4.0 ENVIRONMENTAL ANALYSIS

4.6 WILDLIFE RESOURCES

4.6.1 Terrestrial Wildlife

The Project would cross three general habitat types for terrestrial wildlife: arctic tundra, boreal forest, and transition forest. Some specialized habitats that influence species diversity and life histories are interspersed within these larger habitat types, including lakes, rivers, and wetlands. Rivers and lakes serve as travel corridors, provide habitat for fish and birds, and create unique riparian habitats for terrestrial wildlife. Wetland habitats in Alaska are complex and support a diversity of plant and animal species. Water resources and wetlands are discussed in sections 4.3 and 4.4, respectively.

More than 40 terrestrial large and small mammal species (including furbearers) are found in the habitats within the Project area. Large mammals known to inhabit the Project area include moose, bear, caribou, Dall sheep, muskoxen, gray wolf, and wolverine. Mammals classified as furbearers, such as American marten, American mink, fox, Canadian lynx, gray wolf, least weasel, otter, and wolverine, are also known to occur. Other small mammals, such as the North American porcupine, pika, voles, lemmings, and mice, are also found in the Project area. Three species, Alaska marmot, American water shrew, and little brown myotis, are classified as sensitive by the AKNHP. Only one amphibian, the wood frog, is known to occur in the Project area.

Table 4.6.1-1 describes the terrestrial habitat types, ecoregions and subregions, and representative species known to occur in the Project area. The presence and distribution of terrestrial species in these habitats were derived from publicly available information prepared by the ADF&G, including maps, historical data, and past field surveys; consultations with wildlife resource agencies; and information gathered during traditional knowledge workshops.

4.6.1.1 Sensitive Wildlife Habitat

Sensitive wildlife habitats are those that generally support unique or rare wildlife species, or are other areas identified by state and federal resource agencies. Examples include NWRs, ACECs, national and state parks, and SGRs. The wildlife populations found in these areas are described below. Additional details on the areas themselves, including a map showing the areas relative to Project facilities, are provided in section 4.9. For Project activities occurring in these areas, AGDC has stated that construction would be planned in consultation with resource managers to mitigate impacts.

Federal Resources

The Project would pass near the three NWRs and two NPPs described below. The Project would also cross the BLM-managed Galbraith Lake ACEC and Toolik Lake RNA and ACEC, which provide important Dall sheep habitat (see section 4.6.1.3).

TABLE 4.6.1-1

General Terrestrial Habitat and Representative Terrestrial Species Occurring in the Project Area

Habitat Type/ Subregion [a]	Project Facilities: Gas Treatment Facilities	Project Facilities: Mainline Facilities	Project Facilities: Liquefaction Facilities	Habitat Characteristics	Representative Terrestrial Species [b]
Arctic Tundra					
Beaufort Coastal Plain	X	X	–	Tundra is characterized as being a treeless ecosystem, with long, cold winters and short chilly summers. Tundra has consistently low temperatures that limit plant growth and encourage the creation of permafrost. Lakes, wetlands, rivers, and permafrost-related features such as pingos, ice-wedge polygon networks, peat ridges, and frost boils all occur in tundra. Further from the coast, tundra includes long linear ridges, buttes, and mesas as well as alluvial valleys and glacial moraines.	**Large mammals**: brown bear (*Ursus arctos*), caribou (*Rangifer tarandus),* muskoxen (*Ovibose moschatus*) **Furbearers**: Alaska marmot (*Marmota broweri*), American beaver (*Castor canadensis*), American marten (*Martes americana*), American mink (*Neovision vison*), arctic fox (*Vulpes lagopus*), arctic ground squirrel (*Spermophilus parryii*), Canadian lynx (*Lynx canadensis*), coyote (*Canis latrans*), ermine (*Mustela ermine*), gray wolf (*Canis lupus*), hoary marmot (*Marmota caligata*), least weasel (*Mustela nivalis*), North American river otter (*Lontra canadensis*), red fox (*Vulpes vulpes*), snowshoe hare (*Lepus americanus*), wolverine (*Gulo gulo*) **Other small mammals**: barren ground shrew (*Sorex ugyunak*), brown lemming (*Lemmus trimucronatus*), cinereus shrew (*Sorex cinereus*), collared lemming (*Dicrostonyx groenlandicus*), collared pika (*Ochotona collaris*), common muskrat (*Ondatra zibethicus*), dusky shrew (*Sorex monticolus*), meadow vole (*Microtus pennsylvanicus*), North American porcupine (*Erethizon dorsatum*), northern bog lemming (*Synaptomys borealis*), northern red-backed vole (*Myodes rutilus*), root vole (*Microtus oeconomus*), singing vole (*Microtus miurus*), tundra shrew (*Sorex tundrensis*) **Amphibians**: wood frog (*Lithobates sylvaticus*)
Brooks Foothills	–	X	–		
Brooks Range	–	X	–		
Boreal Forest					
Kobuk Ridges and Valleys	–	X	–	Boreal forests consist of diverse forested habitat including a range of vegetation assemblages, such as quaking aspen groves and spruce bogs. Boreal forest diversity depends on conditions created by cold weather, long winters, forest fires, and permafrost. Permafrost occurs in higher latitudes and uplands; lower elevation continental areas have long, very cold winters and dry, very warm summers. Specialized habitats are intermingled amongst the forest including meadows, marshes, lakes, and rivers, allowing boreal forests to support a wide variety of plants and wildlife.	**Large mammals**: black bear (*Ursus americanus*), brown bear, caribou, Dall sheep (*Ovis dali dali*), moose (*Alces alces*) **Furbearers**: Alaska marmot, American beaver, American marten, American mink, arctic ground squirrel, Canadian Lynx, coyote, ermine, gray wolf, hoary marmot, least weasel, North American river otter, northern flying squirrel (*Glaucomys sabrinus*), red fox, red squirrel (*Tamiasciurus hudsonicus*), snowshoe hare, wolverine, woodchuck (*Marmota monax*) **Other small mammals**: brown lemming, cinereus shrew, collared pika, common muskrat, dusky shrew, little brown myotis (*Myotis lucifugus*), meadow jumping mouse (*Zapus hudsonius*), meadow vole, North American porcupine, northern bog lemming, northern red-backed vole, pygmy shrew (*Sorex hoyi*), root vole, singing vole, taiga vole (*Microtus xanthognathus*), tundra shrew **Amphibians**: wood frog
Ray Mountains	–	X	–		
Tanana-Kuskokwim Lowlands	–	X	–		
Yukon-Tanana Uplands	–	X	–		
Alaska Range		X	–		

TABLE 4.6.1-1 (cont'd)

General Terrestrial Habitat and Representative Terrestrial Species Occurring in the Project Area

Habitat Type/ Subregion [a]	Project Facilities: Gas Treatment Facilities	Project Facilities: Mainline Facilities	Project Facilities: Liquefaction Facilities	Habitat Characteristics	Representative Terrestrial Species [b]
Transition Forest					
Cook Inlet Basin	–	X	X	Transition forests of the Cook Inlet Basin contain gently sloping lowlands with several large rivers including the Susitna, Kenai, and Matanuska. Spruce and hardwood forests dominate. Climate is variable, supporting sporadic permafrost and diverse vegetation. In the Alaska Range, glaciers and rocky mountaintops are found above the tree line. The Cook Inlet Basin is typically free of permafrost and has rich, wet, organic soils that give rise to black spruce forests and woodlands. Specialized features include numerous lakes, ponds, and wetlands.	**Large mammals**: black bear, brown bear, caribou, Dall sheep, moose **Furbearers**: American beaver, American marten, American mink, arctic ground squirrel, Canadian lynx, coyote, ermine, gray wolf, hoary marmot, least weasel, North American river otter, northern flying squirrel, red fox, red squirrel, snowshoe hare, wolverine, woodchuck **Other small mammals**: American water shrew (*Sorex palustris*), brown lemming, cinereus shrew, collared pika, common muskrat, dusky shrew, little brown myotis, meadow jumping mouse, meadow vole, North American porcupine, northern bog lemming, northern red-backed vole, pygmy shrew, root vole, singing vole, taiga vole, tundra shrew **Amphibians**: wood frog

"–" = Facilities do not occur in these habitats.

[a] Subregions associated with the Project are identified in section 4.0 (see table 4-1 and figure 4-1). Vegetation within these areas is described in section 4.5.

[b] Species listed may occur in other areas associated with the Project. Additionally, this table does not include a comprehensive list of all species that may occur within each subregions. Avian species are discussed in section 4.6.2.

Arctic National Wildlife Refuge

The ANWR provides important habitat for polar bear, caribou, breeding waterbirds, and shorebirds; year-round habitat for Dall sheep; and hunting grounds for gray wolves and ermine. Additionally, it is one of two refuges within the NWR System that is home to all species of North American bears (black, brown, and polar) (USFWS, 2018a). The refuge also provides important year-round habitat for American beaver, American marten, American mink, arctic fox, Canadian lynx, common muskrat, moose, muskoxen, North American river otter, North American porcupine, red fox, and wolverine. The ANWR is about 0.3 mile east of the Mainline Pipeline at its closest points near MPs 144 and 146. The PTU and start of the PTTL are about 6 miles west of ANWR.

Gates of the Arctic National Park and Preserve

The Gates of the Arctic NPP supports major parts of the range and habitat of the Western Arctic Caribou Herd. Many other species also occur within the NPP, including American beaver, bald eagle, black bear, brown bear, Canadian lynx, common muskrat, coyote, Dall sheep, fox, golden eagle, gray wolf, great horned owl, hoary marmot, moose, muskoxen, North American river otter, northern hawk-owl, osprey, peregrine falcon, polar bear, and snowshoe hare. The Gates of the Arctic NPP is about 1.1 miles northwest of the Mainline Pipeline near MP 188.

Yukon Flats National Wildlife Refuge

Yukon Flats NWR provides essential breeding habitat for waterfowl. Moose, caribou, and Dall sheep are found throughout the refuge, and furbearers are abundant, including American beaver, fox, Canadian lynx, American marten, common muskrat, North American river otter, least weasel, and wolverine (USFWS, 2018b). The Yukon Flats NWR is about 1.8 miles northeast of the Mainline Pipeline near MP 364.

Denali National Park and Preserve

The DNPP is home to diverse wildlife, including 39 species of mammals and wood frog (NPS, 2018a). The DNPP is less than 0.1 mile west of the Mainline Pipeline near MP 536 (across the Nenana River).

Kenai National Wildlife Refuge

Kenai NWR encompasses diverse habitats and wildlife on the Kenai Peninsula. The refuge is about 3 miles southeast of the Mainline Pipeline near MP 785 and about 6 miles east of the Liquefaction Facilities.

State Resources

The Mainline Facilities would cross the two Alaska SGRs and one state park described below. The closest Alaska state critical habitat area (CHA), Redoubt Bay CHA, is over 12 miles away from the Liquefaction Facilities and the Mainline Pipeline at MP 806.6.

Minto Flats State Game Refuge

The Minto Flats SGR is a large wetland complex that drains to the south/southwest into the Tanana River. Minto Flats provides habitat for a variety of terrestrial species, including moose and black bear. Furbearers are present in the flats, including American beaver, American mink, Canadian lynx, common muskrat, North American river otter, red fox, and wolverine. American marten, which prefers drier land, is also common on the flats (ADF&G, 2018d). Brown bear occur here as well, but infrequently

(ADF&G, 1992). Minto Flats is considered an important calving area for moose from mid-May to early June and provides good foraging habitat for moose year-round (ADF&G, 1992).

Project facilities within the refuge would include the Mainline Pipeline between about MPs 430.9 and 468.6 (including MLV 13 and associated helipad), access roads, material sites, and disposal sites (see appendix C). The Mainline Facilities would affect about 632 acres of the SGR, of which about 350 acres are wetland habitats. This constitutes less than 1 percent of the total SGR acreage.

Susitna Flats State Game Refuge

Susitna Flats SGR provides habitat for a variety of terrestrial wildlife. Moose calve in the brushy thickets each spring, and in the winter, moose from surrounding upland areas travel to the refuge to find food. Alaska's highest density of moose occurs in the Susitna River valley (ADF&G, 1988). The refuge provides important cover and foraging habitat for moose. In the spring, both brown and black bears use the refuge for feeding near salt marshes and sedge meadows (ADF&G, 2018d). Trapping is a popular activity on the refuge, where furbearers such as American beaver, American marten, American mink, common muskrat, ermine, North American river otter, and snowshoe hare are all commonly found (ADF&G, 1988). Canadian lynx, coyote, Gray wolf, red fox, and wolverine are known to occur in the refuge (ADF&G, 2018d; ADF&G, 1988), as well as wood frog (Ritchie et al., 1981, as cited in ADF&G, 1988). Wood frog and many of the furbearers and predators use the abundant freshwater habitats of the refuge: ponds, lakes, riparian areas, river shorelines, and other wetland areas.

The Theodore River Heater Station and construction camp and seven segments of the Mainline Pipeline between MPs 737.3 and 752.4 would be within the Susitna Flats SGR. Other Project facilities within the refuge would include the Sleeping Lady construction camp and pipe storage yard, access roads, disposal sites, and material sites (see appendix C). The Mainline Facilities would affect about 118 acres in the Susitna Flats SGR (less than 1 percent of the total SGR acreage).

Denali State Park

Denali State Park provides 325,240 acres of habitat for 39 species of mammals, 165 species of bird, 1 amphibian, and 15 species of fish (NPS, 2018b). Moose, Dall sheep, brown bears, and black bears are commonly seen in the park. Black bear is the only large mammal species that is more common in lowland areas within the park than in higher elevations (NPS, 2018b). Dall sheep is the more common species in the subalpine zone, while brown bear, caribou, collared pika, gray wolf, and hoary marmot also use the subalpine zone (NPS, 2018b). Other park residents include American marten, American mink, Canadian lynx, coyote, North American river otter, red fox, snowshoe hare, wolverine, and squirrel, vole, and shrew species (ADNR, 2018b). The Mainline Facilities would cross through Denali State Park between MPs 609.1 and 646.9, generally within 0.5 mile of the Parks Highway National Scenic Byway. This includes MLV 21 and associated helipad. Other Project facilities within Denali State Park would include access roads, material sites, disposal sites, and the Horseshoe Pipe Storage Yard (see appendix C). A total of 459 acres would be affected by the Project in Denali State Park (less than 1 percent of the park's total area).

4.6.1.2 General Impacts and Mitigation

Constructing and operating the Project would result in temporary and permanent impacts on terrestrial wildlife and associated habitat. Habitats would be modified, fragmented, and lost. Wildlife behaviors and movements would be affected, and as a result, wildlife would experience increased rates of stress, injury, and mortality. General impacts common to all wildlife species are discussed in the following sections. Impacts specific to moose, bear, caribou, Dall sheep, muskoxen, gray wolf, wolverine, and wood frog are discussed in section 4.6.1.3.

Habitat and Wildlife Impacts

Project construction and operation would result in the loss and alteration of terrestrial habitats. Some of these habitats would also be fragmented and experience edge effects. Construction and operation would affect arctic tundra, boreal forest, and transition forest, as well as the smaller habitat types that occur within them, such as wetlands, riparian areas, meadows, bogs, and scree slopes. As shown in table 4.6.1-2, the Project would affect about 26,217 acres of terrestrial wildlife habitat. Wetland, riverine, and lake habitats would also be affected throughout the Project area, as discussed in sections 4.4 and 4.3.2, respectively.

TABLE 4.6.1-2

Habitat Types Affected by Project Activities (by Subregion) [a]

Subregions by Habitat	Affected Area (acres)
Arctic Tundra	
Beaufort Coastal Plain	3,649
Brooks Foothills	2,021
Brooks Range	3,012
Arctic Tundra Total	**8,682**
Boreal Forest	
Kobuk Ridges and Valleys	98
Ray Mountains	5,386
Yukon-Tanana Uplands	1,048
Tanana-Kuskokwim Lowlands	2,119
Alaska Range	3,180
Boreal Forest Total	**12,831**
Transition Forest	
Cook Inlet Basin	5,704
Transition Forest Total	**5,704**
Total	**26,217**

Source: Affected acreages are based on Project vegetation mapping supplemented by the *Vegetation Map for Northern, Western, and Interior Alaska* (ACCS, 2017c).

[a] Includes terrestrial habitat only. Does not include impacts from the PTTL and Mainline ice roads, GTP ice pads, MLVs, pioneer camp, compressor station camps, or meter stations. Does not include reported impacts in either a waterbody (e.g., right-of-way across Cook Inlet) or on barren land. Impacts on water and wetland resources are described in further detail in sections 4.3 and 4.4, respectively.

Construction of the numerous aboveground facilities (including most new access roads) would result in the permanent loss of wildlife habitat. The lighting and noise associated with construction and operation of these facilities would also affect adjacent habitats, as discussed in more detail below. Mainline Pipeline construction and operation would result in the permanent loss and conversion of habitat. Habitats affected by the construction and operation of the Mainline Pipeline and associated facilities would also experience temporary and long-term impacts, including impacts from light and noise.

The Gas Treatment Facilities would be in the PBU where other industrial activities are occurring. Large mammals on the North Slope in or near the PBU include arctic fox, brown bear, caribou, and polar bear (impacts on polar bear are discussed in detail in section 4.8). The permanent loss of habitat associated with the GTP and operations pad would be minor as the overall area is used for industrial activity. The PTTL, PBTL, and GTP support pipelines would be constructed aboveground on VSMs.

Construction of the Liquefaction Facilities would affect about 700 acres of land. Once constructed, the Liquefaction Facilities would be industrial facilities with little or no wildlife habitat. Large mammals that occur on the Kenai Peninsula near the site of the proposed Liquefaction Facilities include black bear, caribou, gray wolf, and moose. The permanent loss of habitat would be a minor impact since the general area is used for industrial activity, the habitat loss would be restricted to a small area, and a small proportion of the animals on the Kenai Peninsula would be affected given the relative high density of these animals in the region.

Placement of granular fill to support construction of the Mainline Pipeline would result in the permanent loss and conversion of habitats by changing the vegetation composition and disrupting associated hydrological characteristics. Changing these habitat components would reduce habitat suitability for some species of terrestrial wildlife.

In general, wildlife would avoid the disturbance caused by construction activities. Wildlife avoiding these activities would be displaced to adjacent habitat, which could strain resources and resident wildlife and increase rates of competition and predation. Additionally, avoidance and displacement would increase rates of wildlife stress, injury, and mortality.

Temporary or intermittent activities would affect wildlife differently according to the season in which the activities occur. Terrestrial wildlife species active during specific construction seasons would be displaced from seasonal habitats, such as winter, breeding, or foraging habitats, and experience increased vulnerability to predation. Winter construction, for example, would affect hibernating animals, which could be injured or killed if nests or burrows are destroyed or individuals are inadvertently struck by construction equipment. Smaller species including shrews, voles, ground squirrels, and mice would be most vulnerable, although construction equipment could uncover denning bears. Additional species-specific impacts on wildlife during sensitive periods are discussed in section 4.6.1.3.

Although the amount of habitat loss resulting from the Project would be minimal compared to the vast amount of surrounding available wildlife habitat, the Project could cause changes in migration patterns or in the seasonal use of habitat. Constructing the Project would result in some habitat fragmentation, which is the splitting of large continuous blocks of habitat into smaller areas, resulting in smaller habitats, isolated habitats, and, depending on the species, decreased or increased habitat suitability. Habitat would not be fragmented where the Project would be parallel to an existing developed corridor, though forested habitat would be changed to edge habitat in these and other areas.

As discussed in section 4.5.3, the Mainline Pipeline parallels existing corridors for most of its length. As a result, the fragmentation of large continuous forested areas would generally not occur. Forest fragmentation from Mainline Pipeline and access road construction would have a greater impact in areas where forest stands are naturally small, such as the forest-wetland complexes between MPs 677 and 693. Declines in biodiversity for interior forest species have been observed in forest stands of less than 124 acres (Drinnan, 2005), which would occur in this area. Fragmentation could also occur in the southern portion of the Project area, but the impact would be minor because these forests have previously been affected by human development around Cook Inlet.

Potential habitat suitability changes created by pipeline and access road construction and operation due to habitat fragmentation would include:

- a reduction in patch size of available land for foraging, cover, breeding, and prey availability, and isolation of these habitats;

- the creation of edge effects;
- a change in location of barriers to movement;
- the intrusion of invasive plants, animals, and parasites;
- the facilitation of predator movements, such as gray wolves and coyotes; and
- a decrease in species abundance near infrastructure.

These habitat changes would affect wildlife species differently, as some species, such as moose, gray wolves, and some rodents, thrive by hunting or foraging in edge habitat, while others require continuous habitat. New vegetative growth within the right-of-way could serve as a distraction to normal migration patterns by providing forage for moose and other grazers if inedible invasive species do not take over the area. Habitat fragmentation can affect dispersal of small mammals, which may not traverse open areas to avoid predation. Although wolves often avoid human development, they may be attracted to roads with little traffic if increased prey or carcasses occur there. After construction, the Mainline Pipeline could be used as a travel corridor by wildlife.

Fragmentation and edge effects would be greater in forested habitats in the areas noted above. Permanent changes in arctic tundra habitat such as vegetation impacts or granular fill left in place would also contribute to habitat fragmentation.

Pipeline Trenching

Burial of the Mainline Pipeline, as well as elevation of the PTTL and PBTL, would facilitate animal movement across the right-of-way during operation. During Mainline Pipeline construction, however, trenching could temporarily block animal movement across the right-of-way. Mainline Pipeline trenching would have the potential to disrupt activities of large mammals in important seasonal habitats, including seasonal movements, depending on location and timing. For example, during the breeding season, wildlife could exhibit reduced reproduction due to migration pattern changes disrupting their reproductive seasons. Wildlife could also change their migration patterns if open trenches interfere with movements, restricting the wildlife from important habitat such as insect relief areas. General animal movements could be affected, exposing the animals to predation or other dangers.

AGDC, in coordination with the ADF&G and USFWS, would develop procedures to facilitate terrestrial wildlife movement to minimize the disruption of migration patterns through the Project area. Where practicable, AGDC would schedule trenching to avoid sensitive periods for wildlife, but this would not be possible in all cases. AGDC has agreed to implement the following measures:

- minimize the length of trench left "open" for long periods of time;
- install trench crossing areas using construction safety fencing in known migration and feeding areas; and
- provide trench escape ramps, especially in areas of known migration corridors.

In accordance with the Project Plan, AGDC would develop specific procedures in coordination with the appropriate agencies and landowners, as necessary, to allow for wildlife movement and protection during construction.

The 1.0-mile-long PBTL and 62.5-mile-long PTTL would be installed aboveground at about 7 feet above grade, which would provide room for animals to pass under the structure and maintain access to existing habitat, although caribou (particularly those harassed by mosquitoes) do not readily cross beneath elevated pipelines (Smith and Cameron, 1985). The PBTL would avoid additional interruption or impediment to wildlife movement because it would be collocated with existing pipelines for most of its length.

Noise

Construction and operational activities would generate noise that could affect terrestrial wildlife species. Sound impacts would be both temporary during construction and long term for the life of the Project. Noise sources would include:

- single impulse sounds (e.g., blasting);
- multiple impulse sounds (e.g., jackhammers and pile driving at the Liquefaction Facilities);
- non-strike continuous noise (e.g., construction sounds, vehicular traffic, and operating equipment); and
- operational activities at all Project facilities.

Potential impacts on terrestrial wildlife from noise would include:

- hearing damage and mortality;
- temporary or permanent displacement of wildlife;
- disruption of reproduction and hibernation;
- changes in temporal patterns; and
- increased predation.

Terrestrial wildlife species differ in their sensitivity to sounds by species and life history stage. Terrestrial wildlife could suffer temporary or permanent hearing loss due to exposure to loud sound pressure levels, but most terrestrial wildlife species would be capable of avoiding construction sounds that could be physically damaging. Some wildlife life stages, such as the very young, would be less mobile and incapable or less capable of avoiding sounds and therefore the most vulnerable. The majority of impacts on wildlife from construction noise would be behavioral, such as effects on where or when animals eat or sleep. Francis and Barber (2013) grouped these behavioral responses into four categories:

- changes in temporal patterns;
- alterations in spatial distributions or movements;
- decreases in foraging and increases in anti-predator behavior; and
- changes in mate attraction and territorial density.

Behavioral and physiological reactions of animals have been documented to known noise levels ranging between 75 and 105 decibels (dB). This includes ungulates becoming nervous, running (at 82 to 95 dB), or panicking (at 95 to 105 dB). Impulse construction sounds that could reach levels of 106 to 113 dB root mean square (dB_{rms}) at a distance of 33 feet, such as impact pile driving at aboveground facilities and the LNG Plant, would be likely to initially trigger a panic or startle response in nearby terrestrial wildlife. Terrestrial wildlife could perceive loud, intermittent, and unpredictable noise as a threat, which could cause species to avoid construction areas and become displaced. Breeding animals could be affected by impulse noises through lost or reduced reproductive success. Impulse construction sounds would be a temporary and localized construction activity, and impacts due to displacement and disturbance would be temporary.

Baseline or ambient noise levels along the Mainline Pipeline have been measured at 41 to 64 A-weighted dB (dBA); therefore, the baseline noise level is assumed conservatively to be about 40 dBA. The measured baseline at the GTP was 65.7 dBA. Frequent, moderate, and predictable construction and operational noise above these baseline levels would likely interfere with a species' ability to detect other sounds, thereby increasing predation and decreasing mating success for some species. For many species, breeding success relies on successful calling leading up to mating. Noise can also result in a physiological stress response in animals that is energetically costly and could cause wildlife to avoid areas, thereby changing their use of habitats such as forage, cover, and breeding areas. Ultimately, noise can negatively affect survival of individuals if the disruption to forage, cover, and movement patterns is long term.

Sounds would be emitted during operation at all aboveground facilities. Sounds generated by equipment at the GTP, Liquefaction Facilities, and Mainline compressor stations and heater station would generally be continuous and could affect survival and productivity of wildlife in the vicinity. For example, at most compressor stations, the distance from the compressor station to the 40-dBA (ambient) sound level is approximately 1,740 to 2,950 feet. The Liquefaction Facilities would be constructed in an industrial area, and wildlife using habitat near the facility would likely be habituated to disturbance. Vegetated buffers would be left in place at the LNG Plant, specifically along the eastern and southern boundaries of the site, to help provide a noise buffer.

Along the Mainline Pipeline, increased ambient sound levels from compressor stations and the heater station during operation could affect large mammal habitats up to about 0.5 mile away, which would degrade habitat quality. Sounds from compressor stations and the heater station would generally be continuous and could affect wildlife by interfering with important survival or reproductive cues, which could result in reduced survival and productivity. Initial modeling results, however, indicate that the stations would only result in a minor increase in sound levels during operation (see section 4.16). Additionally, AGDC would implement the following measures to reduce noise at the compressor stations and heater station:

- bury piping outside the compressor building underground and engineer all aboveground exterior piping to inhibit sound radiation from the piping and pipe support structures;
- install the compressor units in an acoustically designed building;
- install exhaust stack silencers and combustion air intake silencers;
- house the gas turbine drivers in acoustically treated enclosures, install mufflers in the intake and exhaust system, and provide duct lagging (lagging is an acoustic wrap used to reduce noise);
- install exterior acoustical lagging and muffler for steam releases from the heat recovery steam generator;
- install acoustical/thermal equipment insulation for the electric generator and enclose the generator in an acoustically treated equipment shed; and
- install acoustical pipe lagging for the packaged equipment items.

Traffic associated with Project construction and operation could result in intermittent increases in ambient sound. Pipeline construction, monitoring, maintenance, and inspection activities would be conducted using aircraft and/or vehicles. During construction, AGDC would install helipads that would support Mainline Facilities operation. Pipeline and MLV inspections would likely be conducted by helicopter, with helicopters landing and departing from helipads at the MLVs, compressor stations, and heater station. Traffic associated with travel to Mainline compressor stations or the heater station would primarily be by ground.

Potential operational impacts on wildlife from these activities would include infrequent noise disturbance due to aircraft takeoff, landing, and overflight patterns, and/or vehicle operation. Vehicle noise could cause temporary displacement from sensitive habitats and/or distraction during sensitive periods, such as breeding and migration, which could lead to increased predation risk. Large mammals in some areas could be habituated to human disturbance from hunting and other activities; these mammals might not change their behavior due to construction or operational aircraft or vehicle use. Impacts would be greater in more remote areas with little human activity.

During operation, with recommended noise abatement included in the facility design (see section 4.16.4), the LNG Plant would generate day–night sound levels that would reach about 58 dBA within 0.5 mile and 52 dBA within 1.0 mile. These levels would be near the high ambient level recorded near the site. In AGDC's *Baseline Noise Level Report*, specific noise level measures are provided; these are included in section 4.16.

Blasting

Blasting would be a temporary and localized construction activity, so impacts due to avoidance and displacement would be short term. Blasting during construction has the potential to affect terrestrial wildlife through ground vibration, direct mortality, and creation of flyrock and/or dust. Wildlife occurring in close proximity to blasting could experience injury through concussion. Additionally, blasting would increase rates of avoidance and displacement. The blasting radius would vary greatly for each site based on site conditions, degree of blast confinement, explosive type used, and delays between blasts. The right-of-way would be cleared prior to blasting, so minimal habitat would be present in the immediate area for many species, but effects would also be experienced outside the cleared right-of-way.

To clear areas of wildlife prior to blasting, AGDC would implement non-lethal hazing techniques identified in their ADF&G hazing permits. Hazing techniques could include the use of movement, noisemakers, pyrotechnics, small explosives, or vehicular presence. Given the Project's scale, however, some direct mortality of small terrestrial wildlife species would likely occur. To reduce general blasting impacts, AGDC would implement measures described in the Project Blasting Plan (see section 4.1).

Lighting

Artificial lighting, including equipment lighting, floodlights, aboveground facility lighting, tower or antenna lighting, and lighting on docks or anchored marine barges and vessels, would temporarily and permanently affect terrestrial wildlife behavior and habitat use. Facility lighting would consist of normal and essential lighting panels and lighting fixtures to provide lighting for working areas and for security requirements. In addition to avoidance and displacement, artificial lighting could increase the rate of wildlife predation. These effects would be greatest in areas where construction would occur 24 hours per day and when ambient daylight is limited. During operation, the aboveground facilities would require year-round lighting. Terrestrial wildlife would be anticipated to be susceptible to impacts from lighting during months when little to no daylight is present on the North Slope and on overcast days. Conversely, lighting during summer months could be less of an issue to terrestrial wildlife since day length is greater than 20 hours along portions of the Project.

AGDC would design facility lighting to direct lighting only in places where it is necessary. The light would be designed and shielded where applicable to reduce light trespass, unwanted projection, and upward directed light, which would reduce the effects of light on terrestrial wildlife. Additional information on the lighting requirements and measures to reduce impacts associated with lighting, including our recommendation for lighting at the Healy Compressor Station, is provided in section 4.10.2.

Collisions

Increased vehicular and rail traffic during construction and operation would increase the potential for collisions with terrestrial wildlife species. AGDC would use 625 gravel access roads totaling approximately 269 miles. Estimated numbers of truck and rail loads expected to be required for constructing the Project are provided in section 4.12. All traffic use on new Project roads would be a new impact, as would the increased traffic on existing roads. Since new roads would only be returned to their pre-construction condition if requested by the landowner or land management agency as a part of land lease agreements, all temporary roads are considered to be permanent for the purposes of this EIS. An analysis of the potential future increase in daily vehicular traffic on Alaska highways due to Project construction based on these estimated trucking requirements is provided in section 4.12.2. The analysis indicates that Project construction could increase vehicular traffic on Alaska highways by no more than 3 percent.

An increase in traffic would result in some increase in collisions and wildlife mortalities, but all such effects would be temporary, lasting only as long as construction activities are ongoing, and minor when compared to current traffic levels on public roads and wildlife populations. The potential for vehicle–wildlife collisions would likely be greater on public roads and highways where vehicles travel at higher rates of speed. Some wildlife species would be more vulnerable than others would to vehicle–wildlife collisions, particularly highly mobile species such as bear, caribou, coyote, fox, moose, muskoxen, North American porcupine, red squirrel, and snowshoe hare. In areas where new roads are constructed, wildlife mortality would be anticipated to be higher during construction due to wildlife not being habituated to roads or vehicles in the area. Collisions on existing roads could increase due to the additional traffic from Project vehicles. Additionally, the increased roadkill from collisions could attract scavenging wildlife, making scavenging animals more susceptible to collisions.

To reduce the potential for vehicle collisions with wildlife, AGDC would implement the following measures:

- maintain or increase roadway visibility through vegetation trimming, where applicable;
- limit travel speeds on Project roads; and
- train construction personnel regarding wildlife hazards while driving.

Overall, impacts on terrestrial wildlife from increased traffic would be directly related to wildlife population levels, which are variable across Project facilities. Wildlife mortality would have a greater impact in areas with smaller populations because a greater percentage of the population would be affected. Further detail about collision risk for large mammals and wood frogs is provided in section 4.6.1.3.

Human Presence

Potential impacts on terrestrial wildlife from human presence and use of the Project facilities could include:

- behavioral changes due to attraction or dispersal from areas with evidence of human presence;
- a decrease in reproduction due to stress;
- increased mortality due to increased hunting and poaching.

Constructing the Project would result in greater human–wildlife interactions. These interactions would increase the rates of stress, injury, and mortality experienced by wildlife and could lead to wildlife attacks. As described previously, wildlife would likely avoid the disruption caused by construction and could become used to human presence. Furthermore, wildlife such as bear, fox, coyote, and nuisance wildlife including rats, could be attracted to garbage and unsecured food waste at work camps and other Project areas. Access to human garbage and food waste could also inflate both predator and prey populations, which could have an impact on local wildlife. Landfills and other temporary waste storage areas could expose animals to contaminated media, which could cause mortality or changes in behavior or limit their reproductive success.

Proper camp design, waste management systems, and AGDC's proposed BMPs would reduce potential terrestrial wildlife attraction to the Project area and wildlife access to construction waste. Workers would be trained on good housekeeping practices, including implementation of the Project Waste Management Plan, to reduce the chances for wildlife encounters. Impact minimization measures that would be implemented include minimization of waste generation and proper waste transportation and disposal. These practices would also include reducing scents and securing food and petroleum products that could attract species such as bears.

AGDC would establish closed camps. Personnel would be prohibited from visiting areas outside camps or construction areas during non-work hours. Further, use of buses to and from work sites would reduce the number of vehicles that could potentially interact with wildlife and also further prevent workers from hunting on the Project right-of-way because they could not drive to hunting sites before or after work hours. AGDC would identify and avoid situations where wildlife could be killed in defense of life or property by using environmental monitors who would educate construction personnel on local wildlife, sensitive areas, and potential threats.

While the pioneer and pipeline camps would be temporary and used to support infrastructure development and pipeline construction, the Liquefaction Facilities camp would be in operation during the 7 years of the Liquefaction Facilities construction, and the GTP construction and operations camp would be used for the life of the Project. Therefore, impacts associated with these camps would be long term.

The Project could increase access to hunters and poachers. After construction, public access to permanently maintained lands and access roads would be decided by the landowner; therefore, impacts on wildlife from increased access would vary throughout the Project area. The measures listed below would be required by the state lease for crossings of state lands, which would reduce the potential for human–wildlife interaction and increased hunting and poaching along the right-of-way.

- Project equipment, including transportation, may not be used for hunting, fishing, shooting, or trapping.

- Public access and vehicular traffic on roads that are on state lands and are not managed or owned by the ADOT&PF would be limited to what is required for Project construction and operational activities. Whenever public access needs to be limited, AGDC would be responsible for providing appropriate warning signs and other safety measures for the public, such as blocking entry areas with large boulders, berms, or fencing.

- AGDC would require that workers in remote camps receive wildlife training and would prohibit hunting, trapping, fishing, or traveling outside of camps when the workers are not working.

Effects from increased road access would be most pronounced in portions of the Project route that pass through roadless habitat with very low human population density.

4.6.1.3 Species-Specific Impacts and Mitigation

In the following section, we address the Project's impacts on several species that have been identified by federal and state authorities and the general public as species important to Alaska's ecosystems, as well as important for subsistence and hunting. We also address the only amphibian occurring in the Project area. Recognizing that these species would experience the general impacts described above, the following discussions, as appropriate, elaborate on how these species would specifically be affected by the Project.

Moose

Moose are herbivores, feeding in fall and winter on willow, birch, and quaking aspen twigs and forbs, and in summer on aquatic plants and leaves of birch, willow, maple (*Acer* spp.), and quaking aspen trees. Predators of moose include gray wolves, bears, and humans. ADF&G estimates that between 175,000 to 200,000 moose occur in Alaska, primarily between the Stikine and Colville Rivers. Annually, about 6,000 to 9,000 moose are harvested for food in Alaska. As reported by ADF&G (2018g), 8,853 moose were hunted and killed in 2016 and 7,927 in 2017.

Moose are most abundant along major rivers, on timberline plateaus, and in recently burned areas where dense stands of willow, quaking aspen, and birch shrubs provide leaves for browsing. Moose calve in the spring, with calves weaned in the fall (calves then stay with their mother until the next young are born). Moose congregate near the timberline in late August through November. Breeding occurs in late September and early October. Moose winter range includes active alluvial areas and riparian vegetation, mature forests, and areas cleared by fire or other disturbance. Moose make seasonal movements between calving, rutting, and wintering areas, traveling from a few miles to as many as 60 miles (ADF&G, 2019a).

Moose habitats (rutting, calving, winter, and general) in the Project area are illustrated on figure 4.6.1-1. Locations, estimated population size, general habitat, and crossing locations tracked by game management unit (GMU) are summarized in table 4.6.1-3. GMUs are used by ADF&G to manage certain game species. Because species counts are summarized by GMU, these geographic areas are used in this discussion.

As shown in table 4.6.1-4, Project facilities would cross sensitive moose habitat, including about 98 miles of spring calving habitat, 121 miles of fall rutting habitat, and 244 miles of winter habitat. Additionally, the Gas Treatment Facilities would be constructed in general arctic tundra habitat. Moose habitat would also be affected on the Kenai Peninsula, where Liquefaction Facilities construction would require clearing mixed forest habitat. No moose calving concentrations occur near the proposed Liquefaction Facilities, and the habitats affected on the Kenai Peninsula are not categorized as sensitive.

TABLE 4.6.1-3

Moose Population Estimates and Habitat Crossed by the Project

Habitat Type, Subregion, GMU	Estimated Population Size (by year)	General Description of Habitat in Game Management Units and Moose Populations	Habitat Types Crossed (facility)
Arctic Tundra			
Beaufort Coastal Plain, Brooks Foothills, GMU 26B	109 in 2013; 0.03 moose/mi^2 (Lenart, 2014)	Northern limits of moose range in North America; habitat is limited and concentrates moose into narrow strips of riparian shrub habitats except during calving and summer when some seasonal movements away from riparian corridors occur (Lenart, 2014).	General and wintering habitat (Gas Treatment and Mainline Facilities)
Brooks Foothills, GMU 25A	Current moose abundance is believed to low but unknown (Caikoski, 2014)	Although habitat quality is good, moose density here is among the lowest in interior Alaska (Caikoski, 2014). Populations are likely controlled by wolves and bears.	General habitat (Mainline Facilities)
Boreal Forest			
Ray Mountains, GMU 24A	3,567 in 24A and 24B; 0.9 moose/mi^2 (2012) (Stout, 2014)	Naturally occurring wildfires and floods have a formative impact on habitat in this GMU, which is excellent, providing extensive areas of habitat in all seasons (ADF&G, 2014a).	General and wintering habitat (Mainline Facilities)
Ray Mountains, GMU 25D	2,900 to 4,400; 0.16 to 0.25 moose/mi^2 (2007) (Caikoski, 2014)	Habitat quality is generally good. Density of moose has historically been low, and reproductive rates are high; however, calf mortality from predation is also high (Caikoski, 2014).	General habitat (Mainline Facilities)
Ray Mountains, GMU 20F	1,000 to 2,000; 0.3 to 0.5 moose/mi^2 (population has stayed within this range from 1990 to 2013) (Hollis, 2014)	Much of the habitat is mature black spruce that is poor-quality moose habitat, although many riparian habitats, subalpine hills, and burns contain habitats of sufficient quality to sustain higher densities of moose. Populations have been fluctuating due to predation and habitat limitations. Minto Flats is an important migratory route for male moose that seasonally migrate between mountainous regions and the flats and feeding ground due to the large amounts of available vegetation, including willow and grasses (Braund, 2016).	General and wintering habitat (Mainline Facilities)
Ray Mountains, Tanana-Kuskokwim Lowlands, GMU 20B	14,057; 1.5 moose/mi^2 (2013) (Hollis, 2014)	Migratory and non-migratory populations are distributed throughout this unit. From February to April, some bull and cow moose migrate from the Chena and Salcha River drainages to summer range on the Tanana Flats in GMU 20A (Seaton, 2010).	General, wintering, and calving habitat (Mainline Facilities)
Tanana-Kuskokwim Lowlands, Alaska Range, GMU 20A and 20C	GMU 20A – 10,156; 20 moose/mi^2 (2013). GMU 20C – about 0.6 moose/mi^2 within the DNPP and about 0.3 moose/mi^2 outside the park (1991 and 1994)	As vegetation re-establishes after several large fires that occurred over the past decade, habitat conditions could improve productivity for the GMU 20A moose population, which is considered to be above habitat capacity. Moose populations in GMU 20C are at low densities. Most of the DNPP is within GMU 20C.	General, calving, rut, and wintering habitat (Mainline Facilities)
Boreal and Transition Forest			
Alaska Range and Cook Inlet Basin, GMU 13E	0.9 moose/mi^2 (2009)	Fire suppression since the 1950s has reduced habitat availability for moose in this GMU. Because of the lack of fire-created plant communities, climax upland and riparian habitats are currently the most important for moose in the GMU (ADF&G, 2007).	General, rut, and wintering habitat (Mainline Facilities)
Transition Forest			
Cook Inlet Basin, GMU 16A	2,574 ± 294; 1.9 moose/mi^2 (2009)	GMU 16A is largely road less with limited access. Moose populations have had wide fluctuations due to severe winters and predation.	General and wintering habitat (Mainline Facilities)

TABLE 4.6.1-3 (cont'd)

Moose Population Estimates and Habitat Crossed by the Project

Habitat Type, Subregion, GMU	Estimated Population Size (by year)	General Description of Habitat in Game Management Units and Moose Populations	Habitat Types Crossed (facility)
Cook Inlet Basin, GMU 16B	5,904; 0.9 to 1.4 moose/mi^2 (2010−2014)	Moose were uncommon in GMU 16B until after 1940, when predator control programs allowed populations to expand. This moose population in GMU 16B on the west side of the Susitna River does not appear to have recovered from the severe winter of 1999 to 2000, when deep snow and icing lead to high mortality (Peltier, 2010).	Calving, rut, and wintering habitat (Mainline Facilities)
Cook Inlet Basin, GMU 14A	7,993 ± 1,167 (2011)	Both moose and human population have grown significantly in GMU 14A since the 1930s. Land development is reducing moose habitat in this GMU.	General habitat (Mainline Facilities)
Cook Inlet Basin, GMU 14C	1,965; 1.0 moose/mi^2 (2001)	GMU 14C contains prime browsing habitat in open-canopied, second-growth stands and in greenbelts of more developed areas.	General habitat (Mainline Facilities)
Cook Inlet Basin, GMU 15A	2,554 to 3,855; 1.9 to 2.9 moose/mi^2 (2012)	Populations have been in decline due to collisions with automobiles, predation, and loss of habitat quality after 1969 fires. Mortalities from vehicle collisions were 101 in 2008 to 2009.	General habitat (Mainline and Liquefaction Facilities)

Sources: Braund, 2016; Caikoski, 2014; Herreman, 2014; Hollis, 2014; Lenart, 2014; Peltier, 2010; Peltier, 2014; Peltier, 2017; Seaton, 2010; Selinger, 2010; Sinnott, 2004; Stout, 2014; Tobey and Schwanke, 2010; Young, 2010; Young, 2014

TABLE 4.6.1-4

Sensitive Moose Habitat Crossed by the Mainline Facilities [a]

Sensitive Habitat	Milepost Range		Length Crossed (miles)	Construction Area [c] (acres)	Construction Seasons [b]
	Milepost Start	Milepost End			
Calving – Spring	428.2	747.1	98.0	1,674	Winter and Summer
Rutting – Fall	428.2	742.3	120.7	1,986	Winter and Summer
Winter	64.4	747.1	244.2	3,939	Winter and Summer

Source: ADF&G, 1985, 1986a,b

[a] The Gas Treatment Facilities as well as all 806.6 miles of the Mainline Facilities would be within general year-round habitat.

[b] Start of right-of-way construction season = construction season when right-of-way clearing and preparation activities begin. This could include the installation of work pads, if applicable. Right-of-way construction activities would be continuous through the pipelay season.

[c] Acreages are not additive because habitats overlap.

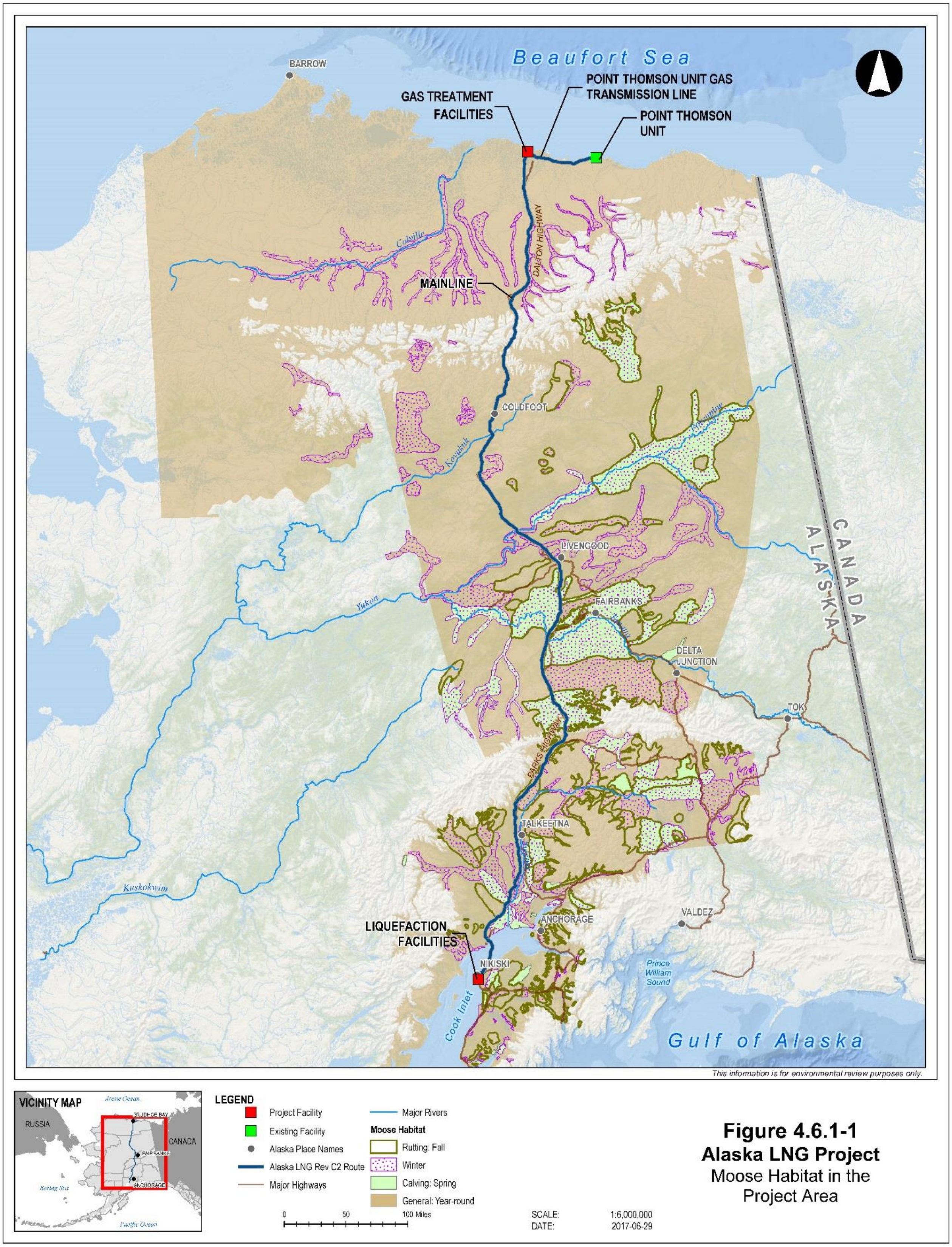
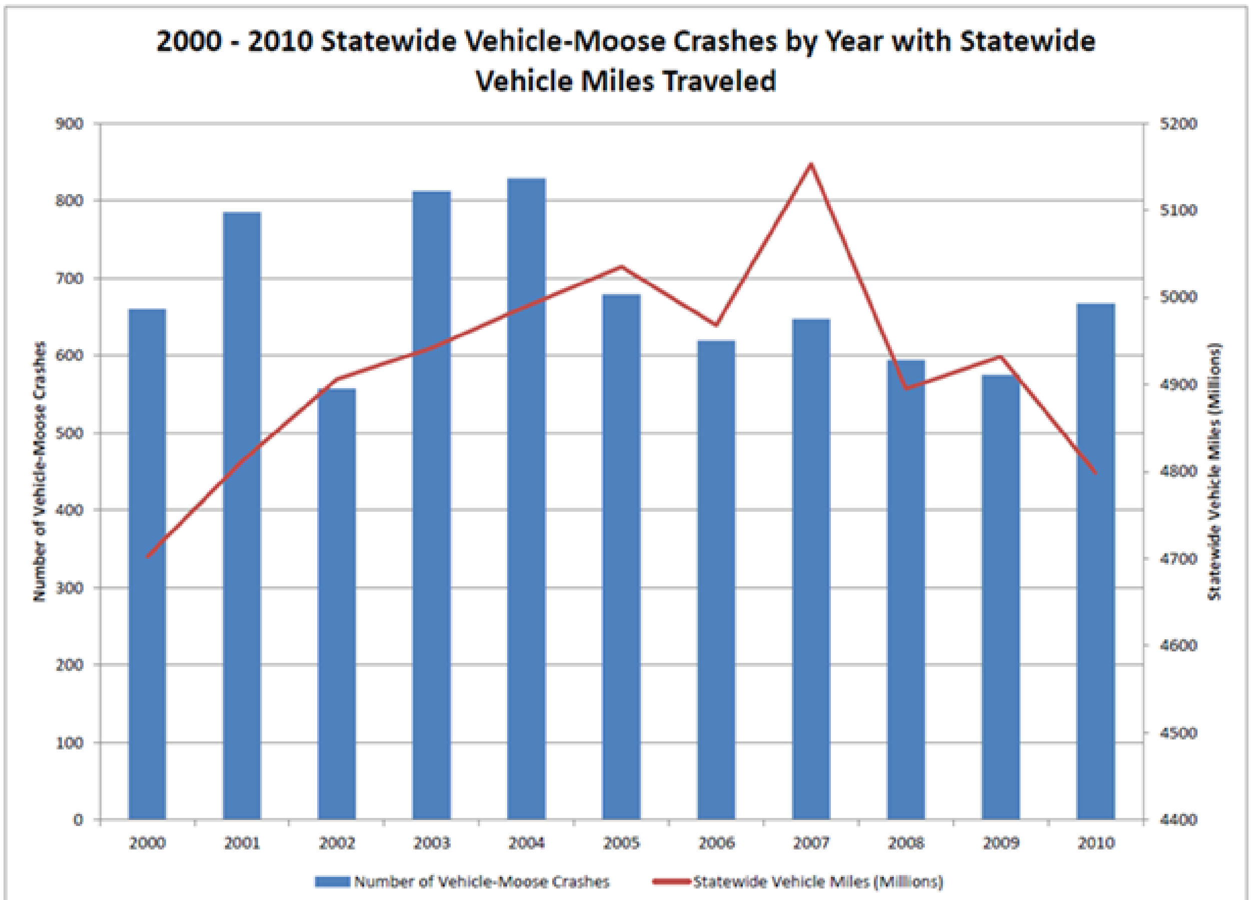


Figure 4.6.1-1
Alaska LNG Project
Moose Habitat in the Project Area

It is expected that a majority of construction activities would occur in winter in areas of spring calving and fall rutting habitat, but some activity would occur during summer. Almost all construction camps would be within 1 mile of moose habitat; four would be within 1 mile of calving or rutting habitat, and eleven would be within 1 mile of winter habitat.

Potential impacts on moose from construction and operation could include increased mortality due to collisions with vehicles and increased hunting pressure from humans and predators, as discussed above for terrestrial wildlife. Additional discussion regarding moose collisions is provided below.

The number of moose–vehicle collisions is related to the amount of vehicular traffic, but the correlation is not that strong and moose populations and snow depth have greater effects on collision numbers. Reported moose–vehicle collisions on Alaska highways ranged from about 550 to 830 collisions per year from 2000 through 2010, with an average of about 680 (ADOT&PF, n.d.) (see figure 4.6.1-2). Winters with especially high snowfall tend to increase vehicle collisions along major roads (Del Frate and Spraker, 1991). Moose–vehicle collisions also increase during fall due to a variety of factors including moose migrations, distraction during rut, and decreasing daylight hours, which reduces a driver's ability to detect and avoid collisions.



Source: ADOT&PF, n.d.

Figure 4.6.1-2. Reported Vehicle−Moose Collisions on Alaska Roads and Highways 2000−2010

Given the average number of moose collisions and the projected increase in traffic due to Project construction, an increase of about 14 moose–vehicle collisions during each year of construction would be expected. This is a conservative estimate because the rates of collisions with moose are typically greater in the winter, and many of the Project construction spreads are summer spreads. Most of the collisions would be expected to result in moose fatalities. Collision mortality is considered one of the leading causes for decline in the moose population on the Kenai Peninsula where the Liquefaction Facilities would be constructed. An average of 250 moose mortalities caused by moose–vehicle collisions occur each year on the Kenai Peninsula (ADF&G, 2018e). Project-related moose–vehicle collisions during operation would be much lower as operational traffic would be much less than during construction. Based on the predicted number of potential moose fatalities relative to the Alaska moose population (greater than 200,000), impacts on moose would be minor.

Moose could be distracted from their normal migration patterns if they encounter new vegetative growth within the right-of-way. The impacts of the potential occurrence of additional moose in the Project area include disruptions to their migration patterns, making them more accessible to hunting and altering their use of habitat because they could be attracted to the forage available in the right-of-way. These impacts would persist for the life of the Project.

Moose using habitats within the vicinity of noise-producing aboveground facilities would experience long-term disturbance as described in the previous section. These impacts specific to moose habitat would extend approximately 0.5 mile from noise-producing Project features, including general habitat surrounding the Theodore River Heater Station and the Galbraith Lake, Coldfoot, Ray River, and Minto Compressor Stations; general and winter habitat surrounding the Sagwon, Rabideux Creek, and Honolulu Compressor Stations; and rutting, calving, winter, and general habitat surrounding the Healy Compressor Station. Impacts on individuals using these habitats would be similar to those described in section 4.6.1.2. The impacts would be experienced for the duration of Project operation, which would limit the ability for animals to use the affected habitats. These areas represent a small portion of available habitats for moose because a 0.5-mile radius around a compressor station would affect about 500 acres, and it is not clear that some increase in noise above ambient would preclude moose from using the habitat. In addition, animals would likely adapt to the constant noise increase or would use other, less disturbed portions of similar habitat.

Based on the above discussion, we conclude that impacts on moose overall due to Project construction and operation would be less than significant.

Bears

Brown bears occur throughout mainland Alaska, with an estimated statewide population of about 30,000 bears. The brown bear population in Alaska is generally considered healthy, with population densities dependent on available habitat. Since grizzly bears are considered a subspecies of brown bears; this section addresses brown and grizzly bears collectively.

Black bears occur over most forested areas of Alaska, with an estimated statewide population of about 100,000. Black bears typically live in forests favoring riverine scrub, lowland broadleaf forest, lowland needle-leaf forest, and upland broadleaf forest, but they will leave forests in search of food. The northern limit of black bears in Alaska is the Brooks Range.

Brown bears consume a wide variety of foods including salmon, berries, grasses, sedges, cow parsnip (*Heracleum* spp.), carrion, and roots. They also prey on moose and caribou, especially newborns, and ground-dwelling rodents. Brown bears are solitary, but congregate at feeding areas such as salmon spawning streams, sedge flats, open garbage dumps, and whale carcasses.

Like brown bears, black bears are opportunistic feeders, eating a variety of vegetation and other animals. Their foraging habits follow a seasonal pattern. Although freshly sprouted green vegetation is favored in the spring, they will eat nearly anything after they emerge from hibernation, including winterkilled animals. Black bears will also prey on newborn moose calves in spring. As summer progresses, feeding shifts to salmon if they are available. In areas without salmon, bears rely on vegetation, berries, ants, grubs, and other insects.

The brown bear mating season is in the spring (May to July). Brown bears enter their dens around September to late October, depending on the geographic area. Cubs are born in the den during January and February. Twins are most common, but litter sizes can range from one to four. In northern areas, brown bears may spend up to 8 months in dens, while in areas with relatively mild winters some male brown bears stay active all winter. Brown bears den in a variety of terrain ranging from pingos (see section 4.2.2), streams, and lake banks at low elevations, to mountain slopes near the crest of the Brooks Range. Brown bears often den in isolated sites on steep slopes and are known to select sites far away from roads and trails on the Kenai Peninsula (Goldstein et al., 2010).

Black bears mate in June and July. One to four cubs are born in their dens. Black bears begin to hibernate in the fall after most food items become hard to find, and then emerge in the spring when food is again available. In northern areas, black bears may spend up to 8 months in dens, while in areas with relatively mild winters some black bears will emerge from their dens during winter. Dens may be found from sea level to alpine areas in rock cavities, hollow trees, excavations, or even piled vegetation on the ground.

Predators of bears include other bears (usually brown), gray wolves, and humans. Bear hunting season occurs in the spring and fall. In 2016, about 461 brown bears and 1,735 black bears were harvested in the state through a combination of registration, draw, and general season open hunts.

General, year-round brown bear habitat would be crossed by the PTTL and Mainline Facilities from the North Slope to MP 806.6. General black bear habitat would be crossed by the Mainline Facilities from the southern border of the Brooks Range south to the Liquefaction Facilities. In addition, bear spring, summer, and fall berry habitat would be crossed by the Mainline Facilities from MPs 186.1 to 251.0, and spring berry habitat would be crossed from MPs 532.7 to 537.8. Figure 4.6.1-3 illustrates black and brown bear habitat types near Project facilities.

Winter construction could disturb denning bears. Because clearing would generally occur in winter when bears would be hibernating, AGDC would review site conditions to determine if any active denning sites are within the Project footprint. If a den is identified, AGDC would consult with the ADF&G to identify appropriate measures to avoid or minimize Project impacts. Winter construction could also awaken hibernating bears, which could result in reduced fitness of adults and survival rates of young if cubs are abandoned.

Seasonal or sensitive mapped brown bear habitats that would be crossed by the Mainline Facilities include 652.3 miles of general year-round habitat, 44.2 miles of summer/fall berry habitat, and 49.3 miles of spring berry habitat, as shown in table 4.6.1-5. As black bear berry habitat is not specifically mapped, it is assumed that black bears use the same berry habitat as brown bears. Three of the construction camps would be within 1 mile of berry habitat, and use of those camps would be anticipated year-round. This would present increased opportunities for wildlife–human interaction impacts because bears use berry habitat during spring and summer. Bears could also be disturbed from berry forage during this sensitive period.

