts to terrestrial environments. By using GPS, surveyors no longer need long clear-cuts of trees and brush for line-of-sight measurements. Many areas are accessed by helicopter, which minimizes the disturbance of vegetation and sensitive environments.

Construction of well collars and ice/snow roads and pads during the exploration phase has the potential to impact vegetation. Ice/snow roads are commonly constructed for winter exploration activities to minimize environmental impacts. Upland vegetation, including shrubs, forbs, and tussocks, is most susceptible to damage from ice/snow roads, with wetlands showing little or no signs of damage (Guyer 2003). Holes are dug into the ground for the construction of well collars. This results in the destruction of a small area of vegetation; thermokarsting in the immediate vicinity of the well collar, if present, may also lead to an accumulation of water and potential shift to more water-tolerant plant species.

Activities during the development phase with the potential to impact vegetation include constructing gravel pads, gravel roads, and pipelines, as well as the direct loss of acreage due to impoundment of water and gravel extraction. The construction of gravel roads and pads will cause a direct loss of habitat. Additionally, dust blown from gravel roads and pads has effects on nearby vegetation. Dust deposition may reduce photosynthesis and plant growth, and leads to an increase in downstream siltation and sedimentation, which can affect plant viability. Water impoundment along gravel roads and pads can create inundation upgradient

and drier habitat downgradient. In addition to changes in species composition related to water impoundment and drainage, the construction of facilities may allow the re-vegetation of disturbance-colonizing species such as fireweed (*Epilobium angustifolium*).

Gravel for the development of gas production may be mined from existing sites, or may require the development of new sites. Stockpiling overburden and excavating gravel would destroy the affected vegetation.

If any portion of a pipeline were to be elevated, a small amount of vegetation would be permanently displaced by the installation of vertical support members (VSM) and vegetation would be cleared within the right of way (ROW). Adjacent vegetation would be potentially altered in terms of species composition (*e.g.* introduction of disturbance tolerant species or a change in the moisture regime). If a buried pipeline is constructed, a larger area of vegetation would be initially disturbed due to the trenching requirements. Trenched areas would be revegetated after installation of the pipeline. In both cases the ROW would be maintained to allow access for maintenance, keeping the vegetation in an early successional stage. All revegetation efforts can utilize local native vegetation to avoid impacts from introduced species.

As stated previously, a remote possibility exists that oil will be encountered in the course of exploring for gas in the Healy area. If oil is encountered the licensee must cease all operations and contact the state. Although the likelihood is small, incidental oil spills, such as from vehicles, are possible. The effects of an oil spill on vegetation depend on the quantity spilled, time of year, impacted species, and terrain. Spilled oil will migrate both horizontally and vertically, depending on the volume spilled, type of cover (plant or snow), slope, presence of cracks or troughs, moisture content of soil, temperature, wind direction and velocity, thickness of the oil, discharge point, and ability of the ground to absorb the oil (Linkins *et al*., 1984).

The spread of oil is less when it is thicker, cooler, or exposed to chemical weathering. If the ground temperature is less than the pour point of the oil, it will pool and be easier to contain. Dry soils have greater porosity and potential for vertical movement (Linkins *et al.* 1984, citing to Everett 1978). If oil penetrates the soil layers and remains in the plant root zone, longer-term effects such as mortality or reduced regeneration would occur in following summers. Plant mortality in non-wetlands is also anticipated as an outcome of certain spill response techniques, such is *in situ* burning. *In situ* burning in wetland areas can be accomplished and still preserve the root viability of many plant species and allowing regrowth during the next growing season.

Drill cuttings, which are rock fragments generated during drilling, will be produced during the drilling of the borehole. Typically, the muds (drilling fluid used to circulate the cuttings out of the hole) used to drill CBM wells, if drilling muds are used at all, do not contain any hazardous materials. During the drilling operations, the cuttings are separated from the drilling muds and the muds are re-used. On-pad temporary cutting storage will be allowed, as necessary, to facilitate annular injection and/or backhaul operations. Surface discharge of drilling muds and cuttings to waterbodies or wetlands is prohibited.

The preferred method for disposal of muds, cuttings and fracturing materials is by underground injection. Injection of non-hazardous wastes generated during development is regulated and permitted by AOGCC through its UIC program. Discharge of drilling muds, cuttings and fracturing materials into reserve pits shall be allowed only if the Director, in consultation with ADEC, determines that alternative disposal methods are not feasible and prudent and the reserve pits comply with ADEC solid waste requirements. 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. The operator must also fill and cap the pit with gravel when drilling operations are completed.

Immediately after removal of a drilling rig, all debris and other waste material not contained within trash barrels will be required to be cleaned up and removed from the well location. No potentially adverse

