Chapter Eight: Reasonably Foreseeable, Cumulative Effects of Licensing and Exploration

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A. Introduction

This chapter considers and discusses reasonably foreseeable effects that the license and subsequent activities could have on habitats, fish and wildlife populations, and their uses of the license area, and potential effects on historic and cultural resources, fiscal effects, and effects on local communities as required by AS 38.05.035(g).

The director has limited the scope to considering and discussing those effects on the important subsistence, sport, commercial species, and uses of the license area described in Chapters Four and Five (AS 38.05.035(e)(1)(B)). As explained in Chapter Two, the director has limited the administrative review for this exploration license to the disposal and exploration phases, and has limited the scope of review to significant effects, meaning known or noticeable impact on or within a reasonable proximity to the license area. Although the license issuance itself is not expected to have any effects other than to provide initial revenue to the state, nearly 100 years of science and research demonstrate the potential cumulative effects that could occur in the license area as a result of subsequent activity. As a result these effects are considered and discussed below, as required by AS 38.05.035(g). Also included in the scope of review are concerns raised in public comments on the license application (AS 38.05.035(g)(1)(A)). In addition to being addressed in this chapter, specific responses to the comments are provided in Appendix A.

AS 38.05.035(h) specifies that speculation about possible future effects is not required. However, a large body of research on the effects of oil and gas exploration, development, and transportation is available to the director, much of which is applicable to the license area. In particular, many studies are available on the effects of oil and gas development for arctic and northern marine habitats, fish, and wildlife, as well as concerning industrial development in boreal forests of Canada. Although the license area may differ from these areas in some respects, the license area shares much in common with these environments, thus much of this body of knowledge is applicable to the license area.

To facilitate a discussion of the potential cumulative nature of effects, this chapter is organized around terrestrial ecosystems, freshwater ecosystems, and the marine environment. Within these broad ecosystems, effects are considered and discussed within general categories of potential oil and gas activities because a certain activity could result in effects across multiple habitats, species, and uses. The protections offered by mitigation measures are discussed as well (AS 38.05.035(g)(vii)).

B. Terrestrial Habitats, Wildlife and Birds

This section considers and discusses potential cumulative effects on terrestrial habitats, wildlife, and birds.

1. Potential Activities and Cumulative Effects

a. Construction and Other General Activities

In arctic environments, the largest effects of oil and gas activities are from physical disturbances (Huntington 2007). During the initial exploration phases, disturbances caused by cross-country travel and construction are the most significant (Hanley et al. 1983). Other activities that may induce impacts include installation of pile foundations, construction of gravel roads, and general terrain disturbance (Hanley et al. 1981). Most impacts are likely to occur during development and production. Oil field development and pipeline construction disturbances may be the most significant (Hanley et al. 1983).

Habitat fragmentation may occur, which may impact biological diversity (Spellerberg and Morrison 1998). Direct loss of habitat, degradation of habitat quality, degradation of water quality, habitat fragmentation, and reduced access to vital wildlife habitats may result with the building and maintenance of roads, trails, highways, and railways. Fish and wildlife may avoid these areas. Fish and wildlife may experience increased exploitation by humans, the splitting and isolation of populations, and disruption in their social structure and the processes that maintain regional populations (ADF&G 2006 citing Jackson 2000). Invasive species may also displace native species as roads can act as travel conduits (ADF&G 2006).

Land surface disturbances may change and destroy vegetation, and alter soil characteristics. Types of land surface disturbances may include vegetation clearing, slash disposal, altered soil characteristics, hydraulic erosion, altered surface hydrology, above ground obstructions and filled areas (Hanley et al. 1983). Construction activities relating to petroleum extraction can cause impacts from the following: off-road transportation; road, pad and airstrip construction; pile foundations; below-ground pipelines; and terrain disturbance (Hanley et al. 1981).

Some effects of constructing production pads, roads, and pipelines may include direct loss of habitat acreage due to gravel infilling, and loss of dry tundra habitat due to entrainment and diversion of water. Construction of roads and gravel pads can interrupt surface water sheet flow and stream flows (NRC 2003). Prior identification of sensitive areas can support the construction of infrastructure away from sensitive habitats. A study of the impacts to habitats from the construction of the Trans-Alaska Pipeline System found that the greatest percentage loss of habitat was from gravel material sites used for construction materials, with the work pad areas and road construction causing the next greatest habitat loss percentages (Pamplin 1979). A secondary effect of construction activities includes dust deposition, which may reduce photosynthesis and plant growth (McKendrick 2000).

The effects upon the ecosystems impacted by roads include potential chemical input from roads to water bodies and to the airshed, and bioaccumulation in soils. Roads can impact fluvial dynamics, sediment transport and floodplain ecology. When roads alter habitats, plant species can be changed or removed, and nonnative plants can be introduced. Additional wildlife habitat impacts from roads can change the density, composition of animal species and populations (NRC 2003).

Road construction, vehicular passage, and oil spills can alter surface albedo (reflectivity of sunlight off the earth's surface) or water drainage patterns, resulting in thaw and subsidence or inundation. Such changes can affect regeneration and revegetation of certain plant species, and species composition may also change after disturbance from construction activities (Linkins et al. 1984).

The effects of roads can also include physical disturbance, habitat loss or fragmentation, and threatening of populations and species near the road edge, mortality of wildlife on roads, the use of road edges as habitat, and dispersal of wildlife along road networks (Spellerberg and Morrison 1998). Human use of land with denning sites can force animals to move (Eberhardt 1977). A study of the effects of roads on brown bears in British Columbia and Montana found that bears used areas within 100 m of roads significantly less than areas farther from the roads, but this behavior change did not translate into a demonstrable effect on the population (McLellan and Shackleton 1988). A study of the frequency and distribution of highway crossings by brown bears on the Kenai Peninsula found that highways affected brown bear travel patterns (Graves et al. 2006).

The presence of linear pipelines may affect moose habitats, causing disruption in migration movements. A study of the effect of the Trans-Alaska pipeline on moose habitats suggested that moose are physically prevented from crossing under pipe structures that are less than 4 ft above ground level (Van Ballenberghe 1978). During shallow snow conditions about 60% of all moose crossings occurred when distances were 6 to 8 ft high. Three-quarters of all crossings occurred where the pipe was 8 ft or less above ground, and more than 90% used crossing locations that were less than 10 ft high. Open ditches of 10 ft or more in depth deflected moose migration (Van Ballenberghe 1978).

b. Aircraft Activity

Effects of aircraft traffic on birds have been studied for several species, locations, and types of aircraft with varying results. Studies regarding the impact of low altitude overflights by helicopter or other aircraft traffic can adversely affect birds by causing stress and the flushing of habitats and nests (Rojek et al. 2007). Research relating to aircraft disturbances of common murres along the California coast showed that aircraft noise and the presence of aircraft flying below 1,000 ft altitude caused head-bobbing behavior or flushing of part or all of a bird colony (Rojek et al. 2007). Helicopters can cause more disturbances due to their low altitude capabilities (Rojek et al. 2007). Flushing and displacing adults and/or broods from preferred habitats during prenesting, nesting, and brood rearing and migration can cause disruption of courtship, chick loss, egg breakage, and predation by predators (Rojek et al. 2007).