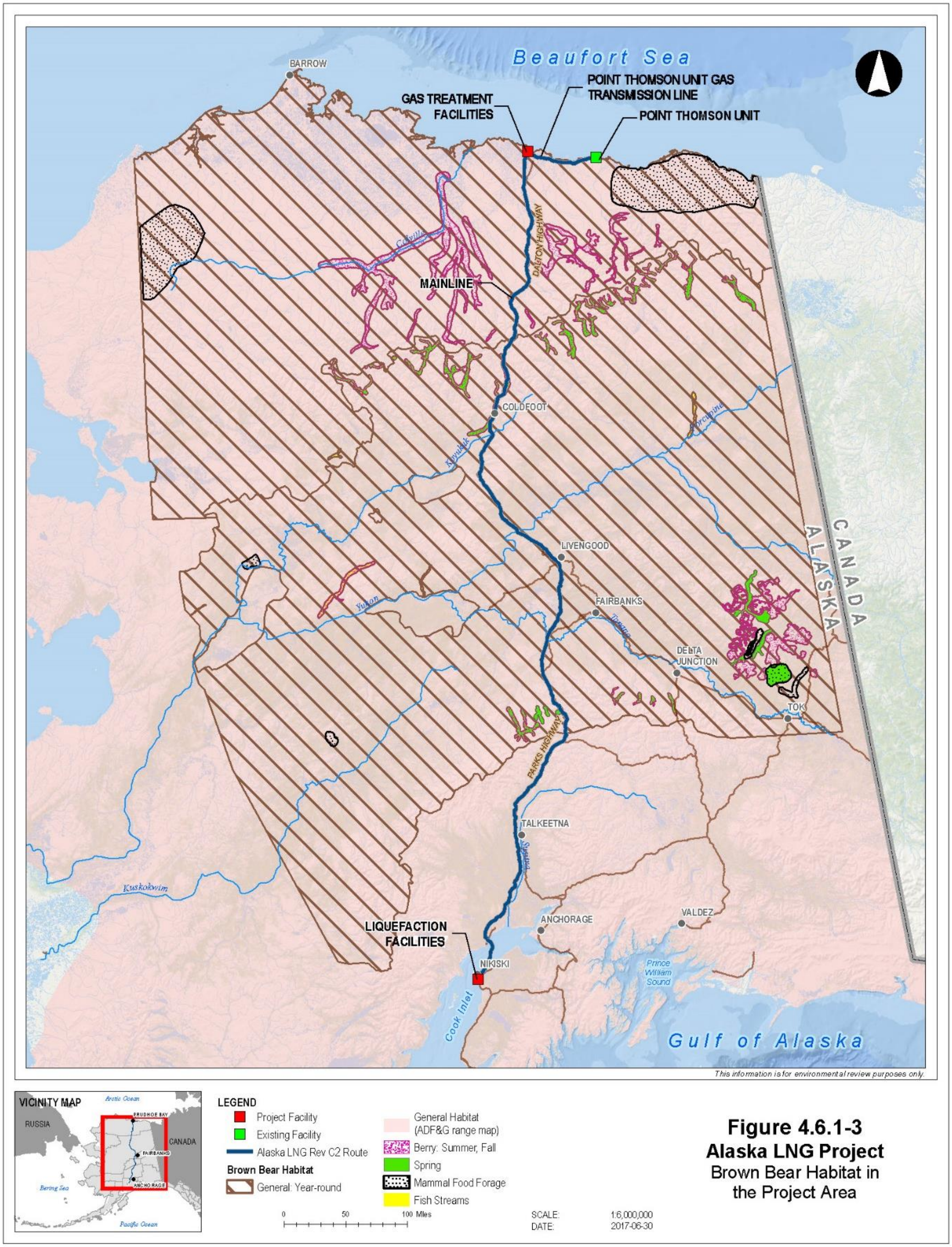


Figure 4.6.1-3
Alaska LNG Project
Brown Bear Habitat in the Project Area

TABLE 4.6.1-5 **Bear Habitat Crossed by the Project**		
Habitat Type	Miles	Acres
PTTL, Mainline Pipeline		
Brown or brown and black bear general, year-round or range	652.3	12,573
Mainline Pipeline		
Brown or black bear berry, summer or fall	44.2	690
Brown or black bear berry, spring	49.3	776

Impacts on sensitive bear habitat would include general construction disturbance and permanent changes to vegetation. Constructing the Project would affect a total of about 12,573 acres of general habitat and 1,466 acres of berry habitat. While impacts on general habitat would be minor given the overall habitat available, construction of the Mainline Facilities would have local impacts on berry habitat, particularly near Coldfoot, Alaska. However, numerous species of berries are distributed throughout the state. Additional unmapped berry habitat may occur and could be affected, such as devil's club (*Oplopanax horridus*), which occurs in the understory on the Kenai Peninsula in the Project area. An adverse impact on berry habitat could result in bear displacement and affect the fitness of bears in the vicinity. Reduced fitness would increase stress experienced by bears, could affect rearing, and could cause bears to seek alternate food sources.

Based on the above discussion, we conclude that impacts on bears overall would be less than significant.

Caribou

About 766,000 caribou in Alaska are managed as 32 herds (ADF&G, 2011). Caribou in Alaska generally prefer treeless tundra and mountains and may winter in boreal forests. They are the most abundant large mammal in Alaska's Arctic region.

Caribou are herbivores and, like most herd animals, migrate up to 50 miles a day in search of food. Large herds often migrate long distances up to 400 miles between summer and winter ranges, while smaller herds may not migrate at all. The caribou summer (May through September) diet generally consists of the leaves of willows, sedges, flowering tundra plants, and mushrooms. Lichens, dried sedges, and small shrubs are consumed in the fall. Caribou movements and migrations are triggered by a number of factors, including changing weather conditions, such as the onset of cold weather or snowstorms, changes in food availability, the presence of predators, and other external disturbances.

Calving occurs in mid to late May in interior Alaska, and in early June in northern and southwestern Alaska. Most adult cows are pregnant every year and give birth to one calf. After calving, caribou coalesce into large herds of primarily cows and calves. These herds are joined by bulls in late June to early July. The herds grow and may split, reform, and move in response to weather and insects, generally moving into the direction of the prevailing winds. Summer caribou herds in the Arctic may contain animals from one or more herds. As insects abate in late summer and early fall, caribou scatter to forage and rut (breed). The rut, which is marked by fighting and breeding, generally occurs during mid- to late October (or September for more southerly herds). After the rut, caribou move to wintering areas. Threats to caribou include predators (gray wolves and bears), disease outbreaks, humans, and weather patterns.

Caribou herds are defined based on their calving ranges (Skoog, 1968) and categorized, since ranges overlap between some herds, as Arctic, Mountain, or Kenai Peninsula Herd groups. Different herds may use the same winter ranges. Four herds seek relief from insects in the windier portions of the Beaufort Coastal Plain Subregion, with two herds using the subregion as calving grounds. Three herds migrate through the Brooks Foothills and Brooks Range Subregions to reach their calving grounds. A herd winters in the southern portion of the Kobuk Ridges and Valleys Subregion and migrates through the subregion to reach its calving and summer grounds in the north. Multiple small herds live in the mountainous portions of the Ray Mountains Subregion. Caribou were extirpated from the Kenai Peninsula in the early twentieth century but re-introduced in the 1960s. Caribou habitat (calving, winter, general, and insect relief) is shown on figure 4.6.1-4; the herds in the Project area are shown on figure 4.6.1-5.

In addition to the general wildlife impacts described above, caribou would also be affected when their specialized habitats or seasonal habitat areas are disturbed by Project activities. Ranges for each caribou herd, their proximity to Project facilities, and impacts of the Project are summarized in table 4.6.1-6. Seventeen construction camps would be within 1 mile of sensitive caribou winter habitat, one of which would also be within 1 mile of insect relief and calving habitat (see table 4.6.1-6).

The Project would affect three of the four herds in the Arctic herd group. The GTP, PTTL, and Mainline Facilities would be within the Central Arctic Herd range, affecting winter, calving, and insect relief habitats. The Mainline Pipeline would pass through the Teshekpuk and Porcupine Herds' general and winter range.

Constructing the GTP would result in the loss of approximately 781 acres of caribou habitat including general, winter, calving, and insect relief (see table 4.6.1-7) used by the Arctic herds. Affected areas would be covered by gravel roads and pads, a material site, a reservoir, and pipelines, resulting in permanent habitat loss. For the Gas Treatment Facilities, which includes the PTTL that would be elevated 7 feet aboveground, disturbances to these habitats from Project operation would be permanent, including the change in the landscape created by the PTTL; however, the right-of-way would be allowed to naturally revegetate or seeded to promote revegetation. During scoping, the residents of Nuiqsut and Kaktovik expressed concerns about the impacts of oil and gas development on caribou and caribou movements.

Caribou studies on the North Slope indicate that oil and gas infrastructure could cause displacement from habitats between 0.6 mile and 3.7 miles for some calving caribou for a brief period each year (Cameron et al., 1992, Nellemann et al., 1996, Haskell et al., 2006). Studies of the behavioral responses of the Central Arctic Herd to the aboveground footprint of oil development in Prudhoe Bay during the 1970s and 1980s indicated that calving shifted away from infrastructure, and the movement of caribou to insect relief locations was restricted by the presence of roads and elevated pipelines. In 2006, the BLM conducted a literature review and synthesis of past studies on the effects of pipeline height on caribou crossing success (BLM, 2006). The BLM found that older pipelines (i.e., those constructed before the minimum height of 5 feet above ground level was stipulated by the State of Alaska) constitute barriers to caribou crossings in the absence of crossing ramps. Generally, pipelines elevated to the minimum height of 5 feet are high enough to accommodate caribou crossings during snow-free periods (BLM, 2006). While there is limited data on pipeline crossings by caribou in the winter, the available evidence indicates that pipeline heights in the range of 7 to 8 feet are more likely to be used by caribou than lower heights during those periods (BLM, 2006).

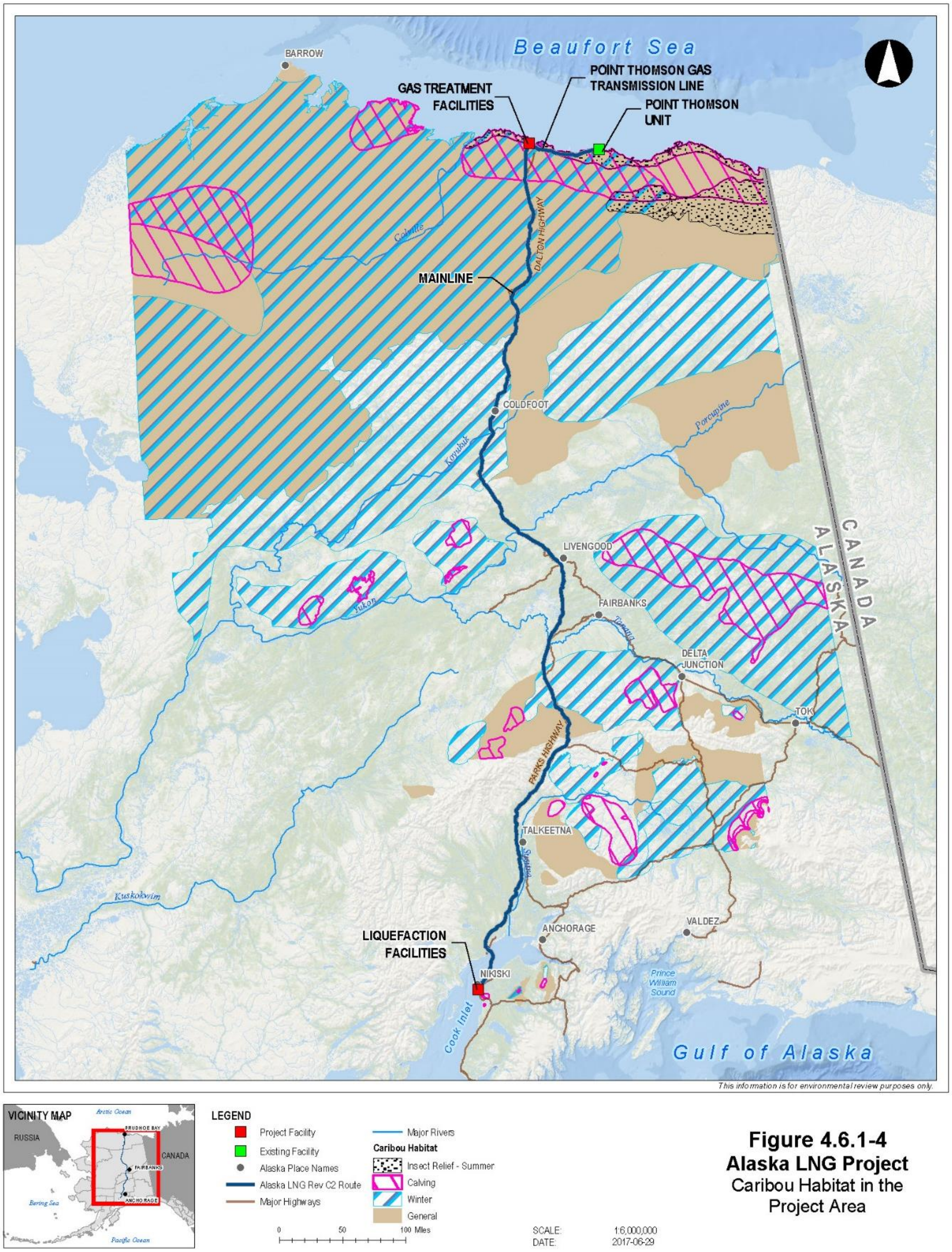


Figure 4.6.1-4
Alaska LNG Project
Caribou Habitat in the Project Area

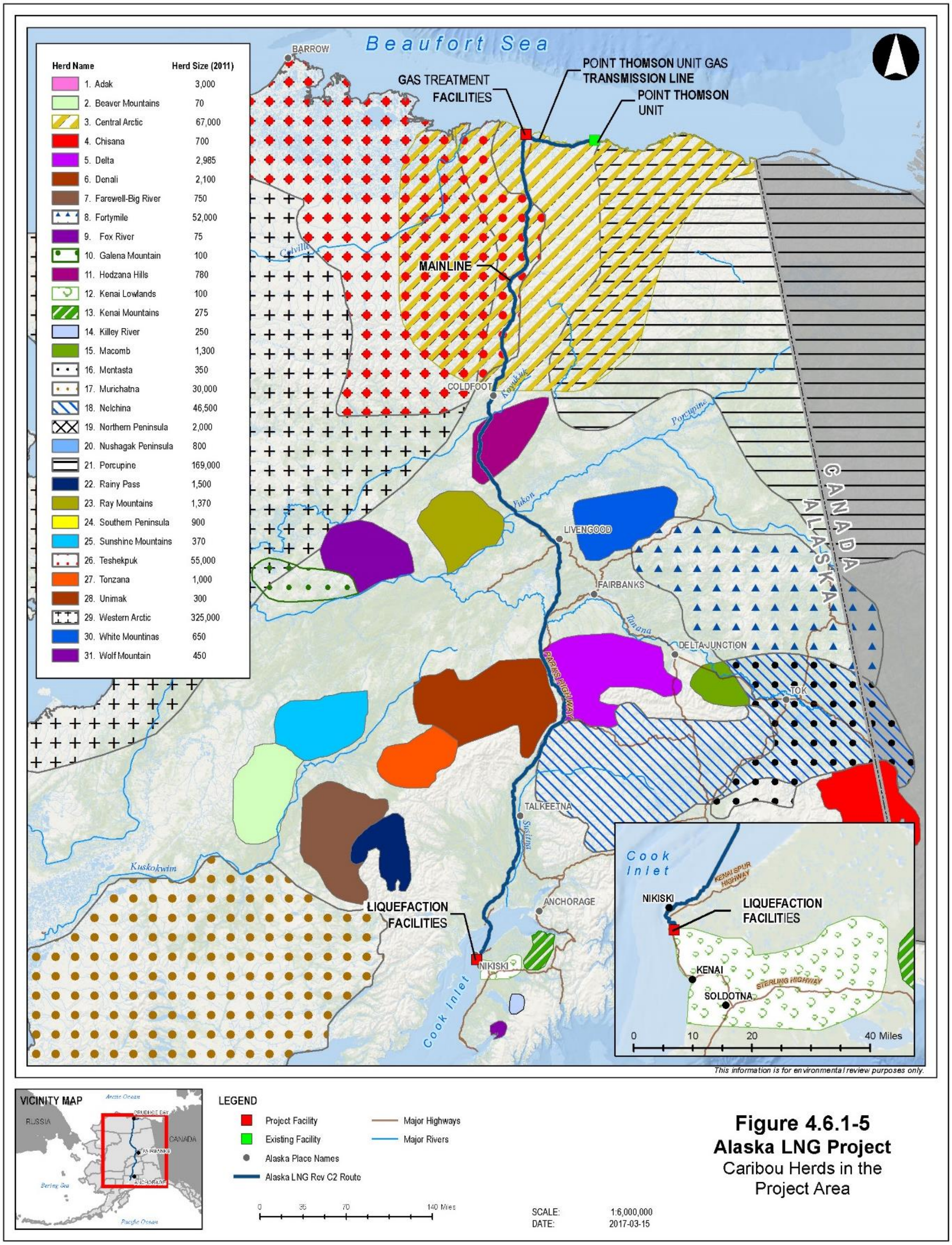


Figure 4.6.1-5
Alaska LNG Project
Caribou Herds in the Project Area

TABLE 4.6.1-6

Caribou Herd Impacts

Caribou Herd	Range	Proximity to Project Facilities	Herd / Herd-Group Specific Impacts
Arctic Herds			
Central Arctic Herd	Traditionally calves between the Colville and Kuparuk Rivers and between the Sagavanirktok and Canning Rivers. The summer range extends from Fish Creek, just west of the Colville River, eastward along the coast to inland within about 30 miles of the Katakturuk River in ANWR. Winters in the northern and southern foothills and mountains of the Brooks Range.	Mainline Facilities would cross summer and winter range; the Gas Treatment and PTTL Facilities would be within the calving range (Griffith et al., 2002) and insect relief habitat.	The Central Arctic Herd has the only calving and insect relief habitats affected by the Project. All construction activities associated with the PTTL would occur in winter, with some impacts extending into spring or summer. Habitats in this area are used for insect relief, general, and winter; therefore, winter use of these habitats would primarily be affected by construction activities for the PTTL. For the Gas Treatment Facilities, as well as the elevated PTTL, disturbances to these habitats from operation would be permanent, including the change in the landscape created by the elevated PTTL. A total of 96.4 miles and about 2,270 acres of spring calving habitat and 1,203 acres of insect relief habitat for the Central Arctic Herd would be affected by facility construction and operation. Mainline Facilities would be constructed within the herd’s general and winter ranges. Three construction camps would be within this herd’s range, including one that would be in insect relief habitat. Since Project facilities would be central within this herd’s range, the Project could serve as a barrier to migration between habitat areas or movement within specialized habitats. Operational activities would result in a permanent disturbance to these habitats.
Teshekpuk Caribou Herd	Primarily ranges on the coastal plain north of the Brooks Range during spring and summer. Calving occurs in areas surrounding Teshekpuk Lake. Extensive use of coastal habitats between Cape Halkett and Utqiagyik for insect relief, broad use of the coastal plain west of the Colville drainage in late summer, and highly variable use of winter ranges.	Mainline Facilities would cross general and winter range. Calving grounds are primarily west of the Project area.	Construction in winter range would include activities during both summer and winter. Since Project facilities would not be central within the Teshekpuk and Porcupine Herds’ range, the Project would be unlikely to serve as a barrier to migration between habitat areas or movement to specialized habitats, such as access to calving range. Three construction camps would be within these two herds’ ranges.
Porcupine Caribou Herd	Migrates between eastern Alaska and northwest Canada. Spring migration to calving grounds is from mid-April through May. Departs calving grounds in late June to early July.	Mainline Facilities would cross general and winter ranges. The PTTL would be west of the Porcupine Herd calving range.	
Mountain Herds			
Hodzana Hills Herd	Resides and calves primarily in the hills at the headwaters of the Dall, Kanuti, and Hodzana Rivers on the border of GMUs 24A and 25D.	Mainline Facilities would cross herd general range along its edge along the Dalton Highway near Finger Mountain.	Construction would include right-of-way construction and pipelay activities during both summer and winter. Operational and maintenance activities could occur at any time of the year. Because of its location at the edge of the habitats for the Hodzana Hills, Delta, Denali, and Nelchina Herds, the Project would affect a relatively small portion of the herds’ ranges.

TABLE 4.6.1-6 (cont'd)

Caribou Herd Impacts

Caribou Herd	Range	Proximity to Project Facilities	Herd / Herd-Group Specific Impacts
Delta Herd	Primarily ranges through the foothills of the Central Alaska Range between the Parks and Richardson Highways, north of the divide separating the Tanana and Susitna River drainages, much of which is within GMU 20A. This herd has also used the upper Nenana and Susitna River drainages north and south of the Denali Highway.	Mainline Facilities are along the western edge of this herd's general range.	
Denali Herd	Primarily uses the DNPP for its range.	Mainline Facilities near the DNPP along the Parks Highway are along the eastern edge of this herd's general range.	
Nelchina Herd	Calves in the eastern Talkeetna Mountains from the Little Nelchina River north to Fog Lakes. This area is also used during post-calving and early summer. Disperses during summer and early fall, with fall distribution extending from the Denali Highway near Butte Lake and across the Alphabet Hills to the Lake Louise flats.	Mainline Facilities are along the western edge of this herd's general range near the Parks Highway.	
Kenai Peninsula Herds			
Kenai Lowlands Herd	Summer in GMU 15A, north of the Kenai Airport to the Swanson River and in the western portion of GMU 15B.	The Liquefaction Facilities would be within this herd's general range.	Construction would include right-of-way and pipelay activities during both summer and winter. Operational activities would be anticipated year-round and would therefore have a permanent disturbance on these habitats. Caribou near helipads planned on the Kenai Peninsula would be expected to experience some level of disturbance during helicopter takeoff and landing. The Project would permanently affect 980 acres of general habitat.

Sources: ADF&G, 2017f; Adams, 2013; Barten et al., 2001; Caikoski, 2014; Dau, 2011; Griffith et al., 2002; Hollis, 2011; Lenart, 2015; McDonough, 2011; Parrett, 2011; Parrett, 2014; Person et al., 2007; Schwanke, 2011; Seaton, 2011a; Seaton, 2011b

TABLE 4.6.1-7

Caribou Habitats Crossed by the Project (acres)

Herd Groups	General	Winter	Calving	Insect Relief [a]
Arctic Herds				
GTP and associated infrastructure [b]	781	781	781	455
PTTL	1,821	1,821	1,434	1,821
Arctic and Mountain Herds				
Mainline Facilities	6,027	10,106	818	38
Kenai Peninsula Herds				
Liquefaction Facilities	902	N/A	N/A	N/A

Source: ADF&G, 1985, 1986a,b

N/A = Not applicable

[a] Habitat mapping consists of overlapping polygons due to caribou use in multiple seasons (should not be total across habitats).

[b] Includes all facilities except work at West Dock (West Dock modification / Dock Head 4, barge bridge, and turning basin), which is outside mapped caribou habitats.

Impacts on all herds, other than the Central Arctic Herds, would be less than significant. Because of impacts during sensitive periods, permanent impacts on sensitive habitats, and the Project location at the center of the Central Arctic Herds' range, we conclude that impacts on these herds from Project construction and operation would be significant. However, we do not know if the impact would be temporary or long term, or to what extent, if any, the GTP and PTTL would affect caribou herd movements. Therefore, to confirm that the GTP and PTTL are compatible with caribou use of the area and to address concerns expressed by local residents, **we recommend that:**

- **<u>Following construction of the GTP and PTTL</u>, AGDC should conduct seasonal monitoring for a period of 3 years to track caribou herd movement and determine if Project infrastructure is creating a barrier to caribou movement. AGDC should file with the Secretary annual reports documenting the findings of its monitoring. <u>At the end of 3 years after construction,</u> if it is clear based on the annual reports that the Project has created a barrier to normal herd movement, AGDC should develop and file with the Secretary, for the review and written approval of the Director of the OEP, a plan to minimize or mitigate any identified issues with caribou movement related to the Project.**

Dall Sheep

Dall sheep are found in the Kenai Mountains, the Chugach Mountains, the Alaska Range, the White Mountains, and the central and eastern Brooks Range. The total population in Alaska was estimated to be about 45,010 sheep in 2010 (ADF&G, 2014b). Dall sheep are found in relatively dry, high elevations and frequent a combination of open alpine ridges, meadows, and steep slopes with extremely rugged rocks and crags in the immediate vicinity. They use ridges, meadows, and steep slopes for feeding and resting. When danger approaches, they flee to the rocks and crags to elude pursuers. A participant in a traditional knowledge workshop noted that the sheep there have been known to swim across the Tanana River (Braund, 2016).

Dall sheep are herbivores that eat a wide variety of plants in summer, and when food is limited in winter, they survive on dry, frozen grass and sedge stems available when snow is blown off the winter ranges. Some populations use significant amounts of lichen and moss during winter. Habitat near the Project occurs in the Brooks and Alaska Ranges. Mainline Facilities would cross general, year-round habitat and a small area of winter habitat on the northern side of the Brooks Range (see figure 4.6.1-6).

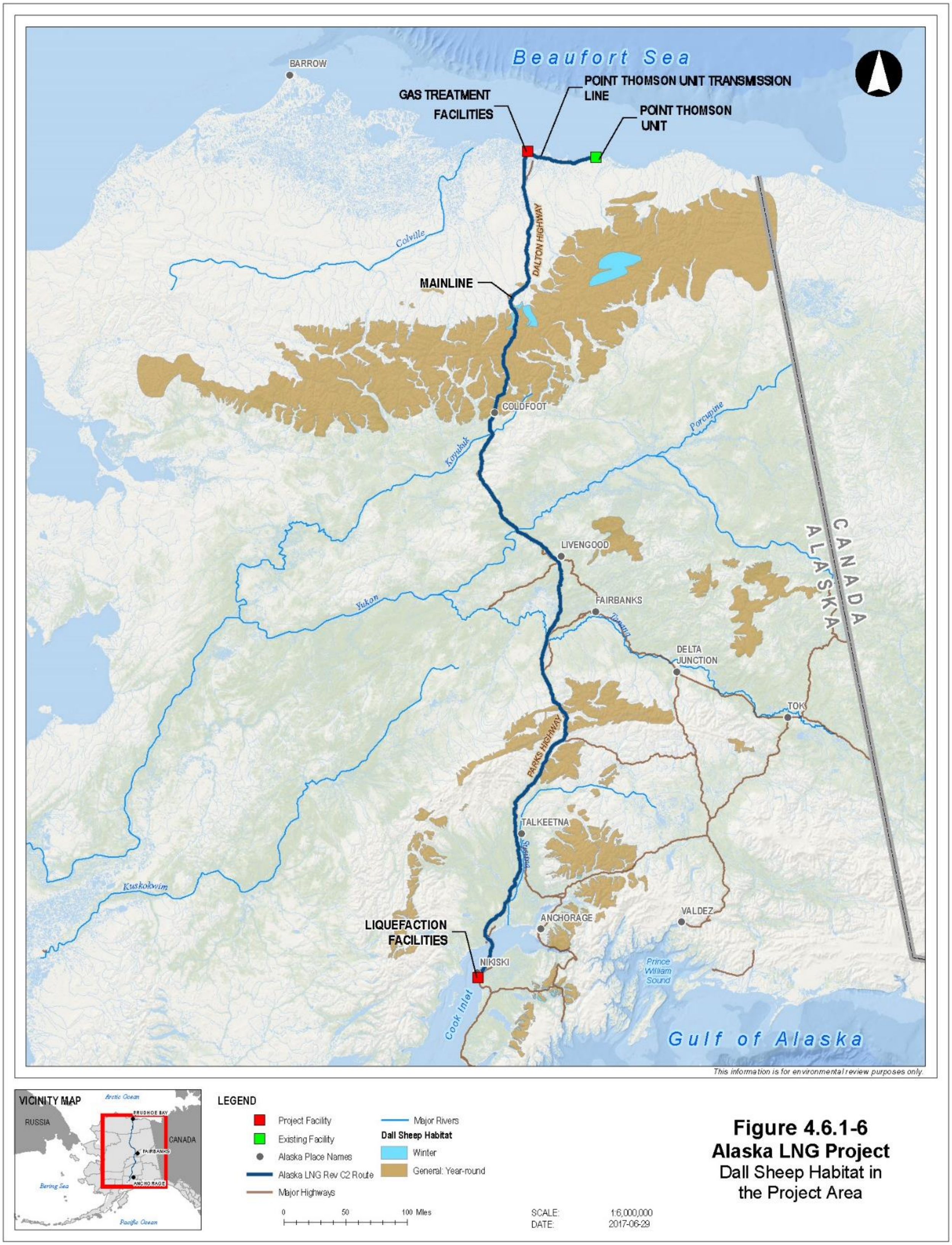


Figure 4.6.1-6
Alaska LNG Project
Dall Sheep Habitat in the Project Area

Some of the suitable habitat for Dall sheep in the Project area is within the BLM-managed Galbraith Lake ACEC and Toolik Lake RNA and ACEC. According to the BLM (2015), the Slope Mountains north of Toolik Lake in the Toolik Lake ACEC/RNA is crucial habitat for Dall sheep. Toolik Lake ACEC/RNA has also been identified as providing crucial Dall sheep lambing and mineral lick areas (see table 4.6.1-8). The Atigun-Sagavanirktok River, which has been nominated as an ACEC, is immediately east of the Toolik Lake ACEC/RNA. Dall sheep have been observed using the east side of the Atigun River near Atigun Gorge as a lambing nursery area, particularly in the spring when green vegetation is just beginning to emerge (Craig and Leonard, 2009). Dall sheep observations and lambing sites are shown on figure 4.6.1-7.

TABLE 4.6.1-8

Bureau of Land Management Areas of Critical Environmental Concern Crossed by the Project

Area of Critical Environmental Concern	Important Resources	Nearest Mainline Pipeline Milepost
Toolik Lake ACEC/RNA	Lambing areas, mineral lick, research activities, cultural	121.0 to 138.2
Galbraith Lake	Cultural, rare/sensitive plants, scenic values, lambing areas	139.2 to 150.5

Sources: BLM, 1989, 2015

The Galbraith Lake ACEC provides important Dall sheep habitat, especially in the early spring as a lambing area and as a spring foraging area for nursing ewes (BLM, 1989; Craig and Leonard, 2009; Summerfield, 1974). Dall sheep observations and lambing sites observed by Craig and Leonard (2009) are shown on figure 4.6.1-7. The ACEC also provides crucial mineral licks for Dall sheep (BLM, 1989), as the species uses up to 30 percent of the ACEC. Craig and Leonard (2009) studied the movements and habitat use of Dall sheep in five ACECs on BLM-managed land in the eastern Brooks Range, including the Galbraith Lake ACEC. Generally, sheep in these areas were found to select summer habitats in high terrain with sparsely vegetated rock and gravel surfaces. Lambing and ewe habitats were commonly observed in or near escape terrain. BLM has observed up to 200 sheep on Black Mountain, a site where early vegetation growth is prevalent (Craig and Leonard, 2009). The west- and south-facing slopes on the east side of the Atigun River valley are used in the spring as lambing–nursery areas (Jakimchuk et al., 1984; Summerfield, 1974). The Galbraith Lake ACEC is also used by Dall sheep in the fall and winter, but less so than in the spring. In the fall, Craig and Leonard (2009) observed signs of Dall sheep on high ridges and low toe-slopes, which were likely in response to snow depths. They also observed ewes and rams using the low slopes of the northwest ACEC in winter.

Other ACECs managed for Dall sheep habitat occurring near the Project area are West Fork Atigun River, Snowden Mountain, Nugget Creek, and Poss Mountain. None of these areas would be crossed by Project facilities.

Dall sheep habitats that would be crossed by Mainline Facilities are identified in table 4.6.1-9. The Mainline Pipeline would approach a sensitive mineral lick site near MP 197 during summer. General year-round Dall sheep habitat would be crossed by the Mainline Pipeline for about 57.2 miles and encompass about 904 acres; about 14.1 miles of Mainline Pipeline would cross 219 acres of Dall sheep winter habitat. Sensitive winter range between MPs 148.1 and 162.7 would have construction activities in summer. Further, Mainline Facilities would be constructed in the Toolik Lake and Galbraith Lake ACECs. One mapped lambing site within the Toolik Lake ACEC would be adjacent to the Mainline Facilities; however, this site is also near the existing TAPS and the highway (see figure 4.6.1-7). Four construction camps would be within 1 mile of Dall sheep habitat, one of which would be in the area of the Galbraith Lake ACEC. Eight access roads and two material sites would be within the Toolik Lake RNA; 14 access roads, two material sites, and one airstrip would be within the Galbraith Lake ACEC.

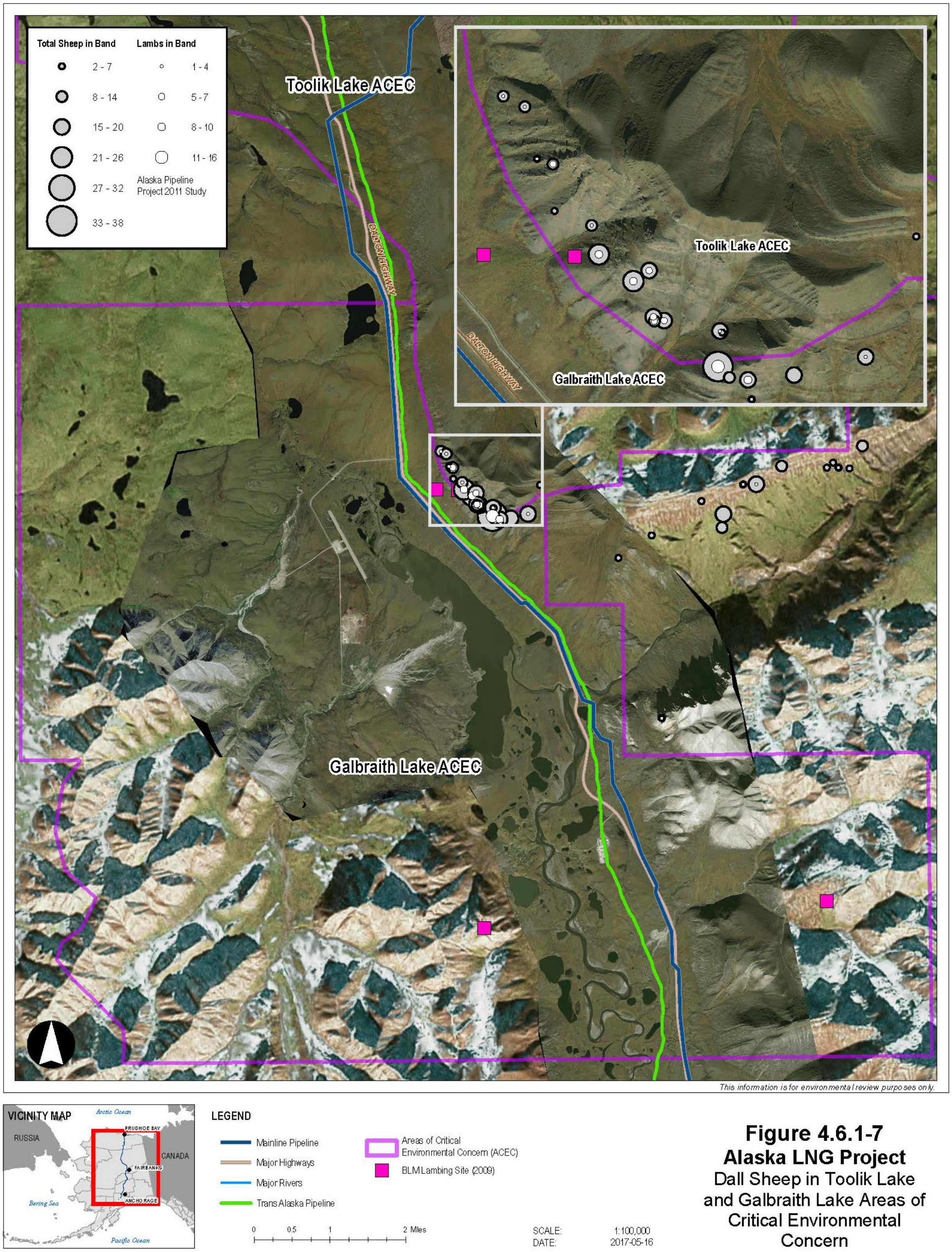


Figure 4.6.1-7
Alaska LNG Project
Dall Sheep in Toolik Lake and Galbraith Lake Areas of Critical Environmental Concern

TABLE 4.6.1-9 **Dall Sheep Habitat Crossed by the Mainline Pipeline**					
Description of Sensitive Season	Mileposts [a]		Length Crossed (miles)	Construction Right-of-Way Area (acres)	Right-of-Way Construction Season [b]
	Milepost Start	Milepost End			
General – Year-round	148.1	239.3	57.2	904	Summer or Winter
Winter	148.1	162.7	14.1	219	Winter

Sources: ADF&G, 1985, 1986a,b

[a] Construction is between start and end mileposts listed; habitat may not be continuously available between the mileposts listed. Length crossed and right-of-way area totals include only that length and area that are within Dall sheep habitat.

[b] Start of right-of-way construction season = construction season when right-of-way clearing and preparation activities begin. This could include the installation of work pads, if applicable. Right-of-way construction activities would be continuous through the pipelay season.

[c] Pipelay season = Construction season when pipe laying activities take place.

Impacts on Dall sheep would be similar to those experienced by general wildlife when Project construction or operation occurs in their habitat range. However, as Dall sheep have specialized habitat requirements, even within year-round habitat, the species could be more limited than other terrestrial mammals in abandoning disturbed areas while construction is in progress or during operational activities. Operational noise would affect Dall sheep habitat, including winter habitat in the Galbraith Lake ACEC, where the Galbraith Lake Compressor Station would be partially within winter habitat. Permanent ongoing effects would be experienced within the area contained by the 40-dBA isopleth, possibly causing a moderate impact on Dall sheep in this area, as a portion of their specialized habitat would be modified; however, individuals would be expected to habituate to using other adjacent similar habitat.

Impacts on Dall sheep for the 14.1 miles of Mainline Pipeline right-of-way where construction would occur during winter within winter habitat would be major, but local, during the construction period and minor during operation when disturbances to Dall sheep from pipeline activities would be limited. Likewise, construction impacts on sensitive Dall sheep habitats in the Toolik Lake and Galbraith Lake ACECs would be major, but local, where construction would occur during times that sheep are present and minor during operation after construction activities are concluded. For other areas where construction activities would occur outside sensitive periods or only adjacent to sensitive areas, construction and operational impacts would be minor. Overall, impacts on Dall sheep populations and their habitats during construction would be less than significant given the available habitat and locations of Project facilities.

Muskoxen

Muskoxen historically ranged across the Arctic areas of Alaska, Canada, and Greenland. They were extirpated from Alaska about 100 years ago due to a combination of over-hunting and climatic conditions (Lent, 1998), but were reintroduced in Alaska's Arctic region starting in 1935. Alaska's population totaled about 4,000 in 2000, but populations have declined in recent years. Muskoxen have a limited habitat range, a low rate of reproduction, and are sensitive to changes in weather and environment. In Alaska, muskoxen are found year-round in coastal plains, river corridors, floodplains, foothills, and bluff habitats of the Beaufort Coastal Plain Subregion (Reynolds et al., 2002).

During summer, muskoxen form relatively small groups (5 to 20 animals) and travel more widely than during winter, when groups tend to be larger (6 to 60 animals) and more sedentary (Lenart, 2009). Muskoxen are herbivores. In summer, they are found in wetter areas such as river bottoms where they feed on grasses and sedges. In winter, they move to higher elevations where the snow cover is less deep. Muskoxen favor inland grasses and sedges and coastal forbs (Arthur and Del Vecchio, 2013). Calves are usually born from April through June, but a small number of calves may be born throughout the summer. Muskoxen usually produce a single calf (Lent, 1998; Arthur and Del Vecchio, 2014).

Threats to muskoxen include predation by brown bears, disease and mineral deficiencies, drowning, starvation due to being stranded on ice, hunting, falling through thin ice, and the combined effects of poor nutrition and winter weather (Lenart, 2009; Arthur and Del Vecchio, 2017). In some years, predation by brown bears may be the most important factor limiting population growth (Arthur and Del Vecchio, 2013). Some mortality is caused by collisions with vehicles on the Dalton Highway (Lenart, 2009). As reported by ADF&G, 243 muskoxen were hunted and killed in 2016 and 258 in 2017 (ADF&G, 2018g).

Project facilities in muskoxen habitat are the PTTL and the northern portion of the Mainline Facilities (see figure 4.6.1-8). Muskoxen fall and winter habitat would be crossed by Mainline Facilities for about 37.9 miles and the PTTL for 15.1 miles (see table 4.6.1-10). Spring calving habitat would be crossed by Mainline Facilities for about 31.1 miles and the PTTL for about 10.1 miles. Summer habitat would be crossed by the Mainline Pipeline for 50.3 miles. Construction would occur during the winter across the majority of fall and winter aggregations, which would increase potential impacts on muskoxen, including work in important habitat areas along the Canning River Delta, Sagavanirktok River Delta, and Sagavanirktok River. Spring calving habitat would be crossed during the winter for PTTL construction and during the summer and winter for Mainline Pipeline construction, minimizing potential impacts on muskoxen calving. About 19.7 miles of Mainline Pipeline right-of-way would be constructed across summer habitat during sensitive summer periods. The remainder of work in summer habitats (30.6 miles) would occur in winter outside the muskoxen sensitive season. Five construction camps would be within 1 mile of muskoxen fall/winter habitat, three within 1 mile of spring habitat, and two within 1 mile of summer habitat.

TABLE 4.6.1-10

Muskoxen General Seasonal Concentration Areas Crossed by the Project

Seasonal Concentration Areas	Mileposts: Milepost Start	Mileposts: Milepost End	Sensitive Season	Length Crossed (miles)	Right-of-Way Construction Area (acres)	Right-of-Way Construction Season [a]
PTTL						
Fall/winter aggregations	39.6	54.7	Fall and Winter	15.1	469.8	Winter
Calving distribution - spring	46.1	56.1	Spring calving	10.1	290.5	Winter
Mainline Facilities						
Fall/winter aggregations	21.4	50.3	Fall and Winter	37.9	616.4	Winter and Summer
Spring calving	50.3	74.8	Spring calving	31.1	494.5	Winter and Summer
Summer distribution	74.8	116.4	Summer	50.3	830.7	Winter and Summer

Source: Lenart, 2015; ADF&G unpublished data (general 2014 distribution points buffered by 5 miles, aggregated by season)

[a] Start of right-of-way construction season = construction season when right-of-way clearing and preparation activities begin. This could include the installation of work pads, if applicable. Right-of-way construction activities would be continuous through the pipelay season.

[b] Pipelay season = construction season when pipe laying activities take place.

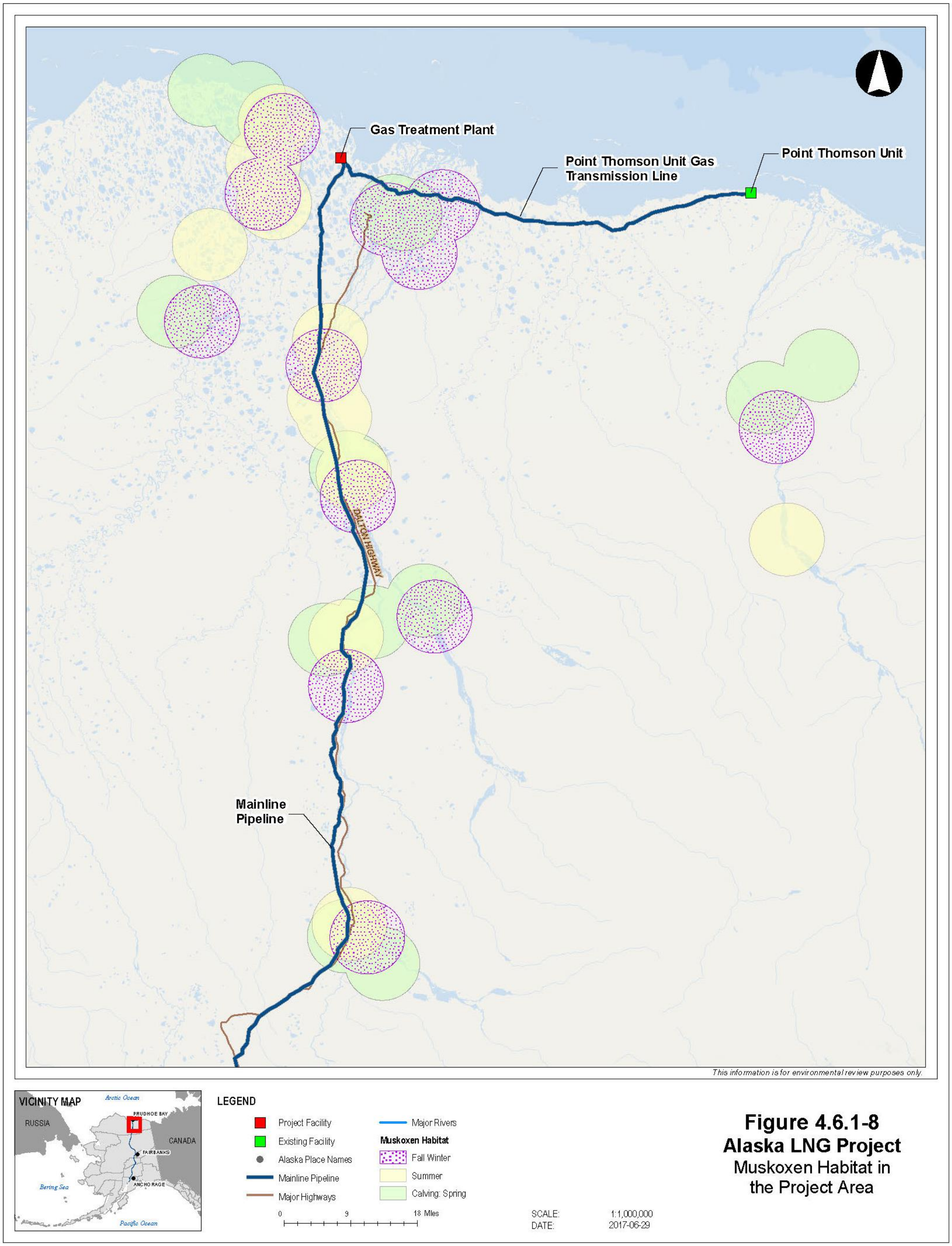


Figure 4.6.1-8
Alaska LNG Project
Muskoxen Habitat in the Project Area

Operational activities in all muskoxen habitat areas would occur year-round; disturbances would be similar to those experienced by general wildlife as discussed in section 4.6.1.2. Muskoxen could occur in the area around the GTP year-round, although most likely during the summer. Operational noise would be experienced in mapped muskoxen winter habitat near the Sagwon Compressor.

In all, work during the most sensitive periods for muskoxen—calving and summer distribution—would cause limitations on muskoxen habitat use, which could restrict calving and feeding activities. In these areas, Project construction would have a local impact on muskoxen. In areas where construction would occur outside sensitive periods, Project construction would have a minor impact on muskoxen populations. Operational effects on muskoxen would be similar to those experienced by general wildlife. Overall, the Project impact on muskoxen would be less than significant.

Gray Wolf

Gray wolves occur throughout rural mainland Alaska as well as the outskirts of Anchorage, Fairbanks, and Juneau. Their statewide population is estimated to be about 7,000 to 11,000 individuals. Wolves are considered scarce in the tundra, but are more common in forest habitats. Wolves are social animals and usually live in territorial packs that include parents and pups, along with some yearlings and other adults. The average pack size is 6 or 7 animals, although packs of 20 to 30 wolves sometimes occur. The larger packs may have two or three litters of pups from more than one female. Typically, one female wolf in a pack has a litter of about seven pups each year.

In most of mainland Alaska, moose and caribou are the primary prey for wolves, with Dall sheep, squirrels, snowshoe hares, American beaver, and occasionally birds and fish as supplements in the diet. The rate at which wolves kill large mammals varies with prey availability and environmental conditions. A pack may kill a caribou or moose every few days during the winter.

The 2012/2013 Trappers Survey indicated that wolves were scarce in the Arctic Tundra Ecoregion and common in both the Beringia Boreal Ecoregion and Alaska Range Subregion, with no changes in population trend from the previous year (ADF&G, 2013). An average of 1,200 wolves is harvested each year across the state (Parr, 2016). Gray wolf populations have been reduced or extirpated from the Kenai Peninsula at times over the last 100 years due to bounties, extensive predator control programs, and the use of poison by trappers, as well as large fires in the 1990s; however, the 2012/2013 Trappers Survey indicated that wolves were common with a decreasing population trend (ADF&G, 2013).

NPS staff has indicated that there is potential for wolf denning and rendezvous habitat near MPs 536 to 543 of the Mainline Pipeline. Sensitive periods for wolves include breeding (February to March) and denning (May to June) (ADF&G, 2008). Estimated wolf densities in GMUs crossed by the Project are summarized in table 4.6.1-11. Any construction or operational disturbance during breeding or denning seasons would have an impact (change in habitat use or behavior) on wolves depending on the distance from construction to specialized habitat areas. Given the statewide distribution of wolves, these impacts would be anticipated to be moderate at a local level, but minor at a population level.

TABLE 4.6.1-11

Gray Wolf Population Estimates for Game Management Units Crossed by the Project

Habitat / Game Management Unit	Milepost Ranges	Population Density Estimate (No. of wolves per 1,000 mi^2) [a]	Pack Estimates (No. of packs) [a,b]
GTP, PBTL, PTTL, Mainline Pipeline			
Arctic Tundra			
26B	PTMPs 0.0–62.5 PBTL (entire line) MPs 0.0–169.9	5 (2003)	5
Mainline Pipeline			
Arctic Tundra, Boreal Forest			
25A	MPs 169.9–177.4	9–14 (2009)	23 (GMU 25A, 25B, 25D, 2009) [c]
24A	MPs 177.4–315.1	10–15 (GMU 24A, 24B, 2011) [c]	58–66 (GMU 24)
Boreal Forest			
25D	MPs 315.1–324.7	11–14 (2009)	23 (2009)
20F	MPs 324.7–356.3	12–20 (1989, 1990)	10–20
20B	MPs 356.3–472.8	16–25 (1989, 1990)	20–30 (GMU 20C, 20B)
20C	MPs 472.8–476.1, 489.1–532.1	14 (2012)	21–35
20A	MPs 476.1–489.1, 532.1–559.2	35 (2008)	25–27
13E	MPs 559.2–641.6	4 (2010)	~5
16A	MPs 641.6–720.9	4–5 (GMU 16B 2007)	2–3
16B	MPs 720.9–777.6	4–5 (2007)	14–16
Mainline Pipeline, Liquefaction Facilities			
Boreal Forest			
15A	MPs 777.6–806.6	21–23 (2010)	5–7 (2010)

Sources: ADF&G, 2012b

[a] Includes the GMU and date of estimate where provided.

[b] Where more than one GMU is noted, estimates include all GMUs and are not available in single GMU estimates.

[c] GMUs not crossed by the Project.

Wolverine

Wolverines are found throughout Alaska but tend to avoid areas used by people. Studies on the Kenai Peninsula have shown wolverines to occur at densities of about five wolverines per 621 mi^2; they are thought to inhabit the remainder of interior Alaska at similar densities (Golden, 1996). Wolverines typically require large expanses of wilderness and use a variety of habitat types ranging from sea level to alpine areas (ADF&G, 2018h); they primarily use shrub, tundra, and rock–ice habitats in the summer; and forest, shrub, and rock–ice habitats in winter (Whitman, 1986). Wolverines are opportunistic carnivores, feeding primarily on carrion and some live prey. They are primarily solitary and travel extensively in search of food (about 300 to 600 miles for females and 700 to 1,000 miles for males). Wolverines would likely be particularly sensitive to any Project construction that would reduce patch size, particularly in areas that were previously pristine or roadless. These effects would be experienced in areas of the Project that would not be collocated with other linear features (see table C-2 in appendix C). Since wolverines are sensitive to fragmentation and disturbance, their range would be permanently reduced or altered in these areas, resulting in a moderate impact on wolverines and their habitats.

Wood Frog

Of the six amphibians that live in Alaska, only wood frogs are known to occur within the Project area. The population size and trends in Alaska are unknown, but are considered stable to slightly declining (AKNHP, 2018b). Wood frogs are the most common amphibian in Alaska (MacDonald and Cook, 2009);

their habitat is present throughout interior and south-central Alaska (see figure 4.6.1-9) (AKNHP, 2018b). They may also occur on the North Slope (Walton et al., 2013). Wood frogs do not occur in the Beaufort Coastal Plain Subregion; therefore, they would not be affected by construction of the Gas Treatment Facilities.

Wood frogs are freeze-tolerant amphibians; their bodies achieve freezing temperatures during hibernation and remain frozen for about 190 days (Larson et al., 2014). They use vegetation types ranging from grassy meadows to open forests, muskeg, and arctic tundra. Wood frogs hibernate in shallow bowl-shaped depressions under a layer of dead vegetation (duff) with snow cover providing extra insulation (Broderson and Tessler, 2008), often at the edge of spring breeding ponds (Larson et al., 2014). They emerge from hibernation in early spring (April and May) and migrate up to 600 feet to shallow breeding ponds (AKNHP, 2018b).

Construction in wetlands would result in the loss and/or conversion of wetland habitat for wood frogs as well as mortality to individual wood frogs that could be crushed or buried during construction. Data provided by AGDC indicates that construction of the Mainline Facilities would result in temporary impacts on 38 acres and permanent impacts on 1,505 acres of herbaceous wetlands that could provide wood frog habitat. Open pipeline trenches would also create a physical barrier to frog movement. Some frogs could fall into the trench, become trapped, and experience mortality.

Increased traffic associated with construction could affect wood frogs. Hibernating, migrating, mating, rearing, and/or foraging activities could all be affected by the Project resulting in increased rate of stress, injury, and mortality. Furthermore, construction noise could result in stress responses in the species, thereby reducing reproductive success, or interfere with breeding since wood frog breeding success relies on successful calling leading up to mating. Loud anthropogenic noise has been demonstrated to impair the ability of female wood frogs to locate calling males (Tennessen et al., 2014). Calling frogs would need to call louder, more frequently, or at novel intervals to compensate for anthropogenic noise (Sun and Narins, 2005; Penna and Zuniga, 2014). These impacts could result in diminished reproductive success of individual wood frogs. Operational noise from the Mainline compressor stations and heater station and the LNG Plant could also interfere with wood frog calling (AKNHP, 2018b).

Wood frogs would experience mortality, disturbance, and loss of habitat due to Project construction and operation; therefore, impacts on this species would be moderate and long term. As wood frogs are common within their range in Alaska, overall impacts on wood frog populations would be minor.

4.6.2 Avian Resources

Alaska is home to more than 500 species of birds (Gibson et al., 2017). For the purposes of this document, we categorize birds into the following groups: raptors,[61] waterbirds,[62] passerines,[63] and upland birds.[64] Most of these birds are migratory; however, many remain in Alaska during winter months. About 25 bird species are known to overwinter in interior and western Alaska, while more than 100 species overwinter along the milder coasts of southern Alaska (ADF&G, 2018l). Birds use the various habitats in the Project area for resting, staging, sheltering, foraging, mating/breeding, nesting, and rearing young. Various federally managed lands and state refuges along the path of the Project also provide important habitat for birds throughout the Project area; descriptions and maps of these areas are provided in sections 4.6.1 and 4.9.2.

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61 Raptors include eagles and owls.

62 Waterbirds are considered waterfowl, divers, cranes, shorebirds, and seabirds.

63 Passerines are perching birds within the order Passeriformes and encompass about 60 percent of all bird species, including songbirds (Merriam-Webster, Inc.; 2018a).

64 Upland birds include grouse and ptarmigan.

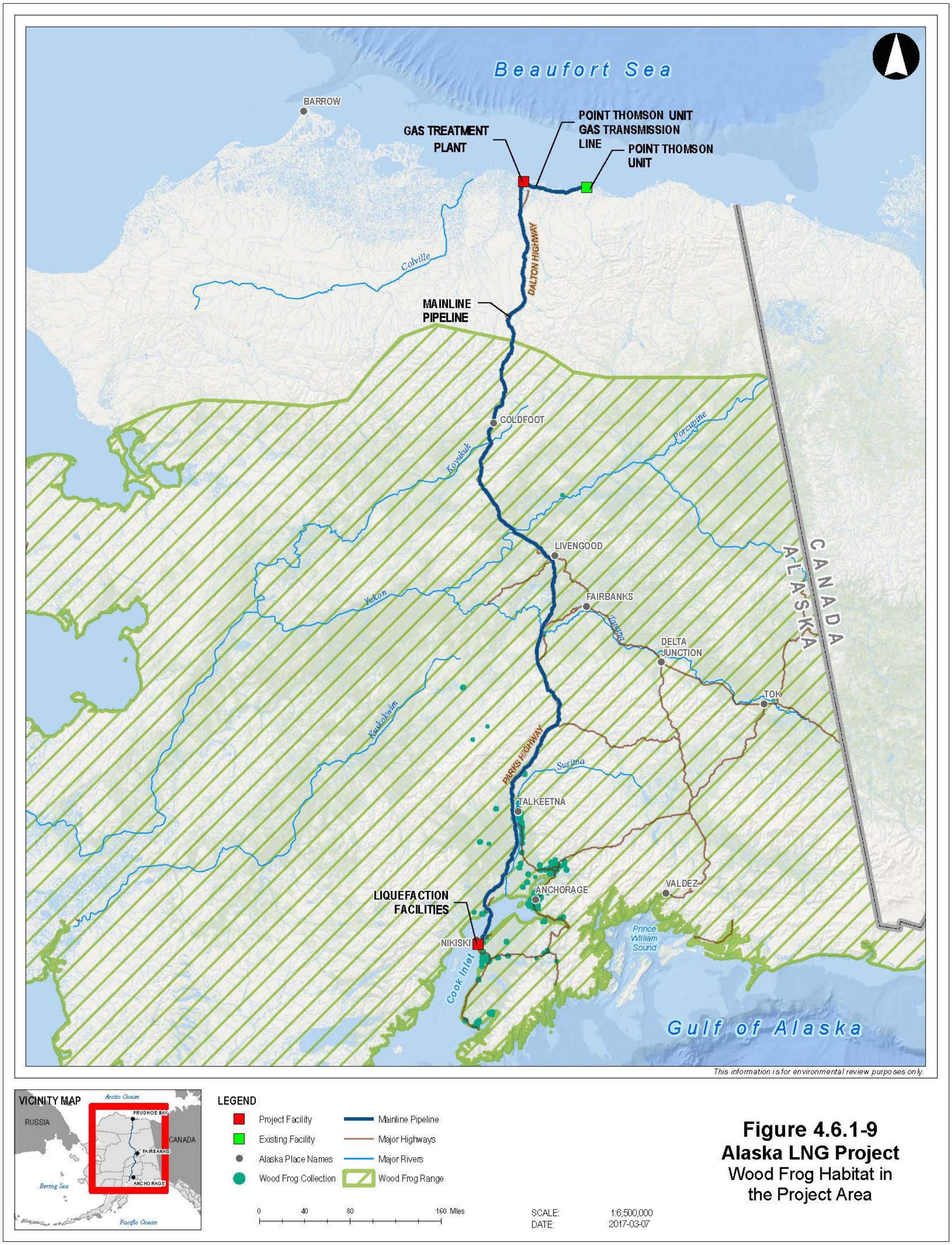


Figure 4.6.1-9
Alaska LNG Project
Wood Frog Habitat in the Project Area

4.6.2.1 General Resources

The presence and distribution of birds within the Project area were identified through review of existing information, maps, agency feedback, historical data, physical surveys, and traditional knowledge workshops. Migratory bird species (including bald and golden eagles) and their habitats that could occur across the entire Project area are discussed in this section (see table 4.6.2-1). Representative avian species listed in table 4.6.2-1 were selected for each subregion and are species that use many or all of the habitat characteristics described for each subregion. Federally listed species, BLM sensitive and watch list species, and Alaska Species of Greatest Conservation Need (SGCN) are discussed in section 4.8.