Table 5.5: Potential Per Well Developmental Surface Disturbance Synopsis

Well Sites		**Support Sites**
Construction = 0.69 acres based on a 150-foot by 200-foot area for exploration, construction and drilling operations. Operations = 0.10 acres based on a 30-foot by 150-foot pad for operations. Note: Well pad size may increase if multiple wells are drilled on the same pad to penetrate separate coal seams, but total acres of disturbance would be less than separate well pads for individual wells. TOTAL = 0.79 acres per well		Field Compressor Sites = 0.025 acre per well. (Assumes one 0.5-acre site per field compressor, one compressor per 20 producing wells. Disturbance per well = 0.5 / 20) Sales Compressor Site = 0.005 acre per well. (Assumes one 1.0-acre site per sales compressor, one compressor per 200 producing wells. Disturbance per well = 1.0 / 200) Gathering lines = 0.30 acres per well (2.0 miles per field compressor at 25-foot width = 2*5280*25 / 20) Sales line = 0.15 acres per well (10.0 miles per sales compressor at 25-foot width = 10*5280*25 / 200) TOTAL = 0.48 acres per well
Roads		**Produced Water Management**
Gravel Access Roads = 0.517 acres based on 15-foot-wide roads by 1,500 feet per well (this applies to both construction and operation phases) Main Spine Roads = 0.689 acres based on 25-foot by 1,200 feet per well (this applies to both construction and operation phases) Cross-Country Temporary Roads = 0.797 acres based on 15-foot-wide roads by 2315 feet per well (this is for a summer development construction phase only) Ice Roads = 0.797 acres based on 15-foot-wide roads by 2315 feet per well (this is for a winter development construction phase only) TOTAL = 2.003 acres per well		Pump Stations = 0.003 acres per well. (Assumes one pump station for every 20 wells, based on 50-foot by 50-foot pad = 50*50 / 20) Injection Facilities = 0.004 acres per well. (Assumes one injection facility for every 200 wells, based on 150-foot by 250-foot pad = 150*250 / 200) TOTAL = 0.007 acres per well
Utility Lines		**Transportation Lines**
Water = 0.485 acres based on 10-foot by 0.40 miles per well (construction only) Elec. Utility Overhead = 0.339 acres based on 8-foot by 0.35 miles per well (construction and operation) Elec. Utility Underground = 0.146 acres based on 8-foot by 0.15 miles per well (construction only) TOTAL = 0.97 acres per well		Low Pressure Gas = 0.60 acres based on 10-foot by 0.5 miles per well (construction only) Intermediate Pressure Gas = 0.45 acres based on 15-foot by 0.25 miles per well (construction only) TOTAL = 1.05 acres per well
Total Area of Potential Disturbance 5.30 acres per well		

materials or substances will be allowed to remain on the drill site. The potential surface effects of a CBM well drilling project are listed in Table 5.5.

Mitigation measures included in Chapter 7 or to be stipulated at the time of activity-specific applications to protect habitat resources from possible effects during the post-licensing phases of development include:

- Impacts to important wetlands must be minimized to the satisfaction of the director, in consultation with OHMP and ADEC.

- The location of winter ice/snow roads are offset from year to year to minimize impacts to vegetation. The offset shall be greater than or equal to the width of the road.

- Seismic exploration activities must use low-ground-pressure vehicles, such as Rolligons, ARDCO, Nodwell, or similar tracked vehicles. To reduce the possibility of ruts, vehicles should not use the same trail for multiple trips unless necessitated by environmental or safety concerns, with the exception of ice/snow roads. To prevent disturbance to underlying vegetation, tracked vehicles should not execute a tight turn by locking one track.

- On-the-ground seismic activities should not begin until the seasonal frost has reached a depth of 12 inches and the average snow cover is six inches deep; these activities should cease when the spring melt begins. Exact dates shall be determined by the director.

- Gravel mining within an active floodplain is prohibited, unless the Director, with the concurrence of OHMP, determines that a floodplain site would enhance fish and wildlife habitat upon site closure and reclamation. Gravel mining in upland sites is restricted to the minimum necessary to develop the field efficiently and with minimum environmental damage.

- Permanent facilities will be prohibited within one-half-mile of the banks of the Nenana River and within at least 500 feet of all fish bearing streams and lakes.

- Permanent facilities shall not be constructed during the exploration phase of gas development.

- Well pad spacing will be reviewed and approved as part of a plan of development. The decision whether to approve a well pad spacing proposal will be based upon a balancing of the gas pool management needs, the anticipated surface impacts, and the technical and economic feasibility of minimizing those impacts. Lessees are encouraged to minimize the number and size of pads and the network of roads between them. Developments are encouraged to share facilities wherever possible.

- Natural drainage patterns should be identified prior to constructing permanent facilities; permanent facilities shall be constructed to maintain natural drainage patterns both during and after construction. Gravel structures shall be designed and sited to minimize the length that is perpendicular to sheet flow.

- Underground injection of drilling muds and cuttings is the preferred method of disposal; surface discharge of drilling wastes into waterbodies and wetlands is prohibited.

- Plan of operations approvals will include monitoring requirements to minimize potential noise and/or visual impacts to adjacent users, and ground disturbance. The monitoring requirements will be tailored to the specific situation and potential impacts.

- The plan of operations will include an emergency preparedness and response plan for potential emergencies that may be associated with the operation of facilities. This may include explosions, fires, gas or water pipeline leaks or ruptures, earthquake or flood events, or hazardous material spills.

- Exploration activities will utilize existing roads, ice roads, or vehicles that cause minimal damage to the ground surface or vegetation. Construction of temporary roads may be allowed. A plan of operations will include an analysis of road and access issues associated with site development. All aspects of vehicular transportation related to the proposed activity and possible effects on existing uses and implementation of mitigation measures will be considered.

- Upon abandonment of sites used under the proposed license, roads, buildings, and other facilities will be removed and the site rehabilitated unless it is shown to the satisfaction of DO&G, after appropriate consultation, such removal and restoration is not in the state's best interests.

- Pursuant to regulations administered by ADEC, AOGCC must determine that evidence obtained through evaluation of exploration data demonstrates with reasonable certainty that the exploration wells will not penetrate a formation capable of flowing oil to the ground surface. If that determination cannot be made, the licensee is required to have an approved oil discharge prevention and contingency plan (C-Plan) and determination of financial responsibility prior to commencing operations.