An older study evaluated the impacts of helicopters to moulting sea ducks on Herschel Island, Canada. This study found that helicopter disturbances at 100 m height had an immediate impact, but that bird behavior showed no lasting effects. Helicopter disturbances did not drive birds from the habitat, and helicopter overflights at 300 m did not affect bird behavior (Ward and Sharp 1974).

In a four-tear study, Ward et al. (1999) observed the effects of aircraft overflights on Pacific brant and Canada geese in Izembek Lagoon, located just west of the license area on the west side of the Alaska Peninsula. The findings showed that 75% of the Pacific brant and 9% of the Canada geese flew in response to overflights. The Pacific brant were more reactive to helicopter rotary wing aircraft (51%) and louder aircraft (49%), as compared to fixed-wing (33%) and low-noise aircraft (40%). The Canada geese were more reactive to helicopter rotary wing aircraft (41%) and louder aircraft (43%), as compared to fixed-wing (20%) and low-noise aircraft (31%) (Ward et al. 1999). The greatest response was to flights at intermediate altitudes of about 1,000 to 2,300 ft. Lateral distance from the birds was also a critical factor in determining the amount of disturbance to the birds (Ward et al. 1999). Although this study provides a great deal of behavioral detail, it shows that because responses to aircraft are influenced by many variables, it is difficult to generalize responses to noise disturbance across species (Wyle 2008).

Larned et al. (1997) found contrasting results about bird impacts from helicopters compared to fixed wing aircraft. They found that eiders tolerated close passes by helicopters at 150 m with mild alarm responses, while fixed wing aircraft caused the entire flock to leave with approaches within 150 to 200 m (Larned et al. 1997).

c. Wildlife and Human Interaction

Also of concern to wildlife managers is the potential for increased interactions of animals with humans. Of particular concern is bear-human interactions and potential subsequent high non-hunting mortality of bears resulting from those interactions (Suring and Del Frate 2002). The proper management of wastes and landfills may reduce availability of anthropogenic foods to the bear population (Shideler and Hechtel 2000). If food is present, human activity serves as an attractive nuisance, attracting foraging bears, especially to refuse disposal areas. This may pose a threat to human safety and the potential need to remove animals that pose a risk to humans (NRC 2003). Foxes readily habituate to human activity, and this can lead to human-animal encounters, the foxes' use of human structures, and attraction to human food sources. Foxes are especially attracted to human activity because of potential scavenging sources (Burgess 2000, citing to Wrigley and Hatch 1976; Eberhardt 1977).

Tundra swan habitats in or near oil fields have experienced some human impacts and habitat loss due to the construction of gravel roads, pads, material sites and other permanent infrastructure (Ritchie and King 2000). The selection of nesting habitat has been more important than oil field facility avoidance (Ritchie and King 2000). Road noise and human presence, including pedestrians, on roads have caused some swans to nest farther from the road than they had previously (>100 to 200 m) (Ritchie and King 2000, citing to Murphy and Anderson 1993). Although these studies only addressed tundra swans, the studies may be applicable to trumpeter swans, which inhabit the license area.

d. Land-Based Seismic Surveys

Clearing operations to prepare seismic lines, and explosions that occur during seismic surveys may disturb wildlife. Birds and wildlife are particularly sensitive during nesting and calving periods (Schneider 2002). Repeated disturbances can result in increased movement rates of wildlife and subsequent significant energy losses, which can be particularly problematic during winter when food supplies may be scarce (Schneider 2002). However, one study found that, with the exception of ovenbirds, abundance of 41 species of songbirds, and location and size of their territories, were unaffected by seismic lines in boreal forests of the Northwest Territories (Machtans 2006). Seismic activity that occurs in winter may disturb denning bears. Studies have found that radio-collared bears in their dens were affected by seismic activities within 1.2 mi of their dens, demonstrated by an increased heart rate and greater movement within the den. However, no negative effect, such as den abandonment, was documented (Reynolds et al. 1986).

Winter seismic surveys can affect tundra vegetation, depending on snow depth, vehicle type, traffic pattern, and vegetation type. Soil-water content, and the freezing and thawing cycles impact soil strength. Water that freezes in the soils impedes the movement of soil particles. In contrast, low soil-water content does not increase soil strength (Lilly et al. 2008).

Effects from seismic surveys during any season could be substantial if operations are conducted improperly. Vehicles can leave visible tracks in the tundra, but they should disappear with the recovery of the vegetation within a few years, especially in moist or wet vegetation areas. Damage was observed to shrubs, forbs and tussocks. More significant impacts were observed on higher, drier sites, with little to no evidence of damage observed in wetlands (Guyer and Keating 2005).

Traditional seismic lines may leave a long-lasting footprint in boreal forests. However, surveys now use global satellite positioning instruments, making the past practice of long clear-cuts through forests for line-of-sight measurements unnecessary. Plant communities on seismic lines have been found to be significantly different from adjoining forests, and seismic lines showed little change for up to 30 years (MacFarlane 2003). The slow recovery rate may be due to factors such as damage to root systems by bulldozers and competition from grass species. Heavy equipment may result in soil compaction and erosion, and cratering may occur from improperly filled shot holes. Increased access for all-terrain vehicles, snow machines, and off-road trucks, and continued use of the lines by these vehicles may also contribute to extended recovery times (Schneider 2002). Studies have shown that low impact lines do not recover any faster, and the length of time for natural plant communities to be restored on low impact lines is unknown (MacFarlane 2003). Bog habitats that have been disturbed may take many years to return to their pre-disturbance state naturally (ADF&G 2006).

Loss of forest habitat that occurs when seismic lines are cleared is magnified by fragmentation. This reduces the usefulness of the habitat, and may lead to avoidance of intact habitat in the area of the seismic lines by some species (Schneider 2002). Habitat fragmentation, which could create “island populations”, displacement, reduction of habitat quality, and potential increased frequency of high energy-cost flight responses have been identified as a concern for some brown bear populations (ADF&G 2000).

Seismic lines may alter predator-prey interactions. In boreal forests, radio-collared wolves were observed significantly closer to linear corridors, and they traveled faster along linear seismic corridors than in the forest. Travel speed was unrelated to whether the seismic line was packed or unpacked, so it is suspected that the visual stimulus of a long distance influences wolves to stay and follow the corridor when they intersect it (James 1999).

e. Discharges from Exploration, Development, and Production

Discharges from exploration, development, and production may be intentional, such as permitted discharges regulated by the NPDES, or unintentional, such as gas blowouts, leakages, and spills. Excluding oil spills, activities related to oil and gas exploration, development, and production are minor contributors of petroleum hydrocarbons to the environment (Huntington 2007).

i. Gas Blowouts

During drilling, shallow gas pockets of natural gas may be encountered. Gas can get trapped in soils, water, and ice in permafrost environments. Sediments in which gas has accumulated are potential hazards for drilling that penetrates them (Hyndman and Dallimore 2001).