The Gas Treatment Facilities cross freshwater, coastal, marine, and terrestrial avian habitat within the Beaufort Coastal Plain Subregion. This region provides habitat for millions of nesting and migrating waterbirds (ADF&G, 2015a; Johnson et al., 2007; Larned et al., 2012; Smith et al., 2017). Coastal wetlands, wet meadows, lakes, and riparian habitats found within this subregion are particularly important for nesting, foraging, brood rearing, and molting (Braund, 2016; Brown et al., 2007). Diving waterbirds (e.g., including loons and ducks) use the deep, open lakes within this region. Larger lakes are used annually by large numbers of molting geese (Milner and Oswood, 1997). Coastal wetlands serve as important feeding, nesting, and staging habitat for waterbirds. Prior to fall migration, tidal and riverine mudflats are used extensively by shorebirds (Johnson et al., 2007; Larned et al., 2012; Powell et al., 2010). Numerous waterbird species are found near the proposed GTP and associated facilities.

The Sagavanirktok River, which would be crossed by the PTTL, contains riparian shrub habitat important for a variety of passerines, as well as dry tundra used by birds such as the American golden-plover (*Pluvialis dominica*) and buff-breasted sandpiper (BLM, 2012). The USFWS commented that passerines using the Sagavanirktok River corridor have limited distribution in the Beaufort Coastal Plain Subregion because of the limited distribution of riparian shrub habitat. The yellow-billed loon may also be found during the nesting season within this subregion. Willow ptarmigan (*Lagopus lagopus*) and rock ptarmigan are year-round residents within this subregion (Clough et al., 1987). Previous aerial surveys have documented tundra swans (*Cygnus columbianus*) nesting within the Beaufort Coastal Plain Subregion. Surveys indicate high-density areas are concentrated west of the GTP near the Colville River Delta (Earnst and Rothe, 2004).

The ANWR lies about 6 miles (9.7 km) east of the PTTL, and has been studied extensively. Avian surveys are limited in the PTTL area. Due to the proximity and similar habitats of ANWR to the PTTL, similar species would occur in the PTTL area. Greater than 200 migratory and resident bird species, including swans, geese, ducks, seabirds, shorebirds, raptors, ptarmigan, and passerines, have been documented on the refuge. Species such as the American golden-plover, bar-tailed godwit, dunlin, and wandering tattler connect the ANWR to the world through their migratory pathways (ADF&G, 2015a; National Audubon, 2013). The numbers of snow geese (*Anser caerulescens*) on the refuge range from 13,000 to greater than 300,000 birds (USFWS, 2015b).

Participants in the traditional knowledge workshops discussed the importance of waterfowl including greater white-fronted geese, brants (*Branta bernicla*), and eiders for subsistence on the North Slope. Residents of Nuiqsut also highlighted the value of waterfowl nesting habitat along the Beaufort Sea coast. Specifically, Point Thomson was an important area identified for waterfowl nesting habitat (Braund, 2016). Subsistence is discussed in section 4.14.

TABLE 4.6.2-1

Representative Avian Species in the Project Area

Ecoregions/ Subregions[a]	Project Facilities: Gas Treatment Facilities	Project Facilities: Mainline Facilities	Project Facilities: Liquefaction Facilities	Avian Habitat Characteristics	Representative Avian Species [b]
Arctic Tundra					
Beaufort Coastal Plain	X	X		Habitat comprised of upland shrub, herbaceous tundra. Nesting habitat for many species includes lowland wetlands on coastal tundra, which are usually large (>0.6 mile in diameter), shallow bodies of water that flood after snowmelt and have well-developed emergent and shoreline vegetation. North Slope dominant plants in nesting wetlands include the aquatic pendant grass, *Arctophila fulva*, and/or water sedge, *Carex aquatilis*. Barrier Islands and lagoons as well as islands in river deltas provide additional nesting habitat. Coastal marine waters provide pelagic species foraging habitat. Winter habitat for some species may include small openings in pack ice, called polynyas. Tidal/riverine mudflats also serve as important bird habitat within this region.	common eider (*Somateria mollissima*) glaucous gull (*Larus hyperboreus*) greater white-fronted goose (*Anser albifrons*) Lapland longspur (*Calcarius lapponicus)* long-billed dowitcher (*Limnodromus scolopaceus*) long-tailed duck (*Clangula hyemalis*) Pacific loon (*Gavia pacifica*) pectoral sandpiper (*Calidris melanotos*) red-breasted merganser (*Mergus serrator*) red phalarope (*Phalaropus fulicarius*) snowy owl (*Bubo scandiacus)* wandering tattler (*Tringa incana*)
Brooks Foothills		X		Habitat characteristics include rolling plateaus, low linear mountains, and intermittent plains. Fast streams and braided gravel flats along thickets of birch, alder, and willow. Habitat includes moist tundra consisting of cottongrass tussocks and intermittent patches of low heath shrubs, mosses, sedges, and lichens growing on soils; habitats are dryer than those found on the Beaufort Coastal Plain.	common redpoll (*Acanthis flammea*) green-winged teal (*Anas crecca*) gyrfalcon (*Falco rusticolus*) hoary redpoll (*Acanthis hornemanni*) jaegers (*Stercorarius* spp.) northern pintail (*Anas acuta*) peregrine falcon (*Falco peregrinus)* phalaropes (*Phalaropus* spp.) rough-legged hawk (*Buteo lagopus*) savannah sparrow (*Passerculus sandwichensis*) Wilson's snipe (*Gallinago delicata*)
Brooks Range		X		Brooks Range is a string of east-trending mountainous ridges composed of sedimentary and volcanic rock. Lower slopes and meadows within this region include moist tundra vegetation including balsam poplar along river bottoms. Higher elevations are dry tundra and include barren, rocky areas interspersed with scattered plants, grasses, dwarf shrubs, sedges, and lichens. Habitat including white spruce at 1,000–3,000 foot elevation marks the edge of the boreal forest region.	Bohemian waxwing (*Bombycilla garrulus*) golden eagle (*Aquila chrysaetos*) gray-cheeked thrush (*Catharus minimus*) merlin (*Falco columbarius*) northern harrier (*Circus cyaneus*) northern shrike (*Lanius excubitor*) peregrine falcon rough-legged hawk Smith's longspur (*Calcarius pictus*) wheatear (*Oenanthe oenanthe*) yellow-rumped warbler (*Setophaga coronata*)

TABLE 4.6.2-1 (cont'd)

Representative Avian Species in the Project Area

Ecoregions/ Subregions[a]	Project Facilities: Gas Treatment Facilities	Project Facilities: Mainline Facilities	Project Facilities: Liquefaction Facilities	Avian Habitat Characteristics	Representative Avian Species [b]
Beringia Boreal					
Kobuk Ridges and Valleys		X		Kobuk Ridges and Valleys Subregion is characterized by a series of paralleling ridges and valleys extending south from the Brooks Range. Forests and woodlands serve as habitat for birds, and dominate much of the area. Trees become increasingly sparse in the west. Habitat features include tall and short shrub communities of birch, willow, and alder found on the ridges.	American pipit (*Anthus rubescens*) golden eagle peregrine falcon rock ptarmigan (*Lagopus muta*)
Ray Mountains		X		Ray Mountains are comprised of compact, east–west oriented ranges. Dominant vegetation serving as bird habitat includes black spruce woodlands, white spruce, birch, and quaking aspen. Subregion is also comprised of floodplains, shrub birch, and *Dryas* lichen tundra at higher elevations. Meandering streams and numerous small ponds serve as bird habitat within this subregion.	bald eagle (*Haliaeetus leucocephalus*) gray-cheeked thrush olive-sided flycatcher (*Contopus cooperi*) rusty blackbird (*Euphagus carolinus*) sandhill crane (*Antigone canadensis*) solitary sandpiper (*Tringa solitaria*) trumpeter swan (*Cygnus buccinator*)
Tanana-Kuskokwim Lowlands		X		Meandering rivers with side sloughs are a dominant feature and provide bird habitat. This area has an abundance of ponds, oxbows, streams, wetlands, and upland vegetation types that provide nesting, foraging, and staging habitat for migratory waterfowl. The subregion's overall wetness creates conditions for boreal forests. Bird habitat includes tall shrub communities of willow, birch, and alder throughout the subregion.	belted kingfisher (*Megaceryle alcyon*) boreal owl (*Aegolius funereus*) common goldeneye (*Bucephala clangula*) common loon (*Gavia immer*) great gray owl (*Strix nebulosa*) Hammond's flycatcher (*Empidonax hammondii*) horned grebe (*Podiceps auritus*) ruffed grouse (*Bonasa umbellus*) rusty blackbird (*Euphagus carolinus*) trumpeter swan
Yukon-Tanana Uplands		X		Area characterized with rounded, even-topped ridges and gentle slopes. Ridges become more rugged in the east and exceed elevations of 6,000 feet. Streams move through narrow, terraced canyons in the east and flat alluvial valleys in the west. Small lakes occur in valleys where drainage has been blocked. This area provides habitat for birds with black spruce forests favoring north-facing slopes; sedge tussocks and scrub bogs in valley bottoms.	boreal chickadee (*Poecile hudsonicus*) boreal owl (*Aegolius funereus)* gray jay (*Perisoreus canadensis*) northern flicker (*Colaptes auratus*) red-tailed hawk (*Buteo jamaicensis*) Smith's longspur

TABLE 4.6.2-1 (cont'd)

Representative Avian Species in the Project Area

Ecoregions/ Subregions[a]	Project Facilities: Gas Treatment Facilities	Project Facilities: Mainline Facilities	Project Facilities: Liquefaction Facilities	Avian Habitat Characteristics	Representative Avian Species [b]
Coast Mountains Boreal					
Alaska Range		X		Mountains within the Alaska Range are very high and steep; much of the area is barren of vegetation and covered by rocky slopes, icefields, and glaciers. Tall and low scrub communities, providing habitat for birds, are common in areas with vegetation growth and include species such as willow, birch, alder, and spruce. Beaches and mudflats within the subregion provide resting and foraging habitat for birds. Spruce forests and spruce-aspen-birch forests occur at lower elevations.	bald eagle black-billed magpie (*Pica hudsonia*) boreal chickadee glaucous-winged gulls (*Larus glaucescens*) golden eagle great gray owl (*Strix nebulosa*) northern goshawk (*Accipiter gentillis*) northern hawk owl (*Surnia ulula*) osprey (*Pandion haliaetus*) pine siskin (*Spinus pinus*) sharp-shinned hawk (*Accipiter striatus*) song sparrow (*Melospiza melodia*) Steller's jay (*Cyanocitta stelleri*)
Cook Inlet Basin		X	X	Common landscapes in this region include relatively flat and rolling topography with an abundance of lakes, swamps, and bogs. This subregion has a variety of vegetation communities but is dominated by stands of spruce and hardwood species. The subregion is typically free of permafrost and has rich, wet, organic soils that give rise to black spruce forests and woodlands. Numerous lakes, ponds, and wetlands provide habitat for and attract large numbers of waterbirds.	Aleutian tern (*Onychoprion aleuticus*) bank swallow (*Riparia riparia*) black-billed magpie black-legged kittiwake (*Rissa tridactyla*) boreal chickadee cormorants (*Phalacrocorax* spp.) dark-eyed junco (*Junco hyemalis*) great horned owl (*Bubo virginianus*) greater white-fronted goose (v. elgasi) harlequin duck (*Histrionicus histrionicus*) Hudsonian godwit (*Limosa haemastica*) murrelets (*Brachyramphus* spp.) northern saw-whet owl (*Aegolius acadicus*) rock sandpiper (*Calidris ptilocnemis*) tree swallow (*Tachycineta bicolor*) tufted puffins (*Fratercula cirrhata*) western sandpiper (*Calidris mauri*)

Sources: ACCS, 2016a; ADF&G, 1973, 1986b, 2015a, 2017g; Alaska Shorebird Group, 2008; Cotter and Andres, 2000; USFWS, 2008a; National Audubon, 2016

[a] Ecoregions and subregions associated with the Project are identified in section 4.0 (see table 4-1 and figure 4-1).

[b] Representative species were listed for each subregion based on habitat descriptions; species listed may occur in other areas associated with the proposed Project. This does not include a comprehensive list of all species that may occur within each subregion.

The Mainline Facilities would be within the Arctic Tundra Ecoregion, specifically, the Beaufort Coastal Plain, Brooks Foothills, and Brooks Range Subregions. Representative avian resources associated with these subregions are listed in table 4.6.2-1. Similar species as described for the Gas Treatment Facilities would occur along the Mainline Facilities in the Beaufort Coastal Plain. Passerines use several of the habitats present with the Brooks Foothills Subregion including the drier uplands, scrub-shrub habitats, and riparian willow stands. Wetland habitat is abundant within the Brooks Foothills Subregion and supports numerous shorebirds, ducks, geese, and swans (Trammell et al., 2016). Raptors, including the golden eagle, gyrfalcon, peregrine falcon, and rough-legged hawk, are also found within the subregion where they forage in the foothills and nest on cliffs and bluffs. The cliffs and bluffs along the Sagavanirktok River are particularly important for nesting raptors (Wright, 2000).

Mainline Facilities would also cross the Beringia Boreal Ecoregion, which includes the Kobuk Ridges and Valleys, Ray Mountains, Tanana-Kuskokwim Lowlands, and Yukon-Tanana Uplands Subregions, where waterfowl rest and stage during migration to and from their breeding grounds in the Arctic Tundra Ecoregion (ADF&G, 1986b). Boreal and great gray owls are also found within this ecoregion (ADF&G, 2015a). The Upper Tanana River Valley is known as an important bird migration corridor where swans, geese, ducks, cranes, and raptors pass through the valley during spring and fall migration periods. This area is particularly important for migrating lesser sandhill cranes (*Antigone canadensis canadensis*), and the region provides breeding and post-breeding habitat for trumpeter swans (National Audubon, 2017c).

The Mainline Pipeline would cross the Yukon-Tanana Uplands Subregion, including the Minto Flats SGR. The Minto Flats SGR, which includes about 500,000 acres, is 35 miles (56.3 km) west of Fairbanks between the communities of Minto and Nenana. This area provides nesting, foraging, and staging habitat for migratory waterfowl (ADF&G, 1986b, 2017g). Breeding populations average 213 ducks/mi^2 at the refuge (ADF&G, 2017g). The Minto Flats SGR sustains one of the largest trumpeter swan breeding populations in North America. Additional birds found at the refuge include sandhill crane, loons, bald eagle, grouse, ptarmigan, owls, and numerous passerines (ADF&G, 2017g). Peregrine falcons are found nesting in cliff habitat within this subregion.

About 200 bird species regularly occur in the Coast Mountains Boreal Ecoregion, which includes the Alaska Range and Cook Inlet Subregions, which would be crossed by the Mainline Facilities. This ecoregion supports the greatest diversity of birds in the Project area (ACCS, 2016a; ADF&G, 2015a) and includes a variety of habitats ranging from mountains to scrub communities, beaches, mudflats, and forests.

AGDC would construct the Mainline MOF near Beluga Landing and the Mainline Pipeline across Cook Inlet, which would overlap with the Cook Inlet Basin Subregion. The diverse habitats in the Cook Inlet Basin Subregion support a variety of bird communities including large numbers of waterbirds (ADF&G, 2015a). Large numbers of dunlin, long- and short-billed dowitchers, Hudsonian godwit, rock sandpiper, and western sandpiper inhabit the Cook Inlet Basin Subregion during breeding, resting, and wintering periods. Habitat within the breeding range consists of moist-wet tundra, often in areas with ponds. In Alaska, shoreline silt barrens and unvegetated intertidal flats are important habitat for post-breeding dunlin (Andres, 1989; Warnock and Gill, 1996). These shorebirds overwinter in habitat types ranging from coastal estuaries, bays, and interior seasonal wetlands to flooded fields (Warnock and Gill, 1996). Black-legged kittiwake and common murre (*Uria aalge*) nest in colonies along Cook Inlet shores. The Cook Inlet Basin Subregion provides nesting habitat for numerous passerine species (ADF&G, 2015a; National Audubon, 2014). Many raptors, including the northern saw-whet owl and boreal owl, may be found in the Cook Inlet Basin Subregion (ACCS, 2016a; The Nature Conservancy [TNC], 2003).

The Cook Inlet Basin Subregion is also important for nearly the entire population of Wrangell Island snow geese as they migrate across the mouth of the Kenai River and Trading Bay in the spring (ADF&G, 2015a). Nearly the entire population of tule white-fronted geese nest in the boreal forest wetlands on the western side of Cook Inlet (ACCS, 2016a; ADF&G, 2015a). Concentrations of tule white-fronted geese also molt and nest in areas within Trading Bay and Susitna Flats SGRs as well as Redoubt Bay CHA (ACCS, 2016a; ADF&G, 2017g; TNC, 2003). Trading Bay SGR and Redoubt Bay CHA are on the west side of Cook Inlet and are about 16 and 12 miles (25.7 km and 19.3 km) west of the Mainline Pipeline near MPs 780 and 803, respectively.

The river flats near the mouth of the Susitna River are important to avian populations. Specifically, participants in the traditional knowledge workshops noted that this area is known for its large waterfowl concentrations and serves as important nesting and feeding grounds for ducks, geese, swans, and eagles (Braund, 2016). Additional avian resources include upland game birds (e.g., ptarmigan and grouse) found in patches of dense vegetation, especially where willow or birch shrubs are abundant, and can also be found in sedge-willow marshes, meadows, and open tundra during the breeding season. Species such as willow ptarmigan move through low willow in valley bottoms during migration (Hannon et al., 1998). Participants in the traditional knowledge workshops reported changes in migration patterns over time; birds are arriving earlier or departing later than what had been observed in the past, and bird diversity has noticeably decreased in this region, possibly due to human impacts (Braund, 2016).

The Cook Inlet Basin Subregion is also an important wintering area for numerous seabirds, including murres, gulls, kittiwakes, cormorants, murrelets, and tufted puffins (ACCS, 2016a; TNC, 2003). Lower Cook Inlet is an important area for foraging seabirds; thousands of seabirds and shorebirds concentrate in this region annually year-round (Renner et al., 2017). For example, several hundred thousand western sandpipers (greater than 25 percent of the global population) depend on habitats for feeding near Trading Bay SGR and Redoubt Bay State CHA in the Cook Inlet Basin Subregion during spring migration (TNC, 2003). Shelikof Strait is a strait in Lower Cook Inlet between the Alaska mainland to the west and Kodiak and Afognak Islands to the east; LNG carriers would travel to and from the Liquefaction Facilities through this strait. The strait is an important area for migrating and overwintering waterfowl and nesting seabirds (NOAA, 1997). Rocky outcrops along the shores provide nesting habitat for peregrine falcon, gyrfalcon, and merlin. Marbled murrelets use rocky plateaus as breeding habitat (ADF&G, 2017h).

The offshore areas where components of the Liquefaction Facilities would be constructed provide important habitat to avian resources. Seabirds and waterfowl use the shallow, nearshore marine waters and semi-protected bays for feeding, staging, and resting. Protected bays are important wintering grounds for waterfowl and seaducks including Aleutian tern, harlequin duck, long-tailed duck, Kittlitz's murrelet, and Steller's eider (*Polysticta stelleri*) (TNC, 2003). Numerous species of shorebirds rely on intertidal habitats within the Cook Inlet Basin Subregion for feeding and migratory stopovers. The Upper Cook Inlet region is the primary wintering range of the rock sandpiper subspecies (*Calidris ptilocnemis ptilocnemis*) (Ruthrauff et al., 2013; Gill and Tibbitts, 1999).

The Kenai Peninsula provides key avian habitats, resting areas, and migration routes, and numerous bird species live in or travel through the region. Additional important habitats include those for aquatic animals (e.g., bays, shallow water areas, and mudflats) and serve as resting and feeding habitats for avian species. Many anadromous streams and rivers drain into Cook Inlet and provide beneficial habitat for birds; one specific area includes Gull Island in Kachemak Bay as identified by participants in the traditional knowledge workshops (Braund, 2016). Hundreds of avian species migrate through the Kenai Peninsula. However, residents have reported witnessing changes in the composition of migrating birds. Specifically, species including Canada geese, cranes, mallards, brants, and swans have overwintered in areas within the Kenai Peninsula region that would have otherwise migrated south for the winter (Braund, 2016).

4.6.2.2 Migratory Birds

Migratory birds are protected under the MBTA[65] (16 USC 703-711); bald and golden eagles are additionally protected under the BGEPA (16 USC 668-668d). EO 13186 (66 FR 3853) directs federal agencies to identify where unintentional take is likely to have a measurable negative effect on migratory bird populations and to avoid or minimize adverse impacts on migratory birds through enhanced collaboration with the USFWS. EO 13186 was issued in part to ensure that environmental analyses of federal actions assess the impacts of these actions on migratory birds. It also states that emphasis should be placed on species of concern, priority habitats, and key risk factors, and it prohibits the take of any migratory bird without authorization from the USFWS.

On March 30, 2011, the USFWS and the Commission entered into an MOU that focuses on avoiding, minimizing, or mitigating adverse impacts on migratory birds and strengthening migratory bird conservation through enhanced collaboration between the Commission and the USFWS. This voluntary MOU does not waive legal requirements under the MBTA, the ESA, the NGA, or any other statute and does not authorize the take of migratory birds.

The Alaska Migratory Bird Co-management Council (AMBCC), which was formed in 2000, includes the USFWS, ADF&G, and representatives of Alaska Natives. The AMBCC collaborates with the Pacific Flyway Council to develop migratory bird hunting regulations and coordinate migratory bird conservation and management (AMBCC, 2017). In Alaska, all native birds except for grouse and ptarmigan are protected under the MBTA; grouse and ptarmigan are protected by the State of Alaska.

Migratory birds follow broad routes called flyways between habitats in Alaska and wintering grounds in Central and South America and the Caribbean. Alaska birds migrate to six continents, following different flyways that include the North American flyways (such as the Pacific, Central, Mississippi, and Atlantic flyways) as well as international flyways (National Audubon, 2017a). Fifty percent of Alaska's waterfowl (e.g., geese, swans, and ducks) use the Pacific flyway, 25 percent use the Mississippi flyway, 10 percent use the Central flyway, and 10 percent use the Atlantic flyway. The remaining 5 percent of waterfowl travel to Mexico, South America, Asia, or the Pacific Islands (USFWS, 2010b). Additionally, several species migrate from breeding areas in northern Alaska to winter near Bristol Bay, the Aleutian Islands, or Cook Inlet where they remain throughout the non-breeding season.

Raptors

Traditionally, federal and state agencies consider raptors as species of special concern. Raptors are high trophic level or apex predatory birds, and serve as indicator species of ecological changes or impacts on the ecosystem (ADF&G, 2015a). The Alaska Raptor Group, which was formed as a subcommittee of Boreal Partners in Flight in April 2008, provides guidance on the study, management, and conservation of Alaska raptors and their habitat (USGS, 2018b). Raptor nest data, including species and location, have been collected along portions of the Project area periodically during the past 32 years (Craig and Hamfler, 2003; Ritchie and Palmer, 2002). Based on this data, suitable nesting habitats exist for raptors along the Mainline Facilities and PTTL and raptor nest concentrations are known.

Raptor species that are known to occur or could be present within the Project area include American kestrel (*Falco sparverius*), American and arctic peregrine falcons (*Falco peregrinus anatum, Falco peregrinus tundrius*), bald and golden eagles, gyrfalcon, merlin, northern goshawk, northern harrier, osprey, rough-legged hawk, sharp-shinned hawk, Swainson's hawk (*Buteo swainsoni*), and western and Harlan's red-tailed hawks (*Buteo jamaicensis*, *Buteo jamaicensis alascensis*) (ACCS, 2016a; Hawk Watch

[65] In 1997, the MBTA was amended to promote the conservation of migratory birds by including subsistence hunting in the regulatory framework. The amendment authorized the USFWS to regulate spring and summer subsistence hunts of migratory birds in Alaska (Naves, 2015) which is further addressed in section 4.14.

International, 2014). In addition, several species of owls (e.g., boreal owl, great gray owl, great horned owl, northern saw-whet owl, and snowy owl) are known to occur or could be present within the Project area (ADF&G, 2018b). Historic raptor nest surveys have identified concentrations of raptor nest sites throughout Alaska; some portions overlap the Project area, including high concentrations from Livengood to Franklin Bluffs (Alyeska, 2002; USFWS, 2006; Ritchie and Palmer, 2002) along the Mainline Pipeline. Many raptor species overwinter in Alaska including gyrfalcon, merlin, and northern goshawk in southern Alaska.

In spring 2015, AGDC completed raptor nest surveys at and near Project facilities to document nests of tree- and cliff-nesting raptors (e.g., peregrine falcon, gyrfalcon, and rough-legged hawk) and bald and golden eagles within 1 and 2 miles (1.6 and 3.2 km) on either side of the Mainline Pipeline. AGDC conducted surveys within a 2-mile corridor (1 mile on either side of the centerline) for appropriate habitat and terrain for nesting raptors. In areas of suitable golden eagle habitat, AGDC expanded the survey to a 4-mile-wide corridor (2 miles on either side of the centerline) to capture more nesting habitat for this protected species based on recommendations from the USFWS. Primary tree-nesting species in forested habitat included bald eagle, osprey, and common raven (*Corvus corax*). Although the common raven is not a raptor, it constructs stick nests and shares nest sites with several raptor species. Nests of other forest-nesting raptors (e.g., American kestrel, merlin, northern goshawk, red-tailed hawks, and sharp-shinned hawk,) and owl species were recorded if sighted during aerial surveys.

The 2015 raptor nest survey focused on tree-, cliff-, and river-bluff-nesting raptors. Surveys covered portions of the Project area including Nikiski (MP 804) to Cook Inlet and Beluga (MP 767) north to Livengood (MP 401) and ended at Franklin Bluffs (MP 30). Species' nests including gyrfalcon, peregrine falcon, and rough-legged hawk were primarily identified within the Brooks Range and Brooks Foothills Subregions. Bald and golden eagles are discussed in section 4.6.2.4.

Waterbirds

Alaska is home to diverse and abundant groups of waterbirds such as loons (e.g., yellow-billed and red-throated loons), waterfowl (e.g., long-tailed duck, geese, and swans), shorebirds (e.g., red-necked phalarope [*Phalaropus lobatus*] and red phalarope), and seabirds (e.g., eiders, terns, and gulls) that are dependent on wetlands and waterbodies for certain life history stages (Smith et al., 2017). Alaska supports about 20 percent of North and South America's nesting waterfowl. Several areas in Alaska are particularly important to nesting waterfowl including the Yukon-Kuskokwim Delta, Bristol Bay Lowlands, Yukon Flats, and the Tanana/Kuskokwim Valley (USFWS, 2010b). The coastal region is also important to breeding and staging waterfowl (Larned et al., 2012).

Nearly 36 species of waterfowl nest in Alaska. Waterfowl species such as the mallard (*Anas platyrhychos*), common merganser (*Mergus merganser*), and bufflehead (*Bucephala albeola*) overwinter in southern Alaska. In Alaska, 37 species of shorebirds are regular breeders, comprising about 20 percent of all shorebird species worldwide (Alaska Shorebird Group, 2008). Many waterbirds such as common eider, glaucous gull, and brant breed and nest in colonies along marine coasts (Pew et al., 2016). The Bering, Chukchi, and Beaufort Sea coasts provide habitat for about 34 million nesting birds. In the Arctic region, many migratory bird species, including snow geese (Johnson, 1998), and tundra swans (Stickney et al., 2002) exhibit site fidelity in which they return to the same location year after year.

Aircraft surveys in Alaska have collected data on major breeding populations of ducks and other waterbirds every spring since 1957 as part of the North American Waterfowl Breeding Pair Survey (USFWS, 2012c). Portions of the surveyed area overlap with the Mainline and Liquefaction Facilities. The 2011 total waterfowl breeding population estimates for ducks numbered about 16,660 in the interior taiga and 21,910 in the coastal tundra (Mallek and Groves, 2011). Overall, total duck numbers in 2011 were below the previous 10-year mean. Population increases for other waterfowl including geese and swans were observed.

Passerines

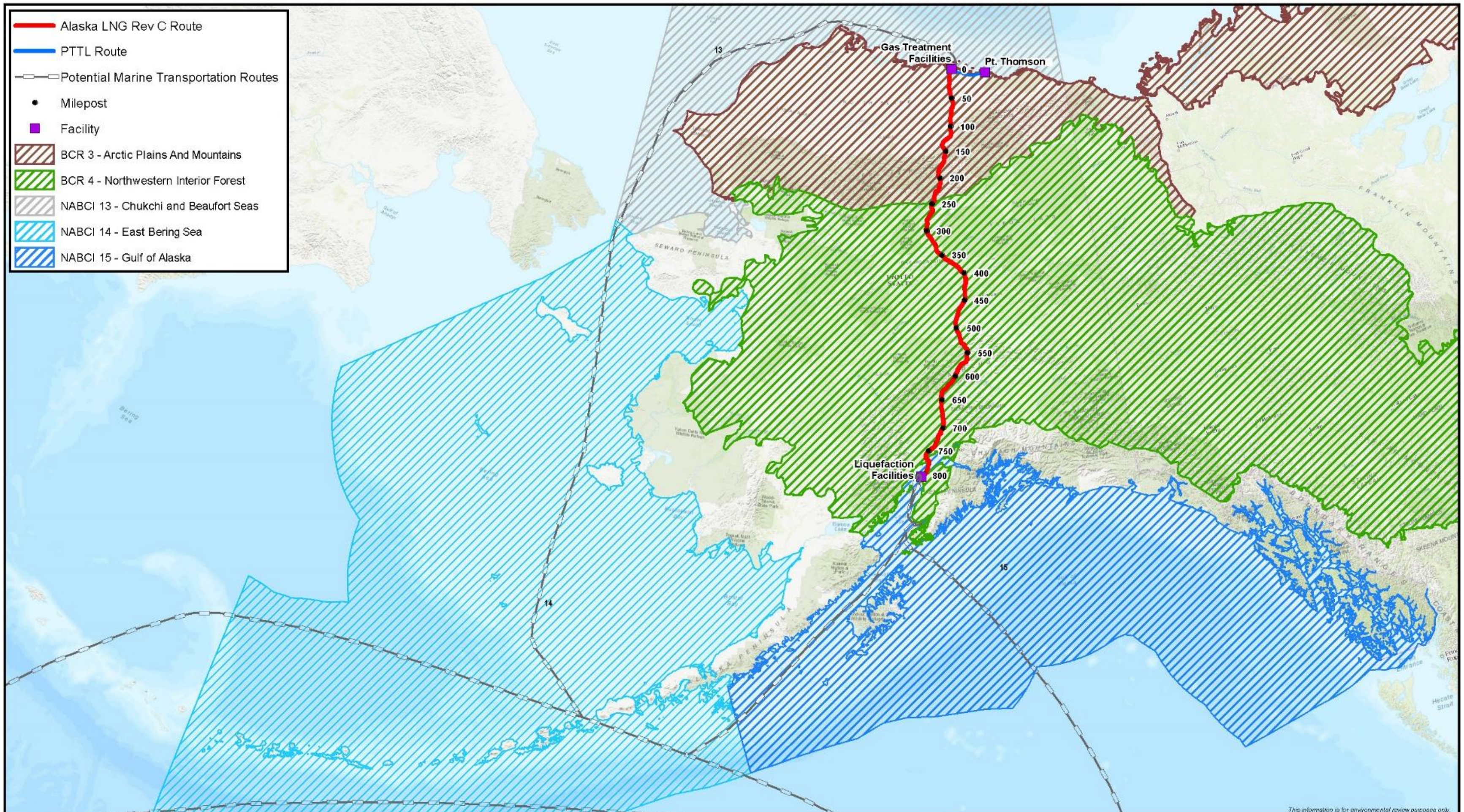
Many passerines migrate to and breed in Alaska from wintering areas in temperate and tropical regions in the Americas, Africa, Europe, and Asia. In the Beaufort Coastal Plain Subregion, over 30 species of passerines have been recorded; however, only one species, the Lapland longspur, is commonly observed nesting on the tundra. Species richness was similar in areas surveyed farther south in the Coast Mountains Boreal Ecoregion (e.g., Tanana-Kuskokwim Lowlands and Alaska Range Subregions) within the DNPP where 36 to 47 species of passerines were identified. The majority of detections included members of three families comprising sparrows, finches, and warblers (Phillips et al., 2017). Passerines overwintering in southern and/or central Alaska include American dipper (*Cinclus mexicanus*), black-billed magpie, brown creeper (*Certhia americana*), common redpoll, and gray jay. Table 4.6.2-1 provides additional representative passerine species found near the Project.

Upland Birds

Upland birds include grouse and ptarmigan. Alaska is home to four species of grouse including ruffed, sharp-tailed (*Tympanuchus phasianellus*), spruce (*Falcipennis canadensis*), and sooty (*Dendragapus fuliginosus*). Three species of ptarmigan are found in Alaska and include willow, rock, and white-tailed (*Lagopus leucura*). All of these species are native to Alaska and are legally hunted through ADF&G's Small Game Program (ADF&G, 2019b). With the exception of the sooty grouse, all species of grouse and ptarmigan are found in the Project area.

USFWS Birds of Conservation Concern

The 1988 amendment to the Fish and Wildlife Conservation Act mandates the USFWS to "identify species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the ESA of 1973." The USFWS has an incentive to encourage proactive management of these species by state agencies and other partners to prevent the need for listing them as endangered or threatened. EO 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*, recommends Birds of Conservation Concern (BCC) lists be consulted as they are intended to stimulate coordinated and collaborative proactive conservation actions among federal, state, tribal, and private partners. The USFWS adopted Bird Conservation Regions (BCR) as the smallest geographic scale of distinct regions in North America that share similar BCC, habitats, and resource management issues for conservation. The Project facilities and associated shipping lanes would be located across two terrestrial BCRs (i.e., Arctic Plains and Mountains and Northwestern Interior Forest) and three marine BCRs (i.e., Chukchi and Beaufort Seas, East Bering Sea, and GOA) (see figure 4.6.2-1) (Bird Studies Canada and North American Bird Conservation Initiative, 2014; North American Bird Conservation Initiative, 2000; USFWS, 2008a). Twenty-one bird species and subspecies in the Project area are designated BCC in these regions (see table 4.6.2-2). Many of these species overlap with Alaska's SGCN and BLM Sensitive and Watch List Species, which are discussed further in section 4.8.



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N W E S

Figure 4.6.2-1
Alaska LNG Project
Bird Conservation Regions Map

DATE: 09/21/2018 | SCALE: 1:9,500,000 when printed at 11x17

TABLE 4.6.2-2

U.S. Fish and Wildlife Service Birds of Conservation Concern

Species	Habitat Association	Bird Conservation Region [a]	Facility
Arctic tern (*Sterna paradisaea*)	Open landscape near water; barrier beaches; marshes, bogs, and grassy meadows; tidal flats	BCR 3	Project-wide
Bar-tailed godwit [b] (*Limosa lapponica*)	Nests in sedge meadows and coastal tundra; staging in nearshore estuarine areas and beaches; observed nesting at Prudhoe Bay	BCR 3	GT-MF
Buff-breasted sandpiper [b] (*Calidris subruficollis*)	Nests on tundra; uses tidal marshes during migration	BCR 3	GT-MF
Bristle-thighed curlew [b, c] (*Numenius tahitiensis*)	Nests on hilly, inland tundra, often placing their lined depressions directly beneath dwarf willow shrubs	BCR 4	N/A [d]
Dunlin [b, c] (*Calidris alpina*)	Intertidal mudflats, estuaries, marshes, flooded fields; sandy or gravelly beaches; shores of lakes and ponds; nests in wet coastal tundra, grass or sedge tundra with pools and bogs	BCR 3	GT-MF
Eskimo curlew (*Numenius borealis*)	Arctic tundra and open grasslands (see section 4.8)	BCR 3	N/A [d]
Horned grebe (*Podiceps auritus*)	Small to medium shallow ponds and marshes with emergent vegetation and open water; associated with spruce species	BCR 4	MF
Hudsonian godwit [b, c] (*Limosa haemastica*)	Nests on grassy tundra, near water; non-breeding habitat includes marshes, beaches, flooded fields, and tidal mudflats	BCR 4	MF-LF
Lesser yellowlegs (*Tringa flavipes*)	Muskeg and freshwater marshes in open boreal forests and forest-tundra transition habitat; shallow wetlands near trees, shrubs, and open water	BCR 4	MF-LF
Olive-sided flycatcher [b, c] (*Contopus cooperi*)	Breed in forest and woodland habitats (e.g., taiga, subalpine coniferous, and mixed coniferous-deciduous forests); nesting sites typically with dead standing trees	BCR 4	MF-LF
Peregrine falcon [b, e] (*Falco peregrinus*)	Various open habitats including tundra, seacoasts, open forest, and mountains	BCR 3, BCR 4	Project-wide
Red knot [b, c] (*Calidris canutus*)	Seacoasts on tidal flats and beaches; sandy or pebbly beaches; river mouths and mudflats; nests on ground in barren or stony tundra and vegetated, moist tundra	BCR 3, BCR 4	VT-MF-LF
Red-throated loon [b, c] (*Gavia stellate*)	Nesting areas around Beaufort Sea; freshwater ponds and lakes in coastal and alpine tundra	BCR 3	Project-wide
Rock sandpiper [b, c] (*Calidris ptilocnemis*)	Non-breeding habitat includes rocky seacoasts, breakwaters, and mudflats; breeding habitat in grassy or mossy tundra in coastal or montane areas	BCR 4	MF-LF
Rusty blackbird [b, c] (*Euphagus carolinus*)	Wet forests including bogs, fens; winters in swamps, wet woodlands, and pond edges	BCR 4	MF-LF
Short-billed dowitcher [b, c] (*Limnodromus griseus*)	Mudflats, estuaries, shallow marshes, pools, ponds, flooded fields, and sandy beaches; nests in grassy or mossy tundra and wet meadows	BCR 4	MF-LF
Smith's longspur [b, c] (*Calcarius pictus*)	Dry, grassy tundra; nests in grass or sedge tussock or mossy hummock near trees	BCR 3, BCR 4	MF
Solitary sandpiper [b] (*Tringa solitaria*)	Muskeg and woodland ponds or pools	BCR 4	MF-LF
Upland sandpiper [b] (*Bartramia longicauda*)	Extensive open tracts of short grassland; dry meadows, pastures; peatlands and scattered woodlands near timberline	BCR 4	MF

TABLE 4.6.2-2 (cont'd)

U.S. Fish and Wildlife Service Birds of Conservation Concern

Species	Habitat Association	Bird Conservation Region [a]	Facility
Whimbrel [b, c] (*Numenius phaeopus*)	Beaches, tidal mudflats, marshes estuaries, sandy and rocky shores; nests in sedge-dwarf shrub tundra, sedge-meadow, bogs	BCR 3, BCR 4	Project-wide
Yellow-billed loon [b, c, e] (*Gavia adamsii*)	Tundra lakes in summer, feeding on rivers and coastal lagoons; coastal waters in winter	BCR 3	GT-MF

Sources: ACCS, 2016a; USFWS, 2008a

GT = Gas Treatment Facilities; MF = Mainline Facilities; LF = Liquefaction Facilities; VT = Vessel Transit; N/A = not applicable

[a] Marine BCRs 13, 14, and 15 do not have species-specific associations like the land-based BCRs, and therefore were not included here. Additionally, species listed are of concern only within this region(s); however, species may occur within other areas associated with the Project, but are not listed as a BCC.

[b] Alaska SGCN.

[c] BLM Sensitive and Watch List Species.

[d] Species is not expected in Project area.

[e] ESA delisted. Yellow-billed loon was a previous Candidate species.

4.6.2.3 Impacts and Mitigation

Project construction and operation would temporarily and permanently affect avian resources. Impacts generally would include habitat degradation and loss, loss of reproductive opportunity as a result of construction and operation activities, elevated stress, increased rates of injury and mortality, collisions, displacement, disturbance, noise and lighting, and human presence. As previously discussed in section 4.6.1, wildlife, including birds, would generally avoid the disturbance caused by construction activities. Individuals avoiding these activities would be displaced to adjacent habitat, which could strain resources and resident wildlife. Additional repeated potential impacts from operational activities would include injury and mortality from vegetation clearing for pipeline maintenance and inspections; stormwater discharge from the Mainline Pipeline aboveground facilities and the LNG Plant; flare operation; human activity; and right-of-way maintenance. Finally, impacts on birds would include injury or mortality from an increase in hunting access and/or predation and spills. Mitigation measures to avoid or minimize impacts on birds and their habitats are provided below. Additional measures for selected avian species can be found in the Project Migratory Bird Conservation Plan. In addition to AGDC's Project Plans and Procedures, AGDC prepared other plans (see table 2.2-1) that would be implemented to reduce overall potential environmental impacts.

Habitat Effects

The temporary and permanent loss and degradation of habitat would affect birds by increasing the rates of stress, injury, and mortality. Impacts from habitat loss and degradation would include loss of foraging, mating, breeding, nesting opportunities, and migratory stopover resources. Furthermore, habitat loss and degradation could result in avoidance and an increase in edge effects. For example, the temporary loss of tall tree stands due to Project construction could reduce owl and other raptor nesting habitat until it is recovered, which would take decades, if it recovers at all. Permanent impacts on forest habitats resulting from Project construction and operation would eliminate habitat (e.g., nesting, perching, feeding, and protective cover) for tree nesting species in those areas.

Mainline Pipeline right-of-way maintenance would permanently convert forest communities to scrub and herbaceous communities within a 10- to 30-foot-wide corridor centered on the pipeline (see section 4.5.2). The presence of an herbaceous and scrub corridor would also create an edge effect in forest communities along the Mainline Pipeline right-of-way and access roads that would persist for at least the 30-year life of the Project, plus vegetation recovery time (see section 4.5.3). An edge effect would also occur at facility boundaries. While edges are common components in many landscapes (e.g., riparian corridors), habitat edge effects on birds vary among species, among different edge types, and across landscapes. Edge effects implications on bird populations range from the alteration of microclimatic conditions to changes in interspecific interactions such as predation and nest parasitism (Sisk and Battin, 2002).

Portions of Project construction activities would overlap with avian nesting seasons. In particular, land disturbance and vegetation clearing could directly affect nesting birds. Some portions of the Mainline Pipeline would be constructed in winter, which could result in disturbance and displacement of resident and overwintering species, such as the western sandpiper. Project construction and operational activities (e.g., vegetation clearing, excavation, initial granular fill placement, brush hogging, water discharge, and off-road vehicle use) that would overlap with avian nesting seasons could directly affect nesting birds by causing disturbance and displacement. Further, adult birds, unfledged young, and eggs would be killed, injured, or damaged if these activities occurred during the nesting season. Impacts on nesting birds would be reduced when following land disturbance timing guidelines recommended by USFWS (see table 4.6.2-3).

TABLE 4.6.2-3

U.S. Fish and Wildlife Service Recommended Timelines to Avoid Land Disturbance and Vegetation Clearing

	Habitat Type			
Alaska Region Associated Facilities	Forest or Woodland (trees present)	Shrub or Open [a]	Seabird Colonies	Raptor [b]
Northern				
Gas Treatment and Mainline Facilities	N/A	June 1 – July 31 [c]	May 20 – September 15	April 1 – July 31
Interior				
Mainline Facilities	May 1 – July 15 [d]	May 1 – July 15 [d]	May 1 – July 20 [e]	March 1 – July 15
South-Central				
Mainline and Liquefaction Facilities	May 1 – July 15 [d]	May 1 – July 15 [d]	April 15 – September 7	March 1 – July 15

Source: USFWS, 2017b
N/A = not applicable
[a] Habitat characteristics include shrub cover or marsh, pond, tundra, gravel, or other treeless/shrubless ground habitat.
[b] Eagles and eagle nests have additional protections under the BGEPA, and a permit could be required to conduct activities near an eagle nest. Additional information regarding bald and golden eagles is in section 4.6.2.4.
[c] Black scoter (*Melanitta americana*) are known to nest through August 10.
[d] Canada geese (*Branta canadensis*) and swans begin nesting April 20.
[e] Seabird colonies in the Alaska interior refer to terns and gulls.

To the extent practicable, AGDC would conduct land disturbance activities on the Beaufort Coastal Plain during winter months and thereby avoid nesting birds. Project-wide, AGDC would conduct vegetation clearing, grubbing, and disruptive activities outside the timing windows identified by the USFWS (provided in table 4.6.2-3) to the greatest extent practicable. However, conditions (e.g., environmental constraints) could preclude winter clearing and AGDC would clear during other seasons. Clearing during the summer nesting season could remove nesting habitat for birds and/or disturb active nesting birds, resulting in nestling/egg and adult mortality. Additionally, clearing near active nests during incubation or brood rearing would likely result in bird disturbance and/or displacement and affect egg and young survival. Permanent habitat displacement for avian resources could lead to long-term impacts or otherwise resonate throughout the life cycle as carry-over effects (Norris, 2005; Sexson et al., 2014). Carry-over effects are events that occur in one season and could influence individual success the following season; carry-over effects could play an important role in migratory bird population dynamics (Norris, 2005). With implementation of our recommendation in section 4.6.2.5 to avoid vegetation clearing and granular material placement in IBAs during nesting seasons, direct impacts on nesting birds would be avoided in these areas; however, granular fill placed in wetlands would cause permanent habitat loss for some species, such as waterfowl and swans.

As discussed in section 2.2, AGDC's Project Plan includes modifications to FERC's Plan. The modifications that we found acceptable, as proposed by AGDC, or acceptable with revisions or recommendations, are summarized in appendix D. AGDC stated in its Migratory Bird Conservation Plan that vegetation clearing would be scheduled outside of the timing windows identified by the USFWS "to the greatest extent practicable." Section VII.A.5 of FERC's Plan prohibits applicants from conducting routine vegetation mowing or clearing for right-of-way maintenance in the migratory bird nesting season between April 15 and August 1 of any year unless specifically approved in writing by the responsible land management agency or USFWS. Although AGDC provided notes from a meeting with the USFWS in Washington, D.C., in which this requirement was discussed, it is unclear if the USFWS approved of AGDC's proposal to conduct maintenance mowing or clearing during the migratory bird nesting season. Moreover, the meeting notes do not satisfy the Plan's requirement to have written documentation from the USFWS or land management agency, and clearing during the migratory bird nesting season conflicts with our recommendation to avoid clearing during the migratory bird nesting season in IBAs (see section 4.6.2.5). A waiver of the clearing restriction would need to come from FERC, based on any input provided by the USFWS. Because AGDC has not clearly indicated that it would comply with the operational vegetation clearing timing requirements of FERC's Plan, **we recommend that**:

- **<u>Prior to vegetative mowing or clearing during the migratory bird nesting season</u>, AGDC should file with the Secretary, for the review and written approval of the Director of the OEP, documentation necessary to satisfy the requirements of Section VII.A.5 of FERC's Plan.**

The BLM commented that temporary impacts on waterbird habitat could occur from water withdrawal from lakes and/or reservoirs. For birds that nest in wetland habitats, nest success correlates with water levels (Schamel, 1977). Water would be withdrawn from surface freshwater sources at the GTP (e.g., for a water reservoir, construction camps, ice roads, and other facilities), PTTL and PBTL (e.g., for hydrostatic testing), Mainline Pipeline (e.g., DMT construction and hydrostatic testing), as well as the Liquefaction Facilities camp. The USFWS commented on the potential impacts on birds when large volumes of water are discharged onto a wetland or on upland habitat. Impacts would include the destruction of eggs and/or nestlings of ground-nesting birds. Section 4.3.4 provides details regarding water use, including surface water withdrawals and water sources for the Project.

Project construction activities supporting site preparation, including excavation, grading, and placement of granular surfaces, would result in nesting habitat loss for birds where the area could support nesting birds. The creation of access roads, including tundra covered by granular fill, would cause permanent habitat loss for nesting, brood rearing, and foraging. Impacts would be permanent for a small subset of ground nesting bird species in areas that would be filled with granular fill and/or where full recovery of vegetation is not possible, including functional loss to the underlying wetlands. The loss or conversion of wetlands could affect numerous bird species, such as waterbirds and seabirds, and would have an impact on passerines as well as tundra-nesting raptors. Permanent habitat loss for birds would also result from habitat conversion for operation and maintenance of the Mainline Pipeline right-of-way and permanent facilities placement and operation. Some of the habitat loss could be mitigated by remediating material sites into ponded habitat areas, as described in section 4.7.1.

Land and offshore-based construction of the Mainline Facilities, including construction of the Mainline MOF, would result in bird disturbance, habitat loss, and habitat alteration (e.g., nest destruction) and could result in the displacement of birds. Similarly, construction and operational activities associated with the Liquefaction Facilities, including operation at the Marine Terminal Facilities, dredging for the Marine Terminal MOF, and removal of the Marine Terminal MOF, would result in habitat loss and disturbance of birds at molting and wintering habitats.

Vessels in transit to the Marine Terminal MOF and Mainline MOF during construction, and LNG carriers during operation, would temporarily stage or anchor at Kachemak Bay and transit through the Shelikof Strait. These areas have high concentrations of waterbirds in nearshore environments during fall (September through November) and winter (December through March) months as well as high concentrations of nesting bald eagles during summer months (June through August) (NOAA, 2018a). Impacts on birds would include the degradation of habitat from vessel traffic, including LNG carrier traffic. Habitat degradation could occur through spills and the introduction of aquatic invasive organisms. However, most vessels and LNG carriers associated with the Project would avoid nearshore environments.

The Mainline MOF near Beluga Landing and the Mainline Pipeline across Cook Inlet between the area south of Shorty Creek (also referred to as Beluga Landing South Shore Approach) near Tyonek and the area near Boulder Point could affect shorebirds during energetically stressed periods. This area (which is included in the Susitna Flats) is important to western sandpipers during spring migration, as well as various other shorebird species (Gill and Tibbitts, 1999). The Upper Cook Inlet region is also the primary wintering range of the rock sandpiper subspecies (*Calidris ptilocnemis ptilocnemis)* (Ruthrauff et al., 2013; Gill and Tibbitts, 1999). Gill and Tibbitts (1999) determined that the Susitna Flats accounted for 82 percent of shorebird use during the winter. Cook Inlet has wetland sites important to the conservation of shorebirds. Construction of the Mainline MOF would occur in April and May, when western sandpipers would be using this area during migration. These activities could affect large numbers of sandpipers if concurrent with energetically demanding periods.

The USFWS commented on the potential for spills related to accidental releases of LNG and/or spills of fuel, specifically where these would enter waterbodies (e.g., coastal and marine environments of Cook Inlet and the Beaufort Sea) and in terrestrial habitats. As described in section 4.3.3, accidental gas releases from the Mainline Pipeline would not be anticipated. During operation, the pipeline would employ industry standards for safety and pipeline monitoring, as outlined in detail in sections 2.5.2 and 4.18.10, that would minimize the duration of an accidental release and result in brief and localized impacts in marine waters.

The use of mechanical equipment to construct and operate the Project could result in accidental spills or releases of fuel and other hazardous materials, adversely affecting water quality for birds. Birds could be affected by equipment related fluid spills through direct ingestion or contact with their plumage as well as inhalation. Threats to avian species increase when spills occur near or within areas of high bird concentration such as large nesting colonies, winter foraging areas, and migratory stopovers (NOAA, 2018d). Examples of these locations include waterfowl nesting/brood rearing concentrations overlapping portions of the Gas Treatment Facilities, Mainline Facilities, and Liquefaction Facilities (ADF&G, 2001a; NOAA, 2018a). Additionally, snow geese nesting concentrations on Howe Island near the Sagavanirktok River delta are about 0.5 mile north of the PTTL (Johnson, 1998; Stickney et al., 2011; Sullender, 2017), and seabird colonies numbering up to 10,000 birds on Gull Island in Prudhoe Bay overlap marine vessel transportation routes (ADF&G, 2001a). The magnitude of impact would depend on fluid type, volume, season, and response.

To minimize the potential for an inadvertent equipment fluid release, AGDC would adhere to the fueling, storage, containment, and cleanup measures described in its Project SPCC Plan. A template for the Project SPCC Plan describing generic practices and procedures to protect freshwater resources from a potential release of fuel or hazardous materials was included in AGDC's application, but this template does not provide specific measures for construction or facility-specific operational plans. AGDC has committed to developing facility/work site-specific SPCC plans prior to construction, as discussed in section 4.2.6. Hazardous materials would be handled in accordance with the Project Procedures as well as the Project Waste Management Plan (see section 4.9.6). Implementation of the Project SPCC Plan, the SWPPP, Project Procedures, and Project Waste Management Plan would reduce the likelihood of spills and the magnitude of spills should they occur.

Newly constructed stormwater ponds at the LNG Plant could affect birds. Stormwater ponds could attract waterbirds, especially ducks and gulls, which could find the ponds attractive for resting. Stormwater ponds could receive pollutants from on-site drainage and birds using these ponds could be exposed to contamination, including oil that could damage the thermal insulation and buoyancy of their feathers leading to hypothermia, stress, injury, and/or mortality. AGDC would implement measures to mitigate impacts on birds using stormwater ponds. These measures include:

- treating waters before discharge to the ponds (e.g., treatment by oily water separators for operational areas, as needed);
- inspecting the ponds after storm events to determine whether oily contaminants from runoff entered the ponds;
- pumping water from the ponds back through the treatment facility if contaminants are present; and
- developing and implementing an SPCC Plan for operation of the Liquefaction Facilities consistent with permit requirements.

With the implementation of recommendations for construction and operational vegetation clearing and avoidance of land disturbing activities during the migratory bird nesting season, particularly in areas where concentrations of more sensitive species occur, we have determined that population-level impacts on birds would not likely occur.

Noise

Birds use a vast array of sounds for communicating, finding mates, establishing and expressing territories, and other social behaviors (Dooling and Popper, 2016). Birds, and particularly nesting birds, can be negatively affected by noise emitted at continuous or irregular intervals during sensitive times of the year (Burton et al., 2002; Drewitt and Langston, 2006). Short-term, startle/response effects of noise in wildlife are well known, whereas effects from long-term noise exposure are poorly understood and difficult to quantify (Gill et al., 1996). Physical damage to birds' ears occurs with short-duration loud sounds or continuous exposure to noise (Dooling and Popper, 2016; Ortega, 2012). Extensive literature exists documenting the effects of anthropogenic noise on wildlife (Barber et al., 2011). Studies show that noise functions as a chronic stressor that can alter stress hormones and have multiple effects on fitness in bird communities (Kleist et al., 2018). Chronic and frequent noise interferes with animals' ability to detect important sounds, whereas intermittent and unpredictable noise is often perceived as a threat. The USFWS states that noise could harm prey species or prevent detection of predators.

Given the energetic costs expended in responding to aural disturbance (e.g., flushing and increased stress), impacts from noise can lead to fitness costs, either directly or indirectly (Francis and Barber, 2013). Behavioral responses to disturbance can include reduced feeding, increased vigilance, and a reduction in parental care. Impacts on wildlife range from mild to severe and include damage to the auditory system, masking of sounds important to survival and reproduction, imposition of chronic stress and associated physiological responses, startle responses, interference with mating, and population declines (Schroeder et al., 2012; Blickley and Patricelli, 2010). Noise (acute and chronic), could cause nest abandonment and failure, increased incubation recess, reduced food supplies to chicks resulting in malnutrition or starvation of the young, and/or territory abandonment (Francis et al., 2009). Disturbance and nest abandonment could result in inadvertently damaging eggs. Egg knuckling is an effect of disturbance for many raptor species (including eagles) and occurs when an incubating adult raptor is disturbed and suddenly flushes their nest and pierces or damages the eggs (Watson, 2004; Ames and Mersereau, 1964).

Noise from construction equipment, vehicle traffic, airplanes, helicopters, blasting, and general Project-related activity during construction and operation could affect bird behavior (AMEC Americas, 2005). Sources include single impulse sounds (e.g., blasting), multiple impulses (e.g., jackhammers, pile driving), and non-strike continuous noise (e.g., construction sounds) (Dooling and Popper, 2016). Construction and operational noise that would disturb birds include clearing and grading for site preparation; building construction, including installation of facility foundations (e.g., pile driving); materials transport; installation and operation of the gravel mine and construction camps; water reservoir installation; and facility operation. It has been shown that animals can experience habituation to noise when exposed for a long period of time, thereby diminishing their behavioral response; however, physiological effects related to duration of the exposure could still occur (McGregor et al., 2013).

Noise can result in adverse impacts at much lower noise levels than those required for hearing damage. Distances at which noise would attenuate to ambient levels would depend on local conditions such as tree cover and density, topography, weather (humidity), and wind, all of which can alter background noise conditions. As a consequence, impacts on birds from construction noise would vary along the Project corridor. The USFWS commented that short, intermittent disturbances like blasting could have greater deleterious impacts on birds than long-term noise. Temporary or permanent displacement and reduced fitness (e.g., foraging opportunities and behavior changes) are likely impacts resulting from noise disturbance. Noise generated during vibratory and impact pile driving could range from 39 to 68 dBA in air depending on the type, conditions, and distance from the source. When reviewing effects of highway noise on birds, Dooling and Popper (2016) found that birds can tolerate up to 72 hours of continuous exposure to noises up to 110 dBA without experiencing hearing damage. However, Ryals et al. (1999) document the amount of hearing loss and found that time of recovery varied considerably among different bird species.

Birds could be temporarily displaced during periods of active sheet and pile driving, but could return to marine construction areas during breaks from these activities (e.g., maintenance days and shifts at night). Birds could become displaced from their nesting habitat if pile driving is initiated early in the nesting season. Initiation of pile driving during the middle of the nesting season could lead to nest abandonment and lost or reduced productivity. Birds, including raptors and common ravens, would initiate nests before the open-water construction season beginning on April 1. Pile driving during spring and fall could displace migrant birds from coastal stopover or staging habitats in Cook Inlet. Blasting could also affect bird hearing (Dooling and Popper, 2016). Behavioral effects from blasting would be similar to those described for pile driving. Additionally, birds within the blast zone could experience injury or death through noise concussion or flyrock strikes. To reduce noise disturbance impacts on birds, AGDC committed to performing non-lethal hazing to clear areas of wildlife prior to blasting (see section 4.6.1.2).

Construction noise associated with the Mainline Pipeline would not be concentrated at any one location for an extended period of time with the exception of DMT installation locations and air transportation to Project sites (see section 4.16). Noise impacts and mitigation associated with the DMT construction method are described in section 4.16.3. DMT would create noise above ambient levels and could affect birds by causing displacement and stress.

Operational noise associated with the Mainline Facilities that would disturb birds include operation of aboveground facilities (e.g., compressor stations, heater station, meter stations, and MLVs) and intermittent noise due to blowdowns (as described in section 4.16.4). Operation of the Gas Treatment and Liquefaction Facilities, as well as Mainline compressor stations, would generate noise above ambient levels that could affect birds. Noise generated from operation of the GTP, LNG Plant, compressor stations, and the heater station would not reach the 93-dBA level for temporary threshold shifts (i.e., behavioral effects) outside of the facility footprint (Dooling and Popper, 2016). Birds that enter the footprints of these facilities could experience behavioral and energetic effects. Sound generated by the facilities would contribute to further increases in industrial noise in the area and could result in displacement of and loss of fitness for waterbirds, passerines, and raptors. While sounds would not reach temporary threshold limits established by Dooling and Popper (2016), noise from the GTP, LNG Plant, compressor stations, and the heater station would be above background noise levels and would operate continuously for the life of the Project. This noise could interfere with hearing, important to survival, or reproductive cues, which could result in reduced survival and productivity near these stations. Sounds from equipment could affect sensitive bird habitat, including waterfowl habitats that occur near compressor stations and the heater station, by raising ambient sound levels that degrade habitat quality. Given that communication is through singing, continuous noise could make finding mates more difficult. Due to the additional continuous operational noise, habitat surrounding aboveground facilities could become uninhabitable by birds, as they would avoid these areas (Habib et al., 2007; Ortega, 2012).

An increase in air traffic, including helicopter and airplane noise associated with construction of the Mainline Facilities and operation of the Liquefaction and Gas Treatment Facilities, would create more noise disturbance for birds around these facilities. For example, nesting birds would flush from their nests during helicopter overflights. Sullender (2017) reports the energetic cost of disturbance may be compounded by an increase in nest predation while the disturbed bird is away. While the nesting bird is flushed, nest predators such as gulls and jaegers can take advantage and prey on abandoned eggs or unfledged chicks. Aircraft flying below altitudes of 4,000 feet and within 4,000 feet laterally of birds would generally elicit behavioral responses. Responses are strongest within 3,280 feet for eiders and 5,280 feet for molting geese (Sullender, 2017). Molting geese can be displaced by as much as 1.8 miles from the disturbing aircraft (Derksen et al., 1982), and eiders will dive under water in an attempt to avoid disturbing aircraft (Mosbech and Boertmann, 1999; Sullender, 2017).