- Techniques that minimize the clearing of trees should be used wherever feasible in order to avoid alterations of valuable fish and wildlife habitats, avoid increasing access to sensitive areas, and avoid increasing the chance of insect infestations (*ibid.*).

b. Effects on Fish

OHMP requires permits for constructing bridges or culverts that cross fish-bearing streams and for any activity that may impede the passage of fish. Activities that may impede fish passage include culvert installation, stream realignment or diversion, dams, low-water crossings, and placement or removal of any material below the ordinary high water mark.

A consultation on essential fish habitat may be required from the National Marine Fisheries Service if a federal action agency becomes involved at any stage of the post-licensing process. The USCOE is a federal action agency, and could become involved with proposed activities in the Healy basin license area if dredging and filling in waters of the United States, including wetlands, is proposed. Consultation recommendations are advisory in nature and will be used by the federal action agency to implement measures for avoiding, mitigating or offsetting the impact of proposed activities on essential fish habitat. Essential fish habitat identified in the proposed license area includes the Nenana River, Lignite Creek, Unnamed Creek (Lignite Springs), K-Dog Creek, Panguingue Creek, Little Panguingue Creek, June Creek, and Bear Creek.

During the exploration phase, seismic activities are typically conducted during the winter months or with helicopters to minimize effects on the environment. Seismic operations using high explosives could cause direct injury to fish resources in lakes and streams (Fink 1996). Pressure waves from high explosives can injure fish near the explosion but the impulses would dissipate to a non-lethal level within a short distance (less than 328 feet) (MMS 1996). Overpressures of 30 to 40 pounds per square inch (psi) will kill fish with swim bladders, and three to four psi can kill juvenile salmonids. Shock waves from explosions can also shock and jar fish eggs at sensitive stages of development (*ibid.*). These types of impacts are mitigated by restricting the use of explosives in close proximity to fish-bearing lakes and streams.

The use of tracked vehicles during seismic exploration may physically damage overwintering habitat. Tracked vehicles that cross fish-bearing lakes or streams may cause compaction or removal of snow layers, which will increase the depth of ice over these surface waters. Increasing the depth of ice will reduce the quantity of available water for overwintering fish and can also increase the salinity of the unfrozen water (BLM 2005).

Water withdrawals from lakes and ponds may be required for the construction of ice/snow roads and pads, for blending drilling muds during exploratory and production drilling activities, and for potable and domestic water uses for drilling camps. Withdrawal of water from lakes and ponds could affect fish resources by entraining juvenile fish, lowering water levels in overwintering areas, and stressing populations by increasing disturbance. Inadequate water levels may also impede the ability of fish to reach overwintering habitat.

Gravel mining may be required during the exploration, development and production phases for road and pad construction. Gravel removal from fish-bearing streams to support oil and gas development activities could adversely impact the habitat in these streams and the fish they support. Gravel removal could increase sediment loads, change the stream bed course, cause instability upstream, destroy spawning habitat, and create obstacles to fish migration.

Construction and associated clearing activities for roads, pads, and pipelines have the potential to impact fish habitat and passage between overwintering, spawning and feeding areas. In areas where heavy equipment used for construction must cross streams there is the potential to damage steam banks. Stream bank degradation creates erosion problems during the open water period, which impacts downstream fish habitat through siltation of the streambeds. Improper placement and construction of roads, pads and pipelines has the potential to alter water flow, which could impede fish passage. Common obstructions to fish passage include improperly sized culverts or low water crossings and ice bridges present during spring breakup (BLM 2005).

Operational spills could result from small, chronic leaks from equipment or facilities. The effects of oil spills of this nature on fish would depend on many factors including the time of year, size of the spill, waterbody affected, concentration, length of exposure and the stage of fish development present (BLM 2005). Potential adverse effects from an oil spill could include lethal concentrations and oiling of the gills causing fish kill, mortality of prey species, mortality from consumption of contaminated prey, and blockage of movement or displacement from important habitats. Mortality of eggs and fry could occur in spawning or nursery areas from the toxic effects of the oil. Sublethal effects may also reduce fitness and affect the ability to endure environmental stress. Effects of oil spills during the winter are expected to be negligible; effects during the open water season could be more harmful, depending on the site-specific conditions. Given requirements for secondary containment of all stopped vehicles and fueling points, it is unlikely that an incidental spill would reach levels that would impact fish.

If a natural gas blowout occurred, indirect effects from pollutant fallout may affect fish. Indirect pollutants from burning hydrocarbons, whether intentional or unintentional, would include NO_x, CO, SO_2 and particulate matter (BLM 2005). Nitrate oxides (NO_x) and sulfur dioxides (SO_2) are the primary components of acid deposition from the atmosphere. Depending on the buffering capacity of soils and waters where acids are deposited, the lowered pH levels may be toxic to fish. Aluminum released by acids leaching through soils is directly toxic to fish (EPA 2005b).

General mitigation measures to protect fish resources from possible effects during the post-licensing phases of development in the proposed Healy basin license area include those identified in Section D.1, Effects on Water Quality, and the following:

- Seismic work should be scheduled to limit the effects on fish eggs. This will be considered by DO&G on a case-by-case basis as a condition for obtaining a geophysical exploration permit.

- Drilling muds and cuttings cannot be discharged into lakes, streams, rivers, or wetlands. Unless authorized by NPDES or state permits, disposal of wastewater into freshwater bodies is prohibited.

- Permanent facilities are prohibited within one-half-mile of the banks of the Nenana River and 500 feet from other fish bearing streams and lakes.

- Licensees must comply with regulations administered by ADEC regarding oil discharge prevention and contingency plans (C-Plans) prior to commencing operations. Lining, diking, and buffer zones are required to separate any oil storage facilities from aquatic habitats.