Explosions and resultant fires may occur during a natural gas blowout. Gas vapors from an explosion are lighter than air and may migrate downwind where they are readily dispersed. Blowouts occur only if hydrogen sulfide is present and can also cause a toxic cloud to accumulate at shallow depths. Condensates, a low-density mixture of hydrocarbon liquids present in raw natural gas, which did not burn in the blowout would be hazardous to any organisms exposed to high concentrations (Kraus 2011).

ii. Hazardous Spills

Hazardous spills can have toxic effects on vegetation, soils, wildlife, birds and fish. Effects of spills depend on time of year, vegetation, and terrain. Oil spilled on the tundra would migrate both horizontally and vertically. The characteristics of the soil, such as porosity, permeability, texture, degree of water saturation and organic matter content, would affect substance movement (Jorgenson and Cater 1996).

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 seasons (Linkins et al. 1984). Hydrogen degrading bacteria and fungi can act as decomposers of organic material, and under the right conditions can assist in the breakdown of hydrocarbons in soils. Natural or induced bioremediation using microorganisms can also occur (Linkins et al. 1984; Jorgenson and Cater 1996). Natural recovery in wet habitats may occur in time durations of 10 years or less, if aided by cleanup activities and additions of fertilizer (McKendrick 2000).

The long term effects of oil may persist in the sediments for many years. Shifting population structure, species abundance, diversity and distribution can be long term effects, especially in areas that are sheltered from weathering processes (USFWS 2004).

Oil leaks or spills in boreal forests can have a range of potential effects, including killing plants directly, slowing growth of plants, inhibiting seed germination, and creating conditions in which plants cannot receive adequate nutrition. Although a single addition of petroleum hydrocarbons does not appear to limit microbial communities in the long term, species richness often decreases (Robertson et al. 2007).

At low concentrations, petroleum hydrocarbons can stimulate plant growth (Robertson et al. 2007). Heterotrophic bacteria and fungi in most natural microbial communities apparently have an inherent ability to degrade organic pollutants, and usually, biological processes eventually degrade or transform most organic compounds. Although mycorrhizal ecosystems may be harmed by oil spills or leaks, they are also used for bioremediation (Robertson et al. 2007).

Oil may cause harm to wildlife through physical contact, ingestion, inhalation and absorption. As food sources are impacted by oil, larger animals, fish, mammals and humans can in turn be affected (USFWS 2004). Impacts to birds from oil releases may foul plumage and destroy insulation value, and resultant loss of buoyancy or hypothermia can kill birds (Burger and Fry 1993). While cleaning plumage, birds can ingest or inhale the oil, causing damage to lungs, liver, kidneys and death. Non-lethal effects to birds can include impaired reproduction or suppression of the immune system (USFWS 2004). Individual animals in the immediate vicinity and the associated nearby habitat and food sources may be impacted. Wildlife species may be disturbed or displaced. Additional efforts may need to divert wildlife from access to the impacted area.

Oil weathers over time, and organisms may be able to tolerate the presence of oil while it is naturally degrading (Jorgenson and Cater 1996).

iii. Releases of Drilling Muds and Produced Water

Common drilling fluids contain water, clay, and chemical foam polymers. Drilling additives may include petroleum or other organic compounds to modify fluid characteristics during drilling. The down-hole injection of drilling muds and cuttings are unimportant if they are not placed into a subsurface drinking water aquifer (NRC 2003). Waters and drilling muds produced and discharged during oil and gas production activities may contain toxic levels of heavy metals, radioactive particles, and brine and persist for longer periods of time.

When these production waters are discharged to land they can be more devastating to plants and animals than crude oil. Where they are discharged into marine waters, the toxic components are distributed differently than oil which floats to the surface (LaRoche and Associates 2011). They may have acute effects on the sea floor flora and fauna, reducing both their abundance and diversity in the immediate area of discharge (Arctic Council 2009). The technique of injecting mud and cutting disposal has greatly reduced the potential adverse impacts caused by releases of drilling muds and reserve pit materials (NRC 2003).

2. Mitigation Measures and Other Regulatory Protections

Although oil and gas activities subsequent to licensing and exploration could potentially have cumulative effects on terrestrial habitats, wildlife and birds, measures in this best interest finding, along with regulations imposed by other state, federal, and local agencies, are expected to mitigate those potential effects.

For example, administration of the federal Clean Water Act (32 USC § § 1251-1376) and state water quality statutes (18AAC75, AS 46.03, AS 46.15) are expected to mitigate potential effects. Therefore, additional DO&G mitigation measures are not included in the finding because water quality regulations are under DEC’s jurisdiction. U.S. Army Corps of Engineers has regulatory authority over wetlands (33 USC 401, 33 USC 403).

Further, standard DNR land use permit conditions serve to protect habitat and water quality from potential negative effects of facility construction and operation. Work areas must be kept clean. Trash, survey markers, and other debris that may accumulate in camps or along seismic lines and travel routes that are not recovered during the initial cleanup must be picked up and properly disposed of. All solid wastes, including incinerator residue, must be backhauled to a solid waste disposal site approved by DEC.

Mitigation measures included in this best interest finding address habitat loss avoidance, and protection of wetland, riparian, and aquatic habitats. A complete listing of mitigation measures is found in Chapter Nine.

C. Marine and Freshwater Habitats, Fish, and Marine Mammals

This section considers and discusses potential cumulative effects on marine and freshwater habitats, fish, and marine mammals.

1. Potential Activities and Cumulative Effects

Potential activities that could have cumulative effects on marine habitats, fish, and wildlife of the license area include seismic surveys, discharges from well drilling and production, construction of support facilities, and ongoing disturbances from production activities such as boat and aircraft traffic. In addition, gas blowouts and oil spills could potentially occur during development and production.

If unregulated, general construction activities could affect marine and freshwater habitats, fish, and marine mammals. The blockage of passage, siltation of streams, and destruction of spawning habitat were the main problems associated with construction of fish passage crossings along the Trans-Alaska Pipeline System (Gustafson 1977). Excavation of gravel construction materials can disturb floodplains and habitats. Construction activities can also cause erosion of river banks, siltation, bottom substrate disturbance, reduced water volumes, altered water quality, barriers to fish passage, and elimination of habitat (Hanley et al. 1983).

Erosion is a potential impact of all phases of exploration and development. If activities associated with oil and gas exploration and development, such as gravel removal, heavy equipment operations, and siting of support facilities are unregulated, they could increase stream sedimentation and erosion, impede fish passage, alter drainage patterns, and have other negative effects on freshwater habitats, fish, and other aquatic organisms (Schneider 2002). Erosion can increase sedimentation and turbidity of aquatic habitats, which can cause decreased primary production, resulting in depleted food for zooplankton, insects, freshwater mollusks, and fish. This can lead to direct mortality, reduced physiological function, and depressed growth rates and reproduction in aquatic organisms (Henley et al. 2000).