Due to the short duration of construction noise and low levels of operational noise, impacts on birds from Project-related noise would not be significant.

Lighting

Artificial lighting, including equipment lighting, floodlights, aboveground facility lighting, tower or antenna lighting, and lighting on docks or anchored marine barges and vessels, would temporarily and permanently affect birds. Sources providing artificial lighting that could pose risks for injury to migratory birds include facility lighting (i.e., during construction and operation), tower or antenna lighting, lighting on docks or anchored marine barges and vessels, worker camp lighting, and flare tower operation. Additionally, artificial lighting sources include facility lighting that would illuminate working areas for work onshore and work over and within water (e.g., screeding and pile driving), lighting for security purposes, and lighting that would illuminate work areas during winter Mainline Pipeline right-of-way construction.

During operation, the aboveground facilities would require year-round lighting. Facility lighting would consist of normal and essential lighting panels and lighting fixtures to provide lighting for working areas and for security requirements. Outdoor general lighting would be high-pressure sodium or light-emitting diode lights mounted on poles about 100 feet high and directed toward facilities, similar to typical street lighting. Lighting design would direct lighting only in places where it is necessary, and would be designed and shielded, where applicable, to reduce light trespass, unwanted projection, and upward-directed light.

Certain lighting on structures (e.g., red steady-state) can be disorienting for birds, which increases collision risk (Manville, 2000; Reed et al., 1985; Russell, 2005). Artificial lighting can alter bird behavior. Artificial lighting could increase predatory risk for some bird species and reduce foraging behavior for birds. Migratory birds use natural light from the sun, moon, and stars for navigation; artificial lighting can disrupt this behavior and increase collision rates (Cochran et al., 2004; Watson et al., 2016). Birds can circle sources of artificial light for hours to days, especially during overcast skies when they are more reluctant to fly outside the illuminated area (Avery et al., 1976; Montevecchi, 2006). These risks would be particularly higher during spring and fall migration periods as birds are migrating along flyways.

During migration and periods of low visibility, birds could be attracted by facility lighting or the low-pressure flare pilot and collide with the flare, communication tower, Marine Terminal, or other buildings or modules (Day et al., 2015). Almost 7 million birds, predominantly night-migrating songbirds, die annually because of collisions with lit communication towers in the United States (USFWS, 2018d). The Beaufort Sea is an important migration route for shorebirds, and a number of seabird species appear to be attracted to lighting events (e.g., flaring); these species are at risk of lighting attraction and potential fatality (Day et al., 2015). Additionally, flaring events in the Arctic could affect fat stores for migrating bird species as lighting events could cause extensive periods of circling (Day et al., 2015; Montevecchi, 2006).

Birds could be particularly susceptible to impacts from lighting during months when little to no daylight is present within the North Slope and on overcast days (e.g., fog and inclement weather). Conversely, lighting during summer months could be less of an issue for birds since day length is greater than 20 hours along portions of the Project.

Offshore and onshore construction-related lighting that would not normally be present during winter could affect overwintering avian wildlife in Cook Inlet (Montevecchi, 2006). These artificial light sources could affect birds that overwinter in this area since they could be attracted to the source, thereby increasing collision risk.

To avoid or reduce lighting effects on birds, AGDC would implement FAA guidelines and the USFWS's *Guidance for Lighting for Birds* (USFWS, 2016c). AGDC would follow the latest version of FAA Advisory Circular AC 150/5345-43 *Specification for Obstruction Lighting Equipment* and AC 70/7460-1 *Obstruction Marking and Lighting* (FAA, 2016). The advisory circulars set forth lighting color and flash requirements. AGDC would follow the standards regarding the number of lights, minimum intensity, and minimum number of flashes per minute. AGDC would implement measures to minimize lighting impacts on birds, including the use of:

- localized task lights (e.g., light hoods to reduce outward radiating light);
- strobe lights for tower lighting; and
- down-shielded lights on buildings and freestanding lighting or security lighting.

Additional details are provided in AGDC's Project Lighting Plan (see table 2.2-1). Because AGDC would design facility lighting to direct lighting only in places where it is necessary, and shield facility lighting where applicable to reduce light trespass, unwanted projection, and upward directed light, effects from light on birds would be reduced. Additional information on the lighting requirements and measures to reduce impacts associated with lighting, including our recommendation for the lighting at the Healy Compressor Station, is provided in section 4.10.2.

Collisions

Birds are susceptible to collisions with Project facilities and equipment. Migratory birds are particularly at risk of collision when darkness and/or inclement weather impairs vision or causes disorientation. Collisions with structures often result in mortality (Black, 2004; Manville, 2005; Weir, 1976). Birds could also experience collision injuries including concussions, internal hemorrhaging, and broken bones.

Project construction and operation would result in permanent increases in vehicular traffic. As a result, birds could be disturbed, displaced, or killed by vehicle collisions. USFWS commented that owls are frequently killed by vehicular collisions as well as other birds of prey due to scavenging on other road-killed wildlife.

Vessel traffic during construction is expected from April through October, which could displace birds from the immediate area. Waterfowl and seabirds would continue to move through the area, but could swim or fly further offshore or inland away from the center of vessel activity near the Marine Terminal. Birds that are more tolerant could continue to use the shoreline habitats in the area, and others could return when vessel activity is minimal such as periods between vessel arrivals and departures. Marine vessels could collide with birds resulting in injury or death. Information is limited, but the best available data to estimate collision risk between marine vessels and migratory birds are observations recorded during Royal Dutch Shell's (Shell) exploratory oil and gas activities in 2012 (USFWS, n.d.[a]; Schroeder, 2013). Ten vessels operating in the Chukchi Sea for 108 days resulted in 131 total bird–vessel encounters. There were 17 fatal collisions with eiders, 13 king eider (*Somateria spectabilis*), and 4 common eider. Of these 17 collisions, 2 involved mobile offshore drilling units and 15 involved support vessels, which are similar to barges. When considering that 10 vessels were involved in the 15 fatal eider collisions with support vessels, an estimated collision rate per vessel would be 1.5 (i.e., 15 ÷ 10 = 1.5 collisions/vessel) over a 108-day season. However, other factors, such as bird density and noise, would also influence the number of collisions. The total number of vessel trips associated with Project construction is provided in section 4.12.

Avian species at greatest risk for collisions with vessel traffic include eiders (e.g., common, king, spectacled, and Steller's) due to their high-speed flight travel, relatively low flight altitude over water, and attraction to bright lights at night (Day et al., 2004 and 2005). Specifically, king eiders fly so low over water that flocks have been reported to split to go around a small boat (Bailey, 1948). Vessel traffic could displace seabirds, shorebirds, ducks, and geese foraging near or moving through the Marine Terminal area. Shoreline habitats near the Marine Terminal Facilities do not appear to be important fall migration stopover or staging habitats for waterbirds or seabirds (NOAA, 2018a); however, overall bird species richness is high in this region (ACCS, 2016b). Vessel traffic at the Marine Terminal could cause mortality from a vessel collision, but traffic is more likely to result in minor, temporary, local disturbance, and displacement of waterbirds in the vicinity. Vessel transit through Cook Inlet, including transfer of the pilot from Homer and Nikiski by boat at the anticipated rate of one every other day to one per day, is also not expected to result in more than minor temporary local disturbance and waterbird displacement. Vessel traffic routes are away from coastal bird habitats and vessels maintain relatively low speeds in Cook Inlet.

Helicopter and aircraft activities during construction and operation would cause a short-term disturbance, distract birds, and increase the collision risk. Impacts on avian resources from air traffic would include injury or mortality from collisions, disruption of seasonal movements, displacement from roadside habitats, and/or reduced productivity from disturbance. Birds would be vulnerable to collision injury or mortality. Birds in the Kenai area may already be accustomed to these activities due to the existing air traffic flying to Kenai Municipal Airport as well as the on-going habitat management projects at the airport reported in the *Wildlife Hazards Management Plan*, updated by the FAA in August 2011 (Wince-Corthell-Bryson and Aries Consultants LTD., 2013). Low-level overflights of nesting colonies can be disruptive to waterfowl especially to colonial-nesting waterfowl and seabirds.

The GTP flare stacks would increase the potential for bird collisions. The GTP flare stacks would be in and near a wetland complex that could be inhabited by nesting waterbirds. Waterbirds using this basin complex could be at an increased risk for collision with the flare stacks. In addition, collocation of stormwater ponds with the ground-flare system could lead to unintentional bird mortality if they are using the pond when the flare becomes active. The flare height would generally preclude an incineration hazard for nesting birds. The bright light emitted during flare events could attract migrating eiders, and could present a collision and incineration hazard for them, although most eiders would migrate offshore and at mean altitudes well below the flare height (Day et al., 2015).

The West Dock Causeway expansion would include a temporary, installed barge bridge and turning basin as discussed in sections 2.1.3 and 2.2.1. The barge bridge would be temporarily installed before the beginning of the open-water season (typically before August) and removed 4 to 6 weeks later (typically October); there are open areas between barges that could affect birds that pass through this breach.

To minimize the potential for bird collisions with Project facilities, AGDC would implement measures as described in its Migratory Bird Conservation Plan. These measures include:

- design communication towers (e.g., monopole towers) to avoid lattice and guy wires;
- place bird diverters on any guy wires that are used to support communication towers and/or antennas;
- design buildings and facility modules to reduce surfaces where birds could roost or nest;
- design buildings and facility modules to prevent bird access to structures where they could become entrapped, such as in exposed pipe ends, exhaust stacks, or exhaust fans;
- design flares to be free standing (no guy wires);
- design communication towers to be freestanding;
- design new power distribution lines and poles with sufficient phase separation or alternative protective methods to prevent bird electrocutions or use as a nesting platform; and
- incorporate anti-perch devices into offshore and onshore structure design to prevent raptor and gull perching and associated enhanced predation on ground-nesting birds.

Human Presence

Construction camps would create the potential for wildlife–human interactions and changes in wildlife behavior or habitat use that would affect birds. Studies have suggested that pedestrian traffic is more disruptive on some bird species than vehicular traffic (Borgmann, 2011). Murphy and Anderson (1993) conducted a study of disturbance effects at the Lisburne Development in the Prudhoe Bay oil field in Alaska and reported that human foot traffic elicited a stronger response from geese and swans. Additional species that have demonstrated high rates of response around human disturbance include nesting swans (Johnson et al., 2003) and nesting raptors (Ritchie, 1987). Researchers have documented that shorebird species occur at lower densities near roads in the Prudhoe Bay oil field than in areas away from roads (Troy, 1988). Overall, human disturbance from vehicular and pedestrian traffic could affect bird activity and have negative impacts on their nest density and success.

Workers would be present at the GTP and LNG Plant at all times, resulting in permanent impacts associated with human disturbance. Most compressor stations associated with the Mainline Facilities would be remotely operated; therefore, this potential would be reduced. Facilities can also provide artificial den sites, thermal refuges, and access to human food for arctic and red foxes, which are predators of many bird species (Stickney et al., 2013). Effective waste management at facilities would reduce the attraction of foxes, bears, ravens, and gulls to the facilities. Birds could also be affected by an increase in hunting pressure from humans and predators due to the creation of new access roads and cleared right-of-way along the Mainline Pipeline.

Construction and operational impacts would include changes to bird habitat types. The construction of aboveground facilities, including communication towers and elevated pipelines associated with the GTP, PTTL, and PBTL, could provide nesting and vantage perches for raptors, common ravens, and glaucous gulls that are not otherwise available across the Beaufort Coastal Plain Subregion (Platte, 2003). USFWS recommended the use of bird deterrence structures (e.g., perch guards) to limit raven nesting on facilities. The facilities could also provide artificial den sites, thermal refuges, and access to human food for birds and their predators. Predators attracted to the area could increase predation risk for nesting birds. For example, on the North Slope, oil development may have affected densities of some predators (e.g., arctic fox, glaucous gull, common raven, and brown bear) that are known to prey on brant and snow geese. Discarded human food wastes potentially attract omnivorous scavengers that may prey on waterfowl (Truett et al., 1997). Effective waste management at the Mainline Facilities would reduce the attraction of predators as is further discussed below. Construction and use of the Mainline MOF near Beluga Landing and construction of the Mainline Pipeline across Cook Inlet (see section 2.1.4) would also result in disturbance to birds, particularly bird displacement, during spring and fall when concentrations of migrating waterbirds are present.

4.6.2.4 Bald and Golden Eagles

Bald and golden eagles occur throughout the Project area. Alaska has the largest population of bald eagles in the United States, numbering about 70,544 birds (USFWS, 2016a). The USFWS commented that large numbers of nesting and migrating bald eagles rely on habitat within the Cook Inlet Subregion. Specifically, shorelines of the Kenai River and coastal waters have high densities of bald eagle nests. Waterbodies within the Cook Inlet Subregion provide important food sources for bald eagles during winter and non-breeding seasons. Breeding habitat for bald eagles within Alaska includes coastal areas, bays, rivers, lakes, reservoirs, and other waterbodies providing abundant food sources (USFWS, 2009a; Suring, 2008). Bald eagles typically nest in old-growth timber including black cottonwood trees, but have been documented nesting on the ground within the Aleutian Islands (ADF&G, 2018h; Suring, 2008). The winter or year-round range of bald eagles is more geographically restricted, including south-central Alaska and the Aleutian Islands, with fewer birds reported wintering in the interior regions of Alaska (ACCS, 2016a).

Golden eagle breeding range extends from the North Slope throughout much of Alaska, but is less common in Kodiak, south-coastal, and southeast regions of Alaska (ADF&G, 2018h). Recent golden eagle population estimates in Alaska range from 1,000 to 4,000; these estimates were used as liberal and conservative estimates in the 2016 USFWS Preliminary EIS to evaluate the potential effects of the revised regulations on eagle population status (USFWS, 2016a,b). Golden eagle preferred habitat in Alaska includes open Arctic and alpine tundra, open wooded country, and mountainous terrain. Breeding habitat includes rugged cliffs or bluffs for nesting (ADF&G, 2018h). Golden eagle wintering or year-round ranges within Alaska are more geographically restrictive and include portions of east-central Alaska and the Aleutian Islands (ACCS, 2016a).

During the 2015 raptor (including cliff-nesting and tree-nesting raptors) surveys, 27 active and 19 inactive bald eagle nests as well as 6 active and 26 inactive golden eagle nests were identified in the study corridor encompassing 1 mile and 2 miles on either side of the Project area. Bald eagle nests were identified within the Cook Inlet Subregion, and golden eagle nests were identified within the Brooks Range Subregion. One active bald eagle nest occurs within 660 feet of the Mainline Pipeline construction right-of-way, and one active bald eagle nest was found within the operating area of the Liquefaction Facilities, and within a 1,200-foot radius of the proposed flare stack.

Constructing the Project could affect nesting bald and golden eagles. Bald eagle nesting varies by latitude in Alaska, but generally begins in January. The bald eagle breeding cycle from initial activity at a nest through the end of fledgling dependency can end as late as mid-October. Sensitivity to bald eagle disturbance during this period varies (see table 4.6.2-4).

TABLE 4.6.2-4

Relative Sensitivity of Nesting Bald Eagles to Disturbance

Phase	Nesting Stage	Sensitivity to Disturbance	Description
I: Mid-January to March	Courtship and nest building	Most sensitive period; likely to respond negatively	Most critical period: disturbance is manifested in nest abandonment. Bald eagles in newly established territories are more prone to abandon nest sites.
II: Mid-March to April	Egg laying	Very sensitive period	Human activity of even limited duration could cause nest desertion and territory abandonment for the nesting season.
III: April to May	Incubation and hatching	Very sensitive period	Adults are less likely to abandon the nest near and after hatching. However, flushed adults leave eggs and young unattended resulting in eggs susceptible to thermal stress (either over-heating or cooling), moisture loss, and predation; and young vulnerable to the elements.
IV: May to June	Early nestling period, 4 to 8 weeks	Moderately sensitive period	Likelihood of nest abandonment and vulnerability of the nestlings to elements gradually decreases. However, nestlings could miss feedings, which could affect their survival, or could prematurely leave the nest due to disruption.
V: July to August	Nestlings 8 weeks through fledgling	Very sensitive period	Gaining flight capability, nestlings 8 weeks and older could flush from the nest due to disruption and die.

Source: USFWS, 2009a

Variability in sensitivity may be related to visibility, duration, noise levels, extent of the area affected by the activity, prior experiences with humans, and tolerance of the nesting pair (USFWS, 2007). If construction and/or operational activities occur within eagle buffers previously defined, eagles could inadequately construct or repair their nest, expend energy defending the nest rather than tending to their young, or could abandon their nest altogether (USFWS, 2007, 2009a). Additionally, disruption, destruction, or obstruction of roosting and foraging habitat can also negatively affect bald eagles. Disruptive activities in or near eagle foraging areas can interfere with feeding, which reduces chances of survival (USFWS, 2007). In particular, forested impacts associated with the Mainline Pipeline right-of-way could remove nesting trees for bald eagles, while blasting activities could remove cliff-nesting habitat for bald and golden eagles. In addition to the direct loss of eagle nesting habitat, the construction of roads, and other utilities could remove and degrade habitat available for bald and golden eagles.

Golden eagle egg laying in upper latitudes and higher elevation sites often found in Alaska can occur as early as January, before late winter snow and storms have subsided (Romin and Muck, 2002; Pagel et al., 2010; ADF&G, 2018h). Egg laying interval between eggs ranges from 3 to 5 days. Incubation begins as soon as the first egg is laid, and hatching can begin as late as March to early-May in central and northern Alaska (Pagel et al., 2010). Relative sensitivity of nesting golden eagles to Project disturbance associated with construction and operational activities would be similar to those presented for bald eagles in table 4.6.2-4. USFWS (2016c) documents that many uncertainties remain concerning the effects of human activities on eagles, and how eagles exposed to different situations may or may not respond.

To avoid disturbing nesting eagles, AGDC has committed to following the 2007 USFWS *National Bald Eagle Management Guidelines*, including maintaining buffer distances between Project activities and bald eagle nests. Most activities require a 660-foot buffer for activities visible to the nest, and a 330-foot buffer for activities not visible to the nest. Helicopter operation would not occur within 1,000 feet of the nest, and blasting would not occur within 0.5 mile of the nest. Table 4.6.2-5 provides USFWS recommended seasonal and spatial buffers for bald and golden eagles.

TABLE 4.6.2-5

U.S. Fish and Wildlife Service Recommended Seasonal and Spatial Buffers for Bald and Golden Eagles [a]

	Seasonal Buffer – Breeding	Spatial Buffer in Non-urban Areas [b]
Bald eagle	Late February to September 15 [c]	330 feet to 0.5 mile
Golden eagle	January 15 to October 15	0.5 mile

Sources: USFWS, 2007, 2009a; ADF&G, 2018h

[a] Dates provided are general guidelines, eagles may nest before and after these dates; buffers apply to any active nest.

[b] Activity and location dependent; refer to the 2007 USFWS *National Bald Eagle Management Guidelines* (USFWS, 2007).

[c] These are guidelines for bald eagle nesting activity (USFWS, 2007).

In order to identify new and confirm previously identified eagle nests, AGDC has committed to the following measures:

- surveying for eagle nests before construction each spring prior to leaf-out to identify any bald eagle, golden eagle, or other raptor nests within 2 miles of the construction corridor, where leaf-out typically occurs by May 30 north of the Brooks Range and May 15 elsewhere;
- consulting with the USFWS regarding any observed eagle nests; and

- changing the construction schedule, if practicable, if planned activities are determined to have a reasonable likelihood for the take of nesting bald and golden eagles, so that activities would be completed outside their nesting season.

If an eagle nest is identified, AGDC would follow the USFWS-recommended seasonal and spatial buffers provided in table 4.6.2-5. In areas where spatial buffers cannot be adhered to and AGDC anticipates the potential for unavoidable incidental take either of individual birds or through disturbance of bald and golden eagle nests during Project construction, AGDC would consult with the USFWS and pursue applicable permit(s).

To the extent practicable, AGDC would clear vegetation during winter months. However, conditions such environmental constraints could preclude winter clearing, and AGDC would clear during the scheduled construction start. In the latter case, AGDC would coordinate with the USFWS and the ADF&G on a site-specific, case-by-case basis regarding potential impacts on bald and golden eagles. Clearing during the summer nesting season could result in the loss of eagle nesting habitat and/or disturb actively nesting eagles. Additionally, clearing near active eagle nests during incubation or brood rearing could affect egg and young survival and result in displacement. Permanent habitat displacement for eagles could lead to long-term impacts or otherwise resonate throughout the life cycle as carry-over effects (Norris, 2005; Sexson et al., 2014).

Noise from blasting activities could disturb nesting bald and golden eagles. Blasting and other loud, intermittent noises should be avoided within 0.5 mile of active nests, unless greater tolerance to the activity (or similar activity) has been demonstrated by the eagles in the nesting area (USFWS, 2007). Some eagles, particularly golden eagles, may be disturbed at distances greater than 0.5 mile from nest sites. AGDC would apply for an eagle disturbance permit from USFWS if blasting would occur within 0.5 mile of bald or golden eagle nesting sites. In addition to the measures described above, AGDC would implement the following measures to reduce impacts on bald and golden eagles from Project activities:

- maintaining buffer distances between eagle nests and activities (e.g., blasting or other loud, intermittent noise), such as keeping a minimum distance of 0.5 mile from eagle nests; and
- applying for an eagle take permit for the Project and coordinating with the nearest USFWS Ecological Services Field Office, USFWS Regional Migratory Birds Permit Office, and the ADF&G in the event that the USFWS *National Bald Eagle Management Guidelines* cannot be followed.

4.6.2.5 Important Bird Areas

IBAs are sites that provide essential habitat to one or more bird species (including federally protected birds) during a portion of the year (e.g., during breeding, wintering, and/or migrating). Areas that qualify as an IBA must support at least one of the following species:

- species of conservation concern (e.g., threatened, endangered, or rare species);
- species with a limited or restricted range;
- vulnerable species because their populations are concentrated in one habitat type; or
- species that are vulnerable because they occur at high concentrations due to congregation (National Audubon, 2010).

IBAs are ranked at either the global, continental, or state-level depending on their importance to a bird species and could be present on public or private lands, or both, and may or may not be protected.

Alaska has 213 IBAs, including 174 global, 8 continental, and 31 state (National Audubon, 2017c; Smith et al., 2017). The majority of Alaska's IBAs are ranked at the global level because they either include 1 percent or greater of the total global population of seabirds, or 1 percent or more of the North American population of waterbirds (Smith et al., 2017). Additionally, colony IBAs represent seabird concentration areas that have received IBA designation due to the large number of bird species present.

Numerous IBAs, including marine, coastal/nearshore, and interior IBAs that provide migration and nesting habitats would be crossed or located near Project facilities and/or actions (see table 4.6.2-6). Figure 4.6.2-2 displays the IBAs crossed or associated with Project facilities and/or actions such as marine vessel traffic. The USFWS recommended considering marine IBAs that the Project could affect, in particular fuel spills from transiting vessels in marine IBAs; this could be particularly harmful due to the bird concentrations typically found in these areas. Fifteen marine IBAs would be transited by Project-related vessel traffic in the Beaufort, Bering, and Chukchi Seas, and in waters around the Aleutian Islands, Shelikof Strait, and Cook Inlet. One of the 15 marine IBAs, the Beaufort Sea Nearshore IBA, would be affected by the West Dock Causeway expansion (see table 4.6.2-6). Impacts on marine IBAs could occur from vessel traffic, but these impacts would not be significant. Four interior IBAs would be crossed by and/or near Project Facilities (see table 4.6.2-6 and figure 4.6.2-2).

Project construction would temporarily affect over 700 acres of bird habitat in the Alaska Range Foothills, Minto Flats, and Susitna Flats IBAs. Construction would reduce the amount of foraging habitat and would result in bird disturbance and displacement. As previously described, an edge effect would occur at facility boundaries and near IBAs and could affect associated bird species. The Mainline Facilities would cross IBAs listed in table 4.6.2-6, which includes acreages for such areas.

Tugs and barges associated with the sealifts would be anchored in the PBOSA 5 miles northwest of West Dock and landward of Reindeer Island during the open-water seasons. Reindeer Island is within the Beaufort Sea Nearshore IBA. The impacts on birds (e.g., waterbirds) from staging tugs and barges at the PBOSA would be similar to impacts caused by vessels in the turning basin of West Dock; birds could be displaced, disturbed, or at risk of collision.

Impacts on birds in the marine environment would be reduced by the following avoidance, minimization, and mitigation measures implemented during Project use of the PBOSA, including:

- vessels would anchor ≥ 0.5 mile offshore of Reindeer Island and vessel crews would not approach or go on the island;
- outdoor vessel lighting (e.g., deck, doorway, stairway) would be downcast, and/or down-shielded, and directed inward whenever possible;
- blackout shades on vessels would be installed and used on outward-facing windows and the shades would be pulled down at dark or inclement weather, when migratory birds are present (May through October);
- a zero-discharge policy would be adhered to in terms of overboarding non-biodegradable materials (e.g., plastics); and
- vessel crews would be instructed not to feed wildlife.

The potential for human–wildlife interactions during construction and operation would be greatest for staffed stations. An overview of the proposed camps' proximity to IBAs is provided in table 4.6.2-7.

TABLE 4.6.2-6

Important Bird Areas Crossed by the Project

Important Bird Area	Ranking	Facility Association [a], Mileposts, and Acreage	Ornithological Summary
Marine, Coastal / Nearshore			
Beaufort Sea Nearshore	Global	Gas Treatment Facilities, 124 acres	This IBA is within the Beaufort Sea where the IBA center is about 9 miles (14 km) from the nearest land. This IBA is known for concentrations of glaucous gull and long-tailed ducks estimated at 19,990 breeding gulls and 293,157 breeding ducks.
Ledyard Bay to Icy Cape	Global	Construction and operational marine vessel traffic [b]	Ledyard Bay to Icy Cape is a broad open bay between Kasegaluk Lagoon and Cape Lisburne on Alaska's northwest coast within the Beaufort Coastal Plain Subregion. This global site overlaps critical habitat for the federally threatened spectacled eider (*Somateria fischeri*). Ledyard Bay serves as a spring staging and fall molting area for the spectacled eider. Federally protected species are discussed in section 4.8.
Kachemak Bay, South Shore	Global	Construction and operational marine vessel traffic [b]	This IBA is in the Cook Inlet Basin Subregion of southeastern Cook Inlet and in the southwestern region of the Kenai Peninsula. Kachemak Bay is an IBA for the presence of the BLM-sensitive Kittlitz's murrelet (*Brachyramphus brevirostris*), which was also previously a candidate species for federal protection. Kachemak Bay provides breeding habitat for about 1,444 Kittlitz's murrelet. Kachemak Bay also provides breeding habitat for about 6,661 breeding marbled murrelets (*Brachyramphus marmoratus*). See section 4.8 for BLM-sensitive and watch list species.
Interior			
Minto Flats	Potential Global	Mainline construction right-of-way MPs 414 to 455, 315 acres	Minto Flats is an interior IBA about 549,096 acres (2,222 square km) in size about 28 miles west of Fairbanks. Minto Flats IBA is associated with Minto Flats SGR in the Ray Mountains Subregion. Minto Flats IBA is known for its high concentration of waterfowl habitat. High concentrations of the BLM-watch list trumpeter swan also breed in this area.
Alaska Range Foothills	State	Mainline construction right-of-way MPs 530 to 568, 108 acres	Alaska Range Foothills IBA is recognized with state ranking. It is in the northeastern region of the DNPP in the Alaska Range Subregion. This IBA has the highest reported densities of nesting BLM-watch list golden eagles in North America, and is the study site for the longest ecological study of golden eagles in Alaska from 1987 to present day. Alaska Range Foothills IBA also provides nesting habitat for a significant number of BLM-watch list gyrfalcons and other subalpine and alpine nesting birds.
Kahiltna Flats-Petersville Road	Global	Mainline construction right-of-way [c] MPs 647 to 662	This IBA is dominated by the Kahiltna River and its floodplain, which contains one of the largest known concentrations of trumpeter swan nesting sites in Upper Cook Inlet. Wetlands are used by molting, post-breeding, and young Tule white-fronted geese (*Anser albifrons* elgasi). Additional species found in this IBA include arctic warbler (*Phylloscopus borealis*), blackpoll warbler (*Setophaga striata*), Bohemian waxwing, golden-crowned sparrow (*Zonotrichia atricapilla*), gray-cheeked thrush, olive-sided flycatcher, varied thrush (*Ixoreus naevius*), and white-winged crossbill (*Loxia leucoptera*).
Susitna Flats	Global	Mainline construction right-of-way MPs 728 to 765, 306 acres	This IBA is associated with Susitna Flats SGR in the Cook Inlet Basin Subregion. Spring migration of ducks, geese, and swans in this IBA number over 100,000 birds. Daily waterfowl counts can exceed 36,000 birds during spring migration. Susitna Flats IBA is known for its concentration of the BLM-sensitive Bering Sea rock sandpiper (*Calidris ptilocnemis* tschuktschor). The entire population of this BLM-sensitive species resides on the area between early October and late April.

Sources: ADF&G, 2017g; National Audubon, 2017c

[a] Facility associations within the interior IBAs (Minto Flats, Alaska Range Foothills, and Susitna Flats) include temporary and permanent access roads, ATWS, material extraction sites, camps, disposal sites, helipads, pipe storage yards, and MLVs.

[b] Approximate acreages are not provided for marine vessel associations.

[c] Kahiltna Flats-Petersville Road IBA is about 0.08 mile (0.13 km) away from the Mainline Pipeline construction right-of-way and is included for its proximity to the Project; therefore, acreages crossed are not provided.

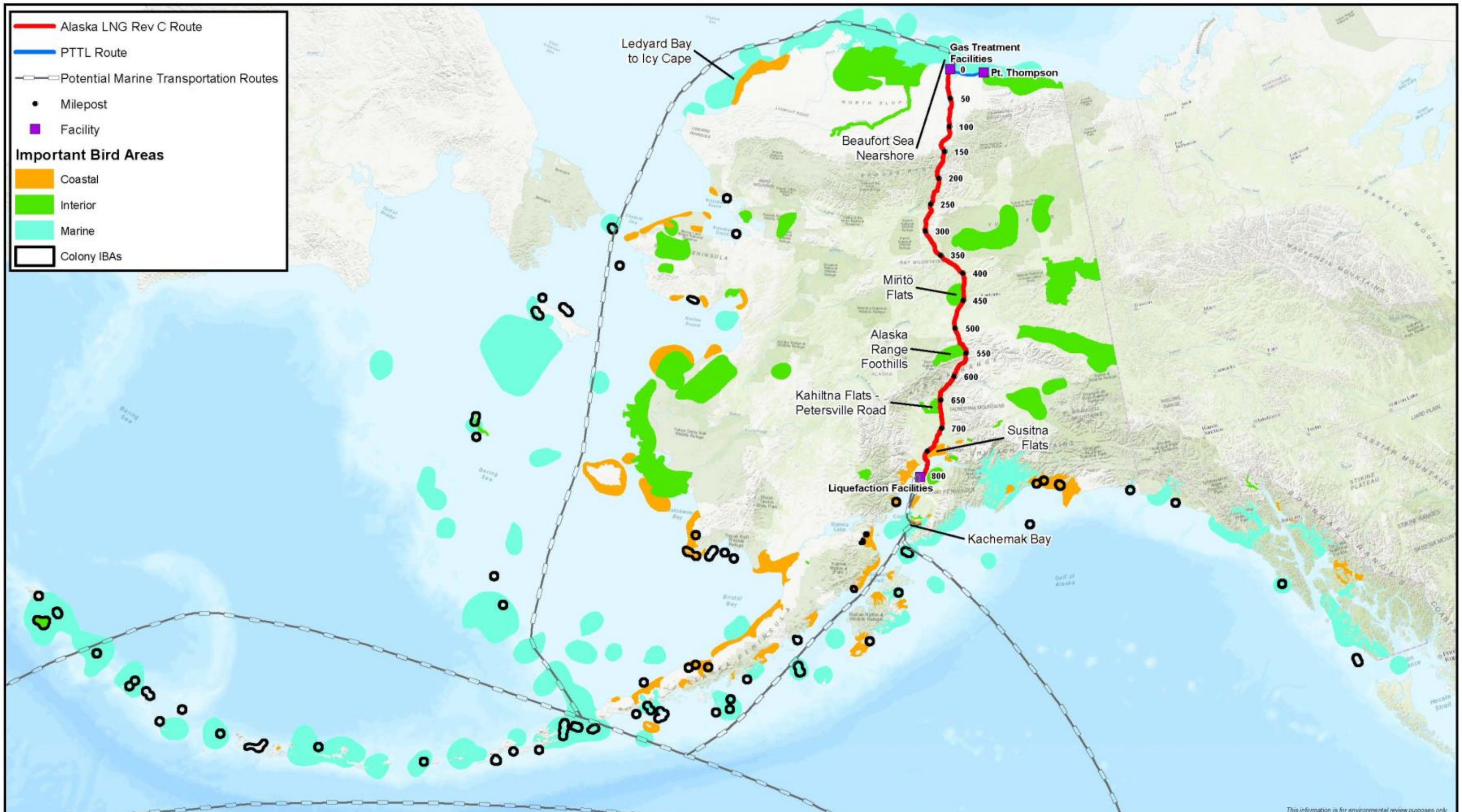

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Figure 4.6.2-2
Alaska LNG Project
Important Bird Areas Map

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TABLE 4.6.2-7

Important Bird Areas and Camps

IBA Name and Ranking	Camp Name	Camp Type/Use [a, b]	Distance from Construction Camp (miles)	Direction
Gas Treatment Facilities				
Beaufort Sea Nearshore, Global	PTTL Prudhoe Bay	Mainline	0.1	East
	Sag Delta	Mainline	0.9	North
	Badami	Mainline	0.9	West by Northwest
Mainline Facilities				
Beaufort Sea Nearshore, Global	Prudhoe Bay	Mainline	0.7	East by Southeast
	Franklin Bluffs	Mainline	28.6	North by Northeast
	Sagwon Compressor Station	Facility	76.0	North
Lower Colville River, Continental	Happy Valley	Mainline	66.5	West by Northwest
	Galbraith Lake SDA – Atigun	Mainline/Pioneer	82.2	Northwest
	Galbraith Lake Compressor Station	Facility	88.5	Northwest
Yukon Flats West, Potential Global	Dietrich	Mainline/Pioneer	86.8	South by Southeast
	Koyukuk DMT	Pioneer	NA [c]	Southeast
	Coldfoot	Mainline	67.9	Southeast
	Coldfoot Compressor Station	Facility	69.7	Southeast
	Prospect	Mainline	54.8	Southeast
	Old Man	Mainline	42.9	East by Southeast
	Ray River Compressor Station	Facility	30.3	Northeast
	Ray River Pipe Storage Yard	Pioneer	NA [c]	Northeast
	Five Mile	Mainline/Pioneer	25.6	Northeast
	Yukon DMT	Pioneer	NA [c]	Northeast
Minto Flats, Potential Global	Livengood	Mainline	16.6	South by Southwest
	Wilbur Creek Pipe Storage Yard	Pioneer	NA [c]	Southwest
	Minto Compressor Station	Facility	1.3	Southwest
	Murphy Dome	Pioneer	NA [c]	Southwest
	Dunbar	Mainline/Pioneer	2.9	Northwest
	Tanana DMT	Pioneer	1.1 [d]	Northwest
Alaska Range Foothills, State	Rex	Mainline	27.5	South by Southeast
	Healy	Mainline/Pioneer	1.2	South
	Healy Compressor Station	Facility	9.6	South
	SDA Nenana at Moody	Pioneer	NA [c]	South
	SDA Lynx Creek Crossing	Pioneer	NA [c]	South
	52-2-064-2 FP	Pioneer	1.0 [d]	West
	Cantwell	Mainline	10.9	North by Northwest
	35-4-033-2 FP	Pioneer	14.2 [d]	North
	Hurricane	Mainline	30.9	North by Northwest

TABLE 4.6.2-7 (cont'd) **Important Bird Areas and Camps**				
IBA Name and Ranking	Camp Name	Camp Type/Use [a, b]	Distance from Construction Camp (miles)	Direction
	Honolulu Creek Compressor Station	Facility	27.7	North
	35-4-025-2 FP	Pioneer	39.0 [d]	North
	35-3-010-1 FP	Pioneer	69.5 [d]	Northeast
Kahiltna Flats-Petersville Road, Global	Chulitna	Mainline	1.1	West
	Logged Pipe Storage Yard	Pioneer	NA [c]	West
	Chulitna DMT	Pioneer	NA [c]	West
	Rabideux Creek Compressor Station	Facility	8.9	Northwest
	Susitna	Mainline	19.2	North
	Deshka DMT	Pioneer	NA [c]	North
Susitna Flats, Global	Sleeping Lady	Mainline	0.0	N/A
	Theodore River Heater Station	Facility	0.0	N/A
	Beluga Marine	Mainline/Pioneer	1.4	North by Northeast
	Shorty Creek - Shore Crossing	Pioneer	NA [c]	Northeast
Liquefaction Facilities				
Kenai River Flats, Continental	Kenai	Mainline/Pioneer	10.9	South by Southeast
	Suneva Lake -Shore Crossing	Pioneer	NA [c]	Southeast

SDA = Special Design Area; NA = not available; N/A = not applicable

[a] AGDC would place pioneer camps in areas associated with aboveground facilities. Each pioneer camp footprint would overlap with the aboveground facility.

[b] For the camps listed as Mainline/Pioneer, it is assumed that the pioneer camp footprint would overlap with the Mainline camp.

[c] Additional camps were included at a later date and are not represented on the Project maps provided in appendix B (see table 2.1.4-5). These camps may be within the boundaries of IBAs, but the exact location is unknown at this time.

[c] The location provided for this camp is an estimate based on information provided by AGDC. The exact location is unknown at this time.

Several camps would be within 1 mile of the Beaufort Sea Nearshore IBA and two camps (i.e., the Sleeping Lady and Theodore River Heater Station Camps) would be within the Susitna Flats IBA. In addition to an increase in disturbance from human presence, the facilities would contribute to an increase in noise and light and could result in displacement, disturbance, and habitat loss for birds. About three helicopter flights per day would generally be associated with Project camps, but there could be as many as six per day.

The Mainline Pipeline would cross the Alaska Range Foothills IBA, known for its high density of golden eagles and other raptors, and would present temporary and permanent habitat impacts on these species. Temporary impacts include those that would disturb avian resources and cause temporary displacement. Permanent impacts include loss of foraging and nesting habitat for birds resulting from vegetation removal from the right-of-way. Mainline Facilities would also cross the Susitna Flats and Minto Flats IBAs, which are areas known for their large concentrations of waterfowl and nesting trumpeter swans, and Kahiltna Flats-Petersville Road IBA, which is also known for large concentrations of nesting trumpeter swans and significant numbers of Tule white-fronted geese (National Audubon, 2017c). About 119 miles (15 percent) of the Mainline Pipeline route would be within interior IBA boundaries. Clearing and granular material placement would occur in the summer along about 59 of those miles, with the remaining miles planned for winter construction. As described in section 4.6.2.3, the clearing season could change due to unforeseen circumstances. Due to the potential impacts on nesting migratory birds from initial land disturbing activities (e.g., construction clearing and granular fill placement during the nesting season), **we recommend that:**

- **<u>During construction and operation within the boundaries of the IBAs</u>, AGDC should conduct vegetation clearing or initial granular fill placement outside of the nesting seasons, as listed in table 4.6.2-3 of the EIS.**

4.6.3 Marine Mammals

This section discusses the marine mammals that could occur within or adjacent to the Project area (other than ESA-listed species, which are discussed in section 4.8). The marine and coastal components of the Gas Treatment and Liquefaction Facilities and the offshore portion of the Mainline Pipeline would all be in areas where marine mammals occur. In addition, vessels transiting through the GOA, Cook Inlet, and the Bering, Chukchi, and Beaufort Seas could interact with marine mammals.

The MMPA protects all marine mammals by prohibiting their take without authorization from NMFS or the USFWS. "Take" under the MMPA means "to hunt, harass, capture, or kill" any marine mammal or attempt to do so (16 USC 1362 [13]). "Harass," as used in the definition of "take," is "any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild" (Level A noise harassment); or "the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering" (Level B noise harassment) (16 USC 1362 [18][a]).

The MMPA designates some marine mammal stocks as strategic or depleted. A strategic stock is one that:

- the level of direct human-caused mortality exceeds the potential biological removal level;
- is based on the best available scientific information, is declining and is likely to be listed as a threatened species under the ESA within the foreseeable future; or
- is listed as a threatened or endangered species under the ESA, or is designated as depleted under the MMPA.

A depleted stock is one that:

- the Secretary of Commerce, after consultation with the Marine Mammal Commission and the Committee of Scientific Advisors on Marine Mammals established under MMPA title II, determines a species or population stock is below its optimum sustainable population;
- a state, to which authority for the conservation and management of a species or population stock is transferred under Section 109, determines that such species or stock is below its optimum sustainable population; or
- a species or population stock is listed as an endangered species or a threatened species under the ESA.

Table 4.6.3-1 lists the marine mammals found within the Project area (other than ESA-listed species, which are discussed in section 4.8). NMFS is responsible for the conservation and management of each of these species.

TABLE 4.6.3-1

Non-ESA Listed Marine Mammal Species Potentially Occurring in the Project Area

Species	Project Component: Beaufort Sea	Project Component: Cook Inlet	Project Component: Vessel Routes	Primary Habitat in Project Area	Project Activities Potentially Affecting Species
Seals					
Harbor seal (*Phocis vitulina*)		Marine Terminal, Mainline Pipeline and MOF, vessel traffic	GOA	Coastal, estuaries, may travel miles up coastal rivers	Trenching, pipelay, marine construction, pile driving, dredging, vessel traffic, air traffic
Northern fur seal (*Callorhinus ursinus*)	Vessel traffic		Bering Sea	Pelagic; rookeries on remote islands	Vessel traffic
Ribbon seal (*Histriophoca fasciata*)	West Dock, vessel traffic			Ice-associates, usually found near the continental shelf break	Marine construction, pile driving, screeding, vessel traffic, air traffic
Spotted seal (*Phoca largha*)	West Dock, vessel traffic		Bering, Chukchi, and Beaufort Seas	Continental shelf and ice, coastal habitats	Marine construction, pile driving, screeding, vessel traffic, air traffic
Whales					
Baird's beaked whale (*Berardius bairdii*)	Vessel traffic	Vessel traffic	Bering Sea and GOA	Deeper waters of the continental slope and edge	Vessel traffic
Cuvier's beaked whale (*Ziphius cavirostris*)		Vessel traffic	GOA	Deeper waters of the continental slope and edge	Vessel traffic
Stejneger's beaked whale (*Mesoplodon stejnegeri*)	Vessel traffic	Vessel traffic	Bering Sea and GOA	Deep offshore waters, over or beyond continental slope	Vessel traffic
Beluga whale (*Delphinapterus leucas*)	West Dock, vessel traffic	Marine Terminal, Mainline Pipeline, vessel traffic [a]	Beaufort, Chukchi, and Bering Seas, and Cook Inlet [a]	Offshore waters associated with pack ice in winter; coastal estuaries, bays, and rivers in spring and summer	Marine construction, pile driving, screeding, vessel traffic, air traffic
Gray whale [b] (*Eschrichtius robustus*)	West Dock, vessel traffic	Vessel traffic	Beaufort and Bering Seas, and GOA	Shallow coastal waters	Marine construction, pile driving, screeding, vessel traffic, air traffic
Humpback whale [c] (*Megaptera novaeangliae*)	Vessel traffic	Marine Terminal, Mainline Pipeline, vessel traffic	Chukchi and Bering Seas, Cook Inlet, and GOA	Coastal waters	Trenching, pipelay, marine construction, pile driving, dredging, vessel traffic, air traffic
Killer whale (*Orcinus orca*)	Vessel traffic	Marine Terminal, Mainline Pipeline and MOF, vessel traffic	Bering, Chukchi, and Beaufort Seas, GOA, and Cook Inlet	Waters over the continental shelf	Trenching, pipelay, marine construction, pile driving, dredging, vessel traffic, air traffic
Minke whale (*Balaenoptera acutorostrata*)	Vessel traffic	Marine Terminal, Mainline Pipeline and MOF, vessel traffic	Bering and Chukchi Seas, and GOA	Pelagic and bays, shallow coastal waters near ice	Trenching, pipelay, marine construction, pile driving, dredging, vessel traffic, air traffic
Narwhal (*Monodon monoceros*)	Vessel traffic		Bering, Chukchi, and Beaufort Seas	Coastal waters	Vessel traffic
Porpoises And Dolphins					
Dall's porpoise (*Phocoenoides dalli*)	Vessel traffic	Vessel traffic	Bering Sea, Cook Inlet, and GOA	Pelagic and coastal waters	Vessel traffic

TABLE 4.6.3-1 (cont'd) **Non-ESA Listed Marine Mammal Species Potentially Occurring in the Project Area**					
	Project Component				
Species	Beaufort Sea	Cook Inlet	Vessel Routes	Primary Habitat in Project Area	Project Activities Potentially Affecting Species
Harbor porpoise (*Phocoena phocoena*)	West Dock, vessel traffic	Marine Terminal, Mainline Pipeline and MOF, vessel traffic	Bering and Chukchi Seas, GOA, and Cook Inlet	Coastal waters	Trenching, pipelay, marine construction, pile driving, dredging, vessel traffic, air traffic
Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)		vessel traffic	GOA	Pelagic and shelf waters	Vessel traffic

Sources: ADF&G, 2018h; NMFS, 2017d

[a] Belugas found in Cook Inlet belong to the Cook Inlet stock, which are listed under the ESA and addressed in section 4.8.

[b] Western North Pacific Distinct Population Segment (DPS) gray whales are federally listed; the Eastern North Pacific DPS gray whales are not. Section 4.8 and the BA address gray whales.

[c] Western North Pacific and Mexico DPS are federally listed; the Hawaii DPS is not. As these DPS are not distinguishable in Alaska, however, section 4.8 and the BA address humpback whales.

4.6.3.1 Species Occurring in the Project Area

Biologically Important Areas (BIAs) for marine mammals are areas where cetacean species concentrate for specific behaviors, such as feeding, reproduction, or migration. BIAs may be essential habitat areas for these species (NMFS, 2017b). Figure 4.6.3-1 shows BIAs in the waters surrounding Alaska that have been identified for cetacean species. Many marine mammal species are important subsistence resources. Subsistence is discussed in section 4.14.

Seals

Harbor Seal

Harbor seals inhabit coastal and estuarine waters along the West Coast of the United States, including southeast Alaska and west through the GOA and Aleutian Islands, in the Bering Sea and Pribilof Islands. Harbor seals are considered non-migratory, but they make local movements associated with tides, weather, season, food availability, and reproduction (Muto et al., 2015). Harbor seals in Cook Inlet are known to move in response to local steelhead and salmon (*Oncorhynchus* spp.) runs in late spring and summer (Boveng et al., 2011). Harbor seals typically haul out near available prey and avoid areas with anthropogenic disturbances (Montgomery et al., 2007). Harbor seals could occur in the Project area year-round near the Marine Terminal in Cook Inlet, the Mainline Pipeline crossing in Cook Inlet, the Mainline MOF, and along LNG carrier routes in the GOA.

Harbor seals lack external ear flaps, which distinguishes them from other pinnipeds. They are generally light gray with dark spots or dark with light rings. Their fused pelvic bones cause them to move awkwardly on land, but they are well adapted for extended diving. The average adult weighs 180 pounds and is 5 to 6 feet long; males are generally larger than females. Harbor seals are sexually mature between 3 and 7 years old. Males live about 26 years, while females live 35 years. Females annually give birth to single pups born between May and mid-July. Harbor seals haul out on rocks, reefs, beaches, and drifting glacial ice. They forage on a wide variety of schooling fish, flatfish, crustaceans, and squid in marine and estuarine waters and occasionally freshwater (Muto et al., 2015; ADF&G, 2018h; NMFS, 2017g).

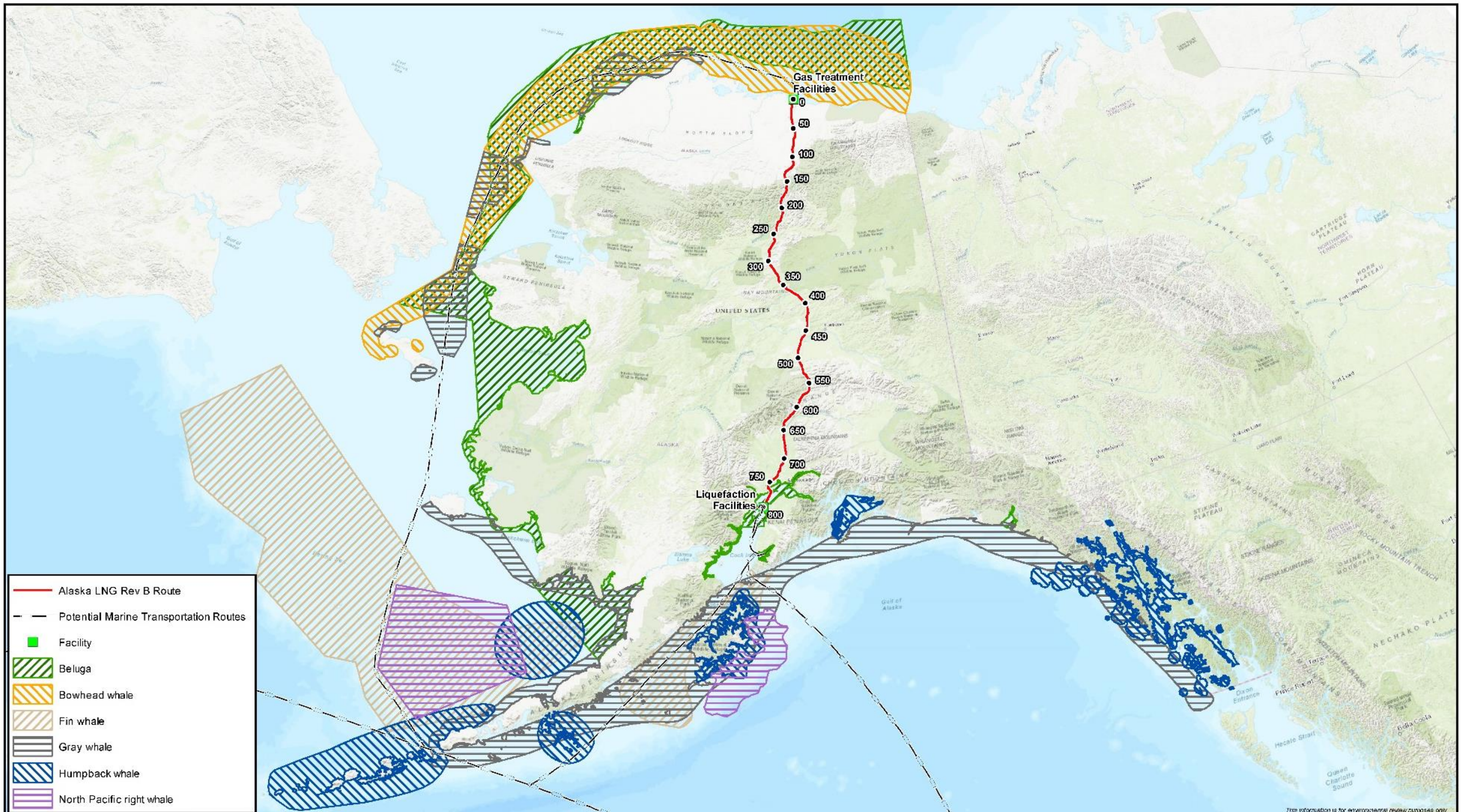

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Figure 4.6.3-1
Alaska LNG Project
Biologically Important Areas

Harbor seals in Alaska waters are assigned to 12 separate stocks, of which the Project could affect three. The Cook Inlet/Shelikof Strait stock, estimated in 2011 to contain 27,386 seals, occurs in the Project area in Cook Inlet (Muto et al., 2015). The Bristol Bay stock, estimated in 2011 to contain 32,350 seals, and the North Kodiak stock, estimated in 2011 to contain 8,321 seals, occur in vessel transit routes north of the Alaska peninsula and in Shelikof Strait (Muto et al., 2015) (see figure 4.6.3-2). These stocks are not designated as strategic or depleted by NMFS (NMFS, 2017g). The nearest documented harbor seal haulout to the Project is at the mouth of the Kenai River 8 miles south of the Marine Terminal. Harbor seal haulouts also occur near the Beluga and Susitna River deltas near the Mainline MOF; they are likely there in spring, summer, and fall months (NOAA, 2018a). Harbor seals may also occur at haulout areas near the Kachemak Bay staging/anchoring area.

Northern Fur Seal

Northern fur seals occur from southern California north to the Bering Sea and west to the Okhotsk Sea and Japan. During summer, most of the population occupies rookeries in the Pribilof Islands and a few other islands in the southern Bering Sea. In Alaska, northern fur seals are found primarily in the GOA and the Bering Sea, moving offshore (from 10 to 100 miles from the coast) in the winter (see figure 4.6.3-3) (ADF&G, 2018h). During the breeding season, males remain onshore from May to August and females remain onshore from June to November (Muto et al., 2016). When not on rookeries, northern fur seals are pelagic (ADF&G, 2018h).

Northern fur seals vary in color. Females and young males appear black when wet and gray or brown when dry; mature males are brownish-black, but their mane lightens around 6 years of age. Northern fur seals have a visible earflap and use their hind flippers to “walk” on land. Males are 7 feet long and weigh 450 to 600 pounds; females are 5 feet long and weigh 80 to 110 pounds. Females are sexually mature at 3 to 5 years of age, giving birth to single pups weighing 10 to 14 pounds in early to mid-June and mating again within 1 week. Males are mature at 5 to 6 years, but do not enter the reproductive population until they are 9 to 10 years old. The life expectancy of northern fur seals is 26 years. Northern fur seals feed on a variety of schooling fish and squid, including herring, capelin (*Allotus villosus*), and pollock (*Pollachius virens*) (ADF&G, 2018h).

The Eastern Pacific stock includes northern fur seals in Alaska. The minimum population estimate for the Eastern Pacific stock is 539,638 (Muto et al., 2017). This stock is not designated as strategic or depleted by NMFS (NMFS, 2017g). Northern fur seals are unlikely to occur along the sealift route through the Bering, Chukchi, and Beaufort Seas because the seals remain near rookeries during the summer shipping season. Northern fur seals could occur near vessel traffic routes in the Bering Sea.

Ribbon Seal

Ribbon seals are ice-associated seals that rarely haul out on land and are found primarily in the Bering Sea along the continental shelf break from late March to early May (see figure 4.6.3-4) (NMFS, 2017g). In the Project area, ribbon seals occur most abundantly in the central and western Bering Sea where they form small groups on the pack ice in the spring to give birth, nurse pups, and molt (NMFS, 2017g). From May to mid-July, ribbon seals move northward with the receding sea ice edge, moving into the Chukchi and western Beaufort Seas (NMFS, 2017g).

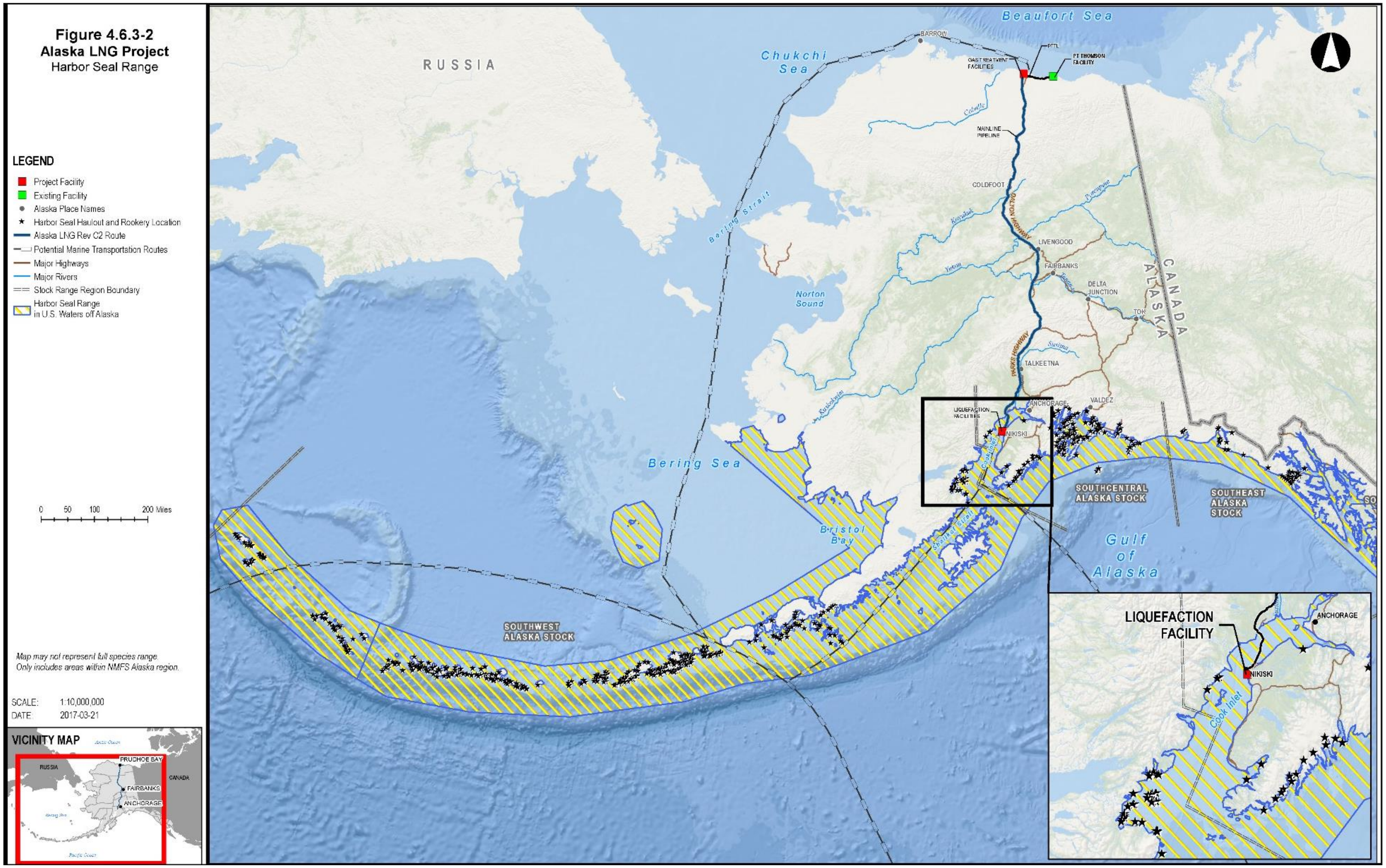

Figure 4.6.3-2
Alaska LNG Project
Harbor Seal Range

Figure 4.6.3-3
Alaska LNG Project
Northern Fur Seal
Range

LEGEND

- Project Facility
- Existing Facility
- Alaska Place Names
- Seal Haulout and Rookery Location
- Alaska LNG Rev C2 Route
- Potential Marine Transportation Routes
- Major Highways
- Major Rivers
- Northern Fur Seal Range in U.S. Waters off Alaska

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Map may not represent full species range.
Only includes areas within NMFS Alaska region.