- Detonation of explosives within, beneath or in close proximity to fish-bearing waters should not exceed 2.7 pounds per square inch unless the water body, including its substrate, is frozen solid. Peak particle velocity stemming from explosive detonation should not exceed 0.5 inches per second during the early stages of egg incubation. Blasting criteria have been developed by OHMP and are available upon request (McLean 2004).

- Exploration and or development plans should include a proposed environmental training program for all personnel involved, including contractors and subcontractors, to assure knowledge of environmental resources and their protection in the proposed license area (*ibid*.).

- Gravel mining required for exploration, development, and production activities should be restricted to the minimum necessary to develop the field efficiently with minimal environmental damage. Gravel mine sites should not be located within an active floodplain of a watercourse unless DMLW, after consultation with OHMP, determines that there is no feasible and prudent alternative, or that a floodplain mine site would enhance fish and/or wildlife habitat after mining operations are completed and the site reclaimed and closed.

- Under Title 41 of the Alaska Statutes, the measures listed below will be required by OHMP for all activities below the ordinary high water mark in designated anadromous water bodies and for activities in fish-bearing waters that could block fish passage. Exceptions to these requirements, including exceptions for the used of spill containment and recovery equipment, may be allowed on a case-by-case basis. Specific information on the location of anadromous waters in and near the area may be obtained from OHMP.
    - Alteration of riverbanks, except for approved permanent crossings, will be prohibited.
    - The operation of equipment, excluding boats, in open water areas of rivers and streams will be prohibited. (Note: certain exemptions may be permitted by OHMP such as for water use to support drilling and in approved floodplain material sites.)
    - Bridges are the preferred watercourse crossings in fish spawning and important rearing habitats. In areas where culverts are used, they must be designed, installed and maintained to provide for the efficient passage of fish at all flows up to and including the two year, two day duration flood.

- Ice bridge crossings of all anadromous and resident fish streams will require prior OHMP permit authorization.

- Water withdrawal from fish-bearing waters shall reserve adequate flow to support indigenous aquatic life and the watercourse must allow fish passage. Each water intake directly accessible by fish shall be designed to prevent the intake, impingement, or entrapment of fish. Water intake criteria, including

maximum screen size and approach velocities, have been developed by OHMP and are available upon request (*ibid.*).

- To the extent feasible and prudent, commercial and industrial uses, transportation facilities (including pipelines), and other non-water-dependent uses other than road and pipeline crossings, should not be sited within 500 feet of fish-bearing water bodies and within one-half mile of the Nenana River. Essential facility siting may be allowed in buffer areas in those instances where no other suitable sites are available. Facilities should not be sited within buffers unless the DO&G, after consultation with OHMP, determines that such facility restrictions are not feasible or prudent. Road and pipeline crossings should be aligned perpendicular or near perpendicular to watercourses.

- Pursuant to regulations administered by ADEC, AOGCC must determine that evidence obtained through evaluation of exploration data demonstrates with reasonable certainty that the exploration wells will not penetrate a formation capable of flowing oil to the ground surface. If that determination cannot be made, the licensee is required to have an approved oil discharge prevention and contingency plan (C-Plan) and determination of financial responsibility prior to commencing operations.

c. Effects on Birds

The Healy basin provides habitat for several species of birds (see Chapter Three). Effects of industrial activities on birds depend on the species impacted, the time of the year, and the age or reproductive state of the impacted species, as well as the disturbance type, intensity, and duration. Cumulative adverse effects on birds from gas activities could result from direct habitat loss, barriers to movement, collision with structures, noise and disturbance during nesting and brood rearing, and pollution of the terrestrial and aquatic environments.

Laws and regulations applicable to birds in the proposed license area include the Migratory Bird Treaty Act and the Bald Eagle Protection Act. The Migratory Bird Treaty Act established the protection of migratory birds, including their eggs. The Bald Eagle Protection Act provides for the protection of both bald and golden eagles by prohibiting, except under certain specified conditions, the taking, possession, and commerce of these birds. Both statutes are addressed in more detail in the Licensee Advisories, Chapter 7.

During the exploration phase of oil and gas development, habitat loss could occur as a result of seismic activities and the construction of ice/snow roads and ice/snow pads. Upland vegetation, including shrubs, forbs, and tussocks, is most susceptible to damage from ice/snow roads, with wetlands showing little or no signs of damage (Guyer 2003). However, on-the-ground seismic exploration performed over tundra during the winter months has the potential to modify the water regime, forcing a shift in species composition in areas that served as trails. This shift in species composition and damage to upland vegetation may result in habitat loss for species of birds that prefer slightly drier or shrubbier environments such as many species of passerines. Some species may experience beneficial impacts. For example, impoundments from roads changing drainage patterns may create additional habitat for water birds such as ducks or geese.

Clearing vegetation or filling wetlands for the construction of gravel pads, roads, storage facilities, and pipelines would also result in the direct loss of bird habitat. The construction of permanent facilities may damage habitat through such indirect measures as surface water impoundment, thermokarsting, and blowing dust from gravel roads and pads. Some habitat loss is actually compensated through the construction of new buildings and structures. Passerines and some ravens and species of raptors are known to use man made structures for nesting. The Migratory Bird Treaty Act protects these birds from disturbance after nesting has begun, even if they are nesting on man made structures.

Activities involved with the exploration, development, and production of natural gas have the potential to generate noise and other disturbances that would impact birds. Birds are particularly susceptible to disturbance when attending a nest, accompanying fledging young, or in a flightless molt condition. Disturbance may cause birds to abandon local nesting, feeding, or molting areas; to expend energy stores necessary for migration or winter survival; and to experience increased predation from animals attracted to the facilities.