Removal of water from lakes, ponds and rivers where fish overwinter may affect the viability of overwintering fish, and longer-term effects of lake drawdown may impede the ability of fish to return to the lake in subsequent years. Removal of snow from lakes may increase the freeze depth of the ice, kill overwintering and resident fish, and adversely affect the ability of fish to utilize the lake in future years. Water depths of 7 ft or more are considered the minimum for supporting overwintering freshwater fish (ConocoPhillips Alaska Inc. 2010). Oxygen depletion, caused by overcrowding or over-demand by biological and chemical processes, can result in fish mortality (Schmidt et al. 1989; Reynolds 1997).

a. <u>Freshwater Environments</u>

The principle impacts to freshwater habitats attributed to seismic surveys involve the acoustic energy pulses emitted by airguns. Seismic surveys typically cover a relatively small area and only stay in a particular area for hours. The airgun firing overpressures the water, and the fish react to the airgun, and immediately swim in an intense effort to flee from the sound. Adverse effects from seismic activities to the migration, spawning, and hatchling survival of fish most likely would be temporary and localized (MMS 2007).

In a study conducted in the Sagavanirktok River, broad whitefish were first observed in their natural state and were sedentary and showed minimal movement. When an airgun was fired in close proximity, the broad whitefish fled the immediate area, and after 2 minutes slowed their swimming speed, and were observed to school as a group back at the original water location. Repeated firing of the airgun revealed that this pattern was consistent, and fish returned to a sedentary posture at the original water location each time. The authors concluded that there was little evidence that energy from the airguns harmed the fish observed (Morris and Winters 2005).

Popper et al. (2005) measured the effects of seismic airgun firing on broad whitefish and found that the firing of airguns had no apparent effect on hearing. The results also showed that the lake chub species experienced only temporary hearing loss, and hearing of northern pike returned after 18 hours.

Similarly, in a 2005 study, airguns were fired in close proximity to Arctic char within a flooded gravel pit at Duck Island mine site on the North Slope. Results showed that no fish deaths occurred as a direct result of airgun noise, no bleeding of the gills was noted, but internal injuries were observed in some fish. No swim bladder damage was observed. Eye injuries were noted at rates ranging from 0.1 to 7%, and body tissue injuries were noted at rates ranging from 6 to 12% in the fish. Fish eye injury was the injury with the highest frequency occurrence (Morris and Winters 2005).

b. Marine Environments

One of the primary concerns about oil and gas development in marine waters is the potential effects that noise from seismic surveys, construction activities, and ongoing boat, drilling, and aircraft activities could have on marine mammals and other marine animals (Hofman 2003). Attempts have been made by scientists, the oil and gas industry, and by environmental groups to compile and draw conclusions about the effects of these activities from existing research, but these reports draw on few experimental studies, relying rather on anecdotal observations, unpublished reports, and non-peer reviewed research (OGP/IAGC 2004; Gordon et al. 2004; WDCS 2004). The lack of experimental research on the effects on marine animals of noise from oil and gas development, and the lack of conclusive results, particularly at the population level, is frequently highlighted by scientific, industry, and environmental organizations alike (Jasny et al. 2005; Gordon et al. 2004; OGP/IAGC 2004; WDCS 2004).

Hofman (2003) reviewed available studies of the effects of industrial noise on whales, finding that some effects on activity patterns of some whales were documented, but that research was insufficient for understanding which species are affected, how many animals are affected, distances at which various species are affected, and the biological significance of the effects. Although some studies found distribution and behavior changes for some whales, the changes were negligible and no harmful effects were documented. Research is also lacking on whether or not some species may become habituated to, and stop being affected by, certain kinds of sounds, or on whether certain species may become more sensitive to sounds with increased exposure (Hofman 2003).

Researching these effects on marine mammals and other marine animals is a difficult undertaking. Hofman (2003) explained the many variables that influence the effects of noise on animals in the marine environment:

> The nature and significance of acoustic effects are dependent on a number of variables. They include the intensity, frequency, and duration of the sound; the location of the sound source relative to the potentially affected animals; water depth, bottom reflectivity and other features of the environment; the distance between the animal and the sound source; whether the sound source is stationary or moving; the species, age, sex, reproductive status, activity and hearing ability of the animals exposed to the sound; whether the animals use similar sounds for communicating, locating and capturing prey, etc.; and whether and how frequently the animals in question are exposed to the sound.

In one of the few controlled experiments on the response of whales to noise, a four-year study examined responses of whales to airguns used in seismic surveys in the Gulf of Mexico. This study found no horizontal avoidance to seismic airgun sounds by sperm whales (Jochens et al. 2008).

In Cook Inlet, beluga whales appear to exhibit site fidelity, returning to estuary areas even after a disturbance, including adults with calves (Moore et al. 2000). They continue to occupy upper Cook Inlet despite oil and gas development, vessel and aircraft traffic, and dredging operations. One study, based on a review of available information, concluded that belugas appear to have become habituated to offshore oil and gas activities in central Cook Inlet (Moore et al. 2000).

A study of interactions between beluga whales and boats in Knik Arm, in Cook Inlet suggested that an increase in boat traffic from recreation or industrial activity and construction in or near areas where the whales congregate and feed might disrupt these important activities in Cook Inlet (Stewart 2012).

An assessment of human and environmental stressors on Cook Inlet beluga whales concluded that threats to quantity and quality of beluga prey species may occur due to continued development. The study determined that Cook Inlet beluga whales may be at risk for chronic, serious sublethal effects if contaminant concentrations in the environment have a similar effect as seen in other marine mammal species (Norman 2011). However, an assessment of the winter prey availability and oil-related contaminants for Cook Inlet beluga whales stated that analyses of hydrocarbon in selected prey tissues showed non-detectable levels, though these results are counter to earlier analysis of their summer prey (Saupe et al. 2014).

A study in the Beaufort Sea found that ringed seals were not affected by noise from pipe-driving and construction sounds, except for helicopters, concluding that seals were likely habituated to the industrial sounds and visual activity (Blackwell et al. 2004). Additionally, a 2003 study in the Beaufort Sea found that the proportion of long-tailed ducks detected in areas with seismic surveys was not significantly different from control areas without the surveys; the study also found that there was no difference in diving behavior of ducks in the seismic and non-seismic areas (Lacroix et al. 2003).

Additionally, there is no evidence that routine oil and gas development and transport activities have a direct impact on the sea otter stock of Southcentral Alaska (Angliss and Outlaw 2008).

An experimental study of the effects of seismic surveys on cod and haddock in the Barents Sea, located north of Norway and Russia, found that fish distribution, abundance, and catch rates were significantly affected, decreasing by up to 50% during and after seismic shooting, compared to rates just previous to commencement of the seismic survey (Engas et al. 1996).

In a study of a rocky reef off Scotland, fish response from seismic airguns showed minor behavioral responses to airgun emissions. The researchers found there were no permanent changes in behavior, and no fish appeared to leave the reef habitat. There were no indications of observed damage to the reef animals (Popper and Hastings 2009, citing to Wardle et al. 2001).