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VICINITY MAP

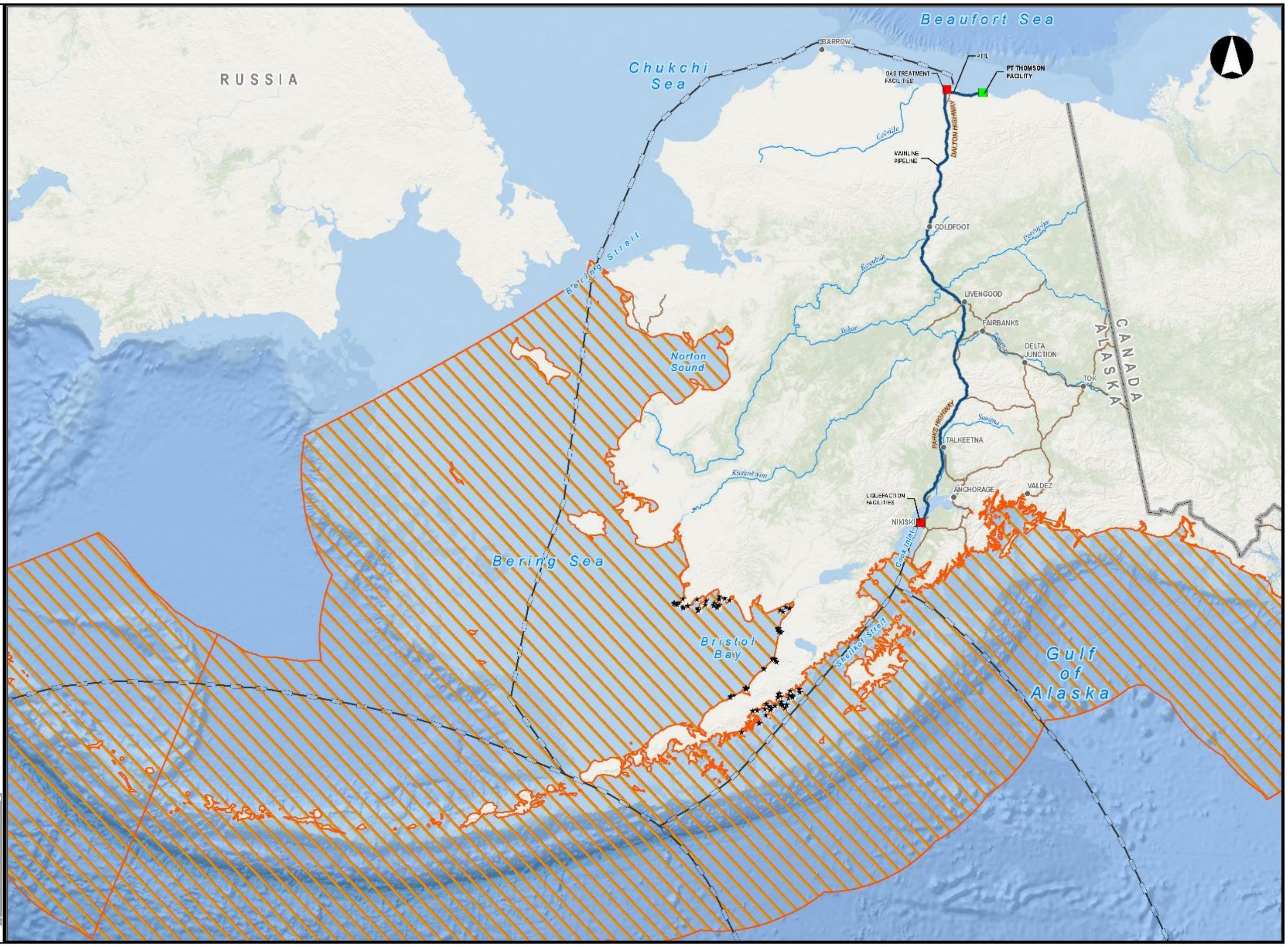
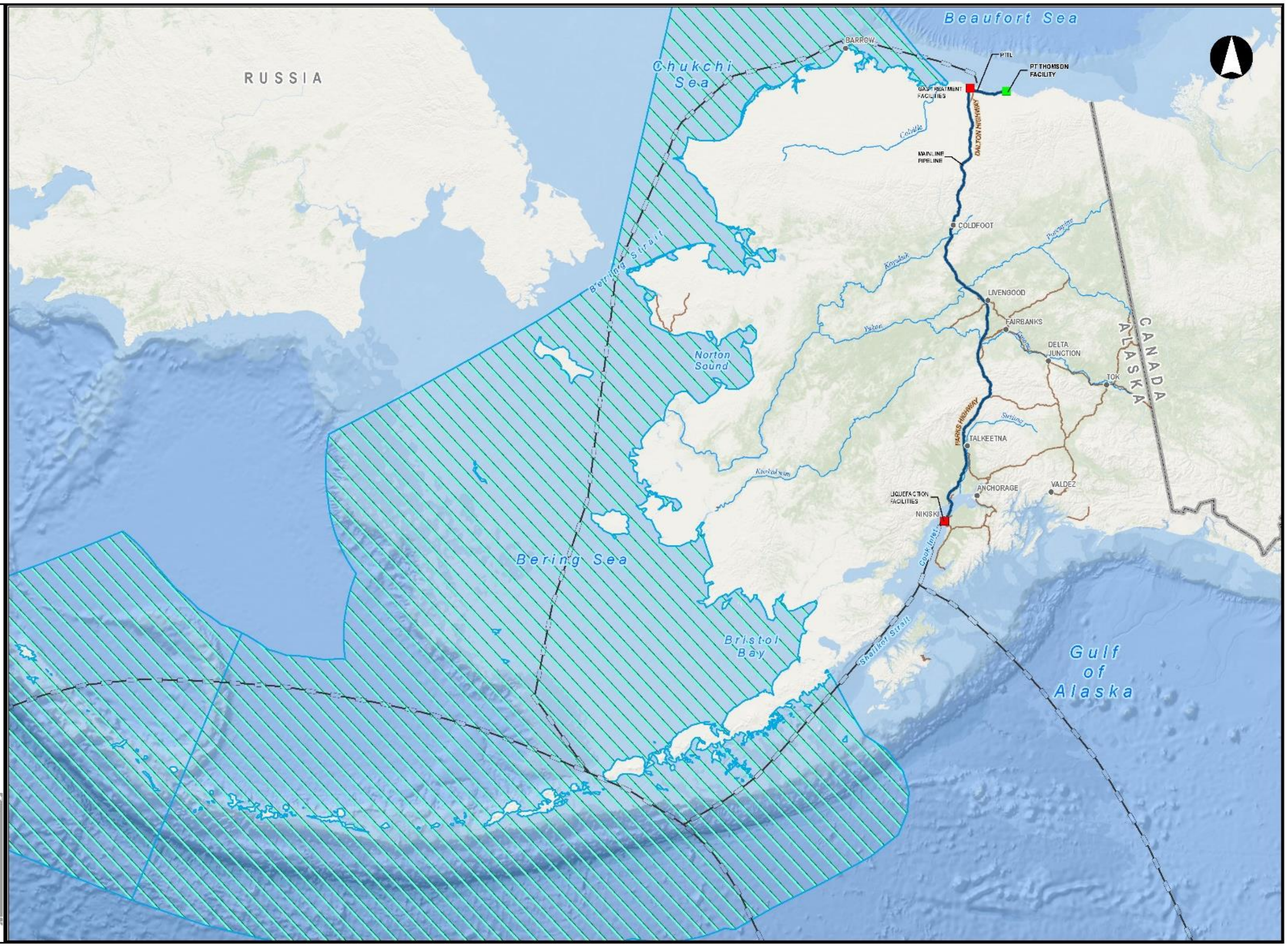


Figure 4.6.3-4
Alaska LNG Project
Ribbon Seal Range



LEGEND

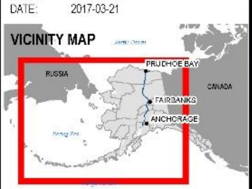
- Project Facility
- Existing Facility
- Alaska Place Names
- Alaska LNG Rev C2 Route
- Potential Marine Transportation Route
- Major Highways
- Major Rivers
- Ribbon Seal Range in U.S. Waters off Alaska

0 50 100 200 Miles

Map may not represent full species range.
Only includes areas within NMFS Alaska region.

SCALE: 1:9,000,000
DATE: 2017-03-21

VICINITY MAP



Ribbon seals have a dark body and light bands (e.g., ribbons) around their neck, front flippers, and hips. They are about 5 feet long and weigh about 175 pounds. Ribbon seals become sexually mature at 3 to 5 years of age. Females produce one offspring per year between April and mid-May. Pups are 3 feet long, weigh 25 pounds, and are white at birth. Ribbon seals live 20 to 30 years (NMFS, 2017g). They forage on a variety of pelagic fish and invertebrates, shrimp, crabs, squid, cod, sculpin, walleye pollock, capelin, and eelpouts (NMFS, 2017g). Ribbon seals in Alaska waters are assigned to the Alaska stock. No reliable estimates or trends are available for the larger population beyond the Bering Sea (Muto et al., 2017). This stock is not designated as strategic or depleted by NMFS (NMFS, 2017g).

Ribbon seals are unlikely to occur along the sealift route through the Bering, Chukchi, and Beaufort Seas because the seals remain near the ice edge during the summer shipping season. Ribbon seals could occur along shipping routes where vessels transit near the ice edge. Ribbon seals are unlikely to occur near the West Dock Causeway in summer, but could occur during winter months as the seals move with the sea ice edge as it extends southwards.

Spotted Seal

Spotted seals are distributed along the continental shelf of the Bering, Chukchi, and Beaufort Seas (see figure 4.6.3-5) (Allen and Angliss, 2014). NMFS has designated the Alaska stock of spotted seals as the Bering Distinct Population Segment (DPS) (Boveng et al., 2009). Spotted seals overwinter in the Bering Sea along the ice edge (Allen and Angliss, 2014). During spring, the seals prefer the southern edge of the ice front and move northward, following the sea ice retreat, or move into nearshore habitats. In summer and fall, spotted seals use coastal haulouts regularly, although they are generally associated with pack ice, where they may haul out in large numbers (Allen and Angliss, 2014).

Spotted seals are silver to light gray with dark spots, and are often mistaken for harbor seals. They have a round head, narrow snout, and short flippers. The average adult is 5 feet long and weighs 140 to 250 pounds; males and females are similar in size. Spotted seals are sexually mature at 4 years of age and live 30 to 35 years. Females generally give birth to pups in mid-March. They forage on small schooling fish, shrimp, and octopus (NMFS, 2017g). The minimum population estimate of spotted seals in the U.S. portion of the Bering Sea is 423,237 (Muto et al., 2017). The stock is not designated as strategic or depleted by NMFS (NMFS, 2017g).

Spotted seals occur in the Beaufort Sea in summer (ADF&G, 2018h). Haulouts occur near Kasegaluk Lagoon, Colville River delta, and the Sagavanirktok River. Surveys conducted at the Colville River delta in 2014 identified small numbers of seals at haulout sites on land (SAExploration, 2014). Historically, spotted seals hauled out near the Sagavanirktok River delta, but whether they currently use this area for haulout is unknown (SAExploration, 2014). An important spotted seal pupping and breeding area occurs in the eastern Bering Sea (NMFS, 2017e). Spotted seals also haul out in large numbers on sea ice. They could occur near the West Dock Causeway during the summer; in vessel routes in the Bering, Beaufort, and Chukchi Seas year-round; and near the PBOSA during the summer.

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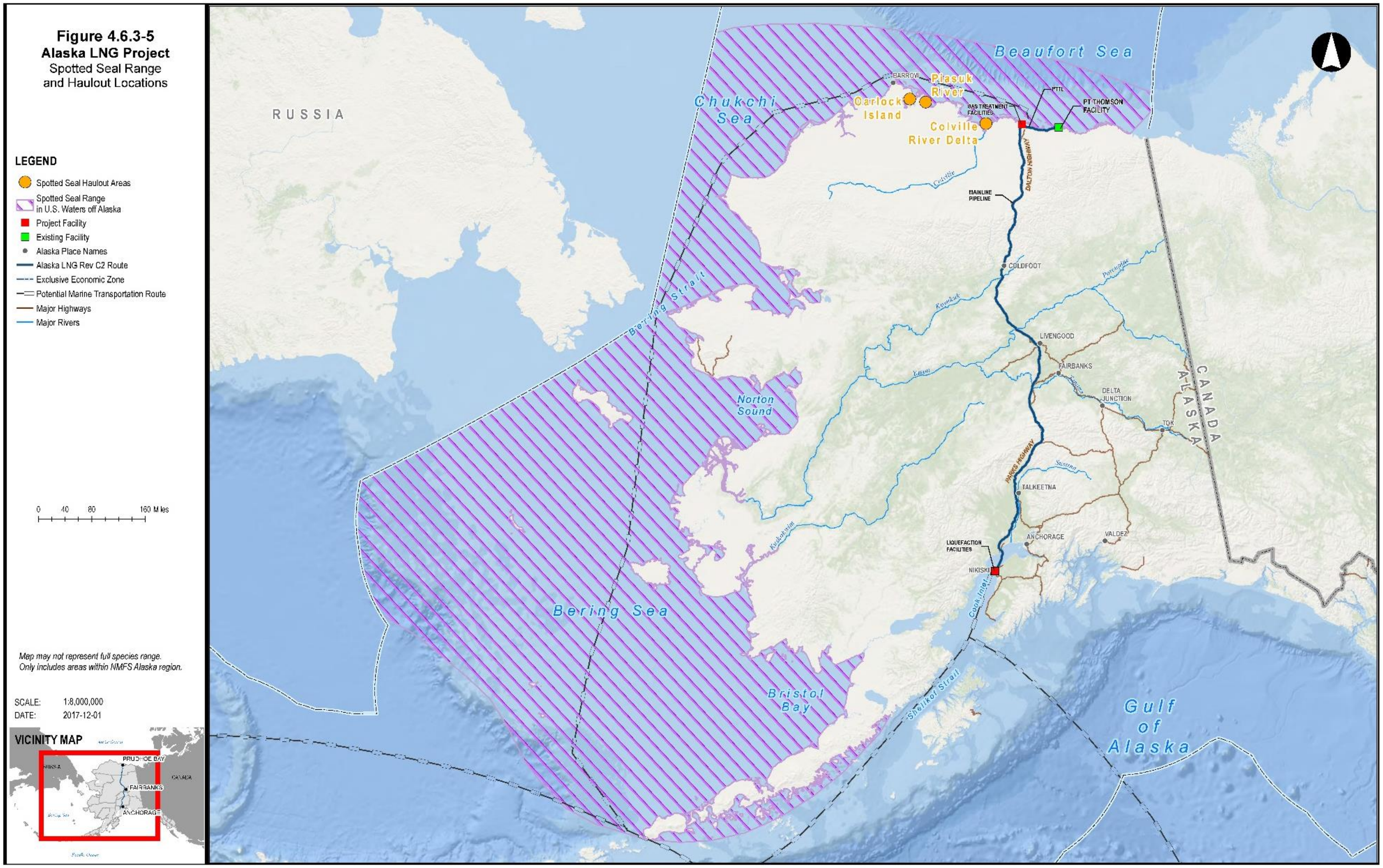


Figure 4.6.3-5
Alaska LNG Project
Spotted Seal Range and Haulout Locations

Whales

Beaked Whales – Baird's, Cuvier's, and Stejneger's

Baird's, Cuvier's, and Stejneger's beaked whales are deep and long diving, toothed whales that feed primarily on squid, octopus, deep-water fish, and crustaceans (NMFS, 2017g). In the Project area in and near vessel traffic routes, Baird's and Stejneger's beaked whales are likely to occur in the GOA and the Bering Sea and Cuvier's beaked whales are likely to occur in the GOA (see figures 4.6.3-6 to 4.6.3-8) (Allen and Angliss, 2013). Baird's, Cuvier's, and Stejneger's beaked whales are not designated as strategic or depleted by NMFS (NMFS, 2017g).

Baird's beaked whales reach up to 40 feet long and weigh about 26,400 pounds. Adults are mottled gray or brown with a lighter ventral surface. They are generally found in groups of 2 to 20 individuals. Females are sexually mature at 10 to 15 years, and males at 6 to 11 years. Females will calve every 3 or more years, usually in March or April, producing single calves measuring 15 feet long. Females and males live 54 and 84 years, respectively (NMFS, 2017g). Baird's beaked whales arrive in the Bering Sea in April or May and are abundant during the summer months; their numbers decrease in October, but some individuals spend the winter in the Bering Sea (Allen and Angliss, 2013). Reliable population estimates are not available at this time (Allen and Angliss, 2013).

Cuvier's beaked whales reach up to 23 feet long, weighing between 4,000 and 6,800 pounds. Adults are dark gray to reddish-brown with a lighter ventral surface. They are typically found alone or in groups of 2 to 12 individuals. Cuvier's beaked whales reach sexual maturity between 7 and 11 years of age and have a lifespan of up to 60 years. Females give birth to single calves every 2 to 3 years; the calves are typically 6.5 to 9 feet long and weigh 550 to 660 pounds (NMFS, 2017g). Strandings primarily inform the distribution of Cuvier's beaked whales in the GOA. Reliable population estimates are not available at this time (Allen and Angliss, 2013).

Stejneger's beaked whales reach up to 18 feet long and weigh about 3,520 pounds. Adults are dark gray to brownish and black with a dark cap across the top of the head. They are typically found alone or in groups of 3 to 15 individuals. Stejneger's beaked whales are sexually mature at about 14.8 feet long. Females usually give birth between spring and fall to single calves measuring about 7.5 to 8 feet long and weighing 175 pounds. Stejneger's beaked whales have an estimated lifespan of a minimum of 36 years (NMFS, 2017g). Strandings primarily inform the distribution of Stejneger's beaked whales in the Bering Sea and GOA. Reliable population estimates are not available at this time (Allen and Angliss, 2013).

Beluga Whale

Beluga whale adults are white, toothed, and have a large melon (e.g., bulbous structure on their forehead). They also have a ridge down their back rather than a dorsal fin. Beluga whales measure about 11 to 15 feet long, and can weigh 1,000 to 3,300 pounds, with females smaller than males. Females are sexually mature at 8 to 10 years of age (males mature slightly later), and give birth to single calves every 3 years. Mating occurs in the spring, and calves are born 14 months later during the summer. Calves are about 5 feet long at birth, weigh 90 to 130 pounds, are gray in color, and nurse for 2 years. Beluga whales have a lifespan of about 30 years. They feed primarily on fish, squid, crabs, and clams (ADF&G, 2018h).

Figure 4.6.3-6
Alaska LNG Project
Baird's Beaked Whale Range

LEGEND

- Project Facility
- Existing Facility
- Alaska Place Names
- Alaska LNG Rev C2 Route
- Potential Marine Transportation Routes
- Major Highways
- Major Rivers
- Baird's Beaked Whale Range in U.S. Waters off Alaska

0 50 100 200 Miles

Map may not represent full species range.
Only includes areas within NMFS Alaska region.

SCALE: 1:9,000,000
DATE: 2017-03-21

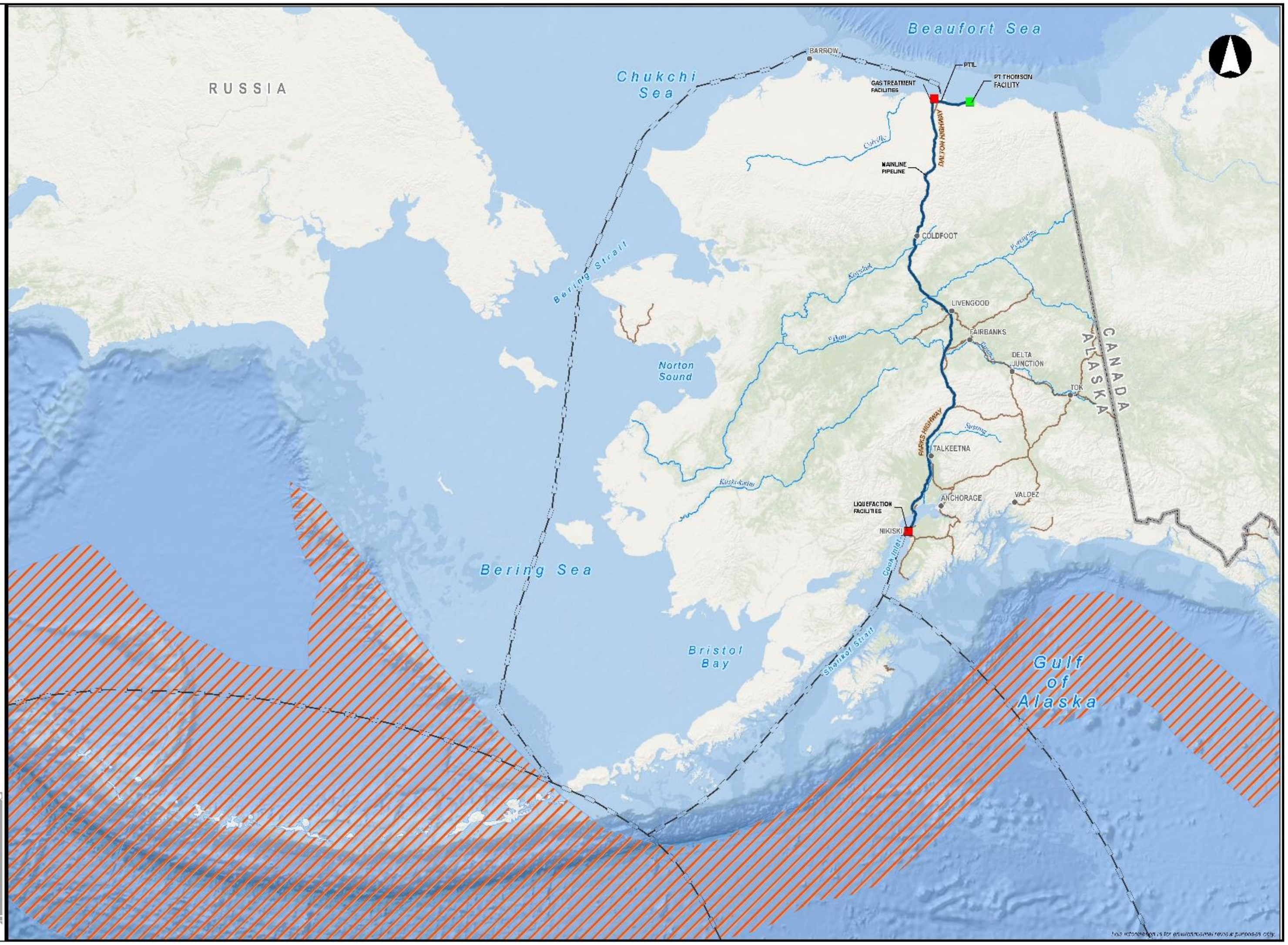


Figure 4.6.3-7
Alaska LNG Project
Cuvier's Beaked
Whale Range

LEGEND

- Project Facility
- Existing Facility
- Alaska Place Names
- Alaska LNG Rev C2 Route
- Potential Marine Transportation Routes
- Major Rivers
- Major Highways
- Cuvier's Beaked Whale Range in U.S. Waters of Alaska

0 50 100 200 Miles

Map may not represent full species range.
Only includes areas within NMFS Alaska region.

SCALE: 1:9,000,000
DATE: 2017-03-21

VICINITY MAP

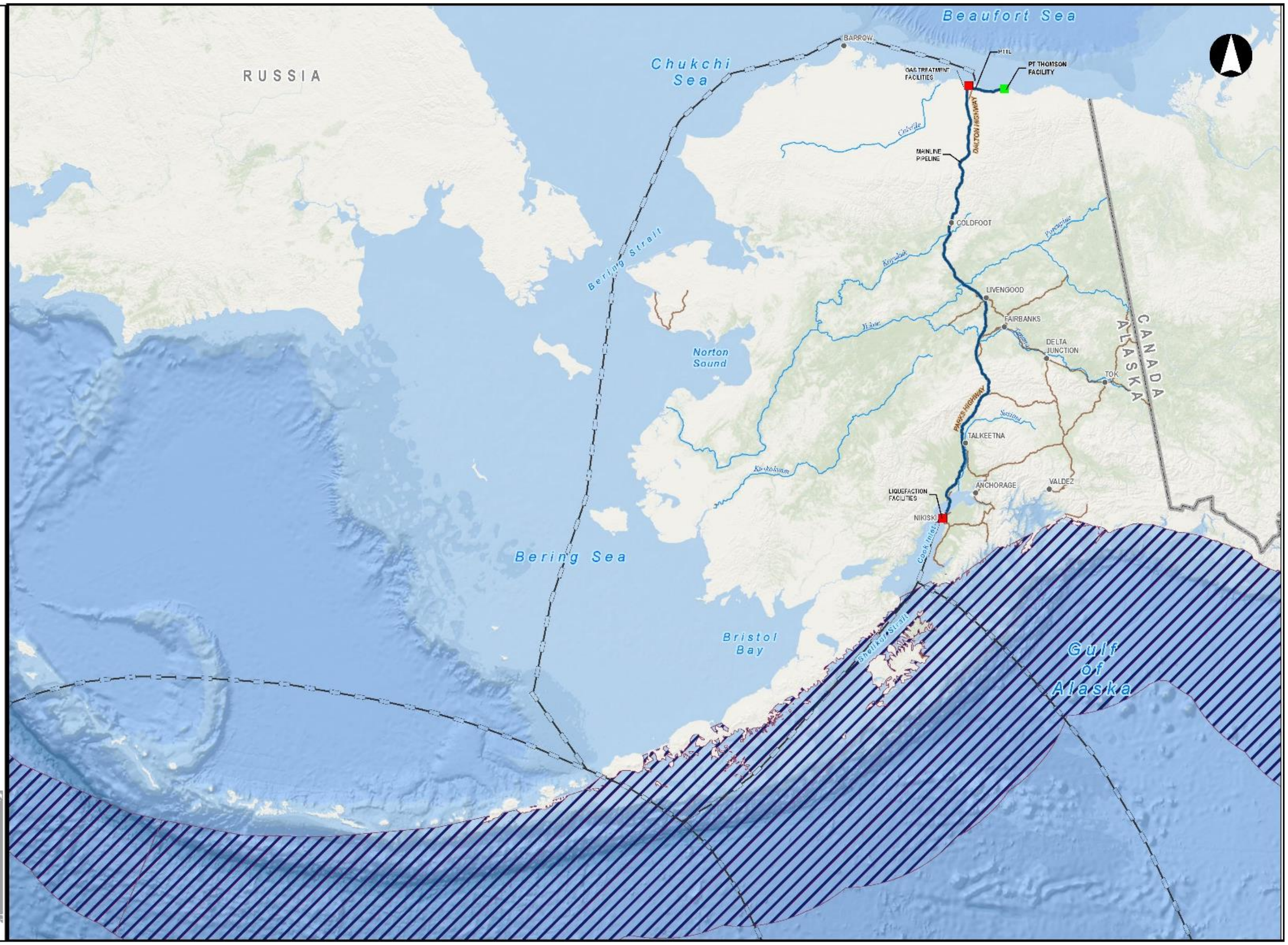


Figure 4.6.3-8
Alaska LNG Project
Stejneger's Beaked
Whale Range

LEGEND

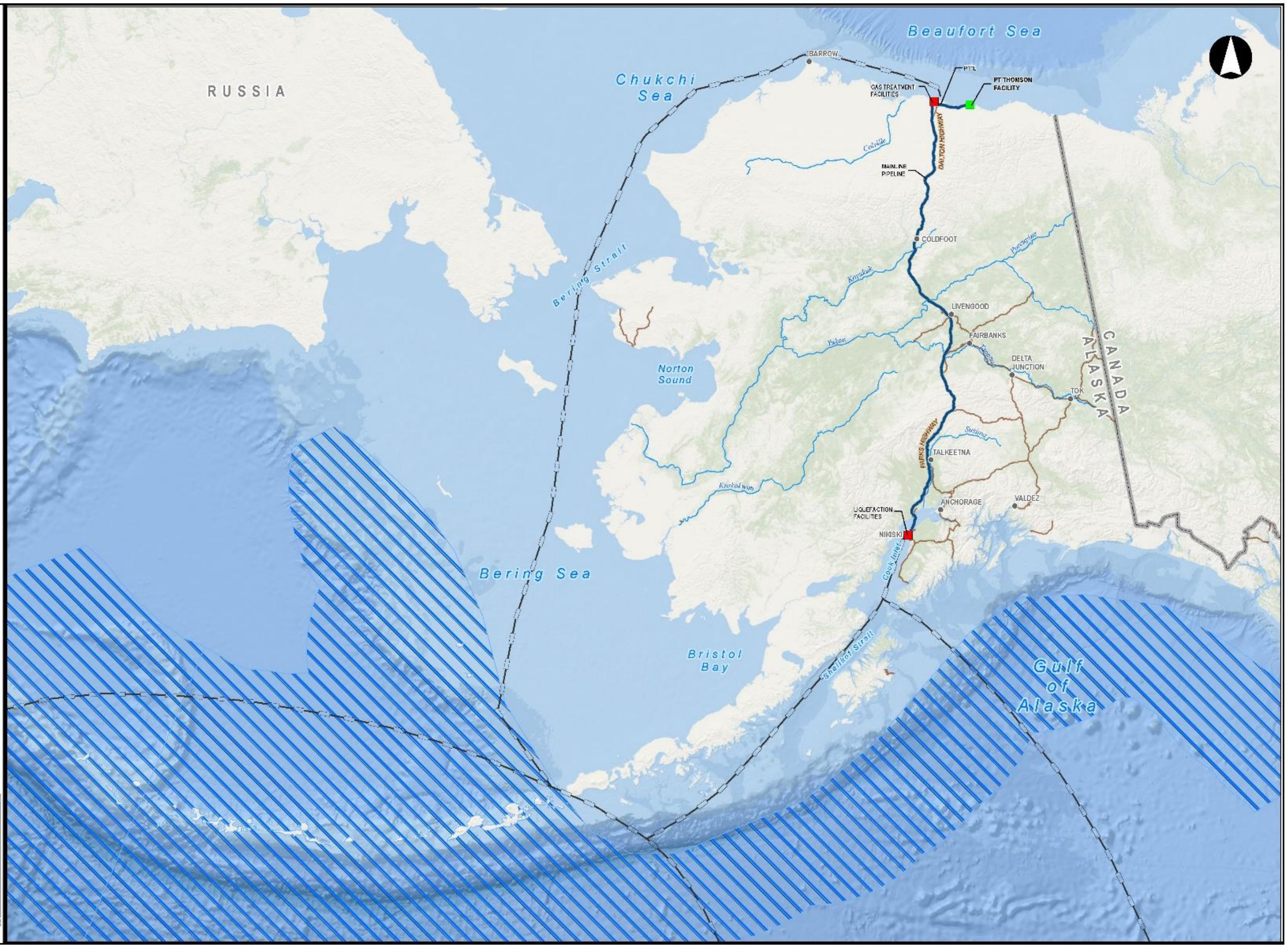
- Project Facility
- Existing Facility
- Alaska Place Names
- Alaska LNG Rev C2 Route
- Potential Marine Transportation Routes
- Major Highways
- Major Rivers
- Stejneger's Beaked Whale Range in U.S. Waters of Alaska

0 50 100 200 Miles

Map may not represent full species range.
Only includes areas within NMFS Alaska region.

SCALE: 1:9,000,000
DATE: 2017-03-21

VICINITY MAP



There are five stocks of Alaska beluga whales: the Beaufort Sea, Bristol Bay, Cook Inlet (ESA-listed), Eastern Bering Sea, and Eastern Chukchi (see figure 4.6.3-9). Section 4.8 discusses the ESA-listed Cook Inlet DPS. Beluga whales from the Bristol Bay, Eastern Chukchi Sea, Eastern Bering Sea, and Beaufort Sea stocks winter in the Bering Sea (Allen and Angliss, 2014). During winter, belugas occur in offshore waters associated with pack ice. In the spring, they move into warmer coastal estuaries, bays, and rivers where they molt and give birth (Allen and Angliss, 2014). The BIA for beluga whale migration occurs north of the Bering Strait into the Eastern Chukchi and Beaufort Seas (see figure 4.6.3-1). Belugas use this area in April and May (NMFS, 2017b).

The minimum population estimates of the Beaufort Sea and Eastern Chukchi Sea stocks are 32,453 and 12,194, respectively; the populations of the Bristol Bay and Eastern Bering Sea stocks are unknown due to lack of recent data (Muto et al., 2017). None of these four stocks are considered depleted or strategic under the MMPA, but due to their association with sea ice, there are concerns about impacts from climate change and related effects on prey availability (Allen and Angliss, 2014; NMFS, 2017g).

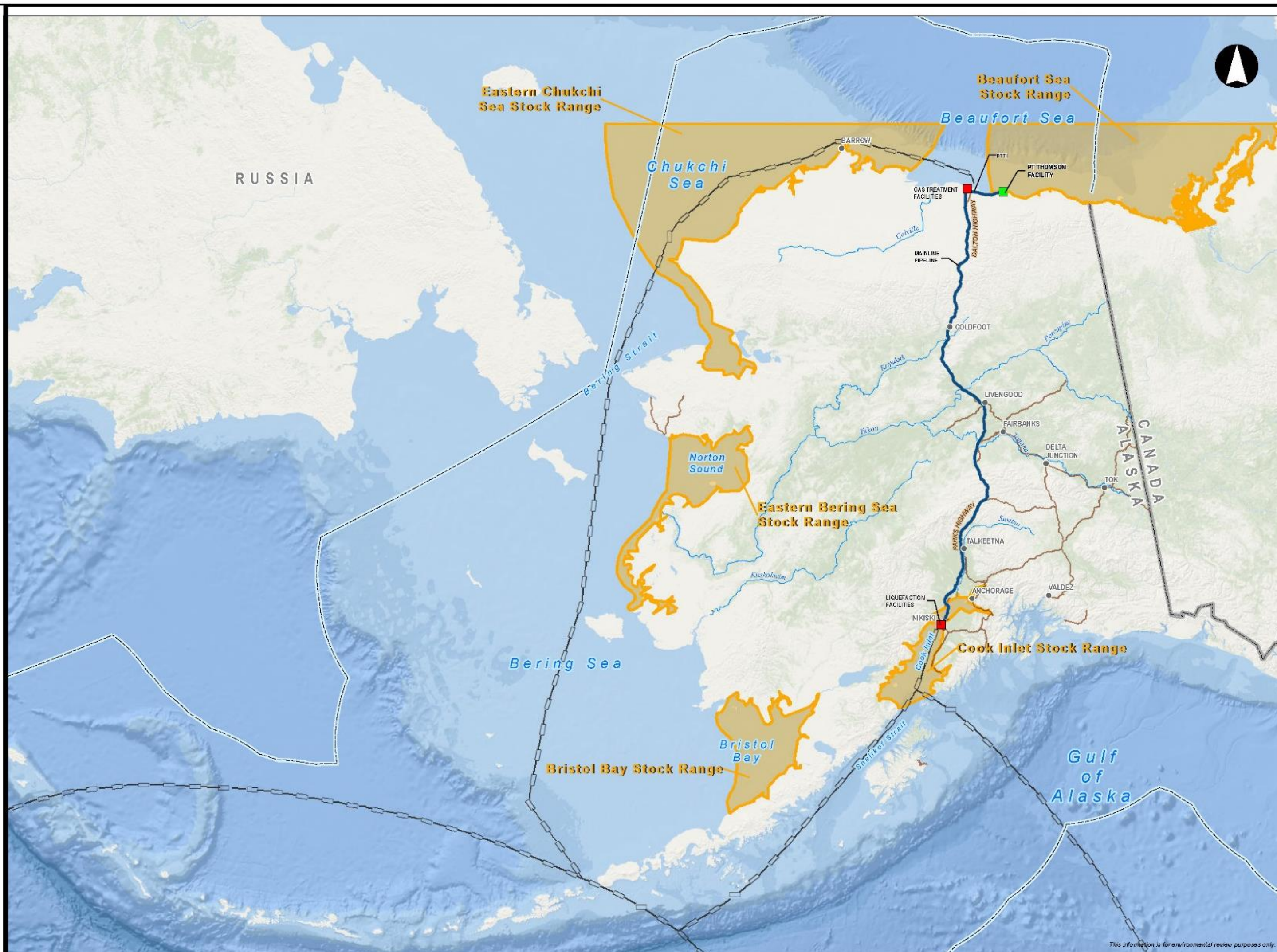
Beluga whales occur in the Beaufort, Chukchi, or Bering Seas during winter and in the Beaufort Sea near the Project during summer. Based on satellite tracking data and numerous aerial and boat-based marine mammal surveys in the Beaufort Sea, belugas may take a coastal route during their fall migration, but the majority of the population travels well offshore during the winter (Funk et al., 2010). In the spring, beluga whales of the Beaufort Sea stock migrate closer to shore to warmer coastal estuaries, bays, and rivers where they may molt and give birth (Allen and Angliss, 2014). During the summer, beluga whales may occur near the proposed West Dock Causeway, in vessel transit routes in the Beaufort Sea, and near the PBOSA. Belugas from the Bristol Bay and Eastern Bering Sea stocks do not likely occur in the proposed Project area during summer months. Beluga whales from these two stocks overlap in distribution during summer and fall, and individuals from either stock could occur in the Beaufort Sea. Beluga whales may also occur near the proposed Mainline Pipeline crossing in Cook Inlet or the Marine Terminal (see section 4.8).

Killer Whale

Killer whales are predominantly black with white patches under the jaw, above and behind each eye, and on the ventral surface. Their dorsal fin, which may reach 3 to 6 feet tall, and gray saddle patch are used to identify individual whales. Killer whales are 23 to 27 feet long; males are larger than females and may weigh as much as 13,300 pounds. Females are sexually mature at an average of 15 years and give birth to single calves every 4 to 6 years, usually between the fall and spring. Males live up to 50 years and females live up to 80 years (ADF&G, 2018h). Killer whales are toothed whales that feed on fish, birds, squid, turtles, and marine mammals. Killer whales have been implicated as causing significant mortality for both northern sea otters and Cook Inlet beluga whales in Lower Cook Inlet (Sheldon et al., 2003; Estes et al., 1998).

Killer whales occur throughout Alaskan marine waters, but they are most commonly observed over the continental shelf from Southeast Alaska through the Aleutian Islands and northward to the Chukchi and Beaufort Seas (see figure 4.6.3-10). Killer whales from both resident and transient stocks are found in the GOA (ADF&G, 2018h). Killer whales are also found throughout Cook Inlet (Braund, 2016; NMFS, 2016b). Resident whales feed exclusively on fish and are genetically distinct from transient whales, who feed primarily on marine mammals (Saulitis et al., 2000).

Figure 4.6.3-9
Alaska LNG Project
Beluga Whale Range



LEGEND

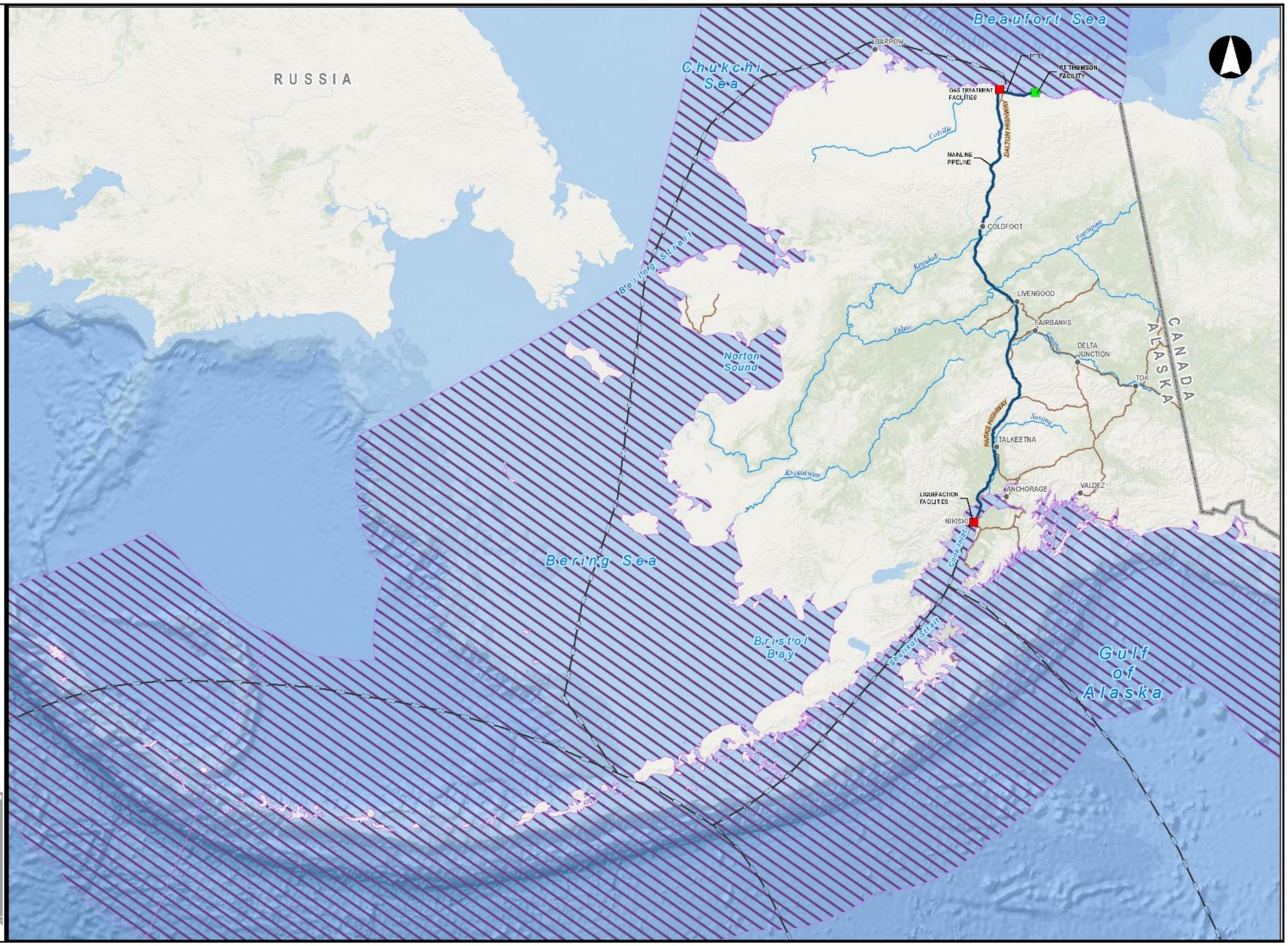
- Project Facility
- Existing Facility
- Alaska LNG Rev C2 Route
- Exclusive Economic Zone
- Potential Marine Transportation Route
- Major Highways
- Major Rivers
- Alaska Beluga Whale Stock Range*

*Note: Ranges for the Eastern Chukchi and Beaufort Sea Stock Ranges likely extend farther north.
What is depicted is the extent of the available data
https://alaskafisheries.noaa.gov/sites/default/files/mapbelgastocks_big.jpg

0 50 100 200 Miles

SCALE: 1:9,000,000
DATE: 2018-03-02

Figure 4.6.3-10
Alaska LNG Project
Killer Whale Range



LEGEND

- Project Facility
- Existing Facility
- Alaska Place Names
- Alaska LNG Rev C2 Route
- Potential Marine Transportation Routes
- Major Highways
- Major Rivers
- Killer Whale Range in U.S. Waters off Alaska

0 50 100 200 Miles

Map may not represent full species range
Only includes areas within NMFS Alaska region.

SCALE: 1:9,000,000
DATE: 2017-03-21

VICINITY MAP

Whales from three transient and resident Pacific stocks could occur in the Project area in Cook Inlet; the GOA; and the Bering, Chukchi, and Beaufort Seas. The current minimum population estimates and trends for these killer whale stocks are:

- Eastern North Pacific Alaska resident stock: 656; this stock is not designated as strategic or depleted by NMFS (NMFS, 2017g; Muto et al., 2016);
- combined GOA, Aleutian Islands, and Bering Sea transient stocks: 587; this stock is not designated as strategic or depleted by NMFS (NMFS, 2017g; Muto et al., 2016); and
- AT1 transient stock: 7; this stock is designated as depleted by NMFS (NMFS, 2017g; Muto et al., 2017).

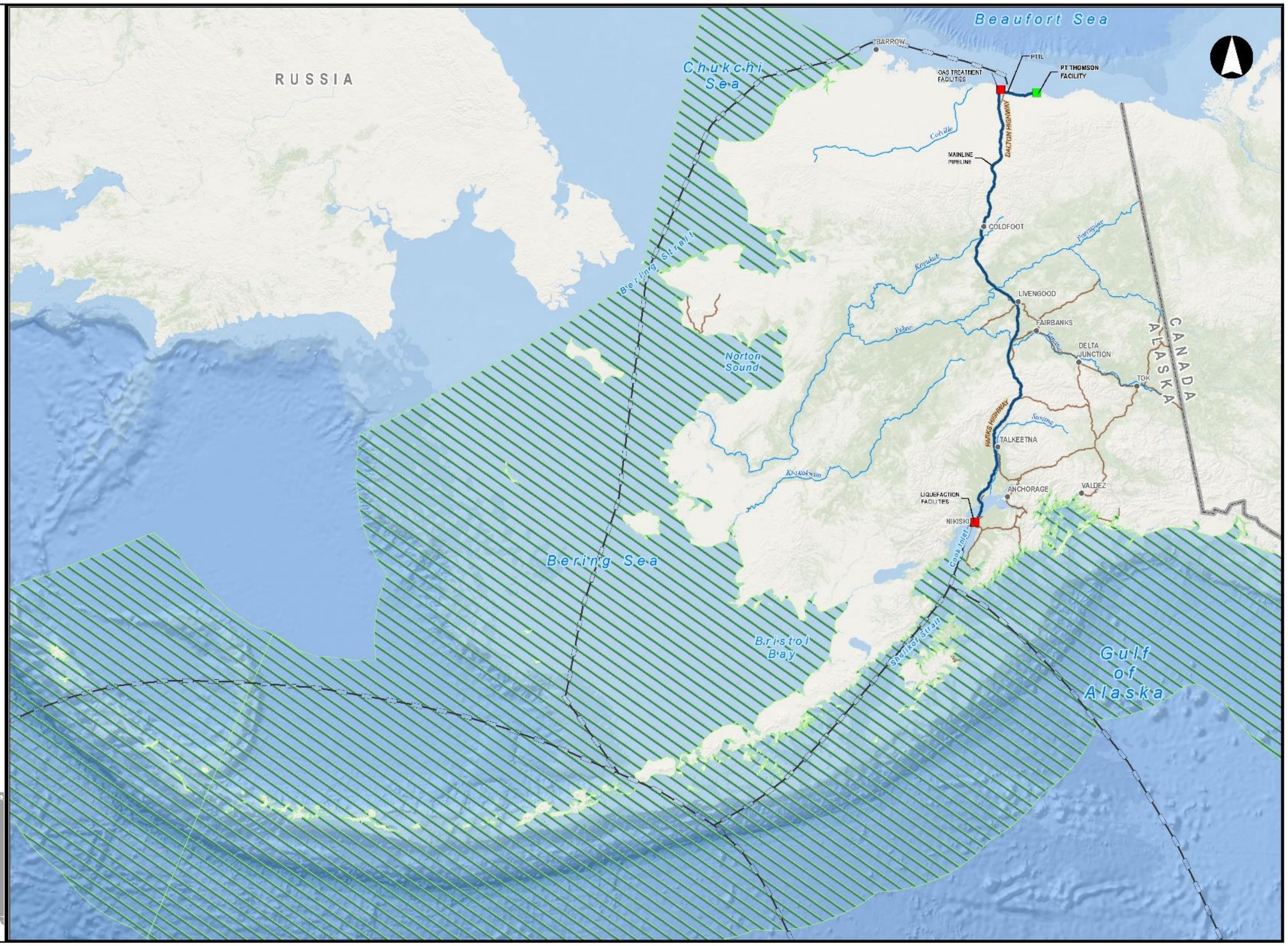
Killer whales from these stocks could occur in vessel transit routes in the Bering, Chukchi, and Beaufort Seas during spring, summer, and fall; along LNG carrier routes through the GOA year-round; near the PBOSA during spring and fall; and near the Kachemak Bay staging/anchoring area in the summer. Traditional knowledge workshop participants noted that killer whales might occur year-round in Cook Inlet near the Marine Terminal and Mainline MOF and along the Mainline Pipeline route (Braund, 2016). Construction vessels would cross concentration areas of killer whales during fall and summer near the Kennedy Entrance and similar concentration areas at the mouth of Resurrection Bay (NOAA, 2018a). Participants in the traditional knowledge workshops reported that killer whales come into Port Graham Bay to feed and occur often near Russian Point (Braund, 2016).

Minke Whale

Minke whales in U.S. waters belong to two stocks: the Alaska stock and the California/Washington/ Oregon stock. The migratory Alaska stock, of which the population estimate is presently unknown, could occur in the Project area (Muto et al., 2015). Minke whales are the smallest of the baleen whales in Alaska waters; females are about 28 feet long, weighing 8 tons, and males are slightly smaller, averaging 26 feet long and 6 tons (ADF&G, 2018h). Minke whales are dark gray to black with a white ventral surface and a white band on their pectoral flippers and a tall, hooked dorsal fin. Minke whales are sexually mature at 3 to 8 years of age (when they reach about 23 feet in length), and they mate and calve in winter. Females give birth to single calves weighing 700 to 1,000 pounds and measuring 8 to 11.5 feet long. Minke whales are usually found in groups of two to three. Their estimated life expectancy is 50 years (NMFS, 2017g). Minke whales are filter feeders, feeding primarily on euphausiids, copepods, and schooling fish (ADF&G, 2018h).

Minke whales occur in shallower coastal marine habitats as well as offshore in deeper water (NMFS, 2017d). Typically, when migrating north in the spring and summer months, minke whales stay in coastal waters, and when migrating south in the fall and winter, they can be found farther offshore (ADF&G, 2018h). Minke whales occur in Alaska waters in spring and summer months throughout the Bering Sea, GOA, and in Southeast Alaska (see figure 4.6.3-11) (ADF&G, 2018h). There is no reliable population estimate for the Alaska stock of minke whale (Muto et al., 2015). This stock is not designated as strategic or depleted by NMFS (NMFS, 2017g). Minke whales are likely to occur in the GOA waters crossed by LNG carriers and construction vessel traffic, and near the Mainline Pipeline crossing and the Marine Terminal in Cook Inlet (Braund, 2016; NMFS, 2016b). They are also likely to occur in the Bering and Chukchi Seas in the sealift vessel traffic routes to Prudhoe Bay.

Figure 4.6.3-11
Alaska LNG Project
Minke Whale Range



LEGEND

- Project Facility
- Existing Facility
- Alaska Place Names
- Alaska LNG Rev C2 Route
- Potential Marine Transportation Routes
- Major Highways
- Major Rivers
- Minke Whale Range in U.S. Waters off Alaska

0 50 100 200 Miles

Map may not represent full species range
Only includes areas within NMFS Alaska region.

SCALE: 1:9,000,000
DATE: 2017-03-21

VICINITY MAP

Narwhal

Narwhals have a long, clockwise-spiraled tusk, which is actually a tooth, extending from the head of males and some females. Narwhals also have small rounded heads, no dorsal fin, and short flippers. Adults are mottled gray and lighten to white as they age. Males are slightly larger than females and reach a maximum length of 16 feet. Female narwhals are sexually mature at 5 years and males at 8 years old. Females typically give birth every 3 years to single calves in mid-July. Narwhals feed on squid, fish, shrimp, and crab (NMFS, 2017d).

Narwhals are an arctic species occurring in the Bering, Chukchi, and Beaufort Seas in Alaska (see figure 4.6.3-12). There is no reliable population estimate for narwhals (Muto et al., 2016). The stock is not designated as strategic or depleted by NMFS (NMFS, 2017g). Narwhals may occur in the Bering, Chukchi, and Beaufort Seas in the sealift vessel traffic routes to Prudhoe Bay and near the PBOSA.

Porpoises and Dolphins

Dall's Porpoise

Dall's porpoises in Alaska waters are considered the Alaska stock. They are the fastest of the small cetaceans. Dall's porpoises have black and white markings similar to a killer whale. Their head and flippers are small and they lack a distinct beak. The average adult is 6.4 feet long and weighs 300 pounds. Females reach sexual maturity at 3 to 6 years, and males at 5 to 8 years. Females give birth every 3 years, usually between June and September, to single calves measuring 3 feet in length. Dall's porpoises live on average for 15 to 20 years and feed on squid and a variety of fish (ADF&G, 2018h; NMFS, 2017g).

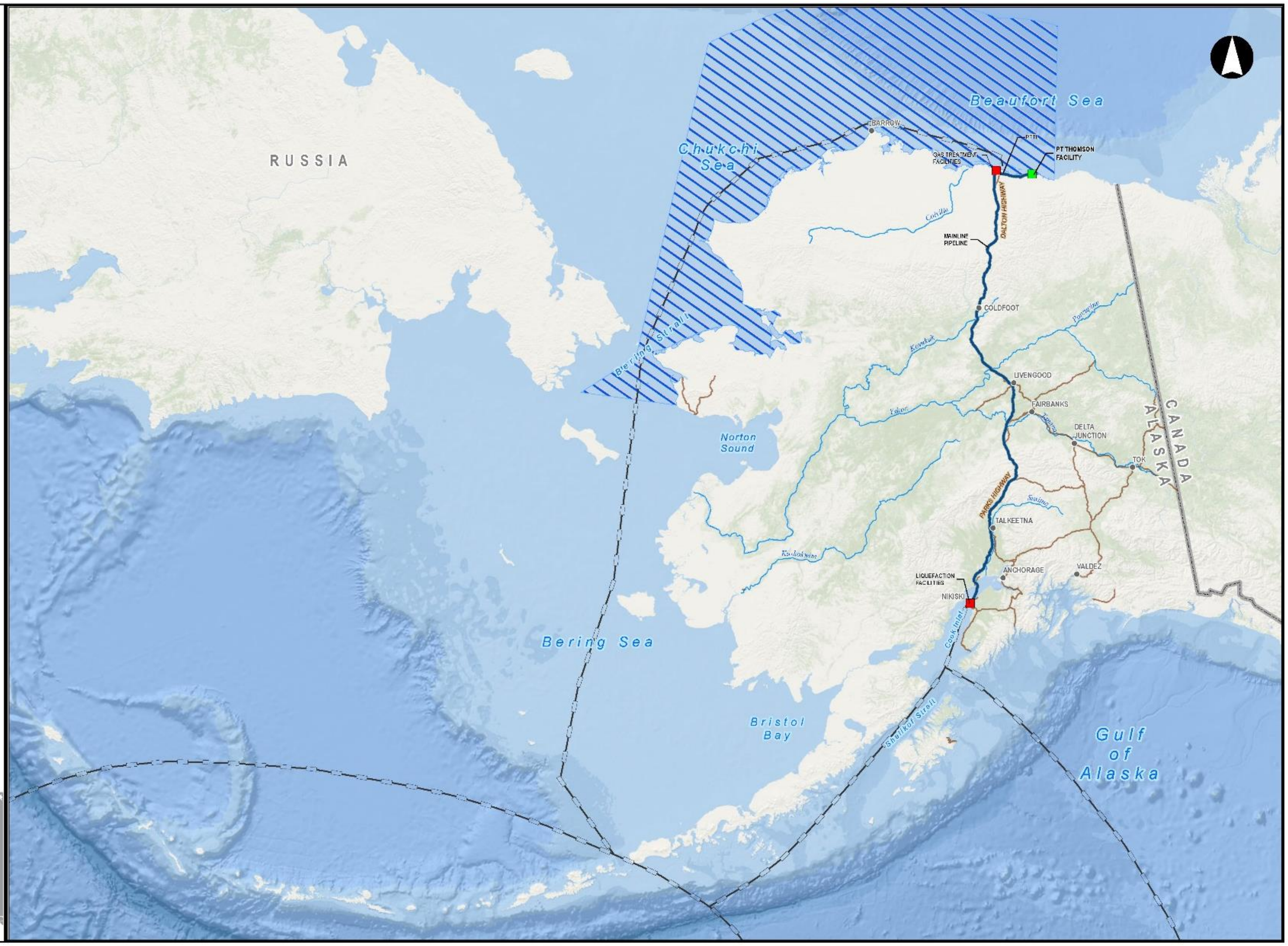
Dall's porpoises are widely distributed across the North Pacific Ocean from the continental shelf to deep oceanic waters. In Alaska, they occur in the Bering Sea, GOA, and Lower Cook Inlet (see figure 4.6.3-13). Dall's porpoises occur throughout the GOA year-round and venture into the Bering Sea in summer. They typically travel in groups of 2 to 20 individuals, but may occur in larger groups (NMFS, 2017g). There are currently no reliable estimates of stock size in Alaska waters (Muto et al., 2015; NMFS, 2017g). The stock is not designated as strategic or depleted by NMFS (NMFS, 2017g). Dall's porpoises are likely to occur along LNG carrier and construction vessel routes in Lower Cook Inlet and the GOA year-round and the Bering Sea in summer.

Harbor Porpoise

The Bering Sea and GOA stocks of harbor porpoises may occur in the proposed Project area (Muto et al., 2016). Harbor porpoises are small cetaceans with blunt snouts and teeth. They are dark gray or brown, fading to lighter gray on the sides, with a white ventral surface. The average harbor porpoise is 5 feet long and weighs 130 pounds; females are slightly larger than males. Harbor porpoises reach sexual maturity at 3 to 4 years, and generally live 8 to 10 years. Females give birth about every 2 years (although they can give birth annually) to single calves weighing 14 to 22 pounds (ADF&G, 2018h; NMFS, 2017g). Harbor porpoises feed on schooling fish and invertebrates, including herring, mackerel, smelt, and squid (ADF&G, 2018h).

Harbor porpoises are widely distributed in coastal areas from southeast Alaska to the Beaufort Sea (see figure 4.6.3-14) (Muto et al., 2016). They occur year-round in coastal areas on the south side of the Alaska Peninsula and Aleutian Islands. Harbor porpoises occur most frequently in waters less than 300 feet deep and generally travel alone or in small groups of less than 10 individuals in fjords, bays harbors, estuaries, and large rivers, primarily frequenting coastal waters (ADF&G, 2018h). Harbor porpoises are shy animals and are known to avoid vessels (ADF&G, 2018h). No reliable population estimates for either the Bering Sea or GOA stocks are currently available (Muto et al., 2017). These stocks are not designated as strategic or depleted by NMFS (NMFS, 2017g).

Figure 4.6.3-12
Alaska LNG Project
Narwhal Range



LEGEND

- Project Facility
- Existing Facility
- Alaska Place Names
- Alaska LNG Rev C2 Route
- Potential Marine Transportation Routes
- Major Highways
- Major Rivers
- Narwhal Range in U.S. Waters off Alaska

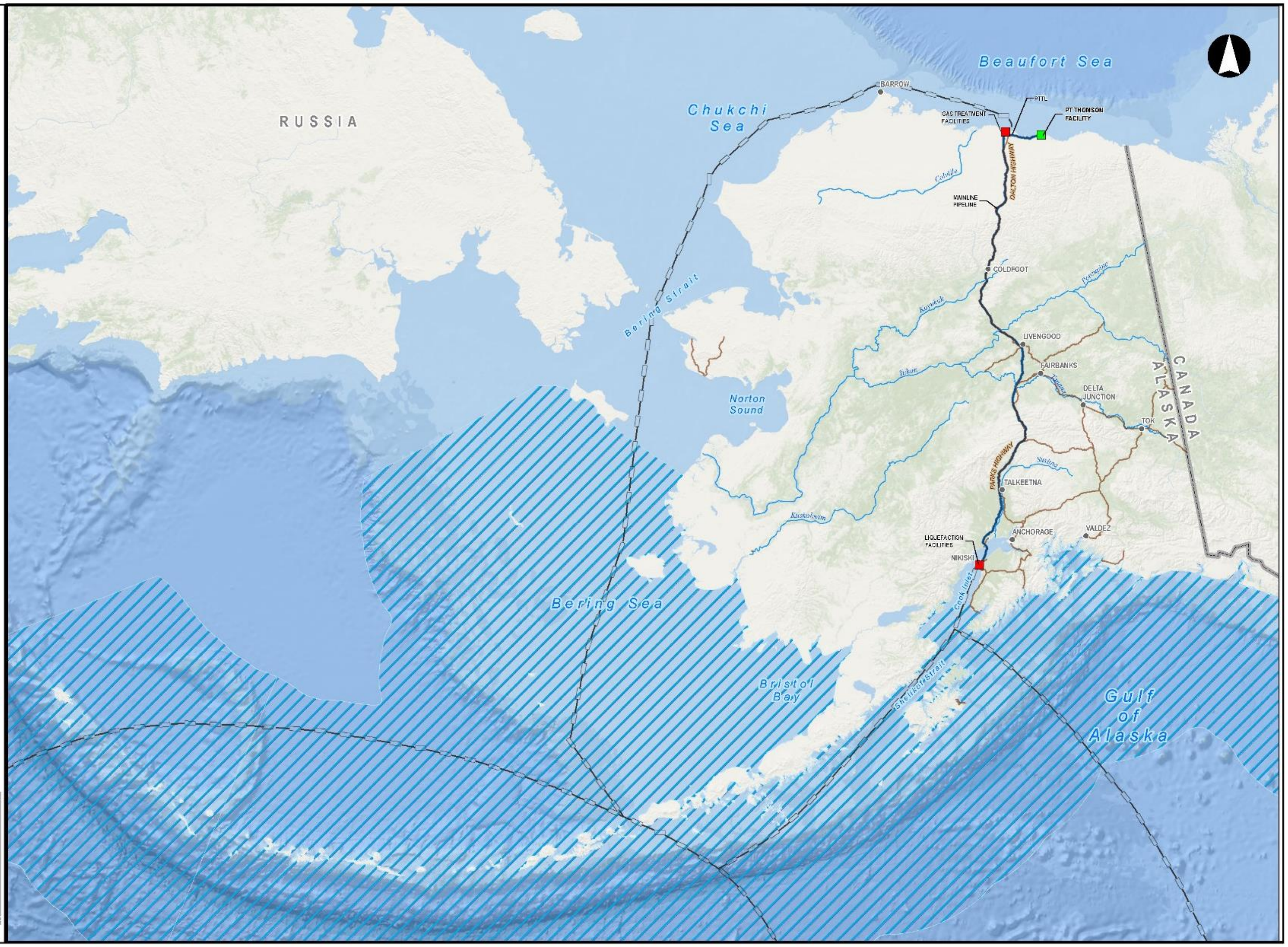
0 50 100 200 Miles

Map may not represent full species range.
Only includes areas within NMFS Alaska region.