Repeated low-level aircraft overflights could cause some nesting birds to flush and expose eggs to chilling or predation. Altitude restrictions on aircraft will help to minimize this impact. Aircraft overflights could also cause disturbance of concentrations of feeding, molting, or staging waterfowl in lakes and other wetlands, which might reduce the ability of these birds to acquire the energy necessary for successful migration. If such disturbances occurred frequently, it could potentially affect the migration and mortality of affected birds. Bird mortality may also result from collisions with vehicular traffic, buildings, elevated pipelines and overhead powerlines. However, it is anticipated that bird mortality from such collisions would be minimal and have little impact on the bird populations.

Prevention of and responsive countermeasures to any oil spill, even those incidental in nature, are particularly critical to assure protection of birds. The number of birds impacted by a spill would depend on the time of year, the extent of the spill, the amount of aquatic habitat affected, and the density of local bird populations.

The direct effect of oil on a bird is to clog the fine structure of its feathers, which is responsible for maintaining water-repellence and providing heat insulation. The loss of thermal insulation, especially in cold climates, results in greatly increased metabolic activity to maintain body temperature. Birds also ingest oil in attempting to preen oil from their plumage. Some species (*e.g.* bald eagles, golden eagles, etc.) may encounter and ingest oil while preying on fish and oil-contaminated carcasses. Relatively small amounts of ingested oil can cause a temporary depression of egg laying and reduce the hatching success of those eggs that are laid. Oil deposited on eggs from the feathers of the adults can also have an adverse impact on hatching, even in small quantities. The birds most susceptible to oiling are those which are gregarious, spend most of their time on the water, and dive rather than fly up when disturbed (NRC 1985). As discussed above, the possibility of an oil spill, even a small, operational spill from vehicles, is considered extremely remote.

If gas development occurs, some alteration of bird habitat and disturbance to populations can be expected. However, a combination of government oversight and implementation of applicable mitigation measures should easily maintain overall bird populations.

Mitigation measures included in Chapter 7 or to be stipulated at the time of activity-specific applications to protect birds from possible effects during the post-licensing phases of development proposed in the Healy basin license area include:

- Facilities may not be sited within one-half mile of the Nenana River and 500 feet from other fish-bearing streams and waterbodies. Drilling mud and cuttings cannot be discharged into lakes, streams, rivers, or important wetlands.

- The Director, in consultation with OHMP, may impose seasonal restrictions on activities located in and adjacent to important waterfowl habitat during the Plan of Operations approval stage.

- Licensees must coordinate with USFWS regarding bald eagle nests. Generally, a survey must be performed prior to beginning any activities during the nesting period; destruction of nest trees or locations is prohibited; no clearing is allowed within 330 feet of a nest, and no activity within 660 feet

of any nest between March 1 and June 1. USFWS also recommends no activity within 660 feet of active nests, or until juveniles have fledged, between June 1 and August 31.

- Illumination for permanent facilities and structures must be designed in consultation with USFWS to prevent illumination from acting as an attractant and causing birds to collide with the structures.

- Attracting wildlife to food and garbage is prohibited. Lessees shall have a written procedure to ensure that the handling and disposal of putrescible wastes will occur in a manner that will not attract wildlife.

- Pursuant to regulations administered by ADEC, AOGCC must determine that evidence obtained through evaluation of exploration data demonstrates with reasonable certainty that the exploration wells will not penetrate a formation capable of flowing oil to the ground surface. If that determination cannot be made, the licensee is required to have an approved oil discharge prevention and contingency plan (C-Plan) and determination of financial responsibility prior to commencing operations.

d. Effects on Terrestrial Wildlife

Caribou and Moose. Caribou (*Rangifer tarandus*) are present in the Healy basin on a seasonal basis. The Delta caribou herd range encompasses the Healy basin, and a known migration pattern runs east-west just north of Ferry (ADF&G 1986a); no calving areas are located within the Healy basin. The entire proposed license area is a moose (*Alces alces gigas*) winter concentration area. Moose calving and rutting concentration areas exist east of the Nenana River (*ibid.*). These species are discussed together as the possible impacts and mitigation measures for each species are similar.

Clearing vegetation and constructing gravel roads and pads in the proposed license area would result in a direct loss of some caribou or moose habitat. As the Healy basin is a known moose winter concentration area, the loss of winter habitat in riparian areas would have the biggest impact on local moose populations. Additional pressure on adjacent habitats would also occur from the displacement of animals around natural gas facilities due to noise and activity. Movement to critical areas, such as wintering and calving grounds, is not anticipated to be adversely affected. However, activities within these areas, especially during the winter, could affect moose foraging and browsing behavior and cause movement to less desirable habitats. If feasible, avoiding areas with high browse value will mitigate these potential impacts. Construction of existing oil and gas facilities on the North Slope of Alaska has necessitated the use of large quantities of gravel. Caribou have been noted to use the gravel roads and pads on the North Slope for insect relief (Cronin *et al.* 1998). Avoiding permanent facilities in the known migration route North of Ferry will help mitigate potential impacts to caribou.

Activities involved with the exploration, development, and production of natural gas have the potential to generate noise and other disturbances that would impact moose and caribou. Aircraft overflights associated with exploration, development, and production would be expected to pass over moose or caribou once during any flight, with disturbance reactions being brief. Increased roads and vehicle traffic would result in increased mortality from collisions. Increased disturbance during the winter months could result in increased energy expenditures and reduce reserves needed for survival. Identifying and avoiding winter moose concentration areas can reduce impacts to moose. Moose can adapt to certain levels of activity over time, and the overall effects of increased noise and disturbance are not expected to adversely affect local moose populations.