The ocean substrate may be physically disturbed from activities such as anchoring or from sedimentation from discharges, potentially resulting in effects on the organisms living there (Lissner et al. 1991). However, research is lacking on the specifics of these potential effects, especially specific to the license area. Recovery time for substrate disturbances can vary from a few days or months to decades, depending on the type and frequency of the disturbance, and the type of organisms inhabiting the substrate (Lissner et al. 1991). Eelgrass beds are vulnerable to increased turbidity, sediment disturbances, and eutrophication that could occur as a result of development activities; these could, in turn, promote growth of epiphytic algae on eelgrass, decrease eelgrass photosynthesis and growth, and smother or uproot eelgrass (ADF&G 2006).

Human intrusions into seabird colonies can result in reduced reproductive success. Eggs, hatchlings, and fledglings are particularly vulnerable to activities that may result in loss of eggs or young, dispersion from the nesting site or rookery, and disruption of vital parent-offspring bonds (Boesch et al. 1987).

c. Discharges from Exploration, Development, and Production

i. Gas Blowouts

In addition to noise and physical disturbances, discharges into the water may result from oil and gas activities (Huntington 2007). If a natural gas blowout occurs the initial explosion and possibility of fire are possible hazards, and vapors may migrate downwind. Blowouts can also cause a toxic cloud of hydrogen sulfide that accumulates close to the ground (Van Dyke 1997). Natural gas and condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations.

ii. Oil Spills

Oil spills could range from small chronic leaks from equipment or facilities to catastrophic pipeline failures or, a blowout. The effects of oil spills on fish habitats would depend on many factors, including the time of year, size of the spill, and water body affected. Type and extent of effects depends on a myriad of factors including habitat involved, species, life history stage, migration patterns, nursery areas, season, type of chemical, amount and rate of release, time of release, duration of exposure, measures used for retaining the chemical, and use of counteracting or dispersing agents (Davis et al. 1984).

Whales and other marine mammals can suffer impacts from exposure to oil. For example, the ingestion of oil leads to both lethal and sublethal effects. Before the *Exxon Valdez* oil spill, little was known about the effects of oil on marine mammals. In the early 1980s researchers observed gray whales swimming through oil seeps off the coast of California and captive bottlenose dolphins initially avoiding but eventually swimming through oiled areas in their tanks (Matkin et al. 2008).

Any mammals using haulout areas are susceptible to effects from oil spilled in the marine environment. If adults are contaminated during a time that pups are being nursed, the young may ingest the oil while nursing. The females may also have trouble recognizing their young which could lead to abandonment and starvation (LaRoche and Associates 2011).

The toxins in oil could affect invertebrates and fish (Jorgenson and Cater 1996). Potential adverse effects include direct uptake of oil by the gills, ingestion of oil, ingestion of oiled plankton or prey, decreased survival of eggs and larvae, and ecosystem changes in freshwater habitats. Adult fish may be affected by reduced growth, enlarged livers, heart and respiration rate changes and effects to reproduction. Toxic compounds in oil could reduce spawning success, and increase mortality of eggs and larvae in spawning or nursery areas. Floating oil can also affect plankton, such as algae, fish eggs and invertebrate larvae (USFWS 2004). Sublethal effects may also reduce fitness and impair an organism’s ability to endure environmental stress. The long term effects to ecosystems impacted by oil spills due to persistence of toxic substances and chronic exposures may continue to affect wildlife (Peterson et al. 2003).

Oil spills can have short- and long-term negative effects on aquatic life, including fish and benthic organisms (Olsgard and Gray 1995). Lethal or sub-lethal effects may subtly reduce or impair physiological and reproductive fitness (Davis et al. 1984). Sedentary animals, such as oysters, clams, and mussels, are more susceptible to releases of petroleum products than fish and shellfish such as crabs and shrimp, which are capable of active avoidance (Davis et al. 1984).

Several studies of the 1989 *Exxon Valdez* oil spill and its effects on pink salmon provided compelling evidence that growth was not reduced by the exposure to the levels of oil in marine waters in 1989. Record returns of adult pink salmon in 1990 and 1991 support the conclusion that pink salmon populations were not damaged at any detectable level by the *Exxon Valdez* oil spill as those two brood years were exposed as embryo or fry to the greatest risk from the oil in 1989 (Brannon et al. 2013).

iii. Releases of Drilling Muds and Produced Water

Unregulated releases of drilling muds, cuttings, produced waters, and other effluents from oil and gas exploration, development, and production can have short- and long-term negative effects on aquatic life, including fish and benthic organisms similar to a release of crude oil (Olsgard and Gray 1995).

Produced water contains naturally occurring substances such as clay, sand, oil, water, metals, and gas. These substances are found in the subterranean strata. Produced waters are usually saline with some level of hydrocarbons and naturally occurring solids and bacteria. They may also contain chemicals added to inhibit corrosion, as well as emulsifiers, coagulants, flocculants, clarifiers and solvents. Produced waters from gas production also can include condensed water, dehydration chemicals, hydrogen sulfide removal agents and chemicals that inhibit formation of hydrates (Veil et al. 2004).

Produced waters may contain hydrocarbon and chemical constituents in volumes that may be toxic to microorganisms and mysid shrimp (*Mysidopsis bahia*) (Brown et al. 1992). Significant accumulation of drilling mud in wetlands can potentially impact benthic habitats and can blanket fish spawning grounds (Schmidt et al. 1999, citing to Falk and Lawrence 1973; and citing to Friedheim; Sprague and Logan 1979). Suspended solids in aquatic habitats can have adverse effects on egg and larval development of amphibians (Schmidt et al. 1999, citing to Richter 1995).

Technological advances in drilling mud systems have developed mud systems less toxic to the environment. Newer synthetic-based muds are formulated from synthetic organics base fluids. They produce even less waste, improve drilling efficiency, are reusable, and have advantages in environmental protection over oil or water-based muds. Synthetic muds can be reconditioned instead of discharged as waste (Wojtanowicz 2008).

d. Groundwater

Oil and gas activities may have effects on groundwater in the license area. Water use from groundwater wells may be required for the construction and maintenance of ice roads and pads, for blending drilling muds in drilling activities, and for potable and domestic water uses at drilling camps (NRC 2003; Van Dyke 1997). Industrial use of groundwater could draw down the elevation of the water table in the vicinity of the industrial well or wells, and could affect nearby domestic well water depths. These effects are usually insignificant and temporary as other hydraulically connected groundwater sources replace pumped volume.

Improper disposal or accidental releases of drilling muds, cuttings, produced waters, and other effluents from oil and gas activites could have short- and long-term negative effects on water resources. Re-injection is the preferred method for disposal of drilling fluids. Disposal of drilling muds and cuttings requires permit approval.