SCALE: 1:9,000,000
DATE: 2017-03-21

VICINITY MAP

Figure 4.6.3-13
Alaska LNG Project
Dall's Porpoise Range



LEGEND

- Project Facility
- Existing Facility
- Alaska Place Names
- Alaska LNG Rev C2 Route
- Potential Marine Transportation Route
- Major Highways
- Major Rivers
- Dall's Porpoise Range in U.S. Waters off Alaska

0 50 100 200 Miles

Map may not represent full species range.
Only includes areas within NMFS Alaska region.

SCALE: 1:9,000,000
DATE: 2017-03-20

VICINITY MAP

Figure 4.6.4-14
Alaska LNG Project
Harbor Porpoise Range

LEGEND

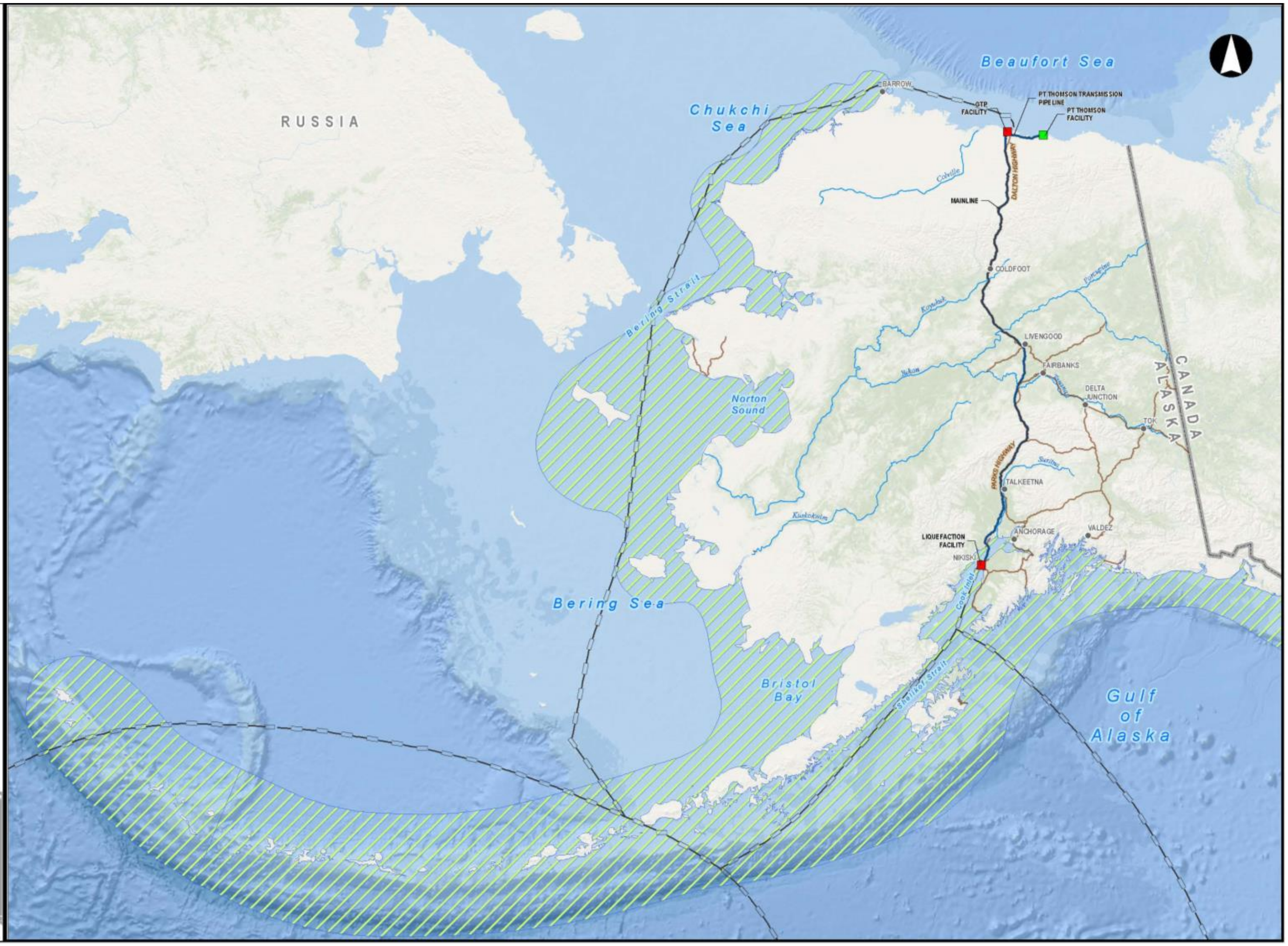
- Project Facility
- Existing Facility
- Alaska Place Names
- Alaska LNG Rev C2 Route
- Potential Marine Transportation Route
- Major Highways
- Major Rivers
- Harbor Porpoise Range in the U.S. Waters off Alaska

0 50 100 200 Miles

Map may not represent full species range. Only includes areas within NMFS Alaska region.

SCALE: 1:9,000,000
DATE: 2017-03-20

VICINITY MAP



Harbor porpoises are likely to occur year-round in vessel transit routes in Lower Cook Inlet and the GOA and in Upper Cook Inlet near the Marine Terminal, the Marine Terminal MOF, the Mainline Pipeline crossing, and the Mainline MOF, though in higher numbers during the spring and summer eulachon and salmon runs (Braund, 2016; NMFS, 2016b). They are also likely to occur in vessel routes in the Bering and Chukchi Seas in summer months.

Pacific White-Sided Dolphin

Pacific white-sided dolphins occur throughout the temperate North Pacific Ocean (see figure 4.6.3-15). In Alaska, Pacific white-sided dolphins are part of the North Pacific stock. No reliable population estimates for the stock are currently available (Muto et al., 2015. The stock is not designated as strategic or depleted by NMFS (NMFS, 2017g). Pacific white-sided dolphins can occur in waters over the continental shelf to deep ocean waters (NMFS, 2017g). In the eastern North Pacific, they occur from the southern Gulf of California, north to the GOA, and west to Amchitka in the Aleutian Islands, and can occasionally occur in the Bering Sea (Muto et al., 2015).

The Pacific white-sided dolphin has a dark gray back and sides, which are separated from a white ventral surface by a black border. The short, thick snout is black at the tip, and the dorsal fin is bicolored. Adults are 7 feet long and weigh 440 pounds; males are slightly larger than females. Females are sexually mature at 5 to 6 years, and males at 8 to 10 years. Females give birth in the spring or summer to single calves measuring about 3 feet long and weighing about 14 pounds (ADF&G, 2018h). Pacific white-sided dolphins feed on squid and schooling fish (NMFS, 2017g).

Male and female Pacific white-sided dolphins travel together in groups, which can be made up of tens to thousands of individuals. The groups can be found in waters over the continental shelf to deep ocean waters (NMFS, 2017g). Pacific white-sided dolphins may occur within the proposed transit routes of LNG carriers in the GOA and occasionally in the Bering Sea.

4.6.3.2 General Impacts and Mitigation

Project construction and operation would affect marine mammals in the Beaufort Sea and Cook Inlet. Vessel traffic through the GOA, Bering Sea, and the Chukchi Sea could also affect marine mammals. In general, the Project would affect foraging, mating, and migration behaviors in oceanic, coastal, and terrestrial habitats. Table 4.6.3-2 lists the Project construction and operational activities with the potential to affect non-ESA listed marine mammals, and identifies which species could be present during those activities based on habitat, range, and timing of the activity.

Section 101(a)(5)(A) and (D) of the MMPA authorizes the Secretary of the Interior to authorize incidental taking of small numbers of marine mammals, upon request, under Incidental Take Regulations (ITR). The USFWS and/or NMFS can issue Incidental Harassment Authorizations for 1 year for harassment only (injury or disturbance), or a Letter of Authorization (LOA) for activities that would result in harassment over multiple years or activities that would result in serious injury or mortality. AGDC has applied to NMFS and the USFWS for Incidental Take Authorizations for construction activities in Cook Inlet for takes of marine mammals,[66] and has indicated that it has applied to NMFS for Incidental Take Authorizations for construction activities in Prudhoe Bay for takes of marine mammals. AGDC has applied for Level A takes of harbor porpoises and harbor seals, and Level B takes of killer whales, harbor porpoises, and harbor seals for construction activities (see section 4.8 for ESA-listed species). During the MMPA authorization process, NMFS may require additional mitigation or alterations to mitigation measures identified in this analysis or AGDC's application to minimize or avoid impacts on marine mammals.

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[66] AGDC's *Petition for Incidental Take Regulations for Construction of the Alaska LNG Project in Cook Inlet, Alaska, Revision 4* was submitted to NMFS on October 1, 2018, and is included in AGDC's response to information request No. 119 dated October 22, 2018 (Accession No. 20181022-5218), available on the FERC website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter 20181022-5218 in the "Numbers: Accession Number" field.

Figure 4.6.3-15
Alaska LNG Project
Pacific White-Sided
Dolphin Range

LEGEND

- Project Facility
- Existing Facility
- Alaska Place Names
- Alaska LNG Rev C2 Route
- Potential Marine Transportation Route
- Major Highways
- Major Rivers
- Pacific White-sided Dolphin Range in U.S. Waters off Alaska

0 50 100 200 Miles

Map may not represent full species range. Only includes areas within NMFS Alaska region.

SCALE: 1:9,000,000
DATE: 2017-03-20

VICINITY MAP

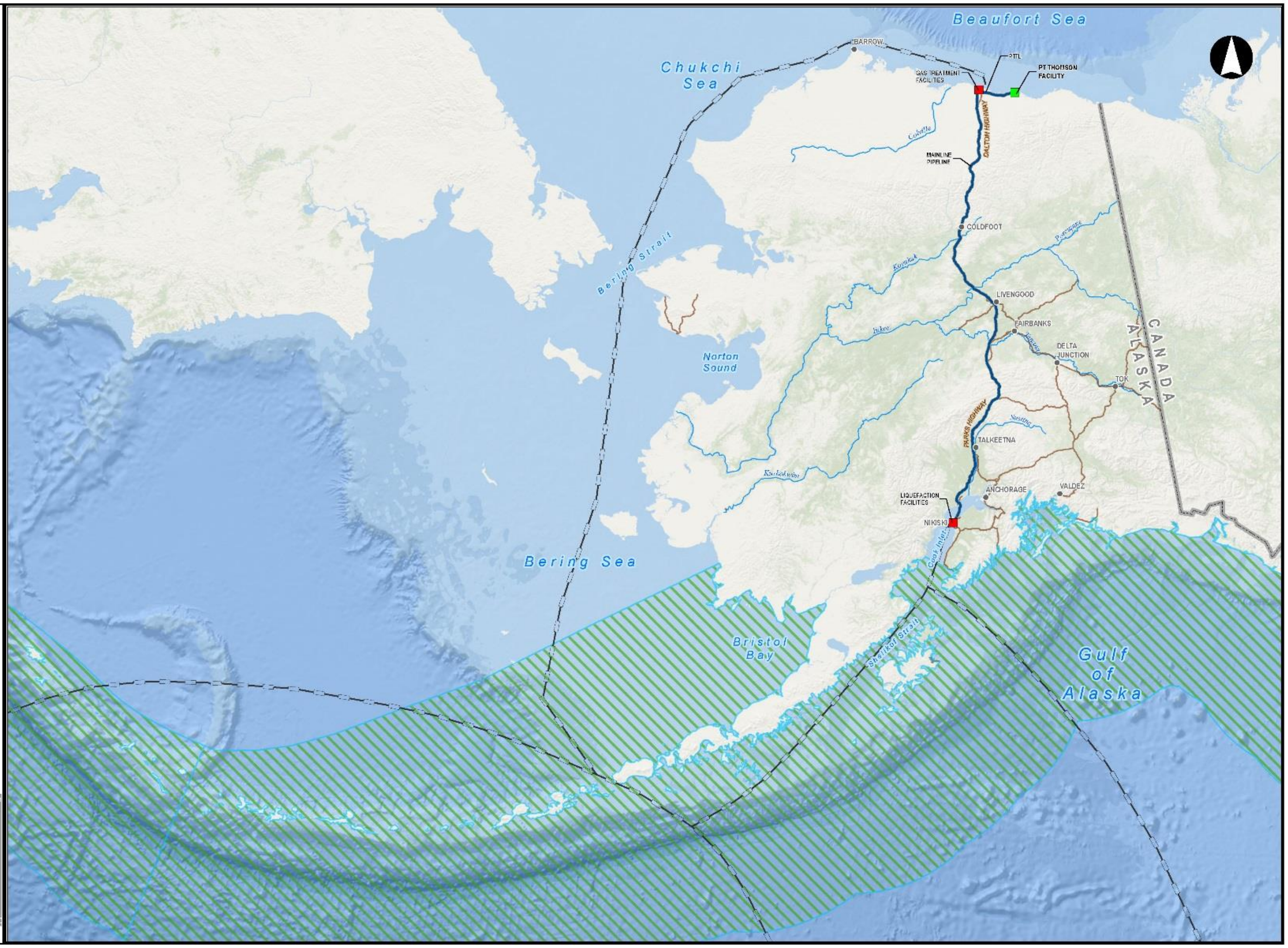


TABLE 4.6.3-2

Seasonal Presence of Non-ESA Listed Marine Mammals Potentially Affected by Project Construction and Operation

Facilities/Activities	Spring (Mar-Apr-May)	Summer (Jun-Jul-Aug)	Fall (Sep-Oct-Nov)	Winter (Dec-Jan-Feb)
Construction				
Gas Treatment Facilities				
West Dock Causeway modifications – dock and berth building, including sheet pile driving (summer, use six seasons)	N/A	Spotted seal; beluga whale; killer whale; minke whale	N/A	N/A
West Dock Causeway modifications – temporary barge bridge placement and removal (start of open water season, ahead of each sealift; at end of each sealift)	N/A	Spotted seal; beluga whale; killer whale; minke whale	Ribbon seal; spotted seal; beluga whale; killer whale	N/A
Seabed preparation – screeding (start of open water season, ahead of each sealift)	N/A	Spotted seal; beluga whale; killer whale; minke whale	N/A	N/A
Vessel traffic for sealifts (during ice-free seasons, about 45 days; for six seasons)	N/A	Northern fur seals; spotted seal; Baird's, Cuvier's, and Stejneger's beaked whales; beluga whale; killer whale; minke whale; narwhal	Spotted seal; Baird's, Cuvier's, and Stejneger's beaked whales; killer whale; narwhal	N/A
Air traffic (throughout construction)	Spotted seal; Baird's, Cuvier's, and Stejneger's beaked whales; killer whale; minke whale; narwhal	Northern fur seals; spotted seal; Baird's, Cuvier's, and Stejneger's beaked whales; beluga whale; killer whale; minke whale; narwhal	Spotted seal; Baird's, Cuvier's, and Stejneger's beaked whales; killer whale; narwhal	Spotted seal; Baird's, Cuvier's, and Stejneger's beaked whales; narwhal
Mainline Facilities				
Mainline Pipeline, Cook Inlet nearshore trenching (about May through October, two seasons)	Harbor seal; killer whale; minke whale; harbor porpoise	Harbor seal; killer whale; minke whale; harbor porpoise	Harbor seal; killer whale; harbor porpoise	N/A
Mainline Pipeline, Cook Inlet pipelay (about May through October, two seasons)	Harbor seal; killer whale; minke whale; harbor porpoise	Harbor seal; killer whale; minke whale; harbor porpoise	Harbor seal; killer whale; harbor porpoise	N/A
Mainline MOF construction (about May through October, one season)	Harbor seal; killer whale; minke whale; harbor porpoise	Harbor seal; killer whale; minke whale; harbor porpoise	Harbor seal; killer whale; harbor porpoise	N/A
Construction vessel traffic to Mainline MOF (about May through October, six seasons)	Harbor seal; killer whale; minke whale; harbor porpoise; Dall's porpoise; Pacific white-sided dolphin	Harbor seal; killer whale; minke whale; harbor porpoise; Dall's porpoise; Pacific white-sided dolphin	Harbor seal; killer whale; harbor porpoise; Dall's porpoise; Pacific white-sided dolphin	Harbor seal; killer whale
Liquefaction Facilities				
Marine Terminal MOF and PLF (year-round, 3 years)	Harbor seal; killer whale; minke whale	Harbor seal; killer whale; minke whale	Harbor seal; killer whale	Harbor seal; killer whale
Marine Terminal MOF dredging (about May through October, 4 years)	Harbor seal; killer whale; minke whale	Harbor seal; killer whale; minke whale	Harbor seal; killer whale	N/A

TABLE 4.6.3-2 (cont'd) **Seasonal Presence of Non-ESA Listed Marine Mammals Potentially Affected by Project Construction and Operation**				
Facilities/Activities	Spring (Mar-Apr-May)	Summer (Jun-Jul-Aug)	Fall (Sep-Oct-Nov)	Winter (Dec-Jan-Feb)
Construction vessel traffic to Marine Terminal MOF (year-round, four seasons)	Harbor seal; killer whale; minke whale; harbor porpoise; Dall's porpoise; Pacific white-sided dolphin	Harbor seal; killer whale; minke whale; harbor porpoise; Dall's porpoise; Pacific white-sided dolphin	Harbor seal; killer whale; harbor porpoise; Dall's porpoise; Pacific white-sided dolphin	Harbor seal; killer whale; harbor porpoise; Dall's porpoise
Marine Terminal MOF removal (April to May, one season)	Harbor seal; killer whale; minke whale	N/A	N/A	N/A
Air traffic (throughout construction)	Harbor seal; killer whale; minke whale	Harbor seal; killer whale; minke whale	Harbor seal; killer whale	Harbor seal; killer whale
Operation				
Gas Treatment Facilities				
Air traffic (periodic)	Spotted seal; Baird's Cuvier's, and Stejneger's beaked whales; killer whale; minke whale	Northern fur seals; spotted seal; Baird's Cuvier's, and Stejneger's beaked whales; beluga whale; killer whale; minke whale	Spotted seal; Baird's Cuvier's, and Stejneger's beaked whales; killer whale	Spotted seal; Baird's Cuvier's, and Stejneger's beaked whales
Mainline Facilities				
Pipeline inspections (aerial, per DOT requirements)	Harbor seal; killer whale; minke whale	Harbor seal; killer whale; minke whale	Harbor seal; killer whale	Harbor seal; killer whale
Liquefaction Facilities				
LNG carriers (operations, year-round)	Harbor seal; killer whale; minke whale; harbor porpoise; Dall's porpoise; Pacific white-sided dolphin	Harbor seal; killer whale; minke whale; harbor porpoise; Dall's porpoise; Pacific white-sided dolphin	Harbor seal; killer whale; harbor porpoise; Dall's porpoise; Pacific white-sided dolphin	Harbor seal; killer whale; harbor porpoise; Dall's porpoise
Ballast water and cooling water exchange (year-round)	Harbor seal; killer whale; minke whale	Harbor seal; killer whale; minke whale	Harbor seal; killer whale	Harbor seal; killer whale
Maintenance dredging at Marine Terminal MOF (as needed)	Harbor seal; killer whale; minke whale	Harbor seal; killer whale; minke whale	Harbor seal; killer whale	Harbor seal; killer whale

N/A = not applicable; no activities are planned during this period.

In the event that maintenance or operational activities would result in takes of marine mammals, AGDC would apply for an Incidental Take Authorization from NMFS and/or the USFWS for these activities. NMFS and/or the USFWS would review each operation or maintenance activity according to MMPA regulatory requirements, and mitigation measures would be developed, applied, and implemented as warranted and required under the authorization.

Noise

Marine mammals use hearing and sound transmission to communicate, navigate, avoid predators, mate, and locate food. Increased noise in their environments can disrupt those behaviors resulting in increased rates of stress, injury, and mortality. In addition, increased noise can cause habitat degradation. Marine mammals can detect underwater noise from industrial activities miles away from the noise source resulting in avoidance or disruption of normal behavior. Some marine mammal species are more susceptible to stranding when exposed to strong underwater sounds such as blasting and sonar (Peng et al., 2015). Increased noise can create a masking effect on important sounds, which in turn can affect the reproductive success of individual marine mammals (Todd et al., 2015). Anthropogenic noise may also indirectly affect the survival and reproductive success of marine mammals by having a negative effect on their prey, such as fish and benthic invertebrates, because prey could be displaced or injured by the noise. Noise impacts on fish and benthic invertebrate resources are described in sections 4.7.1 and 4.7.2, respectively. Airborne noises can alter migration patterns and interfere with normal behaviors of marine mammals.

Marine mammal species have differing hearing capabilities in terms of sensitivity and frequency (NMFS, 2017c) (see appendix L-1). These variances in hearing by species lead to differences in susceptibility to injury or disturbance. While the majority of impacts on marine mammals from construction noise would be behavioral (e.g., avoidance or displacement), noise from some activities, such as pile driving, could cause injury (e.g., hearing loss, increased stress, or death). Sounds would be both short term during construction and long term for the life of the Project.

Project noise effects were evaluated using NMFS's updated *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing—Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts* (NMFS Technical Guidance), dated August 4, 2016 (NMFS, 2016c). Results of those calculations are provided in appendix L-1. As noted above, Level A harassment includes injury to marine mammals, and level B harassment includes behavioral disturbance. Sound levels from some Project activities, such as pile driving, trenching, dredging, and anchor handling, could exceed Level A and/or Level B thresholds established by NMFS for marine mammal habitats (see tables 4.6.3-3 and 4.6.3-4).

TABLE 4.6.3-3

Summary of Level A (Injury) Impact Area or Radius for Marine Mammals [a]

	Pinnipeds – Distance to Injury Impacts		Cetaceans – Distance to Injury Impacts		
Activity	Phocids	Otariids	Low-Frequency	Mid-Frequency	High-Frequency
Prudhoe Bay [b]					
11.5-inch H-pile, impact	<0.1 mi^2	0	0.15 mi^2	0	<0.1 mi^2
14-inch pipe pile, vibratory	0.1 mi^2	0	0.3 mi^2	0	0.4 mi^2
Cook Inlet [c]					
18- and 24-inch pile, impact	2,277 feet	167 feet	0.8 mile	151 feet	1.0 mile
48- and 60- inch pile, impact	1.3 miles	486 feet	2.4 miles	443 feet	2.8 miles
All sizes pile, vibratory [d]	155 feet	10 feet	253 feet	23 feet	374 feet
Sheet pile, impact	0.6 mile	226 feet	1.1 miles	207 feet	1.3 miles
Sheet pile, vibratory	33 feet	3 feet	56 feet	3 feet	82 feet
Mainline Pipeline trenching [e]	N/A	N/A	N/A	N/A	23 feet

N/A = not applicable

[a] Based on Sound Exposure Levels (SEL), as defined in appendix L-1.

[b] 48-inch pipe piles, sheet piling, and screeding would not result in Level A takes of marine mammals (see appendix L-1).

[c] Dredging, anchor handling, and DMT for Mainline Pipeline shoreline installation would not result in Level A takes of marine mammals (see appendix L-1).

[d] Also includes Marine Terminal MOF removal.

[e] Equipment that would generate noise that could reach Level A injury thresholds is represented here (e.g., a trailing hopper suction dredge: see table L-1.1-13 in appendix L-1).

TABLE 4.6.3-4 **Summary of Level B (Disturbance) Impact Area or Radius for Marine Mammals [a]**	
Activity	All Marine Mammals – Distance to Disturbance Impacts
Prudhoe Bay	
11.5-inch H-pile, impact	0.1 mi^2
14-inch pipe pile, vibratory	0.4 mi^2
48-inch pipe pile, impact	1.6 mi^2
Sheet pile, vibratory	6.2 mi^2
Screeding	330 feet
Cook Inlet	
18- and 24-inch pile, impact	1.1 miles
48- inch pile, impact	2.9 miles
60- inch pile, impact	1.3 miles
All sizes pile, vibratory	13.4 miles
Sheet pile, impact	0.6 mile
Sheet pile, vibratory [b]	2.9 miles
Anchor handling	1.3 miles
Dredging [c]	140 to 450 feet
Mainline Pipeline trenching [c]	140 feet to 1.9 miles
DMT	183 feet

N/A = not applicable
[a] Based on Sound Exposure Levels (SEL), as defined in appendix L-1.
[b] Also includes Marine Terminal MOF removal.
[c] Multiple types of equipment or activities could be used or conducted (see appendix L-1).

Underwater Noise

Pile Driving

AGDC would use impact and vibratory pile driving for various activities. Underwater noise generation from pile driving would be dependent on the type and diameter of the piles, the type of hammer used, the substrate the pile is driven into, and other environmental factors. Impact hammers strike the pile; therefore, the duration of the noise is short, but rises quickly and generally does not transmit as far as noise from vibratory hammers. Vibratory hammers vibrate the pile into place, resulting in more continuous or longer-term noise generation; peak noise rises slower, but transmits further underwater than noise from impact hammers.

During construction, each pile could take 1 to 2 hours to install. Underwater noise from pile driving could have a negative effect on the fitness of an individual marine mammal. For example, if individual animals are prevented from feeding or nursing young during pile driving, this could result in decreased fitness. If the individual can move out of the affected area to adjacent suitable habitats, however, the effects would be minimized (Tougaard et al., 2009). Studies show that marine mammals, such as harbor seals and harbor porpoises, avoid areas where pile driving is occurring (Russell et al., 2016; Haelters et al., 2012).

AGDC would install piles and sheet piling for Dock Head 4 using an impact hammer between June and August of one season, with the pile driving expected to take 112 days. The pile driving noise would generate intermittent noise levels that could reach Level A and B harassment and could affect spotted seals and beluga, killer, and minke whales if present near West Dock Causeway during this activity (see tables 4.6.3-3 and 4.6.3-4). Continuous vibratory and impact pile driving methods would be used to install piles and sheet piling for the Mainline MOF, Marine Terminal MOF, and PLF. Appendix L-1 provides the number of piles that AGDC would install in Cook Inlet. The pile driving would occur between about May through October during the ice-free seasonal window over a 5-year period. AGDC would remove the Marine Terminal MOF piles with a vibratory hammer. As indicated in table 4.6.3-2, harbor seals, killer whales, minke whales, and harbor porpoises could all occur in Cook Inlet during the ice-free season during pile driving activities. About half of the pile driving for the Mainline MOF would occur when the tide is out, which would minimize underwater noise impacts on marine mammals for that portion of the sheet piling installation.

Excavation

For the shoreline approaches in Cook Inlet, AGDC proposes to bury the Mainline Pipeline using water-based excavators from the shoreline out to a depth such that the top of the pipe is sufficiently protected from major hazards. This depth is expected to be from about -35 to -45 feet MLLW. Additional details on Mainline Pipeline installation in Cook Inlet can be found in sections 2.2.2 and 4.3.3. Excavation activities would generate continuous and intermittent noise levels that could reach Level A and B harassment (see tables 4.6.3-3 and 4.6.3-4). Harbor seals, killer whales, minke whales, and harbor porpoises could experience harassment from excavation noise in Cook Inlet during Mainline Pipeline installation (see table 4.6.3-2).

To reduce impacts associated with open cuts of the shore approaches, we have recommended that AGDC incorporate the use of the DMT continuation methodology for the shoreline crossings at Beluga Landing South and Suneva Lake, or provide a site-specific justification demonstrating that the methodology would not be feasible (see section 4.3.3). Use of the DMT method would eliminate the risk of Level A harassment (injury) impacts on marine mammals from trenching and reduce the distance for Level B harassment (disturbance) impacts on marine mammals in Cook Inlet from up to 1.9 miles to 183 feet.

Before conducting pipeline construction in Cook Inlet, AGDC would conduct detailed geophysical surveys using single and multibeam echosounders and side scan sonar to determine the bathymetry of the seafloor where the Mainline Pipeline would be installed. Some of these instruments can generate noise at levels that could affect marine mammals (greater than 200 kilohertz). Typically, single beam echosounders operate at frequencies of 3.5 to 750 kilohertz (which have a range that can affect marine mammals), and multibeam echosounders operate at frequencies of 200 to 400 kilohertz (which are not detectable by marine mammals). Echosounders used for geophysical surveys could produce noise that would reach Level B harassment (disturbance) for marine mammals near the activity.[67]

Dredging and Screeding

Screeding would occur at the West Dock Causeway to accommodate barges and vessels. Noise from screeding activities could reach levels above disturbance thresholds established by NMFS (see appendix L-1). Ribbon seal, spotted seal, and beluga whale within 330 feet of screeding could experience Level B harassment (disturbance).

Dredging during the open water season could coincide with harbor seal activity and killer whale, minke whale, and harbor porpoise seasonal movements through Cook Inlet. Construction or maintenance dredging using mechanical, hydraulic cutter, or clamshell dredgers would occur during 4 of the marine

[67] Noise levels would be dependent on vessel speeds and type of equipment used.

construction years and use of the Marine Terminal MOF in Cook Inlet. Maintenance dredging at the Marine Terminal MOF would occur during construction Years 3 and 7. Dredging could generate noise levels above Level B harassment thresholds established by NMFS (see tables 4.6.3-3 and 4.6.3-4). As described above for pipeline construction, AGDC would use single and multibeam echosounders before, during, and after dredging to map the bathymetry of the seafloor. Impacts from these activities would be the same as those described above for the geophysical surveys prior to excavation.

Vessels

Vessels are a major source of noise in coastal environments. Project-related vessel traffic would indirectly affect marine mammals through potential habitat degradation caused by increased shipping noise. Traditional knowledge workshop participants noted how whales in particular move away from the noises generated by vessels (Braund, 2016). Many reactions to ships or boats are presumably reactions to noise and often follow changes in engine and propeller speed. Vessel and associated noise could disrupt whale behavior; research has found that military sonars alter dive behavior, movements, and vocal activity of whales (Allen and Angliss, 2013). In contrast, sea lions in the water tolerate close and frequent vessel approaches, and sometimes congregate around fishing vessels (Richardson et al., 1995).

Material deliveries to the West Dock Causeway with vessels would generate noise that could disturb marine mammals along vessel transit routes and while staged at the PBOSA. Vessels would transit during periods of open ice in the summer months. Northern fur seals; spotted seals; Baird's, Cuvier's, and Stejneger's beaked whales; beluga whales; killer whales; minke whales; and narwhals could all occur in vessel transit routes during the summer months.

Cook Inlet has a naturally noisy acoustic environment with anthropogenic noise sources from vessels, oil platform activities, and aircraft overflights; and natural noise such as bottom substrate transport by high currents from large tidal fluxes (Blackwell and Greene, 2003). Harbor seals, killer whales, minke whales, harbor porpoises, Dall's porpoises, and Pacific white-sided dolphins could all occur in Cook Inlet during spring, summer, and fall seasons; and harbor seals, killer whales, harbor porpoises, and Dall's porpoises could all occur during the winter season. LNG carriers would visit the Marine Terminal year-round. Some vessels could generate noise that has potential to cause Level B harassment (disturbance) of marine mammals. Vessel noise could cause marine mammals to avoid the area near the transiting vessel, but vessels not in transit (e.g., pipelay, anchor handling, and positioning vessels) could also cause Level B harassment (disturbance) as discussed below.

Noise generated by vessels includes propeller cavitation, thrusters, engines, and depth sounders. Most noise and disturbance associated with this traffic would occur during docking from tug propellers and thrusters and from anchor handling tugs during Mainline Pipeline installation on the Cook Inlet seafloor. The primary impact of vessel noise on marine mammals would be masking of sounds (Southall, 2005). Of these sources, sound pressure levels (SPL) associated with LNG carrier docking at the PLF could exceed threshold values for injury or harassment of marine mammals. The onset of thruster noise is generally sudden and can cause a startle reaction in nearby marine mammals. Vessel docking during deliveries to the West Dock Causeway, during Liquefaction Facilities construction, at the Mainline MOF, and during pipeline construction at the Marine Terminal MOF, could generate noise at levels that would disturb marine mammals. Vessels would transport pipeline and materials to various ports in Alaska. Tug and barge combinations would be used to transport pipeline joints to the Mainline MOF during the open water period in Upper Cook Inlet.

In addition, vessels in transit to the Marine Terminal MOF and the Mainline MOF during construction, and LNG carriers during operation, would temporarily stage or anchor at Kachemak Bay

(NOAA, 2018a). Harbor seals haul out on the coasts year round and killer whales are present in the summer in Kachemak Bay (NOAA, 2018a).

Due to the ephemeral nature of vessels in transit, vessel noise impacts would be expected to be minor from vessels transiting to and from and docking at Project facilities in Cook Inlet and Prudhoe Bay during construction and operation. Anchor handling for pipelay activities in Cook Inlet, however, could generate Level B harassment (disturbance) within 1.3 miles of the source (see appendix L-1); this activity would affect marine mammals in that area.

<u>Airborne Noise</u>

Activities that could cause airborne noise levels above disturbance thresholds include pile driving, onshore vehicles, construction activities and equipment, mainline excavation, facility operation, and aircraft overflights. Airborne sounds over water could affect marine mammals at the surface or when hauled out (e.g., seals). These noises could cause startle reactions, or cause marine mammals to avoid or move away from the areas where equipment is generating the noise.

Airborne noise has the potential to affect marine mammals, in particular those species that haul out on land or ice and those that spend a significant amount of time at the surface, such as seals and sea otters. Project activities, such as overflights, pile driving, and general construction noise at coastal facilities (i.e., the West Dock Causeway, PTTL, PBTL, Mainline Pipeline, and the Liquefaction Facilities) could expose marine mammals to airborne sounds. NMFS has established airborne disturbance thresholds for harbor seals and other seal species (see appendix L-1). Noise analyses for the Project implemented the NMFS Technical Guidance, and appendix L-1 provides airborne noise calculation results.

Airborne noise generated during pile driving or VSM installation for the PTTL is unlikely to rise to Level B harassment (disturbance) levels for harbor seals, northern fur seals, ribbon seals, or spotted seals unless an animal is immediately adjacent to the activity (see section 4.16.3 for details on noise levels). Because seals would be anticipated to avoid pile driving, they would not be subject to Level B harassment (disturbance).

Airborne noise from general construction activities on land or over water would reach NMFS disturbance levels for several species, including:

- ribbon and spotted seals within about 0.2 mile of West Dock Causeway;
- harbor seals within about 0.4 mile of the Liquefaction Facilities; and
- harbor seals within about 180 feet of the Mainline Pipeline shoreline excavation in Cook Inlet (see appendix L-1).

There are no known haulouts or rookeries for harbor seals, northern fur seals, ribbon seals, or spotted seals within 0.4 mile of construction activities; therefore, these activities would not be expected to cause Level B harassment to hauled out seals or those in rookeries. Individual animals onshore or in the water within 0.4 mile of these activities, however, could be affected. Seal reactions to noise disturbance include increased alertness, threat displays, moving towards the water, and flushing into the water. If seals are with pups, noise disturbance could cause separation of the adult and pup, energetic costs, and stress. Molting seals could experience increased stress and energy loss from noise disturbance (Wilson, n.d.).

AGDC has not planned any blasting in or within 656 feet of Cook Inlet or Prudhoe Bay for the Mainline Pipeline or the GTP; therefore, no blasting impacts on marine mammals would be expected. Noise generated by the GTP or the LNG Plant during operation would not reach harassment levels for marine mammals that could occur in the vicinity, such as ribbon seals, spotted seals, beluga whales, and harbor porpoises. Sounds from compressor or heater stations for the Mainline Pipeline would not affect marine mammals because the closest facility, the Theodore River Heater Station, would be about 8 miles from the Cook Inlet coast. Noise from operation of the Liquefaction Facilities would not reach harmful levels for marine mammals, but species such as harbor seals could avoid the area immediately around the Marine Terminal Facilities due to the increase in ambient noise (see section 4.16.4 for additional details on noise levels).

AGDC would use air transportation for the movement of workers, supplies, and equipment destined for remote areas of Alaska. The Project would use Anchorage International, Fairbanks International, Kenai Municipal, and Deadhorse Airports as regional hub airports for the transportation of Project personnel as well as airstrips in Point Thomson, Kenai, Beluga, Dutch Harbor, Seward, and Valdez. Air traffic would include both fixed-wing planes and helicopters. About three helicopter flights per day would generally be associated with Project camps, but there could be as many as six per day. Additional aircraft traffic over Cook Inlet, including flights to conduct pipeline operation inspections, could disturb nearby marine mammals. AGDC would use an additional 26 flights (by helicopter or fixed wing) per year to complete pipeline surveillance overflights at a minimum flight altitude of 1,500 feet over Cook Inlet. At that altitude, received sound levels at the water surface would remain below the NMFS threshold value of 120 dB (Nowacek et al., 2007) for continuous sound sources resulting in a minor disturbance to marine mammals. Similarly, overflights for GTP, PTTL, and PBTL operation would maintain minimum altitudes of 1,500 feet.

Helicopters could generate noise levels that reach Level B harassment (disturbance) for harbor seals within 244 feet and for non-harbor seal species within 79 feet of the aircraft. Small airplanes used for the Project may not generate noise levels that reach NMFS disturbance levels for non-harbor seal species. While aircraft is unlikely to reach Level B harassment (disturbance) unless the animal is at the take-off location, research has shown that marine mammals would be affected by aircraft overflights. Noise and visual stimuli from aircraft (helicopter and airplane) overflights have the potential to disturb marine mammals. Use of existing airfields would increase the existing noise due to the number of flights proposed for this Project (see section 4.16). Marine mammals disturbed by aircraft typically will surface for shorter periods, dive, swim, turn away from the noise or sight, or breach (Patenaude et al., 2002). Cetacean reactions to overflights would consist of brief behavioral responses, such as sudden diving or turning away from the sound or visual source, or no response (Nowacek et al., 2007). Helicopters tend to be more disturbing than fixed-wing aircraft (Luksenburg and Parsons, 2009; Born et al., 1999). Pinnipeds tend to react to aircraft overflights by becoming alert and/or entering the water (Luksenburg and Parsons, 2009; Born et al., 1999). Low-flying aircraft (less than 1,500 feet) would most likely affect hauled out pinnipeds that would react to the aircraft by diving into water. Participants in the traditional knowledge workshops have noted how much louder helicopters are than other types of aircraft, and how helicopter noise travels farther across the water, causing marine mammals to avoid these areas (Braund, 2016).

Many researchers have described behavioral reactions of marine mammals to the presence of humans, boats, and aircraft (Richardson et al., 1995). Although most of the data are anecdotal, they provide useful information about situations in which some species react strongly, weakly, or inconsistently, or do not react at all. No specific data on received sound levels are available for most of these incidents (Richardson et al., 1995).

Steller sea lions occupying haulouts exhibit variable reactions to aircraft (Calkins, 1979). Approaching aircraft usually frighten some or all animals into the water. Immature sea lions and pregnant females are more likely to enter the water than are territorial males and females with small pups. Over 1,000 animals stampeded off a beach in response to a helicopter greater than 1 mile away (Richardson et al., 1995). Sea lions on haulouts are less responsive to boats, and rarely react unless a boat approaches within 300 to 600 feet (Richardson et al., 1995). Aircraft noise could affect seals that could be resting out of water, but noise from aircraft flying overhead could also propagate into the water where seals are swimming (Blackwell and Greene, 2003). Even small aircraft could produce loud sounds that exceed 120 dB re 20 µPa at 1 meter and could affect marine mammals found along typical flight paths, such as those near airports or landing pads (Luksenburg and Parsons, 2009). The severity or lack of response to aircraft overflight noise varies by species and is dependent on the behavior of the animal at the time of disturbance (i.e., resting versus traveling) (Luksenburg and Parsons, 2009). Patenaude et al. (2002) found that beluga and bowhead whales in the Alaskan Beaufort Sea showed little reaction to flights that were greater than 597 feet (182 meters) above the ocean surface.

There are no known haulouts within several miles of the Mainline Pipeline in Cook Inlet. Ice-associated seals could occur in Prudhoe Bay either on ice or potentially on land where the seals could see or hear flights in the Sagavanirktok Delta area. Any effects on marine mammals would be minor, consisting of brief behavioral responses.

AGDC would use helicopters during completion of the LNG storage tank roofs, and would use helipads at camps during Mainline Pipeline construction. The Prudhoe Bay and the Kenai Peninsula helipads would have helicopter traffic that could disturb marine mammals in the vicinity for both the construction and operational phases of the Project. The closest helipads to the coast would be the platforms at the Mainline Pipeline MLVs 27, 28, and 29 on the Kenai Peninsula; these would be about 700, 1,500, and 800 feet, respectively, from the Cook Inlet coast.

Mitigation Relevant to Noise-Generating Activities

Using the NMFS Technical Guidance to determine distances to Level A and B harassment, AGDC would set shutdown and harassment zones for pile driving in Cook Inlet and Prudhoe Bay and anchor handling activities in Cook Inlet. Protected Species Observers (PSO) would be used during construction to identify any marine mammals that could come into proximity of these activities. The PSOs would be used to monitor marine mammals during anchor handling procedures, which cannot be stopped once the activity has started due to the need to ensure safety and sound constructability of the pipeline.

PSOs would monitor construction activities and minimize exposures of marine mammals to sound levels in excess of NMFS injury thresholds (Level A harassment). PSOs would have the authority to stop activities immediately, and/or lower noise levels when marine mammals are visible within the shutdown or harassment zones. AGDC would shut down impact pile-driving activities if a marine mammal enters the applicable zone, and pile driving would only resume once the animal has left the zone. As noted above, AGDC would install portions of the sheet piling (about 600 feet) at the Mainline MOF during low tide, which would reduce underwater noise associated with this activity.

AGDC is proposing the following shutdown and harassment zones for pile driving:

- a 328.1-foot (100-meter) shutdown zone for pile driving operations for killer whales and beluga whales to prevent Level A take by injury;
- a 1,640.4-foot (500-meter) shutdown zone for pile driving operations for humpback whales, harbor porpoises, and harbor seals to prevent Level A take by injury;

- a 1.4-mile (2.2 km) Level B harassment zone for impact pile driving operations based on the calculated distance to the 160 dB threshold for pipe piles, to be used:
    - o for potential Level B exposures for marine mammals other than beluga whales; and
    - o as the shutdown zone for beluga whales;
- a 2.9-mile (4.6 km) Level B harassment zone for vibratory pile driving operations based on the calculated distance to the 120 dB threshold for sheet piles, to be used:[68]
    - o for potential Level B exposures for marine mammals other than beluga whales; and
    - o as the shutdown zone for beluga whales; and
- a 1.2-mile (2 km) Level B harassment zone for anchor handling operations based on the calculated distance to the 120 dB threshold, to be used:
    - o for potential Level B exposures for all marine mammals.

The distances to shutdown, harassment, and mitigation zones AGDC committed to above do not apply to all activities and do not match the modeled distances in appendix L-1. Because these distances would not be sufficiently protective to marine mammals for all underwater noise-generating activities that could cause marine mammal disturbance, **we recommend that:**

- **<u>Prior to construction</u>, AGDC should file with the Secretary, for the review and written approval of the Director of the OEP, revised shutdown distances for all underwater noise generating activities (i.e., pile driving [impact, vibratory, and all pile types], dredging, screeding, anchor handling, Mainline Pipeline shoreline installation, and Marine Terminal MOF removal). For the revised shutdown distances, AGDC should establish:**
    - **a. shutdown zones for Level A harassment for all marine mammals based on the modeled distances in appendix L-1, tables L-1.1-3, L-1.1-4, L-1.1-8, and L-1.1-9 of the EIS (pile driving activities should stop until the animal moves out of the shutdown injury zone);**
    - **b. shutdown zones for Level B harassment for Cook Inlet beluga whales based on the modeled distances in appendix L-1, tables L-1.1-10 and L-1.1-12 of the EIS (pile driving and dredging activities should stop until the animal moves out of the shutdown harassment zone); and**

[68] AGDC acknowledged the calculated distance to the 120-dB threshold for vibratory pile driving of pipe piles is 13.4 miles (21.5 km). AGDC states that it would not be feasible to monitor this zone, so the proposed zone is based on the calculated distance for vibratory pile driving of sheet piles. Further, the species of greatest concern, beluga whales, occur within 1.2 miles (2 km) of shore (Goetz et al., 2012), so AGDC determined a zone of 2.9 miles (4.6 km) would be feasible and biologically appropriate. However, the noise could travel along the shoreline up to 13.4 miles from the activity, affecting Cook Inlet beluga whales.

c. **harassment zones for Level B harassment for all marine mammals (except Cook Inlet beluga whales) based on the modeled distances in appendix L-1, tables L-1.1-5, L-1.1-10, L-1.1-11, L-1.1-12, and L-1.1-13 of the EIS (activity noise levels should be lowered when animals enter these zones, until they leave the area, if possible).**

Alternatively, AGDC may commit to conducting a Sound Source Verification <u>during construction</u> that would establish appropriate shutdown and harassment zones based on observed underwater noise levels.

AGDC committed to having at least two PSOs on watch during pile driving activities in Cook Inlet, and at least one PSO on the barge and on watch during pipe laying activities. However, in AGDC's draft Marine Mammal Monitoring and Mitigation Plans for Cook Inlet and Prudhoe Bay, AGDC committed to using land-based PSOs only. Due to the large radius required for pile driving monitoring (up to 2.9 miles), and lack of information on PSOs for removal of the Marine Terminal MOF in Cook Inlet and pile driving in Prudhoe Bay, **we recommend that:**

- **<u>Prior to construction</u>, AGDC should file with the Secretary, for the review and written approval of the Director of the OEP, a revised PSO deployment plan that includes the following:**

  a. **for pile driving activities in Cook Inlet and Prudhoe Bay, AGDC should station at least one PSO at-sea near the edge of the shutdown zone (for Level A) and one PSO stationed at-sea or on land near the edge of the harassment zone (for Level B); and station at least one PSO on the pile-driving barge, or in an adjacent land-based vantage point;**

  b. **for anchor handling activities in Cook Inlet, AGDC should station at least one PSO on the pipelay vessel; and**

  c. **for dredging and screeding activities and Mainline Pipeline shoreline installation, AGDC should station at least one PSO on each dredging and screeding vessel or accompanying vessel.**

AGDC would use a vibratory hammer to drive the top half of some sheet piles before using an impact hammer to reduce generated noise levels. For impact hammering, AGDC would use a "soft-start" technique at the beginning of each day's pipe/pile driving activities, or, if pipe/pile driving has ceased for more than 1 hour, would allow any marine mammal that could be in the immediate area to leave before pile driving reaches full energy. This "ramping up" would alert marine mammals of impending hammering noise and would allow them to vacate the general area (Dahl et al., 2015). NMFS has recommended that AGDC implement a soft-start technique if pile driving has ceased for 30 minutes or more to minimize the risk of harassment to marine mammals that may have entered the exclusion zone during the inactive period.

In its draft Marine Mammal Monitoring and Mitigation Plans for Cook Inlet and Prudhoe Bay, AGDC stated it would implement soft-start techniques after activities had ceased for 30 minutes or more. Additional measures that AGDC would implement to reduce the impacts of pile driving on marine mammals are described below.

- The Level B zone would be cleared 30 minutes prior to a soft-start to confirm no marine mammals are within or entering the zone.

- AGDC would begin impact hammering soft-start with an initial set of three strikes from the impact hammer at reduced energy, followed by a 1-minute waiting period, then two subsequent three-strike reduced energy sets.

- AGDC would immediately shut down hammers at any time a marine mammal is detected entering or within the Level A zone. Hammering operations would not begin until the zone has been visually inspected for at least 30 minutes to confirm the absence of marine mammals, or the marine mammals are seen exiting the area.

- Initial hammering starts would not begin during periods of poor visibility (e.g., night, fog, or wind).

- Any shutdown due to a marine mammal sighting within the zone would be followed by a 30-minute all-clear period and then a standard ramp-up.

- Any shutdown for other reasons resulting in the cessation of the sound source for a period greater than 30 minutes would also be followed by the standard ramp-up procedures.

AGDC would conduct pile driving during daylight hours, making observations of marine mammals in the vicinity possible. Anchor handling would occur 24 hours per day during spring, fall, and winter, and dredging and screeding would occur 24 hours per day and could occur during dark hours when marine mammal observation would not be possible. There is an increased risk of noise generating activities affecting marine mammals entering shutdown or harassment zones during low light or dark times.

AGDC would conduct marine mammal monitoring to collect information on marine mammal presence within the disturbance and injury zones for the Project and would provide the results of the monitoring efforts to NMFS in a draft summary report within 90 days after the monitoring ends. NMFS could make this information available to regional, state, and federal resource agencies, universities, and other interested private parties upon written request. Before Project startup each year, AGDC would identify other monitoring programs in Cook Inlet so that the programs could share information on species sightings.

We have recommended in section 4.8 that AGDC should not conduct pile driving in June and July for construction of the Mainline MOF to minimize impacts on Cook Inlet beluga whales, which are ESA-listed. Avoiding pile driving during those timeframes could also minimize impacts on harbor seals and harbor porpoise. Harbor seals give birth between May and mid-July, and harbor porpoises feed on the summer eulachon and salmon runs in Cook Inlet; therefore, avoiding pile driving in June and July would also minimize the chance of disrupting harbor seal reproduction and harbor porpoise feeding.

To reduce disturbance to marine mammals from aircraft overflights, AGDC would reduce the number of flights to the minimum number practicable, and construction and operational flights would maintain a minimum altitude of 1,500 feet above ground level (except during takeoff and landing or for safety considerations).

Habitat

Project-related activities would result in temporary and permanent marine mammal habitat disturbance and loss. Development of construction work surfaces, ice transportation corridors, and aboveground facilities; granular fill placement; and water/ice withdrawal activities would result in temporary and permanent loss or alteration of potential haulout habitat for harbor seals, northern fur seals, and spotted seals. No known haulouts for these species occur in the Project footprint, but seals could occasionally occur on land or on sea ice in the Project area in Cook Inlet and Prudhoe Bay coastal areas. In particular, harbor seals could occur on land near the Mainline MOF near Beluga; ribbon seals could occur near the West Dock Causeway in winter months as the sea ice approaches land; and spotted seals could haul out at the Sagavanirktok River mouth or the PBOSA. Seals could be disturbed by construction activity and noise and avoid the area; construction activities could make the habitat temporarily unsuitable during active construction periods.

Project facilities would cause permanent habitat loss in Prudhoe Bay and Cook Inlet. The West Dock Causeway and Dock Head 4 would cause a loss of 152 acres of benthic habitat. Marine mammals could avoid the area immediately adjacent to the Marine Terminal due to the additional disturbance from vessel traffic and human presence, and the Marine Terminal would cause a permanent loss of 20 acres of benthic habitat. There would be a permanent loss of about 330 acres of foraging habitat for harbor seals from placement of the Mainline Pipeline on the bottom of Cook Inlet; however, harbor seals typically dive to depths less than 65 feet, and a large percentage of the 330 acres is in deeper waters (ADF&G, 2018h). The Mainline MOF would be left in place after use by this Project, causing a loss of 6 acres of benthic habitat. While AGDC would not continue to use this facility, others could use it. These marine habitats could become unsuitable for most marine mammals due to loss, alteration, and human activity, and would not be available for marine mammals, such as harbor seals, killer whales, and minke whales, to use for feeding, resting, or migrating. Overall, since the percentage of habitat lost due to these facilities is small relative to the habitat available in Cook Inlet and Prudhoe Bay; impacts would be minor but permanent.

Prey Availability

Zooplankton, benthic invertebrates, and fish are all important prey sources for marine mammals in Cook Inlet and Prudhoe Bay. Prey habitat loss and alteration could occur from disturbance related to dredging/screeding in Cook Inlet and Prudhoe Bay; facility construction (e.g., benthic construction and noise from construction equipment) at the West Dock Causeway, the Marine Terminal MOF, and the Mainline Pipeline; and vessel grounding at the Mainline MOF. Acres of impact are described in table 2.1.2-1. About 101 acres of habitat would be temporarily affected in Prudhoe Bay, and 5,151 acres in Cook Inlet. About 152 acres would be permanently affected in Prudhoe Bay and 350 acres in Cook Inlet.

Benthic organisms in Prudhoe Bay include polychaetes, mollusks, isopods, and anthropods and in Cook Inlet include polychaetes, bivalves, and crustaceans. Mainline Pipeline construction in Cook Inlet would occur during the salmon and eulachon runs during two seasons of offshore construction. These species are an important food source for many marine mammals in Cook Inlet, such as harbor porpoises. Noise from pile driving activities and transiting vessels as well as turbidity and sedimentation could affect fish and benthic invertebrates (see section 4.7.1 and 4.7.2, respectively).

Impacts from Project activities on prey resources for marine mammals would be short term and localized. In general, fish could experience increased rates of stress, injury, and mortality near pile driving, but generally, fish would avoid habitats around Project construction activities. Benthic communities would be temporarily lost from placement of the Mainline Pipeline and dredging in Cook Inlet and during screeding activities at the West Dock Causeway. Temporary loss of benthic food sources would not be significant since food resources are sufficient in Cook Inlet adjacent to the Mainline Pipeline corridor, and the area around the West Dock Causeway is often subject to disturbance from seasonal ice scour.

Section 4.7.1 discusses impacts on fish-bearing streams that could provide food for marine mammals. Coastal habitats disturbed during construction, such as at the Marine Terminal MOF (which AGDC would remove after use) and the shoreline approaches for the Cook Inlet Mainline Pipeline crossing, would be restored according to the Project Restoration Plan.

Vessel Strikes

Vessels travelling through the Bering, Beaufort, Chukchi, and Bering Seas to Project facilities during construction and operation could strike seals, whales, dolphins, and porpoises (see table 4.6.3-1 and figure 4.6.3-1). Appendix L-2 identifies the estimated number of vessels that would be required for construction and operation of the Project. For construction vessel traffic in Cook Inlet and the GOA, an estimated 0.1 Cuvier's beaked whale and 0.04 minke whale would be struck during the construction phase of the Project. For LNG carrier traffic in Cook Inlet and the GOA during Project operation, an estimated 0.5 Cuvier's beaked whale and 0.2 minke whale would be struck during the life of the Project. Due to a lack of available strike data, potential strikes were not calculated for activities in Prudhoe Bay or for vessels transiting the Bering, Chukchi, and Beaufort Seas, or for species that only occur in these regions (e.g. narwhals and belugas [non-Cook Inlet stocks]). There are no records of individual strikes available for harbor seals, northern fur seals, ribbon seals, spotted seals, Baird's beaked whales, Stejneger's beaked whale, killer whale, Dall's porpoise, harbor porpoise, and Pacific white-sided dolphin to calculate the potential strike rate from Project activities, but literature suggests these species are vulnerable to being struck and injured or killed by vessels. Blunt force trauma from striking the ship bow or by lethal wounding from propeller cuts usually cause whale mortalities. Seals and sea lions are typically at a lower risk for vessel strike, but strikes are likely underreported or not reported at all due to their smaller size, which causes them to go unnoticed by ships. Vessel speed is the primary factor in the probability of a vessel strike, and of the strike being lethal (Vanderlaan and Taggart, 2007). The percent of lethal whale strikes is significantly reduced by vessels traveling at less than 12 knots (13.8 miles per hour) (Vanderlaan and Taggart, 2007). A variety of vessels would be in use for different phases of Project construction and operation. Vessel transit speeds would vary from less than 10 knots up to 26 knots.

As described previously, barges would make deliveries during six sealifts (two pre-construction and four construction sealifts) at West Dock Causeway during the short ice-free season (typically August and September). Potential effects on marine mammals from vessel traffic at West Dock Causeway would include displacement of spotted seals and potential collisions. There are no known spotted seal haulouts near West Dock Causeway, but seals feed near the causeway due to the higher numbers of fish found near the dock. Beluga, gray, killer, and minke whales could occur in vessel traffic areas approaching West Dock Causeway. Northern fur seals and spotted seals could be in the area for breeding, and the three beaked whale species, beluga whales, killer whales, and minke whales could be feeding and moving through the Chukchi and Beaufort Seas at that time. Vessel traffic would have temporary and minor behavioral effects on marine mammals and could strike individual animals in transit. Sealift barging at West Dock Causeway would be completed outside of bowhead whale migration and fall subsistence whaling periods (Nuiqsut and Kaktovik), but would occur when spotted seal, beluga whale, killer whale, and minke whale are in the area.

Construction of the Liquefaction Facilities would require material and module deliveries via heavy lift vessel (HLV), module carriers, and barges. Typically, shipments would occur during the summer shipping season when harbor seals, killer whales, and minke whales would be present in Cook Inlet. LNG carriers would operate at the terminal year-round in Cook Inlet. Cook Inlet currently supports about 486 ships of 300 gross tons or more per year, or 8 to 10 ships per week (Eley, 2006). LNG carrier traffic into Cook Inlet would be about 204 to 360 port calls per year, depending on capacity, during the life of the Project (see appendix L-2), or an increase of 42 to 74 percent over existing traffic levels. Project LNG carrier traffic would increase transits through the North Pacific Great Circle and Southern Routes by about 9 percent. LNG carriers transiting the open ocean typically travel at about 19 knots or less. In Cook Inlet, LNG carriers would typically use speeds of about 12 knots until tugs take over control about 0.5 mile from the dock and move the carriers at around 2 to 3 knots to the dock, reducing speed as they get closer (Pierce and Pierce, 2012). It is possible that this increase in ship traffic could potentially affect dolphins, whales, and seals off the Alaska coast.

Vessels would transit through a breeding and pupping area for spotted seals in the Bering Sea and through a BIA for beluga whale migration north of the Bering Strait and into the eastern Chukchi Sea and Beaufort Sea. An Environmental Sensitivity Index for killer whales occurs at the entrance to Cook Inlet. These areas would be more likely to have vessel-wildlife interactions due to the concentration of animals at different times of year for various life stages. Narwhals give birth in mid-July offshore in areas that could overlap with vessel routes, which could make them more susceptible to vessel strikes as ships travel to the West Dock Causeway. Similarly, Dall's porpoises give birth between June and September, and beluga whales give birth in coastal estuaries in the Beaufort Sea in spring and summer, making these periods more sensitive and likely to have negative interactions with vessels transiting through these areas.

Marine mammals, particularly baleen whales such as minke whales, could become entangled in buoy and anchor lines used to install the Mainline Pipeline (James, 2013), but whales would likely avoid the pipelay activities area due to the increased disturbance caused by construction activities.

Dredging vessels would not strike marine mammals due to their slow speeds while dredging (Todd et al., 2015), but dredge vessels could strike marine mammals while in transit to the dredge site since speeds could be 12 to 16 knots (Todd et al., 2015).