Impacts to moose and caribou from an incidental oil spill would result from oil contamination of individual animals, contamination of habitats, and contamination of some local food sources. Oil could be

ingested through eating contaminated foods or through grooming. However, the effect of oil spills would be expected to be negligible to the caribou and moose populations. To further reduce impacts from oil spills moose and caribou can be hazed away from the spill area, thus avoiding oiling altogether.

Greater road access to the Healy area may open up more hunting opportunities, thus impacting both caribou and moose. Animals that have been exposed to industrial activity are potentially more vulnerable to hunters, as they will be more habituated to humans. ADF&G can mitigate this possible impact through the hunting regulation process.

Bears. Both black (*Ursus americanus*) and brown bears (*Ursus arctos*) inhabit the area and are concentrated along salmon streams in late summer and fall. Both species could potentially be adversely affected by natural gas exploration, development and production activities.

Primary potential sources of disturbance to bears include seismic activity, vehicular traffic, increase in general human activity associated with construction of facilities, increase in noise, increase in the availability of human food sources, and aircraft overflights. Seismic activity that occurs in winter may disturb denning brown bears up to 1.15 miles from the activity, based on movement recorded from radio-collared bears in their dens (Reynolds *et al.* 1986). Bears cubs are also born during the winter and disturbance of dens during this critical time could impact the cubs.

Road development increases opportunities for bear-human interactions and reduces the value of the bear habitat by increasing disturbance and fragmenting habitat. New roads could increase mortality rates through increased bear/human encounters and increase human access to bear habitat for both legal and illegal hunting (ADF&G 1998). In Montana, an 80 percent decline in use of bear habitat within one kilometer of open roads used by motorized vehicles has been reported. This has been ascribed to either bears avoiding humans or the selective over-harvest of bears habituated to humans (*ibid.*).

A second significant concern relates to increased human activity that may attract foraging bears, especially to refuse disposal areas. Both black and brown bears are attracted to food and garbage associated with human activity, and may become conditioned to non-natural food sources (ADF&G 2004b). The conditioning of bears to human food sources may pose a safety threat and the potential need to destroy "problem" animals (*ibid.*). Increased bear/human interactions due to encroachment into bear habitat can also lead to increases in killing bears in defense of life and property.

Incidental oil spills can affect bears by direct contact, ingesting oil from grooming, eating oiled prey items, and displacement from critical areas as a result of oil spill response activity. Individual bears could be affected by an oil spill; however impacts to bear populations would not be expected.

Overall effects of natural gas activity on brown and black bears in the Healy basin would relate primarily to the disturbance to individual bears and some increased mortality from bear/human encounters. While individual bears might be impacted, there would most likely not be any adverse effects to the regional brown or black bear populations.

Wolves. Wolves (*Canis lupus*) are present in GMUs 20A and 20C; packs usually stay within a range of about 600 square miles but may move outside their territory if they depend on migratory caribou for a food source. Moose and caribou are the primary food sources for wolves in Interior Alaska although Dall sheep may also be taken where available.

The effects of direct habitat loss on wolves would be negligible. The abundance of wolves and other predators in the area is ultimately determined by the availability of prey and game management efforts. The ability of adults to provide food is the key determinant in survival of the young; a reduction in prey species would reduce predator populations (USFWS 1987).

Primary potential sources of disturbance to wolves are seismic activities and aircraft overflights. Helicopters generally invoke a stronger response from wolves and other predators than fixed-wing aircraft. Roads connecting well sites and supply areas would provide a source of vehicle disturbance. Impacts of seismic exploration and drilling on these species are unknown (USFWS 1986), although they are likely to result in some temporary disturbance near these activities.

The general effects of an incidental oil spill on wolves would be similar to that of other terrestrial animals. Potential effects include contamination of individual animals, contamination of habitats, and contamination of some local food sources. As predators, wolves may be attracted to oiled wildlife at a spill site. However, impacts to populations of these species in the area are expected to be minimal.

Dall Sheep. Dall sheep (*Ovis dalli dalli*) occur within the Healy basin and are typically found above 2,500 feet in suitable alpine habitat. Seasonal range use varies by populations. Some populations are rather sedentary, with summer ranges merely an extension of winter ranges (Geist 1971). Other populations, however, migrate to distinct seasonal ranges. These migration routes may be lost if older animals who lead the migrations are eliminated from the population, which would explain why apparently suitable habitat is unoccupied by Dall sheep (Geist 1971, Beckstead 2004).

The Healy basin contains areas of critical habitat for Dall sheep (ADNR 1991). Approximately one-third of the eastern portion of the proposed license area above 2,000 feet is rated as critical habitat with small areas of winter range, lambing cliffs and mineral licks.

Due to the fragmented and disjointed nature of Dall sheep habitat, they are particularly susceptible to both habitat loss and disturbance. Potential reactions of sheep to disturbance include escape behavior, reduction in foraging efficiency, interrupted feeding, increased exposure to predators, and higher heart and metabolic rates, all of which may impact reproductive success and population levels (Beckstead 2004).

The slower speeds of civilian helicopters and fixed-wing aircraft may enable sheep to locate the source and direction of the disturbance while the aircraft is still distant and may allow sheep to respond less strongly to the stimulus (Beckstead 2004, citing Dept. of the Air Force 1995). However, aircraft should avoid circling over sheep. Aircraft overfights of lambing areas should be avoided during lambing, approximately May 15 to June 20.

Furbearers and Other Small Mammals. Several species of furbearers are found in the area, including red fox (*Vulpes vulpes*), river otter (*Lutra canadensis*), marten (*Martes americana*), wolverine (*Gulo gulo*), lynx (*Lynx canadensis*), and beaver (*Castor canadensis*) (ADNR 1991).