Most oil field wastes are considered non-hazardous and waste fluids are recycled, filtered, and treated before reinjection or disposal. Cuttings and waste fluids must be made non-hazardous before injection. Produced water is treated using heat, gravity settling, and gas flotation devices to remove hydrocarbons. After treatment, produced water is reinjected into either the oil-bearing formation to maintain pressure and enhance recovery or into an approved disposal well. Cuttings disposal is done through grinding and injecting on-site, or cuttings are transported to an approved disposal site. Cuttings disposal can cost more than the total cost to drill a well. Wastewater, including sanitary and domestic graywater, is also treated to meet effluent guidelines before discharge. All disposal wells inject fluids deep beneath any drinking water aquifers.

USGS monitors water quality at eight fixed sites in the Cook Inlet area (Brabets and Whitman 2004). Sites studied included the Ninilchik River, two sites on the Kenai River, South Fork of Campbell Creek, Chester Creek, the Deshka River, Moose Creek near Palmer, and Johnson River near Tuxedni Bay. Of the sites that had human activities, only urbanization affected water quality. The Chester

Creek basin was found to have volatile organic compounds, pesticides, an increased number of tolerant species, and changes in physical habitat, all related to urbanization (Brabets and Whitman 2004). Some sites near leaking fuel-storage tanks, fuel-storage facilities, and petroleum refineries have been documented to contain organic-compound contaminants (Glass 1999).

2. Mitigation Measures and Other Regulatory Protections

Although oil and gas activities subsequent to licensing and exploration could potentially have cumulative effects on marine and freshwater habitats, fish, and marine wildlife, measures in this best interest finding, along with regulations imposed by other state, federal and local agencies, are expected to mitigate those potential effects.

For example, because of the potential effects discussed above, effluents discharged by the oil and gas industry into marine and fresh surface waters within the license area and within state boundaries, are regulated through the state's APDES program (see Chapter Seven). This program ensures that state and federal clean water quality standards are maintained by requiring a permit to discharge wastes into the state's waters (DEC 2014d).

Steller's eiders, Steller sea lions, Northern sea otters, and fin, beluga, and humpback whales are provided additional protection under the Endangered Species Act. Designation of critical habitat for Cook Inlet beluga whales (50 CFR Part 226) administered by NOAA and the Southwest Alaska DPS Northern Sea Otter (73 FR 76454) administered by USFWS that overlap the license area's waters are expected to mitigate any effects on the marine habitat. A complete listing of mitigation measures is found in Chapter 9.

D. Air Quality

1. Potential Activities and Cumulative Effects

Oil and gas activities may produce emissions that have the potential to affect air quality. Gases may be emitted to the air from power generation, flaring, venting, well testing, leakage of volatile petroleum components, supply activities, shuttle transportation boilers, diesel engines, drilling equipment, flares, glycol dehydrators, natural gas engines and turbines, and fugitive emissions, which are leaks from sealed surfaces associated with process equipment (BOEMRE 2011; Arctic Council 2009).

On-road and off-road vehicles, heavy construction equipment, and earth-moving equipment could produce emissions from engine exhaust and dust. Sources of air emissions during drilling operations include rig engines, camp generator engines, steam generators, waste oil burners, hot-air heaters, incinerators, and well test flaring equipment. Emissions could be generated during installation of pipelines and utility lines, excavation and transportation of gravel, mobilization and demobilization of drill rigs, and during construction of gravel pads, roads, and support facilities. Emissions could also be produced by engines, turbines, and heaters used for oil/gas production, processing, and transport. In addition, aircraft, supply boats, personnel carriers, mobile support modules, as well as intermittent operations such as mud degassing and well testing, could produce emissions (BOEMERE 2011).

Other sources of air pollution include evaporative losses of volatile organic compounds from oil/water separators, tanks, pump, compressor seals, and valves. Venting and flaring could be an intermittent source of volatile organic compounds and sulfur dioxide (MMS 2008). Gas blowouts, evaporation of spilled oil, and burning of spilled oil may also affect air quality. Should a gas or oil blowout ignite, a light, short-term coating of particulates could be deposited over a localized area. (DEC et al. 2008).

There are significant uncertainties associated with estimates of Alaska's greenhouse gas emissions from the oil and gas sector as there are no regulatory requirements to track carbon dioxide or methane emissions. Alaska's emissions account for 0.7% of all U.S. emissions. Of the 52 million metric tons of carbon dioxide equivalent emissions generated in Alaska, 15 million metric tons of carbon dioxide equivalent are related to the oil and gas industry, approximately 29% (AMAG 2009).

The Alaskan overall oil and natural gas industry historical trend projection for emissions was an estimated 3.0 million metric tons of greenhouse gases statewide in 2005, contributing about 6% of the state's total greenhouse gas emissions (Roe et al. 2007). This is a projected decrease from 1990 and 2000, and continued decreases are expected through 2020. These estimates are for fugitive emissions, including methane and carbon dioxide released from leakage and venting at oil and gas fields, processing facilities, and pipelines. Estimates of emissions resulting from fuel combustion are only available for residential, commercial, and all industries combined, and are not available for the oil and gas industry separately (Roe et al. 2007).

In 2008, improvements were made to the Alaska Greenhouse Gas Emission Inventory. DEC broke down 2005 GHG emissions data by source category and refined it. By applying these refinements with the 2007 Center for Climate Strategies (CCS) updates, it was estimated that Title V oil and gas sources contributed to 29% of GHG emissions in Alaska. In 2008, using the same data, DEC estimated oil and gas development sources were responsible for 73% GHG emissions of all Title V sources (see Table 8.1). In other words, industries in Alaska combusting, refining, storing, and transporting fuel had the highest GHG emission estimates (DEC 2008).

However, in 2005, according to the EPA's Energy CO2 Emissions by state, emissions from the combustion of fuel in Alaska were about the same as Connecticut, Nevada, and North Dakota. And Alaska's fuel combustion emissions were about half of Washington's emissions even though Washington had 10 times the population of Alaska (DEC 2008).

2. Mitigation Measures and Other Regulatory Protections

Administration of the Clean Air Act (42 USC §§ 7401-7671) and state air quality statutes (18 AAC 50, AS 46.03, AS 46.14) are expected to mitigate potential effects to air quality. Therefore, additional mitigation measures are not included in this finding; air quality regulations are under DEC's jurisdiction.

In-situ burning of spilled oil must be pre-approved by DEC and EPA and/or the U.S. Coast Guard (DEC et al. 2008). Controlled in-situ burning of spilled oil is only allowed if it is located a safe distance from populated areas. Approved burn plans require removal of particulates.

Additional information about air quality regulations and permits is found in Chapter Seven and a complete listing of mitigation measures is found in Chapter Nine.

E. Subsistence Use

1. Potential Activities and Cumulative Effects

Subsistence uses of the license area depend on the area's fish, wildlife, and habitats. Therefore, potential cumulative effects from oil and gas activities on the area's fish, wildlife, and habitats could also affect subsistence uses. Potential cumulative effects to fish, wildlife, and habitats are discussed in the preceding sections. Other potential effects on subsistence uses are discussed below.