AGDC has committed to developing a Transit Management Plan to decrease noise and possible strikes. This plan would include decreased speeds and course change minimizations. A Ship Strike Avoidance Measures Package would also be provided to LNG carrier shippers. This package would include the measures proposed by NMFS for avoidance of marine mammals to reduce the likelihood of adverse effects on these species. Potential measures are listed below.

- AGDC would provide training materials to vessel crews, including the use of a reference guide such as the *Marine Mammals of the Pacific Northwest, including Oregon, Washington, British Columbia, and South Alaska* (Folkens, 2001). This is a pamphlet that would be provided to vessels calling on the terminal and would be included as part of the terminal use agreement to the shippers.
- Vessel masters would be asked to provide reports of marine mammal sightings while in the EEZ and to provide the report to AGDC upon docking. This reporting request would be included in the Ship Strike Avoidance Measures Package provided to each vessel, and compliance with the measures and the reporting would be included in all service agreements with shippers.
- Vessels would use minimal speeds that do not sacrifice vessel safety or steerage but minimize noise and maneuverability to avoid collisions with marine mammals.

The following measures would be implemented for vessels in transit to the West Dock Causeway in the Beaufort Sea to reduce impacts on whales, including the risk of strikes:

- slow vessel speeds if whales are spotted during transit;
- avoid groups of whales where possible;
- remain landward of Cross Island; and
- maintain vessel traffic near established navigation routes where feasible.

AGDC would contractually require vessels to comply with the *Vessel Strike Avoidance Measures & Reporting for Mariners* (NMFS, 2008b) and vessels would be informed about the latest information regarding the distribution and numbers of marine mammals likely to be encountered within the activity area or route. The measures consistent with NMFS guidance above, which would use minimal speed that maintains vessel safety and steerage, but minimize potential collisions, are listed below.

- Vessel operators and crews would maintain a vigilant watch for marine mammals and sea turtles to avoid striking protected species.
- When whales are sighted, vessels would maintain a distance of 100 yards or greater from the whales.
- When sea turtles or small cetaceans are sighted, vessels would attempt to maintain a distance of 50 yards or greater from the animal, whenever possible.
- When small cetaceans are sighted while a vessel is underway (e.g., bow-riding), vessels would attempt to remain parallel to the animal's course. Vessels would avoid excessive speed or abrupt changes in direction until the cetacean has left the area.
- Vessels would reduce speed to 10 knots or less when mother/calf pairs, groups, or large assemblages of cetaceans are observed near an underway vessel, when safety permits (e.g., maintaining steerage speed to keep vessel control). A single cetacean at the surface could indicate the presence of submerged animals in the vicinity; therefore, prudent precautionary measures would be exercised. The vessel would attempt to route around the animals, maintaining a minimum distance of 100 yards whenever possible.
- Whales could surface in unpredictable locations or approach slowly moving vessels. When an animal is sighted in the vessel's path or in close proximity to a moving vessel and when safety permits, vessels would reduce speed and shift the engine to neutral. Vessels would not engage the engines until the animals are clear of the area.

Sealifts to the West Dock Causeway would be conducted when surface ice coverage is 30 percent or less during the ice-free period (the average is 61 days, with the earliest opening being July 15, and the latest closing November 4). In addition to the *Vessel Strike Avoidance Measures & Reporting for Mariners*, for sealifts to the West Dock Causeway, additional transport conditions may originate from the *Conflict Avoidance Agreement* with the Inupiat Eskimo Whaling Commission. Some of these conditions are general good practice in line with the Inupiat Whaling Commission recommendations for tugs and barges transiting from Port Clarence to Prudhoe Bay, such as:

- keeping vessels away from active whaling areas;
- keeping outside "quiet zones" (i.e., 20 nautical miles offshore during transit), subject to safe transit navigation;
- imposing speed restrictions if whales are encountered;
- maintaining speeds of less than 10 knots in proximity of feeding whales or whale aggregations; and
- reducing speeds to 5 knots within 900 feet of whales.

HLV and LNG carrier traffic would be routed well offshore of the Aleutian Islands when possible in compliance with the International Maritime Organization's Aleutian "Areas to be Avoided." Avoiding these areas would minimize potential impacts on the harbor seal (and their rookeries), northern fur seal (and their rookeries), ribbon seal, Pacific white-sided dolphin, Dall's porpoise, harbor porpoise, Baird's beaked whale, Cuvier's beaked whale, killer whale, and minke whale, which occur along the Aleutian Island chain.

Spills

Construction and operation of the Project would require fuel transport and staging. An inadvertent release of equipment fuel or other fluids in marine mammal habitats could occur from fuel transfers and an increase in vessel traffic. These spills could affect marine mammals and their prey if present at the time of the spill.

Spills and leaks of oil or wastewater from Project activities that reach marine waters could directly affect the health of exposed marine mammals. If contaminants spill into the ocean, the material would travel with currents. Individuals could show acute irritation or damage to their eyes, blowhole, and skin; fouling of baleen, which could reduce feeding efficiency; and respiratory distress from the inhalation of vapors (NMFS, 2017g). Ingestion of contaminants could cause acute irritation to the digestive tract, including vomiting and aspiration into the lungs, which could result in pneumonia or death (NMFS, 2017g). A spill during winter could be particularly harmful to seals that use leads and polynyas for breathing or feeding (Smith, 2010). Oil and fuel spills occurring over the winter would likely remain on the ice surface as long as the ice surface remained solid. Cleanup on frozen ice could be very effective if done immediately after the spill. Blowing snow could combine with the spilled oil, moving oil across large distances and potentially into open water areas. Spills occurring during fall freeze up would be trapped in freezing ice, later melting out in summer if the spill is not collected and cleaned up prior to melting. During spring thaw, spilled material would become trapped in melt pools between ice floes. Oil or fuel on the ice floes would travel with them as winds moved the ice. Material spilled during summer when no ice is present would travel with the currents.

Oil and fuel spill response resources are limited in the Arctic, making a quick response that would minimize impacts unlikely (BLM, 2012). To minimize the risk of a spill, AGDC would ensure that all contractors comply with the Project SPCC Plan and SWPPP. Measures in the SPCC Plan that would minimize spill risk impacts include use of secondary containment; proper storage, handling, and disposal of fuels; and availability of spill response equipment. Oil spill response plans would be available for vessel groundings or other accidental oil releases. In addition, LNG carriers are required to develop and implement a SOPEP, which includes measures to be taken when an oil pollution incident has occurred or is at risk of occurring. As described in section 4.3.3, accidental gas releases from the Mainline Pipeline would not be anticipated. However, during operation, the pipeline would employ industry standards for safety and pipeline monitoring, as outlined in detail in sections 2.5.2 and 4.18, that would minimize the duration of an accidental release and result in brief and localized impact within marine waters.

Discharge of Hydrostatic Test Water

Hydrostatic testing at the Gas Treatment, Mainline, and Liquefaction Facilities would not be expected to affect marine mammals. Except as discussed below, hydrostatic testing is planned to occur in the summer using water without additives. Test water for the Liquefaction Facilities and marine portion of the Mainline Pipeline would be discharged to Cook Inlet. Hydrostatic testing on the North Slope could occur year-round and, if completed in the winter, would require non-toxic additives to prevent the test water from freezing. Test water for the Gas Treatment Facilities, with the exception of the PTTL, would be discharged to the UIC wells, which would avoid impacts on surface waters. The water used to hydrostatically test the PTTL would be discharged into uplands and wetlands in accordance with applicable federal and state permit requirements (see table 1.6-1). Additional information on hydrostatic test water discharges is provided in section 4.3.4.

Additional Human Presence

Project construction would occur over multiple years, with many activities continuing through operation for the life of the Project. In particular, camp use by Project personnel would create the potential for wildlife–human interactions and changes in wildlife behavior or habitat use.

Human presence where seals may haul out on land in Cook Inlet or Prudhoe Bay or on ice near the West Dock Causeway, GTP, and PTTL could cause animals to avoid those areas. Traditional knowledge workshop participants noted that seals prefer locations with less human activity and traffic for their rookeries and haulouts (Braund, 2016). Activities at the West Dock Causeway include screeding, filling, and barge delivery, causing disturbances for multiple months during the winter and summer seasons over a total of 8 years. Spotted seals are particularly sensitive to disturbance and could abandon haulout or pupping sites after repeated disturbances (Boveng et al., 2009). Mainline Pipeline pipelay and trenching activities in Cook Inlet would occur over two ice-free seasons (from about May through October). Harbor seals, killer whales, minke whales, and harbor porpoises could avoid the area where active Mainline Pipeline construction is occurring due to the presence of human activity onshore and in the water. Harbor seals haul out near the Mainline MOF (near the Susitna River delta area), and could be disturbed by the additional construction activity there. The repeated and regular presence of human activity in these areas during operation could cause marine mammals to avoid using those areas for hauling out.

Wildlife and human interactions could occur due to the potential for close encounters. Environmental training for workers would reduce the likelihood of negative encounters between humans and marine mammals. AGDC developed a Project Waste Management Plan for all work sites to minimize risks of attracting wildlife. All waste containers would be in upland areas and, therefore, would not be expected to affect marine mammals.

Invasive Species

Vessels could introduce aquatic invasive organisms from ballast water discharge, fouled hulls, and equipment placed overboard (e.g., anchors). Invasive species could affect food webs and could out-compete native invertebrates, resulting in habitat degradation and changes to prey availability for marine mammals.

HLVs would ballast loads with cargo rather than water and use minimal amounts of freshwater for ballast. Use of freshwater ballast would reduce the likelihood of transporting marine aquatic invasive organisms. Invasive aquatic organisms on or in semisubmersible vessels, barges, and tugs would be controlled by ballast water regulations. LNG carriers and marine barges used for this Project would meet the requirements of the Coast Guard and EPA VGP regulations (see section 4.3.3 and the Project BWM Plan for additional details). In addition to these federal requirements, vessels calling on Alaska ports must also comply with state ballast water exchange rules and laws (see section 4.3.3). To ensure compliance with U.S. laws and regulations governing ballast water discharges, AGDC would require visiting vessels to possess documentation demonstrating compliance with ballast water regulations and BMPs before allowing ballast water to be discharged into the berthing area. Adherence to these regulations would reduce the likelihood of Project-related vessel traffic introducing aquatic invasive organisms.

4.6.3.3 Facility-Specific Impacts and Mitigation

Gas Treatment Facilities

Construction of the West Dock Causeway at Dock Head 4 would result in loss and alteration of benthic marine substrates (from construction of Dock Head 4 and the barge bridge; see section 4.7.2 for more details). The seabed would be disturbed prior to each sealift, and barges would be grounded during module deliveries. At the West Dock Causeway, the seabed would be graded/screeded before each sealift. Marine mammals associated with the ice, such as ribbon and spotted seals, could be displaced by the screeding activities. This area of marine and benthic habitat used for foraging by ribbon and spotted seals, and potentially gray and beluga whales, would be lost during screeding activities. Once barge deliveries are complete, the benthic community would recolonize the area rapidly following seafloor disturbance since it is already adapted to annual seafloor disturbance from ice scour.

Prey availability could be temporarily reduced due to disturbance of fish passage at the West Dock Causeway. The barge bridge would include gaps at each bow and/or stern connection point to allow for fish passage, minimizing the impact on prey species. Barge bridge placement would also result in an annual, temporary loss of seafloor habitat during the summer (ice-free period). Since the barge bridge would be in place for the majority of the ice-free portion of the year, it would limit the opportunity for recolonization and use of the area by the benthic community. AGDC would not use the West Dock Causeway and Dock Head 4 structures during operation, but these facilities would remain in place; therefore, the impacts of these structures would be permanent.

Traditional knowledge workshop participants noted that there is sensitive or important habitat for seals near the proposed pipelines on the North Slope; seals are becoming rarer in these areas over time (Braund, 2016). Additional development in these areas could contribute to increased rarity of marine mammals and their use of the area.

Mainline Facilities

Trenching would be used to install the shoreline approach portions of the Mainline Pipeline in Cook Inlet from the shorelines to a depth that would protect the pipeline from ice and other hazards (see section 4.3.3). Between the shoreline approaches, the pipeline would be concrete coated and placed on the bottom of the inlet. During Mainline Pipeline construction, temporary impacts on the seafloor from cable sweep and permanent impacts from pipeline placement on the bottom of Cook Inlet would affect foraging habitat for harbor seals. The Mainline Pipeline additionally would permanently displace benthic prey resources, such as crabs and benthic fish, on the Cook Inlet seafloor.

AGDC's method to install the shoreline approaches of the Mainline Pipeline would involve trenching and pipeline burial. Disturbance of benthic habitats and increased turbidity would occur at the trenching locations. In particular, near Beluga, anadromous fish comprise an important food source for marine mammals, such as harbor seals, in the spring, summer, and fall as those fish migrate through the area. To reduce impacts, we recommend that AGDC incorporate the use of the DMT continuation methodology for the shoreline crossings at Beluga Landing and Suneva Lake or provide a site-specific justification demonstrating that this methodology would not be feasible (see section 4.3.3).

The Mainline MOF footprint would result in permanent removal of seafloor habitat. Although AGDC would not use the facility during operation, the facility would be left in place post-construction and would not be removed. About 6 acres of foraging habitat for harbor seals and killer whales and potential haulout habitat for harbor seals would be lost at the Mainline MOF for construction of, and fill placement at, the facility.

Operational inspection or maintenance activities of the Mainline Pipeline in Cook Inlet could have minor impacts on marine habitats from equipment placement or pipeline movement on the seafloor causing short-term increases in turbidity. Marine mammals could dive or swim away from vessels or equipment.

Liquefaction Facilities

The Liquefaction Facilities would affect about 81 acres of the marine environment, including dredging. Dredged material disposal in Cook Inlet could affect about 1,200 acres of foraging habitat for harbor seals and harbor porpoises. An additional estimated 19 acres of habitat would be lost due to construction and operation of the PLF. Dredging could temporarily alter the benthic community, which is a food source for some marine mammals. Dredging would be conducted as needed for maintenance and would repeatedly disturb benthic communities. The physical effects on the benthos from dredging would likely be of short duration due to the high energy and dynamic nature of the Cook Inlet seafloor and water column in these open water areas. Dredging would also temporarily increase turbidity in a localized area in Cook Inlet (see section 4.3.3). Marine mammals could swim into the plume, temporarily experiencing reduced visibility. The turbidity modeling study indicates that the turbidity would return to baseline levels within 100 minutes, and marine mammals would likely swim away from, or out of, the plume.

Marine mammals could avoid the area immediately around the Marine Terminal due to the additional disturbance from vessel traffic and human presence and activities. The area could become unsuitable for most marine mammals due to the loss of habitat and increase in human activity.

AGDC would remove the Marine Terminal MOF after its use for construction. Removal activities could generate underwater and airborne noise, similar to those occurring during construction of the facility, which could disturb marine mammals. Construction and removal of the MOF would disturb benthic habitats and cause a temporary increase in turbidity near the site. Upon removal of the MOF, the disturbed shoreline could erode due to the active nature of Cook Inlet, the large tidal range, and vessel wake activity, causing a loss of fish habitat. Noise impacts are discussed further in section 4.6.3.2.

4.6.4 Conclusion

Project construction and operation would temporarily and permanently affect terrestrial wildlife and their habitats. The loss and degradation of terrestrial wildlife habitat would affect behaviors including migration, foraging, and reproduction, and would increase the rates of stress, injury, and mortality experienced by wildlife across arctic tundra, boreal forest, and transition forest habitats in the state. Any of the terrestrial wildlife species occurring in or near the Project area would experience these effects. For species that are well distributed across the state, effects would be minor on a population level because they would be restricted to a small area. However, impacts would be greater for species with specialized habitat requirements where construction or operation would occur in sensitive habitats and/or during sensitive periods. This includes moose, bear, caribou, Dall sheep, muskoxen, and wood frogs, all of which would experience some construction in sensitive habitats during sensitive periods. Likewise, these species would experience some permanent changes in habitat availability. Generally, given the distribution of these species state-wide and/or the availability of other suitable habitat, population-level impacts on these species from Project construction and operation would not be anticipated. For the Central Arctic Caribou Herd, impacts would likely be significant due to the timing of impacts during sensitive periods, permanent impacts on sensitive habitats, and the Project location at the center of the herds' range. However, we do not know if the impacts would be temporary or long term, or to what extent, if any, the PTTL could affect caribou herd movements. Therefore, we have recommended that AGDC conduct seasonal monitoring to determine if the GTP and PTTL are creating barriers to caribou movement.

Project construction and operation would affect avian resources as a result of habitat degradation and loss; increased stress, injury, and mortality; disturbance and displacement; and loss of reproductive opportunity. Impacts would result from clearing and grading, granular fill placement, facility installation, water withdrawal and discharge, right-of-way maintenance, noise and light, collisions, spills, vessel traffic, and human disturbance. Our recommendation regarding timing restrictions for activities within IBAs and through implementation of Project-specific plans—such as the Project Migratory Bird Conservation Plan, Project Plan, Project Procedures, Winter and Permafrost Construction Plan, Lighting Plan, and SPCC Plan—would reduce impacts on avian species and their habitats. With these measures, population level impacts would not be expected.

Project construction and operation would affect non-ESA listed marine mammals in the Beaufort Sea, Cook Inlet, GOA, and Bering and Chukchi Seas. The Project would affect foraging, mating, and migration behaviors of marine mammals in oceanic, coastal, and terrestrial habitats due to noise, habitat degradation and loss, decrease or loss of prey, vessel strikes, spills, human interactions, and invasive species. Impacts would also be addressed through implementation of Project-specific plans, such as the SPCC and Revegetation Plans, and through compliance with federal regulations regarding vessel transit and ballast water discharges. In addition to AGDC's commitment to provide PSOs, our recommendations to increase the number of PSOs, to provide PSOs for dredging and screeding activities, and to establish appropriate shutdown or harassment zones, impacts on marine mammals from underwater noise would be minimized.

4.7 AQUATIC RESOURCES

4.7.1 Fisheries Resources

Alaska has a variety of freshwater and marine fish in its interior rivers and streams and coastal waters. Many of these fish are commercially important, such as salmon, walleye pollock, Pacific halibut (*Hippoglossus stenolepis*), cod, and Pacific herring (*Clupea pallasii*) (ADF&G, 2015a). Common species fished for sport or personal or subsistence use include arctic grayling, salmon, trout, burbot, Dolly Varden, Pacific halibut, and cod (ADF&G, 2018i). Species such as eulachon, Pacific sand lance (*Ammodytes hexapterus*), Pacific herring, and capelin are important as food for larger fish, birds, and marine mammals (ADF&G, 2015a). Project impacts on fisheries resources are discussed in this section; federally listed, BLM-listed, and Alaska special status fish species are discussed in section 4.8.

The ADF&G manages freshwater fisheries and marine recreational fishing in Alaska. The ADF&G maintains data on anadromous waters and publishes the *Catalog of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (also known as the Anadromous Waters Catalog or AWC) and an associated Atlas (Johnson and Blossom, 2017a,b,c). Identifying waters important for anadromous fish spawning, rearing, or migration is required by AS 16.05.871(a) under the Anadromous Fish Act (AS 16.05.871–.901). The AWC is not a comprehensive list of all anadromous fish waterbodies in Alaska, but rather, a list of waterbodies that have been surveyed by the ADF&G or private parties. Most of Alaska has not been surveyed. Once AWC waters are documented, they are protected by Alaska state law. AGDC would need to apply for a Fish Habitat Permit to cross AWC waters as well as any fish-bearing streams.

The waterbodies that would be crossed by the Project, including those designated as AWC, are listed in appendix I and discussed in section 4.7.1.2. Based on current data, 72 AWC waters would be crossed by the Mainline Pipeline and 14 AWC waters would be crossed by the PTTL.

Pacific halibut fisheries are regulated cooperatively by the International Pacific Halibut Commission, the North Pacific Fishery Management Council (NPFMC), NMFS, and the ADF&G. The Alaska Board of Fisheries, in consultation with the ADF&G, may designate, amend, or discontinue Fish Stocks of Concern (FSC) as required under the Management of Sustainable Salmon Fisheries Policy (5 AAC 39.222). The waterbodies designated as FSC that would be crossed by the Project are included in appendix I and discussed in section 4.7.1.4.

Information on fish resources in streams that the Mainline Pipeline and PTTL would cross was compiled from survey results and multiple public and private datasets. AGDC conducted field studies along the Mainline Pipeline and PTTL and at the GTP in 2013, 2014, and 2015 at select locations in streams and lakes to determine fish resources in those waterbodies.[69] Fish resource information at each crossing is included in appendix I. Descriptions of the waterbodies the Project would cross are provided in sections 4.3.2 (freshwater) and 4.3.3 (marine). Water uses associated with the Project are discussed in section 4.3.4.

AGDC did not conduct surveys at crossings that it believed had insufficient flow to support fish, or at streams that did not have previously documented fish presence information. In total, data are not available for 51 percent of the waterbodies that would be crossed by the Mainline Pipeline and 69 percent of the waterbodies that would be crossed by the PTTL. AGDC has agreed to implement, and we and other agencies are recommending, certain mitigation measures to be employed depending on the fish species present within the stream at the proposed crossing locations (e.g., AWC waters, EFH, and Pacific salmon species); however, without fish use and habitat information at these crossings, these minimization measures may not be accurately applied during pipeline construction. Also, fish data are available for streams that AGDC would cross; however, in many instances these data are well outside the Project area, and species presence can change in a relatively short distance. As discussed in more detail below, a sediment transport study conducted by AGDC predicted that wet-ditch open-cut crossings could affect fish within 290 feet downstream of the crossing. To identify fish resources potentially affected at crossing locations and to ensure adequate minimization measures are implemented during construction, **we recommend that:**

- **<u>Prior to construction</u>, AGDC should complete fish surveys at waterbodies where fish survey data are not available within 290 feet of the current pipeline crossing location and file with the Secretary final reports documenting AWC streams, EFH, and waterbodies with Pacific salmon identified during the fish surveys. AGDC should implement the appropriate minimization measures from the Project Procedures, Fisheries Conservation Plan, and other regulatory requirements at these waterbodies.**

4.7.1.1 Ecoregions

Alaskan ecoregions, defined by climate, terrain, and water sources, are used to describe fish assemblages based on land and aquatic resource relationships. The Project interacts with fisheries resources within the Arctic Tundra, Beringia Boreal, and Coast Mountain Boreal Ecoregions.

The Arctic Tundra Ecoregion (comprising northern coastal Alaska) has numerous shallow tundra lakes and tributaries that freeze to the bottom during winter (between September and May). Fish migrate to deep water areas, such as mainstem channels or lakes, to survive the winter. In spring and summer, tributaries provide productive areas for fish to feed and recover from spawning. Beaded streams (pools/lakes and connected stream segments) are important for connecting and providing seasonally productive migratory fish habitats during spring break-up and before freeze-up (Morris, 2003). Precipitation is low in the Arctic Tundra Ecoregion and stream discharge is also relatively low for these waterbodies. The open water season is short (about 3 months) due to the arctic climate, which contributes to a short growing, feeding, and spawning season for fish. Arctic grayling, burbot, capelin, Dolly Varden, lake trout (*Salvelinus namaycush*), stickleback species, and whitefish species are species common in this ecoregion.

[69] AGDC's *Fisheries Survey Reports* were provided as appendix L to Resource Report 3 (Accession No. 20170417-5339) and are available on the FERC website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter 20170417-5339 in the "Numbers: Accession Number" field.

The Beringia Boreal Ecoregion (comprising interior Alaska) is forested in areas and has a varied topography, including mountain ranges, large rivers, valleys, and oxbow and morainal lakes. The Beringia Boreal Ecoregion includes freshwater systems supported by snowmelt, rainfall, and ice melt that combine to fill the lakes. Typically, these lakes are sustained in August and September following snowmelt runoff that occurs for a short period in June (spring freshet), whereas glacier runoff is sustained over the summer (USGS, 2011). Permafrost is present, but the winter is not as severe as the North Slope winters and fish have longer access to the open water period for feeding, spawning, and growth. South of Atigun Pass, some streams remain flowing throughout the winter. Similar to the Arctic Tundra Ecoregion, fish often overwinter in deeper channels and lakes where the water remains unfrozen. Some rivers could have discontinuous flow during the winter that further limits the available overwintering habitat. In the spring, as the snow melt increases, stream flows increase and fish begin their migration from overwintering areas into more productive tributaries. Popular sport fish species in the ecoregion include arctic grayling, Dolly Varden, northern pike, lake trout, Pacific halibut, and all five Pacific salmon species. Pacific sand lance and capelin, common prey species, are also found in the ecoregion. Many species are long lived and slow growing due to cold waters.

The Coast Mountain Boreal Ecoregion (comprising south-central Alaska) has the most diverse weather, waters, and fish species of the three ecoregions. The climate is maritime and moderate, which provides precipitation in the form of rain (typically a minimum of 15 inches) and snow (typically a minimum of 40 inches). The Alaska Range feeds Cook Inlet with numerous tributaries, mainstem channels, and varied freshwater and marine habitats for the five Pacific salmon species, rainbow trout (*Oncorhynchus mykiss*), Pacific halibut, sculpin, lamprey, Pacific sand lance, capelin, and eulachon. The winters are much shorter than in the Arctic Tundra and Beringia Boreal Ecoregions. Temperatures are milder year-round, rivers and streams can remain open during the winter, and lakes do not typically freeze to the bottom.

Cook Inlet is a tidal estuary about 218 miles long (see figure 4.3.3-5). The tidal range in Cook Inlet can be as great as 30 feet, with tidal currents from 4 to 9 knots. Upper Cook Inlet includes the northern end of the inlet down to Anchor Point, and Lower Cook Inlet extends from Anchor Point south to the GOA. Upper Cook Inlet has freshwater input from the Susitna, Little Susitna, Beluga, and McArthur Rivers, and contains a number of significant shoals. Lower Cook Inlet contains a number of large bays and islands, and opens to the GOA. Freshwater inputs in Lower Cook Inlet primarily come from overland runoff and rivers in Upper Cook Inlet. Upper Cook Inlet is generally covered in ice from November or December to March, April, or May depending on location and winter temperatures. Lower Cook Inlet typically stays ice-free, but coastal areas and smaller bays can ice over from January to March.

4.7.1.2 Fish Communities

Four types of fish communities would interact with the Project: anadromous, freshwater (or resident), marine, and amphidromous. Anadromous describes a migratory fish born in freshwater that spends part of its life cycle in marine environments before returning to freshwater to spawn. Freshwater or resident fish reside in freshwater for their entire life cycle. Marine fish reside in a saltwater environment for their entire life cycle. Amphidromous species move between fresh and marine waters at certain life stages, but not necessarily for the purpose of breeding. Newly-hatched larvae of amphidromous species occur in freshwater/estuaries and may drift into marine environments; the species later returns to freshwater/estuaries to grow into adults and eventually spawn. Amphidromous species are categorized as "anadromous" for purposes of the AWC and in the context of this EIS.

Fish distribution within the Project area varies by species and region. Basic movement patterns include movements to spawning areas, which can be in spring (arctic grayling, rainbow trout, eulachon), summer (Pacific salmon), fall (Dolly Varden, ciscoes, whitefish), or winter (burbot, sculpins). Table 4.7.1-1 provides general movement and habitat use periods for select coldwater resident and anadromous fish in interior Alaska streams. The freshet period (spring thaw resulting from snow and ice melt) can be a critical period for fish migrating to spawning grounds (Jones et al., 2015a). These higher flow periods allow for fish movement through areas otherwise inaccessible during lower flow periods (Jones et al., 2015a). Freshet periods are typically short term and can last as little as a week when water levels are high enough for fish to move.

Gas Treatment Facilities

The Gas Treatment Facilities would affect freshwater, coastal, and marine fish habitats within the Beaufort Coastal Plain in the Arctic Tundra Ecoregion. Portions of the Gas Treatment Facilities are within or near the Beaufort Sea on Prudhoe Bay. The Beaufort Sea, which is covered with ice for about 10 months of the year, has a narrow (less than 90-mile-wide) and shallow (less than 200-foot-deep) continental shelf. Common fish observed during fish studies for the Project along the coast of Prudhoe Bay included arctic cod, arctic flounder (*Pleuronectes glacialis*), arctic grayling, arctic char (*Salvelinus alpinus*), Dolly Varden, broad whitefish, humpback whitefish, least cisco, burbot, fourhorn sculpin (*Myoxocephalus quadricornis*), rainbow smelt (*Osmerus mordax*), saffron cod, and ninespine stickleback (*Pungitius pungitius*) (NOAA, 2005).

The most sensitive period for fish habitat within the Gas Treatment Facilities would occur during winter when the majority of rivers and ponds freeze solid. Locations deep enough to maintain unfrozen water with adequate dissolved oxygen levels for overwintering fish are most sensitive to disturbance (Leppi et al., 2016). Riverine overwintering pools typically contain the highest densities of fish when compared to ponds and lakes used for overwintering. A study conducted by the ADF&G delineated the seasonal migration of fish species and habitat use in the National Petroleum Reserve Alaska using radio telemetry. Use of tundra lakes and small tundra drainages was significant for all species investigated. Results showed that arctic grayling make major movements during breakup and in late fall, when they move to small tundra drainages. In the fall, arctic grayling were found in lakes or sizable systems that contain deep water conditions for escape prior to freeze-up because the drainages do not provide adequate depths for overwintering (Morris, 2003). Burbot generally moved long distances to find adequate food sources. Radio telemetry data show that burbot move in late fall from shallower main channel habitats upstream from the confluence for wintering and potentially for spawning (Morris, 2003). For example, from October through May, ice and reduced stream flows restrict fish movement to deeper water within the Sagavanirktok River; the deep water provides important overwintering habitat for fish (Scanlon, 2015).

The Putuligayuk and Sagavanirktok Rivers and tributaries to the Sagavanirktok River would be crossed by both the PTTL and Mainline Pipeline. A number of fish studies have been conducted on these rivers. Hemming (1990, 1993, and 1995) investigated fish use of the Putuligayuk River and nearby waterbodies, documenting use by broad whitefish, round whitefish, fourhorn sculpin, and ninespine stickleback. The Putuligayuk and Sagavanirktok Rivers are known to provide rearing habitat for anadromous fish species, such as Dolly Varden and rainbow smelt (Johnson and Blossom, 2017a,b,c). The largest char stock identified in the Alaska portion of the Beaufort Sea drainages overwinters in the Sagavanirktok River (ADF&G, 1991). Summer rearing/feeding habitat for anadromous fish occurs in the three crossings of the Putuligayuk River and smaller channels; three crossings of the Sagavanirktok River (including the Main and West crossings); East Sagavanirktok Creek; and two unnamed tributaries. These rivers provide habitat for anadromous fish accessing the Beaufort Sea, as well as freshwater resident fish species (see appendix I). The Sagavanirktok River supports populations of pink salmon and chum salmon, and arctic grayling spawn in tributary streams to the Sagavanirktok River.

TABLE 4.7.1-1

General Cold-Water/Anadromous Fish Habitat Use Periods for Selected Species in Interior Alaska Streams [a]

Species/ Life Stage (age)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sheefish (*Stenodus nelma*)												
Juvenile												
Adult												
Spawning												
Incubation (in gravel)												
Rearing												
Broad whitefish (*Coregonus nasus*)												
Juvenile												
Adult												
Spawning												
Incubation (in gravel)												
Rearing												
Least cisco (*Coregonus sardinella*)												
Juvenile												
Adult												
Spawning												
Incubation (in gravel)												
Rearing												
Round whitefish (*Prosopium cylindraccum*)												
Juvenile												
Adult												
Spawning												
Incubation (in gravel)												
Rearing												
Humpback whitefish (*Coregonus pidschian*)												
Juvenile												
Adult												
Spawning												
Incubation (in gravel)												

TABLE 4.7.1-1 (cont'd)

General Cold-Water/Anadromous Fish Habitat Use Periods for Selected Species in Interior Alaska Streams [a]

Species/ Life Stage (age)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rearing	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■
Arctic grayling (*Thymallus arcticus*)												
Juvenile						■■■■	■■■■	■■■■				
Adult				□□□■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■□		
Spawning				□□□■	■■■■	■■□□						
Incubation (in gravel)				□□□■	■■■■	■■□□						
Rearing	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■
Northern pike (*Esox lucius*)												
Juvenile								■■■■	■■■■	■■■■		
Adult				□□■■	■■■■							
Spawning				□■■■	■■■■							
Incubation (in gravel)				□■■■	■■■■	■■□□						
Rearing	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■
Burbot (*Lota lota*)												
Juvenile			■■■■	■■■■	■■■■							
Adult	■■■■	■■■■										■■■■
Spawning	□■■■	■■■■										
Incubation (in gravel)	□■■■	■■■■	■■■■									
Rearing	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■
Longnose sucker (*Catostomus catostomus*)												
Juvenile						■■■■	■■■■					
Adult	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■
Spawning						■■■■	■■■■	■■■■				
Incubation (in gravel)						■■■■	■■■■	■■■■	■■□□			
Rearing	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■
Dolly Varden (*Salvelinus malma*)												
Juvenile				□□■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■		

TABLE 4.7.1-1 (cont'd)

General Cold-Water/Anadromous Fish Habitat Use Periods for Selected Species in Interior Alaska Streams [a]

Species/ Life Stage (age)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult												
Spawning												
Incubation (in gravel)												
Rearing												
Chinook salmon (*Oncorhynchus tshawytscha*)												
Spawning migration												
Spawning												
Incubation (in gravel)												
Rearing												
Juvenile migration (0)												
Juvenile migration (1)												
Coho salmon (*Oncorhynchus kisutch*)												
Spawning migration												
Spawning												
Incubation (in gravel)												
Rearing												
Juvenile migration (0)												
Juvenile migration (1)												
Chum salmon (*Oncorhynchus keta*)												
Spawning migration												
Spawning												
Incubation (in gravel)												
Rearing												
Juvenile migration (0)												

Source: R2 Resource Consultants, 2013

[a] Middle and Upper Yukon River tributaries

During surveys conducted by the ADF&G in the National Petroleum Reserve Alaska, survey results revealed that broad whitefish use all habitats—large channels, small tributaries, and lakes. The fish were observed leaving summering areas and moving to areas below spawning reaches well in advance of spawning. General patterns of movement showed fish would use tributaries for feeding in summer for about 2 months and move back to their winter habitat by mid-August (Morris, 2003). Three basic movement periods were identified for broad whitefish: spring movements to small streams or productive riverine habitats, summer movements to locate productive habitats, and summer/fall movements to spawning and wintering areas (Morris, 2003). Small tundra drainages receive use by all species, particularly by broad whitefish and arctic grayling during the summer. Several systems used by broad whitefish and arctic grayling require high-water events in spring for access and again in fall for escape.

Mainline Facilities

The Mainline Pipeline and associated facilities would occur within the Arctic Tundra (MPs 0.0 to 252.0), Beringia Boreal (MPs 252.0 to 516.5), and Coast Mountain Boreal Ecoregions (MPs 516.5 to 806.6). Similar to the Gas Treatment Facilities, the northern end of the Mainline Pipeline is in the Arctic Tundra Ecoregion where overwintering habitats are particularly sensitive to disturbance. In the Beringia Boreal Ecoregion, rivers are important for migrating fish during the spring melt and ice breakup. The Coast Mountain Boreal Ecoregion includes important anadromous fish and marine habitats. Watersheds that the Mainline Pipeline would cross are described in section 4.3.2.

A total of 523 stream crossings were identified within the Mainline Facilities areas. Each of these crossings was categorized into one of the three FERC waterbody classes (minor, intermediate, and major) based on the anticipated wetted width at the time of crossing. Based on these criteria, there are 424 minor, 88 intermediate, and 11 major waterbodies that would be crossed by the Mainline Pipeline (see appendix I). A summary of significant drainages and waterbodies that the Mainline Pipeline would cross from north to south is provided below.

After leaving the GTP, the Mainline Pipeline would cross the Putuligayuk River (described above under the Gas Treatment Facilities) and then parallel the Sagavanirktok River, crossing numerous side channels. The Putuligayuk and Sagavanirktok Rivers are classified as AWC along their entire length, primarily because of the presence of anadromous Dolly Varden. The Sagavanirktok River and some of its side channels also support resident fish such as arctic grayling, ninespine stickleback, round whitefish, and slimy sculpin (*Cottus cognatus*). The main channel of the Sagavanirktok River is sensitive year-round because it provides rearing and overwintering areas for many fish species, and is particularly sensitive during the May to October open-water season when it is used by migrating anadromous fish. Many streams within the Mainline Pipeline corridor north of Oksrukuyik Creek are also sensitive from May to October because they provide summer foraging habitat for a number of species.

The Mainline Pipeline corridor also would cross the headwaters of the Kuparuk River in the Arctic Tundra Ecoregion. Twenty-four fish species have been reported in this region, with the most common anadromous species being Dolly Varden, broad whitefish, and arctic cisco (*Coregonus autumnalis*). During traditional knowledge surveys, Kaktovik residents noted how fish that are usually found in warmer water south of the town of Kaktovik, such as saffron cod, are now being caught in the area around Galbraith Lake (Braund, 2016).

Whitefish spawn in the fall on the North Slope and in the winter in deep lakes or mainstem channels. During spring break-up, whitefish migrate to summer rearing and feeding habitat briefly before returning to spawning areas. Movement from spawning to winter habitat is short. Juvenile whitefish rear in channels, ponds, and estuaries until mature, when they migrate upstream to spawn. Arctic grayling move from winter areas during breakup on the North Slope to spring spawning areas, then move to summer feeding or recovery areas before moving back to winter habitat.

South of the Brooks Range, the Mainline Pipeline would follow the course of the Dietrich River and the Middle Fork Koyukuk River. Although none of the waterbodies within the Dietrich River system are classified as AWC waters, the Dietrich River flows into the Middle Fork Koyukuk River, which is classified as an AWC water. The Middle Fork Koyukuk River and several of its tributaries support stocks of resident Dolly Varden and anadromous chum and Chinook salmon. The Middle Fork Koyukuk River contains very sensitive rearing habitat year-round. Most of the tributaries, side channels, and sloughs associated with the Middle Fork Koyukuk River and other waterbodies in interior Alaska are sensitive from April through October.

The Mainline Pipeline would cross several waterbodies south of the Dietrich River and the Middle Fork Koyukuk River that provide habitat for chum and/or Chinook salmon, including Minnie Creek, Marion Creek, the South Fork Koyukuk River, Jim River, Douglas Creek, Prospect Creek, and the Yukon River. Fish habitat in these waterbodies and associated side channels are very sensitive throughout the year. Although few AWC streams exist between Prospect Creek and the Yukon River, Bonanza Creek and Fish Creek empty into the South Fork Koyukuk River, which is an AWC stream. Chum salmon occur in Bonanza Creek downstream from the Mainline Pipeline crossing. The Kanuti River provides anadromous fish habitat near its mouth, upstream of the Mainline Pipeline crossing.

Species locally abundant throughout the Yukon River drainage include rainbow smelt, lake chub (*Couesius plumbeus*), inconnu/sheefish (*Stenodus nelma*), arctic grayling, Dolly Varden, northern pike, burbot, lake trout, and pygmy whitefish (*Prosopium coulteri*) (ADF&G, 2017e). All five Pacific salmon species can also be found in the Yukon River drainage (ADF&G, 2017e). During traditional knowledge surveys, residents noted a number of important fish drainages that would be crossed by the Project, as described below.

- The Yukon and Koyukuk River drainages and tributaries are important habitat areas for salmon and non-salmon fish species.

- Hess Creek is an important subsistence fishery, with northern pike, arctic grayling, and sheefish.

- Important fish habitat for Pacific salmon, arctic grayling, whitefish, suckers, and other subsistence fish species is present in drainages such as Fish Creek, the South Fork and Middle Fork Koyukuk River, the Kanuti River, and the Dietrich River, all of which would be crossed by the Mainline Pipeline. In the springtime, the suckers move upriver in the Kanuti River. Arctic grayling make seasonal migrations within the Middle Fork Koyukuk River. Participants in traditional knowledge surveys reported that Dolly Vardens spawn near the Dietrich River and can be caught in the winter though holes in the ice (Braund, 2016).

In the Tanana River drainage, whitefish species are common in streams, as are coho, chum, and Chinook salmon; arctic grayling; Alaska blackfish (*Dallia pectoralis*); burbot; and lingcod (*Ophiodon elongatus*) (ADF&G, 2017e; Braund, 2016). Rainbow trout (not native to the drainage) are stocked in a number of streams for anglers (ADF&G, 2017e). Traditional knowledge workshop participants noted that many of the streams and rivers that would come into contact with or border the Mainline Pipeline, including the Chatanika, Tolovana, and Tanana Rivers, serve as spawning grounds for certain fish species, (Braund, 2016). The Chatanika River is important habitat for Pacific salmon and whitefish (ADF&G, 2017e; Braund, 2016). Participants in traditional knowledge surveys reported that Pacific salmon are not very abundant in the Minto Flats area, but northern pike, sheefish, and arctic grayling are common, and the Tolovana River near Minto Flats is a key salmon spawning area and a whitefish and salmon migration corridor (Braund, 2016). The Tanana River is important for migrating salmon (Chinook, coho, and summer and fall chum) (ADF&G, 2017e; Braund, 2016).

Traditional knowledge workshop participants indicated that sockeye salmon only spawn in tributaries with lakes or ponds, whereas coho or pink salmon spawn in flowing water (Braund, 2016). Workshop participants also noted that higher water levels are important for the salmon to migrate upstream and floods can wipe out salmon eggs laid in gravel beds (Braund, 2016). In the Nenana River watershed, traditional knowledge workshop participants noted that arctic grayling leave smaller streams and move into the larger channel of the Nenana River in winter months (Braund, 2016). Because of this movement in and out of small streams, arctic grayling have been observed traveling between tributaries of the river (Braund, 2016). Other common species in Nenana River tributaries include Dolly Varden, burbot, and slimy sculpin (Hander and Legere, 2013). The Mainline Pipeline would cross a number of waterbodies in the Nenana River watershed that provide valuable fish habitat. Participants in traditional knowledge surveys reported that the Nenana River is important for salmon migration/runs (Braund, 2016). They also reported that Montana Creek, Honolulu Creek, the Chulitna River, and Alexander Creek are important tributaries for salmon, having spawning areas and migration routes, and Lynx Creek provides important coho salmon spawning habitat (Braund, 2016).

The Susitna River is a major producer of sockeye, Chinook, coho, and chum salmon, which provide an important food resource for the federally listed Cook Inlet beluga whale. The following fish species are also commonly found in the Susitna River watershed: arctic grayling, burbot, Dolly Varden, lake trout (in lakes), northern pike, rainbow trout, and whitefish (ADF&G, 2017e; Braund, 2016). Sockeye salmon are an economically and ecologically important fish found throughout the Susitna River system. Two sockeye salmon spawning runs occur in the Susitna River; sockeye salmon typically spawn any time between June and September in lakes or in tributaries with direct access to lakes (Jennings, 1985). However, in the Susitna drainage, they often spawn in side channels and sloughs of the major streams, including the Susitna River. Sockeye salmon runs have been declining over the past decade and are now considered a FSC by the ADF&G (Shields, 2010). Traditional knowledge workshop participants noted that the Susitna River delta is also important for eulachon and other fish (Braund, 2016). Workshop participants observed how silt buildup in river channels, like in the Susitna River, is forcing fish to use the middle of the river and to stay further offshore in Cook Inlet due to the silt buildup at the river's mouth (Braund, 2016). The Chulitna River supports spawning and rearing habitats for multiple salmonids and other anadromous species such as Dolly Varden, Bering cisco (*Coregonus laurettae*), humpback whitefish, eulachon, and longfin smelt (*Spirinchus thaleichthys).*

The Mainline Pipeline would cross Upper Cook Inlet between the towns of Beluga and Nikiski, and the Mainline MOF is near Beluga on Upper Cook Inlet's western shore. The substrate in Cook Inlet varies from estuarine to semi-exposed rock and there are protected marsh bays along the rocky shoreline within the Susitna River drainage (ADF&G, 2017d). The fish community of Upper Cook Inlet is characterized largely by migratory fish, eulachon, and the five Pacific salmon species that return to spawn in rivers or outmigrate as smolts. Moulton (1997) documented 18 fish species in Upper Cook Inlet (Robards et al., 1999). The nearest AWC water to the shore crossing of the Mainline Pipeline on the west side of Cook Inlet is an unnamed stream about 1.7 miles to the northeast. The nearest AWC water to the shore crossing of the Mainline Pipeline on the east side of Cook Inlet is over 10 miles south of the facility along the coast. AWC streams that occur near the Mainline MOF include Threemile Creek, about 1.5 miles north of the facility, and two unnamed streams about 1.3 miles south. Threemile Creek is listed for chum salmon (presence), coho salmon (spawning and rearing), Chinook salmon (presence and rearing), pink salmon (spawning), and sockeye salmon (presence). The two unnamed streams are listed for coho salmon (presence and rearing) (Johnson and Blossom, 2017a,b,c).

Liquefaction Facilities

The Liquefaction Facilities occur in the Coast Mountain Boreal Ecoregion. No catalogued AWC streams have been identified in the footprint of the LNG Plant, access roads, and camps. The nearest AWC waterbody is the mouth of the Kenai River, about 9.5 miles south of the LNG Plant (Johnson and Blossom, 2017a,b,c). Migratory fish such as eulachon and Pacific salmon, however, could transit near the Marine Terminal in Cook Inlet. Resident species within the Alaska Range Ecoregion include the pond smelt (*Hypomesus olidus*) and pygmy whitefish (Jones and Hamon, 2005).

Within the Kenai Peninsula drainage on the north Kenai Peninsula, resident freshwater fish include rainbow trout, resident Dolly Varden, lake trout, and arctic grayling. Rainbow trout, as with arctic grayling, spawn in the spring; thus, streams used for spawning by this species are sensitive to disturbance during the April to June spawning and incubation period. Fish resources in Cook Inlet near the Marine Terminal would be similar as those described above for the Mainline Pipeline crossing of Cook Inlet. Traditional knowledge workshop participants noted that the five Pacific salmon, Pacific halibut, trout, rockfish, flounder, and cod are found in the Kenai Peninsula region (Braund, 2016). Known occurrences of anadromous species within the Kenai Peninsula drainages include longfin smelt, Pacific lamprey (*Entosphenus tridentatus*), and sockeye salmon, which spawn in the Kenai Peninsula area from late May through August. Traditional knowledge workshop participants noted that drift fishermen catch salmon in the river channels and along the coast on the Kenai Peninsula, and freshwater bullhead (sculpins) are commonly seen leaving freshwater and traveling into Cook Inlet on the Kenai Peninsula (Braund, 2016). In the Kenai Peninsula area, traditional knowledge workshop participants stated that fish declines have been caused by blocked fish movement from deadfall trees in rivers and ATVs crossing streams (Braund, 2016).

4.7.1.3 Pacific Salmon

Pacific salmon are the anadromous fish that would be most affected by the Project due to their widespread populations, use of a wide variety of aquatic habitats throughout the year, and their importance to subsistence, commercial, and sport fisheries throughout the state of Alaska. There are five salmon species in Alaskan waters that would be affected by the Project: Chinook, sockeye, coho, pink, and chum. Waterbodies with known populations of each of these species are listed in appendix I. The typical seasonal movement pattern for salmon species follows three phases:

- movement to summer feeding areas following ice breakup;
- movement within feeding areas during summer; and
- movement in the late summer to wintering areas.

For salmon species on Alaska's North Slope, chum and pink salmon move into spawning streams along the Beaufort Sea coast between July and September, and smolts (young salmon) outmigrate to the ocean during or very near peak break-up flows. Pacific salmon in the interior Alaska regions of the Project occur year-round but are restricted to Chinook, coho, and chum salmon. Timing of interior Alaska salmon spawning, fry emergence, and smolt outmigration typically occurs later than in south-central Alaska. In addition, chum salmon populations in interior Alaska can have both summer and fall spawning migrations. Within the Susitna River drainage area in south-central Alaska, which has been extensively studied due to hydroelectric evaluations, life stages of the five Pacific salmon are present year-round. All five salmon species die after spawning. Tables 4.7.1-1 and 4.7.1-2 show the seasonality of juvenile salmon presence in interior Alaska and the Susitna River, which illustrates the migratory periods of the five salmon species near the Project area. Life history information for the five Pacific salmon species can be found in the EFH Assessment (see appendix M).

TABLE 4.7.1-2

Seasonality of Juvenile Salmon Presence in the Susitna River [a]

Species/ Life Stage (age)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chinook salmon (*Oncorhynchus tshawytscha*)												
Spawning run					□□□■	■■■□	■■■■	■■■■				
Incubation	■■■■	■■■■	■■■■	■■■■	■□□□		□□■■	■■■■	■■■■	■■■■	■■■■	■■■■
Fry emergence			■■■■	■■■■	■□□□							
Rearing (0)			■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■
Rearing (1)	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■					
Juvenile migration (0)			■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■□			
Juvenile migration (1)			□□□■	■■■■	■■■■	■■■■	■■■■	■■□□				
Chum salmon (*Oncorhynchus keta*)												
Spawning run					□□□■	■■■■	■■■■	■■■■	■■■■			
Incubation	■■■■	■■■■	■■■■	■■■■	■■□□			■■■■	■■■■	■■■■	■■■■	■■■■
Fry emergence			■■■■	■■■■	■■□□							
Rearing (0)			■■■■	■■■■	■■■■	■■■■	■■■■	■■■■				
Juvenile migration (0)					■■■■	■■■■	■■■■	■■■■				
Coho salmon (*Oncorhynchus kisutch*)												
Spawning run							■■■■	■■■■	■■■■	■□□□		
Incubation	■■■■	■■■■	■■■■	■■■■	■■■■			□□■■	■■■■	■■■■	■■■■	■■■■
Fry emergence			■■■■	■■■■	■■■■							
Rearing (0)			■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■
Rearing (1)	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■
Rearing (2)	■■■■	■■■■	■■■■	■■■■	■■■■	■■■□						
Juvenile migration (0)				■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■□□		
Juvenile migration (1)				■■■■	■■■■	■■■■	■■■■	■■■■	■■■■			
Juvenile migration (2)				■■■■	■■■■	■■■■						
Pink salmon (*Oncorhynchus gorbuscha*)												
Spawning run						□□□■	■■■■	■■■■	■■■■			
Incubation	■■■■	■■■■	■■■■	■■■■			□□□■	■■■■	■■■■	■■■■	■■■■	■■■■
Fry emergence			■■■■	■■■■								

TABLE 4.7.1-2 (cont'd)

Seasonality of Juvenile Salmon Presence in the Susitna River [a]

Species/ Life Stage (age)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Juvenile migration (0)			■■■■	■■■■	■■■■	■■■■	■■□□					
Sockeye salmon (*Oncorhynchus nerka*)												
Spawning run					□□□■	■■■■	■■■■	■■■■	■■■■	■□□□		
Incubation	■■■■	■■■■	■■■■	■■■■				□■■■	■■■■	■■■■	■■■■	■■■■
Fry emergence			■■■■	■■■■	■■■■							
Rearing (0)			■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■
Rearing (1)	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■					
Juvenile migration (0)					■■■■	■■■■	■■■■	■■■■	■■■■	■■□□		
Juvenile migration (1)				■■■■	■■■■	■■■■	■■■■					

Source: R2 Resource Consultants, 2013

[a] Light gray indicates total duration of residence in the middle Susitna River and dark gray represents periods of peak use.

4.7.1.4 Fish Stocks of Concern

If a waterbody is identified as containing FSC, the state may develop a salmon fishery management plan (FMP) or take regulatory action, as appropriate. The Sustainable Salmon Fisheries Policy defines three levels of concern (yield, management, and conservation) for salmon fisheries with yield being the lowest level of concern and conservation being the highest level of concern. The ADF&G maintains a list of FSC that is updated on an annual basis. As of April 11, 2017, the FSC includes:

- chum, sockeye, and Chinook salmon in Cook Inlet;
- Chinook salmon in Kodiak;
- sockeye salmon on the Alaska peninsula (Swanson's Lagoon);
- Chinook salmon in the Yukon; and
- Chinook and chum salmon in Norton Sound.

No FSC waters would be crossed or affected by the Gas Treatment or Liquefaction Facilities. There are five salmon fish stocks considered FSC in waterbodies that would be crossed by the Mainline Pipeline (four Chinook salmon stocks and one sockeye stock). Juveniles and adults from these stocks are likely to occur in marine waters in Upper Cook Inlet. Table 4.7.1-3 indicates the number of waterbody crossings of anadromous streams within river systems with designated salmon FSC.

TABLE 4.7.1-3

Fish Stocks of Concern Potentially Affected by Mainline Pipeline Construction

River System	Salmon Type	Year Designated Stock of Concern	Level of Concern	Year Last Reviewed	Number of Crossings in River Systems	Milepost	Proposed Crossing Method
Yukon River a	Chinook	2000	Yield	2015	1	356.5	DMT
Yentna River	Sockeye	2007	Yield	2016	1	720.9	Dry-ditch open-cut
Alexander Creek	Chinook	2010	Management	2016	1	727.8	Dry-ditch open-cut
Lewis River Floodplain A	Chinook	2010	Management	2016	1	745.4	Dry-ditch open-cut
Theodore River	Chinook	2010	Management	2016	1	748.5	Wet-ditch open-cut

Source: ADF&G, 2017i. Current as of April 11, 2017.

a No impacts on this FSC would be expected as the Yukon River would be crossed by DMT, which would avoid in-stream activities.

4.7.1.5 Commercial and Recreational Fisheries

Fisheries in Alaska include commercial, subsistence, and recreational. Many subsistence fisheries occur throughout Alaska, where marine, anadromous, and freshwater fish are harvested. Further analysis of subsistence resources is provided in section 4.14. Marine invertebrate fisheries are discussed in section 4.7.2. A discussion of economic impacts on commercial fisheries is provided in section 4.11.3.

Commercial fisheries in Alaska consist of salmonids, walleye pollock, Pacific halibut, Pacific cod, sablefish, herring, flatfish, rockfish, and lingcod (ADF&G, 2018c). Commercial fisheries use seines, gillnets, trolling, longline, fish wheels, jigs, trawls, and pots for fishing the many varied fish species around the state. Commercial fishing occurs in marine and freshwater environments.

Recreational fishing in Alaska includes sport and personal use fisheries. Sport fishing is important to the Alaskan economy, and many people come to Alaska to fish in its rivers and along its coasts. Common fish species taken include salmonids, arctic grayling, whitefish, northern pike, Pacific halibut, and rockfish.

Personal use fishing is limited to Alaska residents and is subject to special regulations such as type of fishing gear, time and location restrictions, and special bag limits. Common fish species taken under personal use regulations include salmonids and herring.

Seventy-seven commercial or recreational use fisheries would be crossed by the Mainline Pipeline centerline, and five recreational use fisheries would be crossed by the PTTL centerline. A list of commercial and recreational fisheries waterbodies that would be crossed by the Mainline Pipeline and PTTL is included in appendix I.

Gas Treatment Facilities

Commercial fisheries are not authorized in federal waters in the Arctic Management Area (NPFMC, 2009). The nearest commercial fishery, which is a gillnet fishery, is for arctic and least cisco at the Colville River delta, about 40 miles west of the Gas Treatment Facilities. These fisheries are primarily active in October and November; however, no commercial harvests have been reported since 2007 (ADF&G, 2015c, 2018c). No impacts on commercial fisheries would be expected from activities associated with the Gas Treatment Facilities.

Recreational fisheries in the Arctic Tundra Ecoregion are slow growing and support minimal harvest (ADF&G, 2012a). Recreational sport anglers commonly fish for Chinook salmon, chum salmon, arctic char, Dolly Varden, lake trout, arctic grayling, inconnu (sheefish), northern pike, and burbot. A small recreational fishery in Prudhoe Bay is supported primarily by oilfield workers catching Dolly Varden and arctic grayling (ConocoPhillips, 2005).

Dolly Varden is the species most often targeted by anglers near the PTTL (ADF&G, 1991). Recreational fisheries on five waterbodies that would be crossed by the PTTL include the following (Johnson and Blossom, 2017a,b,c):

- Shaviovik River East — PTMP 25.5
- Kadleroshilik River — PTMP 35.3
- East Sagavanirktok Creek — PTMP 42.3
- Sagavanirktok River Main Channel — PTMP 44.2
- Sagavanirktok River West Channel — PTMP 53.6

Mainline Facilities

Waters known to support commercial fisheries that would be crossed by the Mainline Pipeline include:

- Unnamed stream — MP 90.3
- Minnie Creek — MP 229.1
- Yukon River — MP 356.5
- Tanana River — MP 473.0
- Nenana River No. 1 — MP 476.0
- Nenana River No. 2 — MP 489.2
- Yentna River — MP 720.9
- Beluga River — MP 757.2
- Cook Inlet — MP 779.5

Primary freshwater/anadromous commercial fisheries in the interior of the state are for Chinook and chum salmon, but there are also smaller fisheries for sockeye, pink, and coho salmon (ADF&G, 2018c). Within Cook Inlet, the primary commercial fisheries are for the five Pacific salmon species and smelt, but commercial fisheries also include Pacific cod, sablefish, lingcod, Pacific halibut, walleye pollock, and rockfish (ADF&G, 2018c). The Upper Cook Inlet set gillnet fishery occurs near the Mainline Pipeline route across Cook Inlet, the Mainline MOF, the Marine Terminal, and the vessel transit routes. Upper Cook Inlet has commercial set and drift net fisheries for salmon. All five species of Pacific salmon are harvested, but sockeye and pink salmon are the most abundant. Fishery dates vary annually based on run timing and number of fish but are typically between June and August. Drift-net fisheries are limited to within 1 mile of shore. Drift-net fishing in the Nikiski area is usually close to shore to avoid strong currents in deeper water. Drift-net openings and setnet openings often fall on the same days. Drift-netters are required to remain 600 feet from an active setnet site, but otherwise can put their nets up to the shoreline (5 AAC 21. 310).

The Mainline Pipeline would cross 77 recreational fisheries in waterbodies and tributaries of various flow regimes and widths (see appendix I). Recreational fisheries in these waterbodies include burbot, arctic grayling, sheefish, whitefish, northern pike, Dolly Varden, and the five species of Pacific salmon (ADF&G, 2017e). Sport fishing is accessible along the Dalton Highway in the North Slope and Yukon drainages in the following waterbodies that the Mainline Pipeline would cross:

- Dan Creek MP 90.3
- Oksrukuyik Creek No. 1 MP 108.6
- Oksrukuyik Creek No. 2 MP 121.6
- Kuparuk River MP 130.9
- Atigun River No. 1 MP 145.2
- Atigun River No. 2A MP 166.2
- Atigun River No. 2B MP 166.6
- Atigun River No. 2D MP 167.1
- Atigun River No. 2E MP 167.6
- Atigun River No. 2F MP 168.1
- Atigun River No. 2G MP 168.6
- Dietrich River No. 1 MP 179.2
- Dietrich River No. 2 MP 181.3
- Dietrich River No. 3 MP 208.8
- Middle Fork Koyukuk River MP 211.1
- Minnie Creek MP 229.1
- Marion Creek MP 236.5
- Slate Creek No. 1 MP 241.0
- South Fork Koyukuk River MP 260.7
- Prospect Creek MP 281.3
- Fish Creek No. 1 MP 298.8
- Kanuti River MP 307.1
- Yukon River MP 356.5
- Hess Creek MP 381.7

The Yukon River, which would be crossed by the Mainline Pipeline at MP 356.5, is the fourth largest drainage basin in North America. Watershed descriptions are provided in section 4.3.2. Herring and salmon, especially Chinook salmon, are the most important fisheries resources in the Yukon River region (ADF&G, 2017a). In the Tanana River drainage, recreational fishing occurs for Chinook salmon, coho salmon, arctic grayling, burbot, lake trout, and northern pike in the Tanana and Chatanika Rivers (ADF&G, 2018i). In the Susitna River drainage, recreational fishing occurs for the five Pacific salmon species, rainbow trout, arctic grayling, and Dolly Varden (ADF&G, 2018i). Lakes in the Northern Cook Inlet Management Area provide recreational fishing opportunities for Chinook and chum salmon, rainbow trout, arctic char, and arctic grayling, as well as the introduced northern pike (ADF&G, 2018i). In Cook Inlet, there are gillnet and set-net commercial and personal use fisheries for Susitna River sockeye salmon stocks.