The effects of direct habitat loss on these species would be negligible. The abundance of red fox and other predators in the area is ultimately determined by the availability of prey and game management efforts. The ability of adults to provide food is the key determinant in survival of the young. Reduction in prey species would reduce predator populations (USFWS 1987).

Most of these species are unlikely to be affected by development within the area. Primary sources of disturbance are seismic activities and aircraft overflights. Roads connecting well sites and supply areas would provide a source of vehicle disturbance. Impacts of seismic exploration and drilling on these species are unknown (USFWS 1986), although they are likely to result in some temporary disturbance near these activities. Attraction of animals to garbage and other waste can also result in adverse impacts to individual animals. Fox are particularly adept at obtaining human food sources.

The general effects of an incidental oil spill on these species would be similar to that of other terrestrial animals. The potential effects include contamination of individual animals, contamination of habitats, and contamination of some local food sources. Predators, particularly foxes, may be attracted to oiled

wildlife at a spill site. Foxes and coyotes may be attracted to the human activity at a spill site by the possibility of finding food or garbage. Generally, impacts to populations of these species in the area are expected to be minimal.

Mitigation measures included in Chapter 7 or to be stipulated at the time of activity-specific applications to protect wildlife resources from possible effects during the post-licensing phases of development proposed in the Healy basin license area include:

- Exploration activities must utilize existing road systems, ice/snow roads, or vehicles that do not cause significant damage to the ground surface or vegetation to minimize habitat loss. Construction of permanent roads will be prohibited during the exploration phase.

- Facilities must be sited at least one-half mile from the banks of the Nenana River and 500 feet from other fish-bearing streams and lakes.

- Avoidance of salmon streams when fish are present minimizes the displacement of bears from important feeding habitat.

- Pipelines should utilize existing transportation corridors and be buried where soil and geophysical conditions permit. Above ground pipelines must be designed, sited, and constructed to allow for the free movement of moose and other wildlife. Increased snow depth in the area should be considered to allow adequate clearance for wildlife.
- Waste from operations must be reduced, reused, or recycled to the maximum extent practicable. Garbage and domestic combustibles must be incinerated whenever possible or disposed of at an approved site in accordance with ADEC regulations. New solid waste disposal sites, other than for drilling waste, will not be approved or located on state property during the exploration phase of license activities.

- Exploration and development plans should include a proposed environmental training program for all personnel involved, including contractors and subcontractors, to assure knowledge of environmental and fish and wildlife resource values in the proposed license area (McLean 2004).

- Exploration and production activities should not be conducted within one-half mile of occupied bear dens, unless alternative mitigation measures are approved by ADF&G. Information regarding den sites should be obtained from the ADF&G Division of Wildlife Conservation prior to commencement of any activities. Occupied dens encountered in the field should be reported to the Division of Wildlife Conservation.

- For projects in close proximity to areas frequented by bears, lessees are encouraged 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 the drill sites; (b) organize layout of buildings and work areas to minimize human/bear interactions; (c) warn personnel of bears near or on drill sites; (d) if authorized, deter bears from the drill site by hazing; (e) provide contingencies in the event bears do not leave the site or cannot be deterred by authorized personnel; (f) discuss proper storage and disposal of materials that may be toxic to bears; and (g) provide a systematic record of bears on the site and in the immediate area. The ADF&G Division of Wildlife Conservation offers to assist lessees in developing educational programs and camp layout and management plans as lessees prepare their lease operations plans (*ibid.*).

4. Effects on Subsistence Uses

As discussed in Chapter Four, communities in the project area utilize portions of the proposed license area for subsistence uses such as moose, caribou and migratory bird hunting, trapping, and fishing. There are no commercial harvests of any of these resources in the Healy area. Restrictions on sport hunting in the proposed license area are in effect. In GMU 20A, the Ferry Trail Management Area has moose hunting restrictions and is open to caribou hunting by permit only. The Healy-Lignite Management Area, also in GMU 20A, is open to hunting by bow and arrow only (ADF&G 2004c).

Several factors affect subsistence activities including the availability of fish and wildlife populations, weather, methods of harvest, availability of transportation, state and federal hunting and fishing regulations, and local economic conditions. Subsistence harvests are relied upon as a primary source of food for all of the surrounding communities. Any reduction in local fish and wildlife populations due to development could result in increased travel distance and hunting time required to harvest resources, potential reductions in harvest success rates, and increased competition for nearby subsistence resources. Exploration and development also could adversely affect subsistence activities if access to hunting and fishing areas is restricted or if industry operations occur at the same places and times as subsistence activities. The development of roads in support of oil and gas development could increase human access to the area, which could result in increased competition and hunting pressure. Another concern to local residents would be the adverse effects of a gas release on fish, wildlife, and habitats in the proposed license area, discussed above in Section 3.b.

Reducing impacts to subsistence resources from natural gas development is a primary consideration in planning for the possible issuance of an exploration license. Avoidance or reduction of impacts on subsistence from gas exploration, development, production, and transportation activities requires mitigation measures, operator and licensee company policies, and appropriate wildlife conservation and protection laws. All plans of operation are reviewed for consistency with applicable laws, including the local government, state and federal management plans. Mitigation measures for fish, wildlife and their habitats are included in their respective sections in Chapter 7. Additional site-specific and project-specific mitigation measures may be imposed as necessary if exploration and development take place. The following are summaries of some applicable mitigation measures and licensee advisories designed to mitigate potential impacts to subsistence activities.

- Public access to, or use of, the proposed license area may not be restricted except within the immediate vicinity of drill sites, buildings, and other related facilities. Areas of restricted access must be identified in the plan of operations. Facilities and operations shall not be located so as to block access to or along navigable and public waters as defined in Alaska statute.