Oil and gas exploration, development, and production could result in increased access to hunting and fishing areas. For example, roads built by oil companies during exploration and development recently and over the last 50 years are important for access to subsistence resources for Tyonek and Beluga residents in the Cook Inlet area, who travel to subsistence areas primarily by truck. However, increased public access to hunting, fishing, and trapping areas due to construction of new roads could also increase competition between user groups for fish and wildlife resources. Roads can also raise concerns among subsistence users that increased traffic is affecting distribution of wildlife (Braund 2007).

Oil and gas activities can raise other concerns among subsistence users. For example, Tyonek and Beluga residents have expressed concerns that disturbance from oil rigs has contributed to decline in beluga and seals; that pollution from oil rigs has resulted in fish diseases and declines in clam abundance; and that oil development has changed bear distribution and waterfowl habitat (Braund 2007). However, independent research corroborating these concerns is not always available.

A major oil spill could decrease resource availability and accessibility, and create or increase concerns about food safety which could result in effects on subsistence users, effects which could linger for many years. For example, subsistence harvests of fish and wildlife by residents of fifteen predominately Alaska Native communities, as well as by residents in larger rural communities, declined by as much as 70% after the 1989 *Exxon Valdez* oil spill (Fall 1999).

Within two years of the spill, subsistence harvests and participation had returned to pre-spill levels, although communities closest to the spill lagged behind. However, concerns remained about food safety, availability of many species was reduced, efficiency was reduced, and opportunities to teach subsistence skills to young people were lost (Fall 1999). By 2003, harvest levels were higher than pre-spill levels, or were within the range of other rural communities. However, harvest composition remained different from the pre-spill composition, and concerns about the safety of some shellfish species remained (Fall 2006). There is limited information available on whether, after an oil spill, spatial redistribution of a species affects harvest and the time required for a successful hunt (NRC 2003).

Additional complex factors may confound effects of an oil spill, including demographic changes in communities, increased competition for fish and wildlife resources by other user groups, predators, and increased awareness about other contaminants (Fall 2006). Because many subsistence resources affected by the spill had not fully recovered, subsistence in areas affected by the *Exxon Valdez* oil spill was still not considered to have fully recovered in 2010 (EVOSTC 2010).

Although the oil and gas industry has the potential to provide jobs and income to subsistence users, work in the oil and gas industry may reduce the time available for subsistence activities (Stanek et al. 2007; EDAW/AECOM 2007). Some studies have found that "higher levels of household cash income were directly correlated with peoples' commitment to, and their returns from, natural resource harvesting" (EDAW/AECOM 2007, citing to Kruse 1986). Other studies have shown that young men in Inupiaq communities balance wage employment with seasonal subsistence activities, even when there are large numbers of high paying job opportunities (EDAW/AECOM 2007, citing to Kleinfeld et al. 1983). The availability of time-saving technologies, such as ATVs, snow machines, and outboard motors, has counter-balanced decreased availability of time, and "cash derived from wage employment did not replace subsistence but underwrote it" (EDAW/AECOM 2007, citing to Lonner 1986).

2. Mitigation Measures and Other Regulatory Protections

Oil and gas activities could potentially affect subsistence uses, mostly as secondary effects from effects on habitat, fish, or wildlife. Mitigation measures in this written finding, along with regulations imposed by other state, federal and local agencies, are expected to mitigate those potential effects. A complete listing of mitigation measures is found in Chapter Nine.

F. Sport and Commercial Fishing and Sport Hunting

1. Potential Activities and Cumulative Effects

In addition to subsistence, other important uses of fish and wildlife populations in and around the license area include sport and commercial fishing; and sport hunting. Potential activities that could have effects include seismic surveys, discharges from well drilling and production, construction of road and support facilities, and ongoing disturbances from production activities such as pipeline activities, vehicle, boat, and aircraft traffic. In addition, gas blowouts and oil spills could potentially occur during development and production.

Potential effects from oil and gas activities on the area's terrestrial and freshwater habitats and fish and wildlife populations could affect these uses. Potential effects to the area's habitats and fish and wildlife populations are discussed in the preceding sections.

2. Mitigation Measures and Other Regulatory Protections

Oil and gas activities could potentially affect sport and commercial fishing, and sport hunting, primarily from effects on habitat, fish, and wildlife. Mitigation measures in this best interest finding, along with regulations imposed by other state, federal and local agencies, are expected to mitigate those potential effects. A complete listing of mitigation measures is found in Chapter Nine.

G. Recreation and Tourism

1. Potential Activities and Cumulative Effects

Effects from oil and gas development on fish, wildlife, and their habitats could affect recreation and tourism. Possible effects from oil and gas activities on fish and wildlife populations and habitats are discussed in the preceding sections. Other potential effects on recreation and tourism are discussed below.

Oil and gas activities could decrease an area's visual quality and attraction to tourists. Excess turbidity and sedimentation in an area's waters can decrease recreation value (USGS 2014). It could likewise restrict local access to an area. For example, after the *Exxon Valdez* oil spill, access to visibly oiled areas was limited to recreational users such as kayakers. Some unoiled areas were used more heavily because activities were displaced from the oiled areas. Because some species had not completely recovered from the spill and oil remained in some localized areas, recreation and tourism were considered to be recovering, but not yet recovered as of 2010 (EVOSTC 2010). Alternatively, oil and gas activities could result in increased access to recreational areas due to the construction of new roads.

2. Mitigation Measures and Other Regulatory Protections

Oil and gas activities subsequent to leasing could potentially affect recreation and tourism, mainly as secondary effects from effects on habitat, fish, and wildlife. Measures in this best interest finding, along with regulations imposed by other state, federal and local agencies, are expected to mitigate those potential effects. A complete listing of mitigation measures is found in Chapter Nine.

H. Historic and Cultural Resources

1. Potential Activities and Cumulative Effects

The license area has documented occurrences of historical and cultural resources. The potential impacts to these resources may be from accidental oil spills, erosion and vandalism (Dekin et al. 1993).

Impacts and disturbances to historic and cultural resources could be associated with installation and operation of oil and gas facilities, including drill pads, roads, airstrips, pipelines, processing facilities, and any other ground disturbing activities. Damage to archaeological sites may include: direct breakage of cultural objects; damage to vegetation and the thermal regime, leading to erosion and deterioration of organic sites; shifting or mixing of components in sites resulting in loss of association between objects' and damage or destruction of archeological or historic sites by oil spill cleanup crews collecting artifacts (BLM 2007; USFWS 1986).

Spills can have an indirect effect on archaeological sites by contaminating organic material, which would eliminate the possibility of using carbon C-14 dating methods (USFWS 1986). The detrimental effects of cleanup activity on these resources are minor because the work plan for cleanup is constantly reviewed, and cleanup techniques are changed as needed to protect archaeological and cultural resources (Bittner 1996).