- License 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, during review of plans of operations, will work with other agencies, the affected local governmental organizations, and the public to identify and avoid potential conflicts. Restrictions may include alternative site selection, seasonal drilling restrictions, and use of alternative technologies.

- Construction of permanent roads will be prohibited during the exploration phase.

- A plan of operations application must describe the licensee's past and prospective efforts to communicate with local communities and interested local community groups.

- Employee training must ensure that project personnel understand and use techniques necessary to preserve biological resources and understand community values, customs and lifestyles.

5. Effects on Cultural and Historic Resources

Cultural and historic resources are those sites and artifacts having significance to the culture of the people within the proposed license area. ADNR, Office of History and Archaeology, maintains an inventory of cultural resources, including objects, structures, buildings, sites, districts, and travel ways within the region through the Alaska Heritage Resources Survey.

Historical and cultural resources identified in the licensing areas include isolated Native villages and gravesites, cabins, fish camps, mine sites, and transportation and mining-related sites. The Office of history and Archaeology has surveyed the known sources and found 92 historic and prehistoric archaeological sites within the proposed licensing area. Though portions of the proposed license area have been surveyed, the unsurveyed portions of the proposed license area have potential for many unreported sites to exist.

If a potential historic site is discovered during project activities, an archaeologist should immediately be brought onsite to confirm the presence and subsequent preservation of any archaeological resources. The archaeologist should then complete the reporting requirements for the State Historic Preservation Office (SHPO) for the site's inclusion in the AHRS, including the site name, description, location, and pertinent dates.

State policy on these resources is reflected in AS 41.35.010: "It is the policy of the state to preserve and protect the historic, prehistoric and archaeological resources of Alaska from loss, desecration and destruction ...." Existing statutes, which apply to both known sites and newly discovered sites, follow:

- AS 41.35.200(a) prohibits a person from unlawfully appropriating, excavating, removing, injuring or destroying any historic, prehistoric, or archaeological resources of the state. Historic, prehistoric, or archaeological resources include deposits, structures, ruins, sites, buildings, graves, artifacts, fossils, or other objects of antiquity which provide information pertaining to the historical or prehistorical culture of people in the state as well as to the natural history of the state.

- Violators of AS 41.35.230(2) are subject to criminal (misdemeanor) penalties and civil penalties (fines up to $100,000 per violation) AS 41.35.210;

- 215.

- AS 41.35.010-41.35.240 prohibits the unlawful destruction, mutilation, defacement, injury to, removal of or excavation of a grave site, tomb, monument, gravestone, or other structure or object at a grave site, even if the grave site appears to be abandoned, lost, or neglected. Violators of this statute are subject to the same penalties listed above.

Naturally occurring impacts to cultural resources within the region result from earthquakes, tree falls, stream erosion, and other disruptive processes. Potential impacts to these resources could occur during the exploration, development, or production phases, but are most likely to occur during gas development activities.

Prehistoric and historic archaeological resources could be affected by activities associated with installation and operation of facilities, including drill pads, roads, airstrips, pipelines, processing facilities, and any other ground-disturbing activities. Damage to archaeological sites can include breakage of cultural objects; damage to vegetation and the soil thermal regime leading to erosion and deterioration of sites; and

shifting or mixing of components in sites resulting in loss of association between objects. Work crews at archaeological or historic sites could also damage or destroy sites by collecting artifacts (USFWS 1986).

Disturbance to historical and archaeological sites might occur as a result of activity associated with accidents such as a gas well blowout or explosion. Archaeological resources in the immediate vicinity of the blowout might be destroyed, and cleanup activities could result in disturbance by workers near the accident site. Any hydrocarbon spill or deposition could have an indirect affect on archaeological sites through contamination of organic material, which would eliminate the possibility of using carbon dating methods (USFWS 1986). Information obtained from past, large-scale cleanups indicates that archaeological resources generally were not directly affected by spilled oil, and the greatest effects resulted from vandalism, because more people were exposed to cultural resource locations. The detrimental effects of cleanup activity on cultural resources during a cleanup were minor because the cleanup work plan was constantly reviewed and changed as needed to protect archaeological and cultural resources (Bittner 1993). Various mitigation measures used to protect archaeological sites during cleanups include avoidance (preferred), site consultation and inspection, onsite monitoring, site mapping, artifact collection, and cultural resource awareness programs.

Cumulative effects on archaeological sites from normal gas exploration, development, and production activities are expected to be low. In the event that an increased amount of ground-disturbing activity takes place, state and federal laws and regulations should mitigate effects to archaeological resources.

Site-specific and project-specific mitigation measures may be imposed as necessary if exploration and development take place. General mitigation measures and licensee advisories designed to address potential impacts to cultural and historical resources include:

- Licensees are required to conduct training for all employees and contractors on environmental, social, and cultural concerns in the area of activity.

- Prior to ground-disturbing exploration activities and subsequent development, licensees must conduct an archaeological inventory. The inventory must include an analysis of the effects on any prehistoric, historic, and archeological site that might result from the proposed activity.

- The inventory of prehistoric, historic, and archeological sites must be submitted to the Director, and to SHPO who will coordinate with the local borough government for review and comment. If a prehistoric, historic, or archeological site or area could be adversely affected by an activity, the Director, after consultation with SHPO and the local borough, will direct the licensee as to the course of action to take to avoid or minimize adverse effects.

- If a site, structure, or object of prehistoric, historic, or archeological significance is discovered during operations, work must stop, and the licensee must report the discovery to the Director as soon as possible. The licensee 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 local governmental organizations, has directed the licensee as to the course of action to take for its preservation.