For example, historic and cultural resources may be encountered during field-based activities, and these resources could be affected by accidents such as an oil spill. Following the *Exxon Valdez* oil spill, 24 archaeological sites experienced adverse effects including oiling of the sites, disturbance by clean-up activities, and looting and vandalism. Monitoring of the sites over a seven-year period indicated that vandalism continued to be a minor problem, and that although some sites were initially badly damaged by oiling, residual oil does not appear to be contaminating known sites, and sites are now considered to be recovered (EVOSTC 2010).

2. Mitigation Measures and Other Regulatory Protections

Various mitigation measures used to protect archaeological sites during oil spill cleanups include avoidance (preferred), site consultation and inspection, onsite monitoring, site mapping, artifact collection, and cultural resource awareness programs (Bittner 1996). Measures in this best interest finding, along with regulations imposed by other state, federal, and local agencies, are expected to mitigate those potential effects.

Because historic and cultural resources are irreplaceable, caution is necessary in order to not disturb or impact them. AS 41.35.200 addresses unlawful acts concerning cultural and historical resources. It prohibits the appropriation, excavation, removal, injury or destruction of any state owned cultural site. In addition, all field based response workers are required to adhere to historic properties protection policies that reinforce these statutory requirements, and to immediately report any historic property that they see or encounter (AHRS 2014). A complete listing of mitigation measures is found in Chapter Nine.

I. Fiscal Effects

This section considers and discusses the fiscal effects, both statewide and local, of licensing activities, as required by AS 38.05.035(g)(1)(B)(ix). Licensing and subsequent activity may generate income for state government, with some possible fiscal benefits including increased revenue sharing, creation of new jobs, and indirect income multiplier effects. Fiscal effects may be statewide and local.

1. Statewide Effects

Alaska’s economy depends heavily on revenues related to oil and gas production and government spending resulting from those revenues. Oil and gas revenues fund education and the state’s operating and capital budgets.

The primary source of state revenues is North Slope oil production, although oil and gas are also produced from Cook Inlet. In FY 2013, oil and gas revenues totaled $6.4 billion and comprised approximately 92% of the state's general fund unrestricted revenue. The Alaska Department of Revenue (DOR) forecasts FY 2014 oil revenue at $4.4 billion and the forecast for FY 2015 is $3.9 billion (DOR 2013). However, North Slope and Cook Inlet production are declining. Alaska North Slope production peaked at 2.006 million barrels per day in FY 1988, declining to 0.532 million bbls per day in FY 2013 (DOR 2013). DOR anticipates volumes will decline by 4.5% in FY 2014 to about 0.508 million bbls per day, declining further to 0.498 million bbls per day in FY 2015. Cook Inlet oil fields produced 0.012 million bbls per day in FY 2013 and have an FY 2014 projection of producing 0.014 million bbls per day (DOR 2013).

If a discovery is made, this project will contribute to state revenues. The level of that contribution is unknown, dynamic, and will depend on many factors. In comparison to the state's total revenue from oil and gas activities, revenue from this exploration license is expected to be small. However, even relatively small discoveries can contribute to the energy needs of a village or community, and could relieve the state of providing energy subsidies to some extent.

The exploration license may provide other long-term contributions to the state's fiscal wellbeing. Exploration licensing supplements the state's long-standing conventional oil and gas leasing program for areas such as the North Slope and Cook Inlet, by targeting areas outside known oil and gas provinces. The intent of licensing is to encourage exploration in areas far from existing infrastructure, with relatively low or unknown hydrocarbon potential, where there is a higher investment risk to the operator. Through exploration licensing, the state receives valuable subsurface geologic information on these regions regardless of whether revenue is ever generated. Further, because the upfront capital for obtaining an exploration license is generally less than for obtaining leases, new, smaller companies may be encouraged to begin operating in Alaska. And, even relatively small successes can spur additional activity and investment in exploring and developing Alaska's oil and gas resources.

2. Local Effects

Most of the communities discussed in Chapter Three are in an unincorporated area of the state, and none are individually incorporated as municipalities under state law. Unlike incorporated municipalities such as the North Slope and Cook Inlet, royalties, rents, license fees, and other revenues generated by licensing or oil or gas production in the unincorporated portion of the license area will not directly return to the area unless a municipal government entity is established in the unincorporated area. If incorporated, the revenues from oil or gas production could fund education, health, and public safety programs, and transportation system improvements throughout the license area. Additionally, local incorporated municipalities may generate significant revenue through property taxes on infrastructure required for oil and gas development and production.

Relative to other fiscal effects, economic activity associated with oil and oil or gas exploration, development, and production may increase other economic activity in the license area, but benefits to the economies of the local communities may be smaller than for the larger state economy. In rural Alaska communities, where there are typically smaller economies, the multiplier is 1.3. The economic multiplier associated with dollars injected into a community depends upon the size of the local market. A small market means the multiplier is small and most of the money that comes into the community leaves almost immediately in the purchase of goods and services somewhere outside the community (Colt et al. 2003). Population and employment changes in any of the communities might occur depending on the amount of exploration activity and the size of an oil or gas discovery.

J. Effects on Communities

The following sections describe the potential effects of activities associated with oil and gas exploration, development, production, and transportation on employment, population, income, utilities, and other resources in the communities of the area.

1. Employment

Oil and gas jobs already in the area include maintenance, inspection, and other activities related to oil and gas exploration and production in Cook Inlet. Residents of the license area would likely benefit from the development of oil or gas resources in the area through increased job opportunities in the oil and gas industry. Other employment directly related to the oil and gas industry could include environmental and wildlife studies, planning and design activities, materials acquisition, facility construction, seismic surveys, drilling, transportation, and logistics.

The exploration license may create additional employment opportunities in the 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 in the vicinity of the license area will depend on the subsequent production of commercial quantities of oil or gas.

The local labor force 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, the licensee and its contractors are encouraged to hire local and Alaska residents to the extent they are qualified and available.

2. Access and Land Use

Communities and surface estate owners in the area adjacent to exploration activities could be affected. For example, use of transportation systems could increase, such as air charter services, airstrips, or roads, for transportation of personnel or construction equipment. Roads could be constructed to provide access to more remote areas. Other effects include disturbance due to increased air traffic, machinery noise, and loss of privacy due to the presence of project workers. The extent of these effects depends on the size of exploration projects and the proximity of facilities, and utility, pipeline, and transportation corridors to the affected community.

Some portions of the area could be developed from existing roads or access routes; however, much of the acreage is remote from existing infrastructure. Some use of existing roads and trails may occur during exploration license activities. It is likely that an increase in vessel traffic and mooring activity as a result of any exploration work in the license area could have an effect on the economy and dock availability in Homer or Nikiski as they are the closest deep water ports that provide harbor and service to the oil and gas industry (Klouda 2012; Armstrong 2013; Homer 2013).

3. Mitigation Measures and Other Regulatory Protections

Although oil and gas activities could potentially have effects on local communities, mitigation measures in this written finding, along with regulations imposed by other state, federal and local agencies, are expected to mitigate those potentially negative effects. Positive effects are expected on local governments and economies, employment, personal income, reasonable energy costs, and opportunities for industrial development. A complete listing of mitigation measures is found in Chapter Nine.

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