Liquefaction Facilities

As described above, Cook Inlet has various commercial and recreational fisheries. Commercial fishing near the Marine Terminal consists of setnetting and drift netting for salmon. The ADNR issues setnet leases. A setnet lease gives the leaseholder first priority to use a site for commercial salmon setnet fishing on state-owned tidelands. This "first priority" applies when the leaseholder is personally fishing the site. Near the Marine Terminal, the primary commercial fisheries are the Upper Cook Inlet setnet fishery and the Upper Cook Inlet drift net fishery. The Marine Facilities construction footprint overlaps seven setnet fishery lease sites. The Northern Kenai Peninsula Management Area provides recreational fishing opportunities for rainbow trout, Dolly Varden, arctic grayling, lake trout, and steelhead (ADF&G, 2018i).

The most highly sought-after fishes for recreational fishing within the Marine Terminal area include Pacific halibut, and Chinook, sockeye, and coho salmon. The most significant recreational fisheries near the LNG Plant include the Kenai River (the mouth of the river is about 9.5 miles to the south), and the Kasilof River dipnet salmon fishery (about 20 miles south) (Johnson and Blossom, 2017a,b,c). Personal use fisheries for salmon, eulachon, and herring also occur in Cook Inlet.

4.7.1.6 General Impacts and Mitigation

Project construction and operation would result in temporary, short-term, and permanent impacts on freshwater and marine fish habitat and fish communities. Turbidity and sedimentation, alteration or removal of in-stream and streambank cover, streambank erosion, introduction of water pollutants, water depletions, and entrainment of small fishes during water withdrawals resulting from Project activities could increase stress, injury, and mortality of fish in the Project area. Alteration, disturbance, and destruction of in-stream habitats used by fish for feeding, breeding, and migrating would have impacts on fish in waterbodies at the time of construction and during operational activities. These activities would include pipeline crossings, right-of-way clearing, grading, and trenching; access road construction and use, including culverts and bridges; facility construction in Cook Inlet; West Dock Causeway use; dredging and screeding; overwater lighting; and material site development. The following discussions further describe impacts from construction and operation on fish habitat and communities in freshwater and marine water, and the measures that AGDC would implement to minimize impacts. Impacts on ichthyoplankton resources are described in section 4.7.3. Impacts and avoidance, minimization, and mitigation measures for federally listed, BLM-listed, and Alaska special status fish species are discussed in section 4.8.

The following Project-specific plans include measures that would minimize impacts on fish and fish habitats:

- Project Plan and Procedures;
- Site-specific Waterbody Crossing Plans;
- Winter and Permafrost Construction Plan;
- DMT Plan;
- SPCC Plan;
- Water Use Plan;
- Invasives Plan and ISPMP;
- Restoration Plan;
- Blasting Plan;
- Waste Management Plan; and
- Fugitive Dust Control Plan.

The Project Procedures include the following measures designed to minimize or avoid impacts on sensitive fisheries resources (see FERC [2013] and appendix D).

- All equipment would be parked overnight and/or fueled at least 100 feet from a waterbody or in an upland area at least 100 feet from a wetland boundary. These activities could occur closer only if the EI determines, in advance, that there are no reasonable alternatives and the Project and its contractors have taken appropriate steps (including the use of secondary containment structures) to prevent spills and provide for prompt cleanup in the event of a spill.

- Hazardous materials, including chemicals, fuels, and lubricating oils, would not be stored within 100 feet of a wetland, waterbody, or designated municipal watershed area, unless the location is designated for such use by an appropriate governmental authority. This applies to storage of these materials and does not apply to normal operation or use of equipment in these areas.

- Concrete coating activities would not be performed within 100 feet of a wetland or waterbody boundary, unless the location is an existing industrial site designated for such use. These activities can occur closer only if the EI determines that there are no reasonable alternatives and the Project sponsor and its contractors have taken appropriate steps (including the use of secondary containment structures) to prevent spills and provide for prompt cleanup in the event of a spill.

- Pumps operating within 100 feet of a waterbody or wetland boundary would use appropriate secondary containment systems to prevent spills.

- Unless expressly permitted or further restricted by the appropriate federal or state agency in writing on a site-specific basis, in-stream work, except that required to install or remove equipment bridges, would occur during the following time windows:
    - coldwater fisheries—June 1 through September 30; or
    - in accordance with AS 16.05.871 (d).

- ATWS (such as staging areas and additional spoil storage areas) would be at least 50 feet away from the water's edge, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land. In areas where it is determined that no reasonable alternative exists, ATWS may be in or within 50 feet of a waterbody (see table I-6 of appendix I).

- ATWS (such as staging areas and additional spoil storage areas) would be at least 50 feet away from wetland boundaries, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land. In areas with long stretches of contiguous wetlands where it is determined that no reasonable alternative exists, ATWS may be in or within 50 feet of a wetland (see table I-6 of appendix I).

- Each equipment bridge would be designed and maintained to withstand and pass the highest flow expected to occur while the bridge is in place. Culverts would be aligned to prevent bank erosion or streambed scour. If necessary, energy dissipating devices would be installed downstream of the culverts. We have recommended that AGDC design bridges to withstand at least a 10-year flow event and for AGDC to repair or upgrade bridges as needed throughout use to maintain functionality (see section 4.3.2).

- Unless otherwise approved by the appropriate federal or state agency, the pipeline would be installed using one of the dry-ditch methods outlined below for crossings of waterbodies up to 30 feet wide (measured at the water's edge at the time of construction) that are subject to ADF&G Title 16 fish passage requirements or federally designated as critical habitat.

- Where a dry-ditch open-cut crossing is not required, minor waterbodies may be crossed using the wet-ditch open-cut method. At these crossings, in-stream construction activities (including trenching, pipe installation, backfill, and restoration of the streambed contours) would be completed within 24 hours (except for blasting and other rock breaking measures).

- Where a dry-ditch open-cut crossing is not required, intermediate waterbodies may be crossed using the wet-ditch open-cut method. At these crossings, in-stream construction activities (including trenching, pipe installation, backfill, and restoration of the streambed contours) would be completed within 48 hours (except for blasting and other rock breaking measures).

- Clean gravel or native cobbles would be used for the upper 1 foot of trench backfill in all waterbodies that are subject to ADF&G Title 16 fish passage requirements.

Our evaluation of the Project's potential interactions with fishery resources considered species occurrence, life history strategy, and timing of Project-related activities. Specifically, fish habitat could be affected by Project activities temporarily through construction activities and permanently through modification of habitat and some operational activities (e.g., maintenance dredging and LNG carrier movements). Potential effects on fish communities could result from any activities that physically harm fish or affect the ability of fish to carry out their life processes. The introduction of harmful substances could alter fish habitat directly by causing changes to water quality and/or sediment quality to the extent that fish health decreases and mortality occurs, or indirectly through trophic interactions with biological resources used by fish. A table summarizing the impacts of Project components on fisheries by season is included in appendix N-1.

Access Roads

Development of access roads could increase turbidity and sedimentation in waterbodies during construction and operation of the Gas Treatment, Mainline, and Liquefaction Facilities. Clearing, grading, and placement of granular fill for road installation in and near waterbodies could affect fish and fish habitat during construction. Impacts would primarily occur through the introduction of sediment and increased turbidity, but also through dust generation from ground disturbance. Sediment input and increased turbidity can reduce fish productivity directly by smothering fish eggs, inhibiting fish feeding, displacing fish, clogging fish gills, altering stream bottom characteristics, and displacing aquatic organisms that are food resources for fish. High sediment input rates could also lead to changes in stream channels and substrate composition. Waterbodies confined by ice-rich banks and beaded stream segments would be most likely to experience higher levels of sediment input and increased turbidity during construction. Most fish-bearing streams in ice-rich soils would be crossed during the winter, limiting the potential for increased sediment during periods of fish use. AGDC would implement mitigation measures to reduce the potential for sediment introduction into watercourses during construction activities for the Mainline Pipeline, including dust suppression and implementation of the Project Plan, Procedures, and SWPPP.

The development of ice roads across waterbodies for construction and operation could cause interference with fish passage during breakup. Ice roads would melt slower than the surrounding ice in the waterbody, causing a blockage for fish in the spring and affecting fish migration. Ice blockages in-stream could also result in flooding of adjacent riparian areas, stranding fish when the blockage melts, and temporarily altering habitat. AGDC would slot, breach, or weaken the ice at stream crossings prior to breakup to minimize the risk of flooding, which would also reduce the chance of blockages for fish movement.

Twenty-nine access roads would require new culverts to maintain stream flow. Seven of these waterbodies are AWC waters and all have known Pacific salmon use. All access roads, associated granular fill, culverts, and bridges would be left in place after construction; therefore, all bridges and culverts would be permanent at waterbody crossings post-construction (except for ice bridges). Some of these access roads would be used for multiple years of construction and could continue to be used for operational activities. Placement of granular fill for access roads could permanently affect surface flows by disrupting flow paths.

Maintaining connectivity is important for migratory fishes in Alaska, especially in the Arctic Tundra Ecoregion where fish move between limited overwintering habitats and summer feeding and breeding areas (Sullender, 2017). Improper design of culverts left in riverine wetlands or waterbodies could cause permanent or long-term impacts on migratory Pacific salmon or other anadromous or locally migrating fish by restricting their ability to reach spawning areas or move out of rearing areas. Fish passage blockage could lead to the gradual erosion and decline of the population and genetic diversity (NMFS, 2018c). AGDC committed to installing appropriately sized culverts within access roads to maintain surface water movement during construction and operation. Culverts that remain in place could impede fish movement if not properly sized. Over time, unmaintained culverts can cause blockage to fish movements due to washout under the culvert, development of plunge pools at culvert outlets, seasonal debris flows, and overall failure of the structure (Furniss et al., 1991; O'Doherty, 2015).

In 2014, NMFS recommended that AGDC follow the *Anadromous Salmonid Passage Facility Design* (NMFS, 2011a) for culvert design. AGDC has not yet committed to implementing these measures. Because these measures would help ensure the successful spawning of fish species within the waterbodies that the access roads would cross, we are recommending that AGDC adopt them as part of a Project Fisheries Conservation Plan. Additional recommendations in this section also direct AGDC to include various resource protection measures in the Fisheries Conservation Plan. **We recommend that:**

- **<u>Prior to construction</u>, AGDC should develop a Fisheries Conservation Plan, filed with the Secretary for the review and written approval of the Director of the OEP, that includes a Culvert Design and Maintenance Plan and follows the guidance in *Anadromous Salmonid Passage Facility Design* (NMFS, 2011a) for all fish bearing streams. The Maintenance Plan component should indicate the frequency of inspections for permanent culverts.**

AGDC would install appropriately sized culverts within access roads to allow surface flow and maintain the hydrologic characteristics of adjacent wetlands. In addition, granular fill work pads would be contoured to allow natural drainage and hydrologic connectivity. Granular fill left in place at riverine wetland areas could permanently impede fish migrations. These impacts could be long term and reduce productivity of those species in that waterbody.

Fish using overwintering habitats could be killed if culverts are installed in overwintering habitat or immediately upstream of overwintering pools in winter. Turbid and sediment laden water could enter the pool, or equipment could directly injure fish. Ice barriers would prevent the fish from escaping the sediment laden water, which could result in clogged gills and oxygen depletion, potentially resulting in the death of those individuals within the pool. Further discussion on overwintering habitat impacts is provided in section 4.7.1.7 (Mainline Facilities).

Habitat impacts on individual waterbodies from development of access roads would generally be localized, short term, and minor. With implementation of our recommendation to design and maintain culverts using the *Anadromous Salmonid Passage Facility Design* (NMFS, 2011a), we conclude that impacts on fisheries from culvert installation and maintenance would not be significant.

Water Withdrawals

Water would be withdrawn from surface freshwater sources at the GTP for a water reservoir, construction camps, ice roads, and other facilities; at the PTTL, PBTL, and Mainline Pipeline for hydrostatic testing; for DMT of portions of the Mainline Pipeline; construction camps and ice roads for the Mainline Pipeline; and Liquefaction Facilities camps. Water would be withdrawn from Cook Inlet for hydrostatic testing of the Mainline Pipeline and LNG tanks at the Liquefaction Facilities during construction. Dust control water for construction activities would be withdrawn from wells which, due to their depth and lack of contact with surface water, would not be expected to affect fishery resources. A summary of the volumes and sources of water required for the Project is provided in section 4.3.4 and the Project Water Use Plan.

Water would be withdrawn from six natural lakes and rivers for construction and operational activities at the Gas Treatment Facilities. One of these lakes has known populations of arctic grayling, Dolly Varden, and broad whitefish, which are sport fish; fish populations are unknown in the remaining five sources. Twenty-four waterbodies with known fish populations (17 of which are listed as AWC) would be used as water sources for PTTL construction. Waterbodies containing 12 different species (which includes the five Pacific salmon species) would be used for construction water withdrawals for the PTTL.

Forty-one waterbodies with known fish populations (30 of which are listed as AWC) would be used as water sources for construction of the Mainline Pipeline. These waterbodies collectively contain 21 different fish species (including the five Pacific salmon species). Some of these waterbodies would not be crossed by the Mainline Pipeline but would be used as a water source for pipeline construction, ice road development, and other construction activities.

Water withdrawal activities could affect fish in multiple ways. Fish or fish eggs could be entrained or entrapped within the water pumping system itself or become impinged on the intake structure at the point of water withdrawal. Excessive withdrawal from any one site could also have impacts by reducing the available water downstream of the water withdrawal location. Water withdrawal during winter (such as for ice roads) could lead to water levels that reduce habitat quality, including an inadequate volume for pools within the waterbody to resist freezing, exposure of embryo- and fry-stage salmon to freezing winter conditions, and inadequate volume to retain dissolved oxygen concentrations high enough for fish survival. Water withdrawn from waterbodies for ice road construction could be made up of ice chips, water, or both. Winter withdrawal could lead to reduced flows in streams and could affect spawning beds and fish eggs within the gravel, as well as impede fish passage to and between important overwintering habitats. Fish overwintering areas can exist as isolated pools or stream reaches that would be highly sensitive to water removal.

Summer season withdrawal could have similar effects on fish and fish habitat if the volume removed is too large. Reductions in water levels and flows could increase water temperatures beyond the thermal tolerances of some fish species, but could also increase productivity (in other words, warmer waters could grow more algae that smaller fish could feed on) for juveniles of others. Any withdrawal that led to discontinuous surface flows within a creek or lake outlet would trap fish. NMFS commented that extensive freshwater withdrawals from ground or surface water sources near coastal zones to support Liquefaction Facilities operation have the potential to increase saltwater intrusion. This could notably alter area wetland function and fish use of an area (NMFS, 2018c).

During winter, water withdrawal effects could last for the entire winter construction season. Summer withdrawals would have less potential for long-term adverse effects on fish and fish habitat due to the availability of flowing water and recharge, but excessive withdrawal could still lead to short-term impacts depending on the timing of the withdrawal. The Project Procedures require AGDC to "maintain adequate waterbody flow rates to protect aquatic life, and prevent the interruption of existing downstream uses," which would minimize downstream impacts on fish in waters with withdrawals, but small or juvenile fish could be impinged on the intake structure due to their weaker swimming ability and size. Because the proposed intake velocities are unknown, it is assumed that small and juvenile fish would be impinged, likely resulting in mortality of those individuals.

The ADF&G provided mitigation measures to AGDC to minimize impacts on EFH and AWC species as a result of water withdrawals, including impingement/entrainment of fish fry, but AGDC has not committed to adhere to ADF&G's proposed minimization measures. Because we find that these mitigation measures are necessary to ensure that no population level effects would occur on sensitive fisheries resources, **we recommend that:**

- **<u>Prior to construction,</u> AGDC should include the following measures in its Fisheries Conservation Plan:**

  a. withdraw no more than 20 percent of current flow rates in waterbodies listed as AWC, including EFH, or with known populations of Chinook, sockeye, coho, pink, and/or chum salmon, to reduce the risk of low water levels and downstream impacts;

  b. do not exceed 0.5-foot-per-second water withdrawal velocities at the operating pump intake in waterbodies listed as AWC, including EFH, or with known populations of Chinook, sockeye, coho, pink, and/or chum salmon, if water withdrawals would occur <u>when sensitive fish fry and/or juveniles would be in-stream</u>;

  c. raise water withdrawal pump intakes from the stream bed to avoid the entrainment of eggs or fry from the gravel bed; and

  d. use screen openings on all water withdrawal equipment of 0.25 inch (0.1 inch or less in areas with sensitive life stages, e.g., pink and chum salmon fry, whitefish fry, and arctic grayling fry) to reduce the risk of impingement of small or juvenile fish.

AGDC would use about 10 million gallons of Cook Inlet seawater to hydrostatically test the offshore portion of the Mainline Pipeline and an additional 42 million gallons of seawater for hydrostatic testing the LNG tanks (for additional details, see section 4.3.4). Smaller juvenile individuals of fish could be killed or injured at the screened intake where they could be impinged on the seawater intake screening or entrained in the hydrostatic test water system. Larval fish and eggs could also be entrained.

To decrease the potential for entrainment and impingement of marine life, AGDC stated it would screen its intake hoses in Cook Inlet with 0.25-inch mesh and place the screened intake in a water column deep enough to ensure adequate suction head at low tides, but well above the seafloor. The pump would be either electric submersible or electric vertical turbine installed at the beginning of the ice-free season (typically May) and removed at the end of the ice-free season (typically October).

In addition to hydrostatic testing, fish could also be impinged or entrained by LNG carriers, which require cooling water. LNG carriers have cooling water intakes, with a typical screen size of 0.2-inch-wide bars spaced every 0.8 to 1 inch to prevent entrainment of larger items (primarily marine life and floating debris). In the summer, salmonids migrate to Cook Inlet from freshwater streams upon emerging from the gravel at their hatching sites and could be both impinged and entrained when in close proximity to LNG carriers docked in Cook Inlet. Impacts on ichthyoplankton resources are described in section 4.7.3 and in the EFH Assessment (appendix M).

Project-wide hydrostatic test water withdrawn from surface freshwater sources and Cook Inlet would be discharged either back to the source or to an upland or wetland location according to federal and state permit requirements. Discharges to Cook Inlet would be insignificant due to the large water volume in the inlet; discharges would be about 0.02 percent of the volume of Cook Inlet. Discharges to waterbodies used as freshwater sources could affect fish habitat. Discharges could locally increase flows, alter water temperatures, and increase turbidity in receiving waters and those waterbodies downstream of the discharge point. Discharge of the hydrostatic waters could create thermal refugia for larval, juvenile, and adult fish. These thermal refuges could concentrate prey resources making them more vulnerable to predation, but the refuges would be short term and localized.

Hydrostatic test water would be discharged to upland or wetland areas through erosion control devices to reduce the potential for scour, erosion, and sedimentation into nearby waterbodies in accordance with the Project Procedures and the APDES permit requirements, except in the case below. AGDC would not use additives in test water except where hydrostatic testing would occur year-round on the North Slope. Test water containing additives would be discharged into UIC-permitted wells at the GTP, thus avoiding the introduction of chemicals into surface waters and impacts on fisheries resources.

Over 3 billion gallons of water would be used for various Project activities, such as hydrostatic testing, camps, DMT, filling of the reservoir at the GTP, and ice roads. Water intake screening would be used in accordance with our recommendation above to reduce the risks of fish impingement or entrainment, and water withdrawals would be limited to no more than 20 percent of the waterbody's current flow. BMPs and implementation of the Project SWPPP would reduce impacts from water discharges (see section 4.3.2 for additional information).

Although fish eggs and larval fish could still be entrained in water withdrawals, with implementation of the mitigation measures recommended above, we conclude that impacts on fish and fish habitat from water withdrawals and discharges would be localized, short term, and minor. In addition, the Project would acquire the necessary permits and approvals from state and federal agencies and obtain or comply with water rights before appropriating surface waters, including obtaining Anadromous Fish Act (AS 16.05.871-.901) and Fish Passage Act (AS 16.05.841) permits from the ADF&G and a Temporary Water Use Authorization from the ADNR. The ADNR and ADF&G may have additional requirements that would further limit the impacts on fisheries.

Pile Driving

Pile driving at the Marine Terminal, Mainline MOF, and West Dock Causeway would result in a temporary increase in turbidity and pressure (pressure impacts are addressed in the noise section below), during which mobile species would be anticipated to temporarily avoid the area. Increased turbidity in the water column could result in physical impairment of fish species, causing potential suspended solids-induced clogged gills (i.e., suffocation or abrasion of sensitive epithelial tissue), and alteration of foraging behavior for visual predators. Typically, fish would avoid areas of increased suspended sediment (Wenger et al., 2017). The effects would be limited to the period during and immediately following pile driving. Turbidity levels would rapidly return to background levels following pile driving.

Lighting

Artificial lighting would be used during construction activities throughout the Project area and could have impacts on fish. Sources include lighting on docks, at aboveground facilities (including the Gas Treatment and Liquefactions Facilities) or anchored marine barges and vessels. Temporary facility lighting would provide security and illuminate working areas for onshore work and work over and within water (e.g., screeding and pile driving). Project lighting is further described in section 4.10.

The response of fish to artificial light can be quite variable depending on a number of factors. Specific responses by fish to light seem dependent on the intensity of the light as well as the species and age-class of the fish (Hoar et al., 1957). Schools of juvenile chum salmon show a marked preference for light while juvenile sockeye salmon retreat to darker areas. Juvenile coho salmon are indifferent to light of moderately high intensities, but become inactive in lights of very low intensities. While the responses of fish to light are sometimes based on innate behaviors, in other cases these responses may be based on the presence of prey. For example, artificial lighting is documented to decrease the daily vertical migration of zooplankton that come to the surface to feed on algae under the cover of darkness. As described in the preliminary Project Lighting Plan, to minimize lighting effects during construction, AGDC would shield and direct light as needed to illuminate work areas and meet safety requirements, but avoid extending the light off site unnecessarily. Safety, security, and maintenance of the construction schedule would be the primary considerations for construction lighting.

During operation, the aboveground facilities would require year-round lighting. Facility lighting would consist of normal and essential lighting panels and lighting fixtures to provide lighting for working areas and for security requirements. Outdoor general lighting would be mounted on poles about 100 feet high and directed toward facilities, similar to typical street lighting. Lighting design would direct lighting only in places where it is necessary and be designed and shielded, where applicable, to reduce light trespass, unwanted projection, and upward-directed light.

Lighting used during construction activities and at permanent facilities could affect fish behaviors. Due to the limited areas of Project lighting that would be used near waterbodies, and the measures in the Project Lighting Plan to reduce light in off-site areas, we conclude that impacts on fish from lighting would be localized and minor.

Shading of the seabed would occur from the addition of Dock Head 4 at the West Dock Causeway, the Mainline MOF, and at the Marine Terminal's PLF and MOF. Acreages of construction and operational impacts are found in sections 2.1.2 and 4.3.3. Shading caused by temporary structures could cause fish to avoid areas, but permanent structures could have a permanent effect on fish use of an area. Shading can cause changes to prey abundance at the site and disrupt fish migratory behavior (Ono et al., 2010). Pacific salmon are less likely to use the habitat under over-water structures (Ono et al., 2010), and overall, juvenile and adult fish are less likely to occur under over-water structures (Able et al., 2013).

An assessment of over 60 studies by Simenstad et al. (1999) found evidence that juvenile salmon react to shadows and other artifacts in the shoreline environment created by over-water structures. Because juvenile salmonids (especially Chinook salmon) tend to migrate through shallow-water habitats along shorelines, over-water structures can affect migration. Simenstad et al. (1999) found that juvenile salmon use both natural refuge and shaded areas as refuge, but generally migrate along the edges of these areas rather than entering them. In response to predators, however, they will seek refuge within shaded areas.

Upon encountering over-water structures, juvenile salmon could exhibit behavioral changes, including splitting into smaller schools and seeking alternate pathways, which can ultimately cause a delay in migration (Simenstad, et al., 1999). Permanent structures could make the area less preferable for salmonids, which could avoid the area due to the change in prey composition, resulting in avoidance of the shaded areas. Some non-salmonid fish (such as perch and sculpins) are more likely to use shaded areas for shelter (Toft et al., 2007).

Shading generated by Project construction over-water structures would likely cause changes in the behavior of salmon near the structures for multiple seasons, but these effects would not have a significant impact on salmon communities during construction because they would be localized and would be removed after a few years. Longer-term impacts from permanent over-water structures could cause salmon to avoid those areas, but we conclude that this impact would not be significant because there is sufficient suitable habitat in adjacent areas.

Noise

The primary sources of underwater sound from Project construction activities that would affect fish include:

- impact pile driving at West Dock Causeway for the barge bridge during June, July, and August for one season;
- impact and vibratory pile driving for the Mainline MOF between April and May of Year 2;
- impact pile driving for the Marine Terminal between July and October of Year 1 and between April and June of Year 2;
- excavation of the Mainline shoreline trenches for one season;
- anchor handling for Mainline Pipeline installation between April and October for two seasons;
- dredging in Cook Inlet in Years 1, 2, 3, and 7;
- screeding in Prudhoe Bay at the Dock Head 4 turning basin for one season, and screeding at the West Dock Causeway for six seasons;
- VSM installation; and
- vessel activity during construction and operation.

Noise effects on fish include behavioral responses, masking, physiological stress responses, hearing loss, injury, and mortality. In addition, percussive effects from activities such as pile driving can damage fish swim bladders and cause temporary or permanent injury. There is evidence that pile driving causes increased acute stress responses and repeated exposure reduces overall fitness of exposed fish (Debusschere et al., 2016). Pile driving has also been shown to have lethal and sub-lethal effects on nearby fish through barotrauma and noise (Popper and Hastings, 2009; Kolden and Aimone-Martin, 2013).

Direct impacts would include potential mortality/injury to migrating juvenile and adult fish near the noise-generating activities. Underwater noise effects criteria for fish have been established by the Fisheries Hydroacoustic Working Group (a coalition of NMFS; the USFWS; the Federal Highway Administration; DOT offices from California, Oregon, and Washington; and national experts on sound propagation). Calculations of noise impacts on fish from various construction activities are provided in appendix L-1. As shown in this appendix, dredging activities in Cook Inlet, screeding activities in Prudhoe Bay, and in-stream VSM installation would be unlikely to cause noise disturbances to fish.

Impact and vibratory pile driving, which are both proposed for the Project, generate sound that would cause behavioral effects and injury to fish. Pile driving activities in Prudhoe Bay could cause injury to fish at the source and up to 159 feet from the activity and behavioral effects at distances from 2 feet to 2.3 miles from the pile. Pile driving activities in Cook Inlet could cause injury to fish at the source and up to 446 feet from the activity, and behavioral effects at distances of 5 feet to 13.4 miles from the pile. Pile-driving has been shown to cause serious injury to nearby fish, damaging swim bladders and causing barotrauma and temporary hearing loss (Wenger et al., 2017; Popper and Hastings, 2009; Halvorsen et al., 2012). However, fish are most likely to experience behavioral effects, such as moving away from the source of the noise and a reduced ability to find prey or avoid predators due to masking of natural sounds (Dickerson et al., 2001).

The installation of each pile would take about 1 to 2 hours. Tables L-1.1-2 and L-1.1-6 in appendix L-1 summarize the numbers and types of piles to be installed in Prudhoe Bay and Cook Inlet, respectively. The long duration of noise impacts from these activities in the same area over multiple years could make the habitat unsuitable for fish use during construction. In particular, the five Pacific salmon species could be affected by pile driving noise in Cook Inlet. Pacific salmon are a key prey resource for Cook Inlet beluga whales that feed near the Susitna River and the proposed Mainline MOF, and are important recreational and commercial fisheries in Cook Inlet. Noise effects on Pacific salmon in Cook Inlet could have a negative effect on beluga whales and fishing activity in Cook Inlet (noise impacts on Cook Inlet beluga whales are discussed in section 4.8.1 and in the BA in appendix O). Using impact hammer soft starts (where the source level is increased gradually before use at full power) to minimize effects on marine mammals in Cook Inlet could also reduce effects on fish in the area. Impact hammer soft starts would alert fish of impending hammering noise and allow them to vacate the general area prior to the production of maximum sound energy during impact pile driving.

Sound generated by vessels could also have negative impacts on fish. Fish have been shown to react when engine and propeller sounds exceed a certain level (Ona and Godø, 1990). Avoidance reactions have been observed in fish such as cod and herring when vessel sound levels were 110 to 130 decibels (dB) (Ona and Godø, 1990), but others have found that fish may be attracted to stationary vessels (silent, engines running, and in dynamic-positioning) and vessels underway (Røstad et al., 2006). Any avoidance reactions would last minutes longer than the vessel's presence at any one location and would be limited to a relatively small area immediately around the vessel (Mitson and Knudsen, 2003; Ona et al., 2007).

Sound from anchor handling during the Mainline Pipeline pipelay across Cook Inlet and transiting Project vessels could potentially affect fish. Noise from anchor handling could cause behavioral effects on fish within 277 feet of the activity. When activated, in-hull bow thrusters produce large bursts of cavitation sound. Fish exposed to unnatural sounds would be expected to avoid the area of active pipelay. Vessels in transit would likely cause behavioral disturbance to fish in the area, but this would not be expected to cause a significant impact on fish in Cook Inlet because the area is mostly a transition zone to other river locations, and the sounds would be similar to those currently taking place in Cook Inlet. Transiting vessels would have minor impacts since the disturbance to fish would only occur when in close proximity to the ship, which would only be at any one location for a short period of time. We note there are other vessels that routinely transit Cook Inlet, so fish may already be acclimated to temporary noise disturbances from vessels. Cook Inlet is a relatively industrialized area in Alaska, subject to routine sound-generating activities, such as dredging, gas and oil drilling, marine seismic surveys, pile driving, and vessel traffic (as reviewed in Norman [2011]). In Cook Inlet, the lowest ambient sound levels measured away from industrial areas averaged 95 dB relative to 1 microPascal (re 1 µPa) and reached as high as 124 dB re 1 µPa north of Point

Possession during the incoming high tide (Blackwell and Greene, 2003). The highest noise levels measured were from a tug docking a gravel barge and were 149 dB re 1 µPa (Blackwell and Green 2003).

During operation, LNG carriers would transit through Cook Inlet to the Marine Terminal year-round. Vessels associated with Liquefaction Facilities operation would include LNG carriers and up to five assist tugs that would be used for docking and undocking, vessel escorts, ice management, and firefighting. LNG carriers would call at the Liquefaction Facilities year-round, 204 to 360 times per year, depending on capacity. LNG carriers could therefore add 204 to 360 port calls per year to vessel traffic in Cook Inlet, potentially resulting in a 42- to 74-percent increase in large ship traffic in Cook Inlet during operation.

Sound from routine Marine Terminal operation would be associated with LNG carrier operations, including hoteling, maneuvering, and tug vessels when moored to the Marine Terminal. Sound generated by LNG carriers could have negative impacts on fish; calculated and modeled sound levels for these activities are between 170 and 185 dB at the source (McKenna et al., 2012; McCrodan and Hannay, 2013). Due to the noise generated by the LNG carriers and supporting tugs visiting the Marine Terminal, behavioral noise effects on fish would be expected to occur within about 328 feet around the Marine Terminal, making this habitat less preferable for some fish for the life of the Project (McCrodan and Hannay, 2013). The greatest effect on fish resources would be noise from vessels during migratory periods for salmonids and other anadromous species from the Kenai River. In addition, the set gillnet fishery for Chinook salmon near the Marine Terminal could be affected by vessel noise and traffic. Section 4.11.3 includes additional details regarding impacts on commercial fisheries.

Blasting at the Gas Treatment Facilities gravel mine site and water reservoir are more than 1.5 miles from the Beaufort Sea, and no blasting is planned within or near Cook Inlet; therefore, noise impacts from blasting on marine fish would not occur. Trench and material site blasting in and near freshwater waterbodies for the Mainline Pipeline are discussed in section 4.7.1.7.

Noise generated by Project construction activities would likely cause changes in nearby fish behavior and cause fish to avoid the area over multiple seasons. These effects are not expected to have a significant impact on fish communities during construction because they would be localized and temporary. Longer-term impacts from vessel noise during operation could cause some species to avoid the area around the Marine Terminal. We conclude that this impact would not be significant because there would be ample suitable habitat in adjacent areas.

Permafrost

Existing ground and surface water regimes, which are essential elements to sustainable anadromous fisheries, may be influenced in unpredictable ways from thawing permafrost (NMFS, 2018c). During construction, AGDC would minimize impacts on thermal erosion of permafrost and subsurface changes through the use of erosion control devices (e.g., ditch plugs and water bars) to maintain hydrology and slope stability. AGDC's proposed use of granular fill work pads would conduct solar radiation to underlying permafrost, however, causing permanent changes to the subsurface thermal regime and drainage patterns. Additionally, thermokarst has the potential to occur adjacent to granular work pads, and permafrost thaw could extent up to 20 feet outside the construction right-of-way.

AGDC would minimize the potential for extensive permafrost thaw during Project operation with its Gas Control Center, which would control pipeline gas temperatures by heating or cooling gas at compressor stations and a heater station, as discussed in section 4.2.5. This would include adjusting gas temperatures for seasonal variations in discontinuous permafrost areas to match ground temperatures to the extent possible. In addition, AGDC would conduct routine aerial and ground surveys per the Project

Pipeline Operation and Maintenance Plan discussed in section 4.2.5 and implement remedial actions where warranted. Impacts on permafrost could be permanent, however, causing changes in stream flow regimes, water chemistry, and fish habitat (Vonk et al., 2015). The effects on fisheries could be significant and long term in localized areas. See sections 4.2.4 and 4.2.5 for further discussion of impacts on permafrost.

Spills and Waste

Spills could occur during construction and operation Project-wide. Most spills would be minor, and impacts minimized, with implementation of the Project Plan, Procedures, and SPCC Plan. The chemicals released during spills could have acute fish impacts, such as altered behavior, changes in physiological processes, or changes in food sources. Fish could also experience greater mortality if a large volume of hazardous liquid should be spilled into a waterbody. Furthermore, ingestion of large numbers of contaminated fish could affect fish predators in the food chain (see sections 4.7.2 and 4.7.3). Minor releases of hydrocarbons (e.g., diesel fuel or lubricants) could result in short-term, minor, direct adverse impacts on juvenile and adult fish, including death or chronic impacts on individuals. For construction activities during winter, the potential for spills entering fish-bearing habitats prior to being contained would be reduced as many waterbodies would be frozen, and AGDC's cleanup would be more successful and complete on a hard surface.

Spills could occur at various locations along the Project during construction, but most would be associated with fuel and hydraulic systems of construction equipment and fuel transfers. Fuel spills that failed to be contained prior to reaching waterbodies with fish and fish habitat could affect fish. Effects would depend on the season, size, and areal extent of the spill. Spills would be expected to have acute effects on fish near the spill location and could lead to fish avoidance of the area. Spills that move appreciably downstream from the spill location would have a higher potential to affect more fish and more habitat over a longer distance.

AGDC would implement measures outlined in the Project Procedures and SPCC Plan during construction, including secondary containment for single-walled containers; parking and fuel setbacks from sensitive features such as waterbodies and wetlands; and daily maintenance and inspection of construction equipment for leaks. Additionally, the SPCC Plan and Project Procedures include preventive measures, such as personnel training and refueling procedures, to reduce the likelihood of spills, as well as mitigation measures, such as containment and cleanup, to minimize potential impacts should a spill occur. AGDC has committed to developing facility/work site-specific SPCC plans prior to construction (see section 4.2.6).

Adherence to the SPCC Plan would minimize the risk of a spill reaching surface waters. If a spill should occur, adherence to the measures in the SPCC Plan would decrease the response time for control and cleanup, thus avoiding or minimizing the effects of a spill on aquatic resources. Additionally, the SPCC Plan would require that adequate supplies of suitable absorbent material and other materials and equipment necessary for the immediate containment and cleanup of inadvertent spills be available on all construction spreads. Training and lines of communication to facilitate the prevention, response, containment, and cleanup of spills during construction activities also are described in the SPCC Plan.

During operation, the increase in vessel traffic would result in an increased risk of spills in marine fish habitats. Vessels associated with the Liquefaction Facilities operation would include LNG carriers and four to five assist tugs used for docking and undocking, vessel escorts, ice management, and firefighting. AGDC would ensure that all contractors comply with the Project SPCC Plan and SWPPP. Oil spill response plans would be provided by AGDC for accidental releases of oil. In addition, LNG carriers are required to develop and implement a SOPEP, which describes measures to be taken when an oil pollution incident has occurred or a ship is at risk of one. These measures would minimize and mitigate vessel spills in Cook Inlet during Project operation.

As discussed earlier (see section 4.3.3), accidental gas releases from the Mainline Pipeline during operation would not be anticipated. During operation, the pipeline would employ industry standards for safety and pipeline monitoring, outlined in detail in sections 2.5.2, 4.18.10, and 4.18.10. These standards would minimize the duration of an accidental release, result in brief and localized impacts within marine waters. While occasional maintenance along the pipelines could be necessary during operation, the likelihood of potential spills within a stream would be minor; should spills occur, impacts would be mitigated through implementation of the Project SPCC Plan.

All waste generated from construction would be handled in accordance with the Project Waste Management Plan. AGDC would store all hazardous waste and contaminated soils at collection sites until they could be disposed of according to state and federal regulations. To prevent and mitigate against inadvertent contamination from waste, AGDC would properly contain all waste in upland areas until disposal. Existing sources of potential contamination could also occur in the Project area and could be disturbed by Project construction and operation (see section 4.9.6). AGDC would implement mitigation measures to avoid the release of known existing contamination in soil and groundwater, along with the Project Unanticipated Contamination Discovery Plan should any unknown contamination be encountered. With the implementation of the Project Waste Management Plan and Unanticipated Contamination Discovery Plan, we conclude that impacts on fish from waste generation or contamination would be unlikely.

With the design features and AGDC's implementation of the Project Plan, Procedures, SPCC Plan, SOPEP, Waste Management Plan, and Unanticipated Contamination Discovery Plan, construction and operation of the Project would not be likely to spread existing contamination or cause contamination to waterbodies that would affect fish or fish habitat. While a spill has the potential for adverse environmental impacts, most spills would be temporary and minor, and adherence to the Project SPCC Plan and other plans would greatly reduce impacts should a spill occur.

4.7.1.7 Facility-Specific Impacts and Mitigation

Gas Treatment Facilities

Water quality impacts from Project construction activities in Prudhoe Bay include screeding, pile driving, and water discharges. Screeding and pile driving at the West Dock Causeway of the Gas Treatment Facilities would increase turbidity and sedimentation. Arctic flounder, fourhorn sculpin, and arctic cod could be affected by the increased turbidity caused by screeding activities. Sediments in Prudhoe Bay are typically fine grained, which keeps them suspended longer than other sediments and allows them to travel further from their source once disturbed (see section 4.2.3). Increased suspended solids can clog fish gills and make it more difficult for predator species to find prey and for prey species to avoid predators. Small, juvenile fish are more susceptible to clogged gills than larger adult fish. Further, because suspended solids can reduce the amount of dissolved oxygen in the water, the reduced efficiency of clogged gills can lead to greater mortality rates (Wenger et al., 2017).

Sediment samples were collected in 2014 from five locations in Prudhoe Bay near West Dock and analyzed for physical and chemical parameters.[70] These data indicate that the West Dock Causeway area of Prudhoe Bay is generally free of contamination with metals or hydrocarbons (OASIS and BP Exploration [Alaska], Inc., 2010). Therefore, we would not expect contaminant releases to marine waters during screeding.

[70] AGDC's 2014 *Marine Sampling Program: Evaluation of Test Trench Dredging and Disposal Reuse* was included as appendix R2 of Resource Report 2 (Accession No. 20170417-5357), available on the FERC website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter 20170417-5357 in the "Numbers: Accession Number" field.

Construction of Dock Head 4 and use of the barge bridge would cause marine fish habitat effects; acres of impact are provided in table 2.1.2-1 and a description of construction activities is provided in section 2.2. During construction of the West Dock Causeway area, AGDC would place granular fill behind the sheet piling to construct Dock Head 4. Anadromous fish habitat would be permanently lost within this area as the granular fill would remain in place after construction. Turbidity would temporarily increase while the granular fill is put in place, but the turbidity would be contained in the area behind the sheet piling. Mobile species would avoid the area due to both turbidity and sound associated with construction, including sheet pile installation; non-mobile species could be affected by noise (noise impacts are discussed above in section 4.7.1.6).

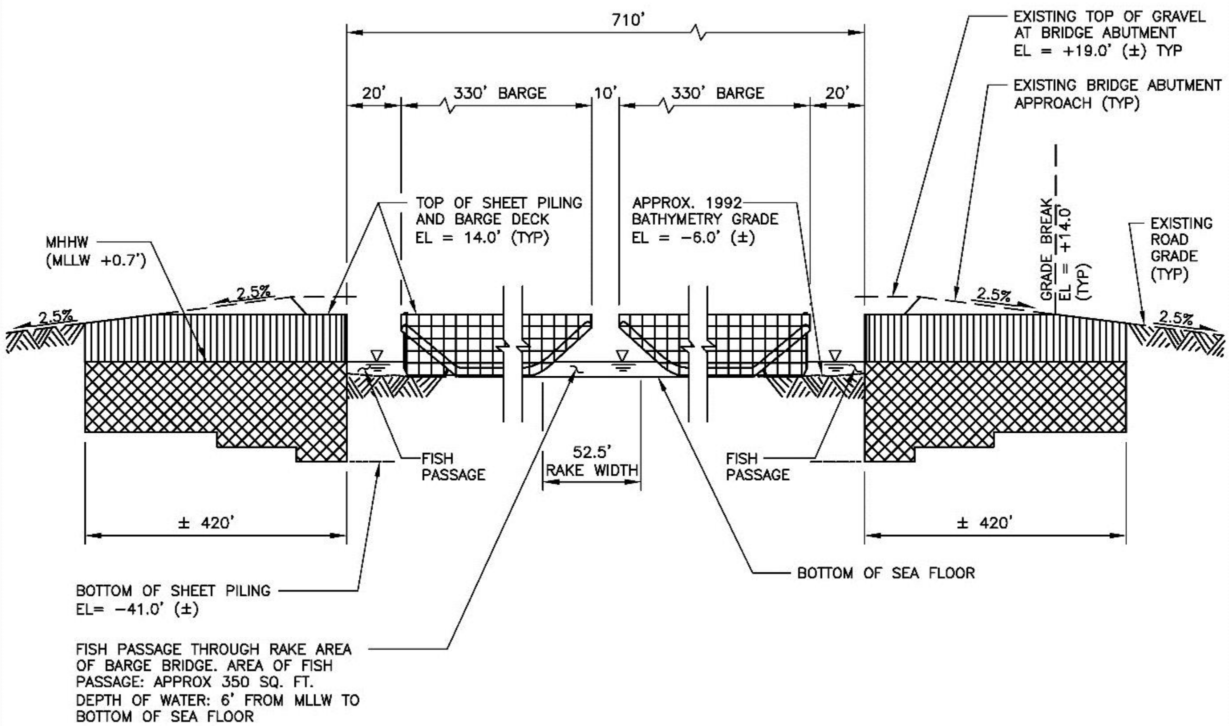
A temporary barge bridge would be constructed at West Dock, consisting of two barges ballasted to the sea floor, to bridge the gap between the dock bulkheads. The barge bridge would be moved into place at the start of each open-water season and removed at the end of the season. Arctic cisco adults migrate through this area in the summer. Chum and pink salmon smolt could be present in the shoreline area during the spring and summer, and adults could make their spawning runs in summer, moving along the coast before entering freshwaters. To minimize impacts, the design of the barge bridge offers three areas for fish passage: the area between the barges and two areas between each barge and the dock bulkheads (see figure 4.7.1-1).

Water quality impacts from increased turbidity and sedimentation during activities in Prudhoe Bay would be expected to result in temporary, minor disturbance to fish in the area. The removal of the barge bridge at West Dock Causeway each season, as well as the gaps between the barges and dock bulkheads would allow for fish passage, and only cause impacts on habitats during installation and removal each season. We conclude that the impacts would be minor, short term, and less than significant.

A major water use activity associated with the Gas Treatment Facilities is the use of water from the Putuligayuk River to fill the water reservoir at the GTP for operations. The Putuligayuk River is an AWC water used for recreational fishing. It is known to support populations of arctic cisco, broad whitefish, round whitefish, Dolly Varden, least cisco, fourhorn sculpin, ninespine stickleback, and rainbow smelt. Initial filling of the water reservoir would take 2 years, after which about 98 million gallons of water would be required annually to maintain water levels for operations. Annual refilling would take an estimated 20-day period during high-water events in May and June. Water withdrawals at the Putuligayuk River for the GTP reservoir would not draw more than 20 percent of the river's flow in accordance with our recommendation in section 4.7.1.6 (see table 4.7.1-4).

Potential effects on resident and anadromous fish using the Putuligayuk River would be minor due to the limitations on water withdrawals. Construction and operational withdrawals would not be expected to reduce the amount of water available for fish in the river to a degree that would cause a negative impact because AGDC would be limited to a maximum of 20 percent of the existing water flow. In addition, AGDC would install an intake screen to reduce the potential for fish entrapment, entrainment, and impingement associated with the withdrawal. With the implementation of water withdrawal restrictions and screening, we conclude that impacts from water withdrawals at the Putuligayuk River would not be significant.

A total of 105 stream crossings were identified within the PTTL centerline. These include 102 minor, 1 intermediate, and 2 major waterbodies (see table I-2 of appendix I). Construction would occur during the winter for all crossings. The PTTL would be installed aerially over all waterbodies using a dual pile pier design that could be placed in the stream. The in-stream supports would require drilled pipe pile foundations to maintain the pipeline aboveground. The PBTL does not cross fish-bearing waters and would therefore have no impact on fish or fish habitat.



PRELIMINARY & SUBJECT TO CHANGE. ALL DRAWINGS AND DIMENSIONS TYPICAL.

This information is for environmental review purposes only.

Figure 4.7.1-1
Alaska LNG Project
West Dock Causeway
Barge Bridge Fish Passage

DATE: 2018-03-17 SCALE: N.T.S.

TABLE 4.7.1-4 **Water Withdrawals from the Putuligayuk River for the GTP Water Reservoir**			
Mean Base Flow by Month [a]		Pump Rate as a Percent of Base Flow	
Month	Stream Flow (gpm)	At a Pump Rate of 2,500 gpm b	At a Pump Rate of 5,000 gpm [b]
May	53,416	5%	9%
June	255,507	1%	2%
July [c]	16,960	15%	30% c
August [c]	13,948	18%	36% c
September [c]	23,300	11%	21% c

[a] Summary of flow data from a University of Alaska Fairbanks Water and Research Center Putuligayuk River Station (Kane and Hinzman, 2015) in which recordings were generally taken every 15 minutes, although May and September data were limited; not all years had data for these months.

[b] Two motor-driven pumps would be included, with normally one pump in operation (about 2,500 gpm) and the other as a standby spare; if a faster reservoir fill-rate is desired (about 5,000 gpm), they would be run in parallel.

[c] Withdrawals are not planned during these months, but data have been included as a potential contingency. If withdrawals are required, we have recommended that the withdrawals would not exceed 20 percent of flow rate.

Fourteen streams that would be crossed by aerial span for the PTTL are listed as AWC. These waters support populations of Dolly Varden, pink salmon, chum salmon, Bering cisco, least cisco, arctic cisco, and rainbow smelt. Installation of 364 VSMs would occur in active channels of 77 waterbodies, which could have local effects on the stream bed through erosion in the immediate vicinity of the piles (see table I-5 of appendix I). Overwintering fish, or eggs and fry in the gravel, at the Sagavanirktok River Main Channel and Shaviovik River crossings could be directly or indirectly killed or injured by in-stream construction of the pilings. AGDC would place pilings about 150 feet apart. Because the Sagavanirktok River Main Channel and Shaviovik River crossings are 3,300 and 550 feet wide, respectively, work would occur in the stream bed. Recommended construction timing windows are described below in the Mainline Facilities section. With the use of VSMs and implementation of agency recommended timing restrictions for in-stream work, we conclude that significant population level impacts on fish from PTTL installation would not occur.

Mainline Facilities

<u>Waterbody Crossings</u>

Inland Waters

AGDC proposes to cross 257 waterbodies (49 percent) during winter, and so most of these waterbodies would be frozen except for 14 waterbodies that have known overwintering habitat. Construction at waterbody crossings that are frozen to the streambed would not affect fish at the crossing; however, if overwintering habitat exists near or at the crossing, fish, fry, or eggs may be present at the time of in-stream construction. The remaining 266 waterbody crossings (51 percent) would be constructed during summer. Descriptions of the proposed waterbody crossing methods (wet-ditch open-cut, dry-ditch open-cut, frozen-cut, DMT, and aerial) are provided in sections 2.2.2 and 4.3.2. A list of the stream crossings, including crossing method and season, is provided in table I-1 of appendix I. Construction activities within or adjacent to streams and adjacent wetlands could increase turbidity and sedimentation, alter stream channels or substrate composition, alter or remove cover, increase erosion, or degrade habitat. Impacts on fish could include displacement; changes in feeding or breeding behaviors; interference with passage; and stress, injury, or death.

Increased turbidity and sedimentation from construction of the Mainline Pipeline could affect fisheries resources, similar to that described above for access roads. Increased turbidity from waterbody crossings could temporarily reduce dissolved oxygen levels in the water column and reduce respiratory functions in fish, which could temporarily displace individuals to unaffected stream segments, reduce fish health, or increase fish mortality. Turbid conditions could also reduce the ability of fish to find food sources or avoid prey. The extent of impacts from turbidity and sedimentation would depend on sediment loads, stream flows, streambank and streambed composition, sediment particle size, timing of construction, and the duration of the disturbances (see section 4.3.2). In the Arctic Tundra Ecoregion, due to the short summer, fish are unable to find alternative sites if their feeding or breeding habitats are disturbed (Sullender, 2017).

Sediment could be introduced to watercourses during in-stream construction of pipeline crossings. Because data was unavailable to quantify impacts on turbidity and sedimentation from wet-ditch open-cut crossings, AGDC conducted a sediment transport study on 11 minor and intermediate waterbodies representative of waterbodies that the Project would affect.[71] The study assumed that AGDC would store excavated spoil at least 10 feet from the water's edge, construction would take 24 or 48 hours across each waterbody (consistent with the Project Procedures), and there would be a base threshold to maintain water quality standards for designated uses (see section 4.3.2). According to the sediment transport model, average sediment accumulation would range from 0.02 to 0.4 inch about 160 feet downstream of excavation. AGDC's model predicted that trenching would lead to a localized exceedance of the designated use water quality standard during construction activities.[72] The maximum downstream distance exceeding water quality standards would be about 290 feet, which would last about 1 hour. Sedimentation impacts would be minimized by AGDC implementing BMPs in the Project Plan and Procedures, which include:

- installing sediment barriers immediately after initial disturbance of the wetland or adjacent upland in summer or in winter prior to the spring snow melt;
- installing and maintaining temporary sediment barriers across the entire construction right-of-way at the base of slopes greater than 5 percent where the base of the slope is less than 50 feet from a waterbody or wetland;
- locating all extra work areas (such as staging areas and additional spoil storage areas) at least 50 feet away from water's edge, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land;
- using sediment barriers to prevent the flow of spoil or slit-laden water into any waterbody; and
- designing and maintaining equipment bridges to prevent soil from entering the waterbody.

Fish in watercourses with naturally high turbidity (e.g., glacial streams) may be more resilient to sediment introduction than sites with naturally clear water. High sediment inputs can alter habitat by increasing turbidity and suspended solids, settling into the substrate, and accumulating in slack water areas. Increased turbidity may cause habitat avoidance, increased stress, decreased feeding efficiency, and

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71 Results of AGDC's sediment transport study are available in AGDC's *Alaska LNG Sediment Modeling Study: Mainline Stream Crossings*, provided in the response to information request No. 106 dated August 15, 2018 (Accession No. 20180815-5078); along with supplemental materials provided in the response to information request No. 85 dated November 19, 2018 (Accession No. 20181022-5218). These documents can be viewed on the FERC website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter 20180815-5078 or 20181022-5218 in the "Numbers: Accession Number" field.

72 The relevant AWQS for turbidity (assuming the streams' designated use of Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife) is not to exceed 25 NTUs above natural conditions (ADEC, 2018e).

mortality among fish species. Sediment that settles out of the water column could alter substrate composition, which could affect spawning success and habitat use.

The wet-ditch open-cut crossing method would generate the greatest sediment and turbidity, but the elevated levels would be short term and occur over short distances downstream of the crossing. According to the Project Procedures, for wet-ditch open-cut streams, AGDC would complete all in-stream work in less than 24 hours for minor streams (less than or equal to 10 feet across) and less than 48 hours for intermediate streams (greater than 10 but less than or equal to 100 feet across). Fish migration through the waterbody during construction would be restricted, but due to the short timeframe for in-stream work, the effect on migrating fish would be minor. Construction of waterbody crossings either when frozen to the streambed or dry would be similar to upland pipeline installation. Construction impacts on fish are not anticipated from winter construction in areas without overwintering habitat, as fish would not be present due to the frozen condition, but pipeline installation causing changes in streambank and streambed composition would affect fish habitat. This effect would be minimized by AGDC restoring stream bed and bank contours to pre-construction conditions (or a stable angle of repose). Movement of stream bottom sediment during spring break-up and flood events would also be expected to mitigate most streambed habitat effects. Adherence to the Project Plan and Procedures would ensure that streambank erosion would be minimized.

Dry-ditch open-cut methods (e.g., flume and dam-and-pump) would be employed in both winter and summer to flowing waterbodies. Dry-ditch open-cut construction is planned at 66 known fish-bearing streams that would have flow during their respective construction season; 29 would occur in AWC streams. Fewer than half of the dry-ditch open-cut method crossings in anadromous streams would be constructed during winter; the majority would occur during summer (see table I-1 of appendix I). The dry-ditch open-cut crossing methods would reduce turbidity and sedimentation impacts on fisheries. The dam-and-pump method (versus flume) would be used in cases where sensitive fish species passage is not necessary or indicated through resource agency guidance.

In addition to the dry-ditch open-cut methods, in braided systems with multiple nearby channels or in dynamic systems characterized by frequent and common channel shifts, diversions would be constructed by AGDC to move flow to a historic channel, or newly created channel within the braidplain. In all cases, potential would exist for short-term impacts on fish in the immediate vicinity of the construction area. Fish passage could be impeded or blocked during this timeframe, which could lead to delayed or eliminated access to spawning habitats by some fish during critical migration periods. If construction blocks fish migrations (through waterbodies or flooded wetlands, especially during the spring freshet period), it could have a major local impact on that fishery including the loss of a year class and spawning year of the species. Crossing locations in or upstream from spawning areas could dewater spawning gravels and kill eggs or larval fish, depending on the installation timing. The primary potential for impacts during pipeline installation at crossings using this method would be associated with spawning migrations and spawning habitat impacts. Identification of anadromous fish spawning habitat is not comprehensive along the alignment, and additional spawning areas are likely to be present at stream crossings.

Riverine wetlands can be important habitats for migrating fish. Where riverine wetlands are adjacent to AWC waters, subsurface placement of a pipeline could cause modifications to hydrogeology. Twelve proposed PTTL riverine wetland crossings and 31 proposed Mainline Pipeline riverine wetland crossings have known anadromous fish use. The primary potential for impacts during pipeline installation at these crossings would be associated with spawning migrations and spawning habitat impacts. Crossing locations in or upstream from spawning areas could dewater spawning gravels and kill eggs or larval fish, depending on the installation timing. In addition, linear granular fill features (e.g., access roads and granular work pads along the construction right-of-way) left in place after construction could permanently modify natural drainage patterns that would affect adjacent wetlands. Additional information on granular fill in wetlands is discussed in section 4.4.3. One potentially affected wetland is associated with the Unnamed Tributary to Chulitna River, which is listed as AWC and has EFH. This wetland would have granular fill left in place after construction, which could impede coho salmon spawning migration due to altered drainage at the crossing from the permanent granular fill. Due to the potential permanent impact on migrating salmon by placing granular fill in this wetland, **we recommend that:**

- **<u>After completing in-stream construction activities at the Unnamed Tributary of the Chulitna River,</u> AGDC should remove all granular fill from the adjacent wetland near MP 655.2.**

Two aerial span crossings would be constructed along the Mainline Pipeline: one crossing of the Nenana River (MP 532.1) and one crossing of Lynx Creek (MP 537.9) (see table I-1 of appendix I). The aerial span construction method would not affect these freshwater resources because support structures would be constructed above the ordinary high water mark and no in-stream construction activities would occur. Therefore, there would be no impacts on fish resources from aerial span crossings for the Mainline Pipeline.

Streambank vegetation and structure, such as logs, rocks, and undercut banks, provide important fish habitat. Construction through waterbodies (except with DMT) would temporarily remove this habitat, which could displace fish to similar habitat upstream or downstream of the pipeline crossing. Displacement would result in increased competition for habitat and food sources that could affect fish health and survival. In areas where waterbodies are adjacent to forested areas, the reduction of large woody debris in streams and on land could affect salmon habitat use post-construction (Mossop and Bradford, 2004). Large logs provide in-stream channel structures (i.e., pools and riffles) that are critical to salmon spawning and rearing. Removal of forests that provide large woody debris to adjacent streams and the length of time for revegetation of those forests (see section 4.5) could alter salmon use at affected crossings, but the affected area would be relatively small compared to the available habitat within the stream reach.

Winter habitats are of substantial importance to arctic freshwater and anadromous fish, such as Chinook salmon, coho salmon, arctic char, arctic grayling, and arctic cisco. Overwintering habitat is a limiting factor for fish in Alaska, with limited areas within a stream that have suitable depths where the stream does not freeze to the bottom. These areas can be isolated and contain no discernable flow during the winter. Fish will congregate in these areas during the winter. Open-cut pipeline installation across 14 waterbodies with occupied overwintering habitat in the winter could cause fish to be killed and would increase sedimentation downstream from open cutting through unfrozen deeper water. In addition, the disturbed sediment would travel downstream and affect any overwintering fish between the crossing and the next frozen section of the stream. Winter crossings of sensitive overwintering areas on the North Slope could have significant effects on fish wintering at the crossing location and, depending on the density of fish, could have long-term effects on fish populations in the stream if mortality occurs. An impact on an occupied overwintering fish stream reach could lead to the complete loss of a year class of fish in that stream segment (Weber et al., 2013). All fish and eggs at these crossings would be expected to either be injured or killed directly by construction or indirectly by an increase in turbidity and sedimentation downstream and at the crossing. The fish would not be able to escape construction equipment or increased turbidity at the crossing location and downstream.

Winter construction at the 14 crossings with known overwintering habitat (i.e., not frozen to the streambed) would be expected to have lethal impacts on any fish at the crossing location. All but one of these crossings are listed as AWC waters (see table I-1 of appendix I). There is a lack of information on overwintering habitat at 186 winter crossings; therefore, additional overwintering habitat could be affected at other crossings. Individual overwintering fish populations could be significantly affected, but the extent of these impacts is unknown.

The ADF&G has recommended construction timing windows to minimize impacts on fish resources. Due to the lack of commitments by AGDC to adhere to the recommended crossing windows provided by the ADF&G, and to further minimize impacts on sensitive fishery resources, **we recommend that:**

- **AGDC should include the following measures, <u>to be implemented prior to any in-stream construction activities</u>, in its Fisheries Conservation Plan:**

  a. avoid in-stream construction in the winter (i.e., when frozen conditions limit stream flow) in waterbodies with known overwintering habitat (as listed in appendix I of the EIS); and

  b. conduct in-stream construction in the timeframes provided by the ADF&G, as listed in appendix N-2 of the EIS, in waterbodies listed as AWC, including EFH, or with known populations of Chinook, sockeye, coho, pink, and/or chum salmon.

In accordance with the Project Procedures, the ADF&G may further restrict or ease these timeframes during construction based on that year's timing of the spawning runs (early or late); species composition; prior year's crossing examinations for redds, eggs, and fry; and the accuracy of the area's cataloging of species and habitat.

After construction, there would continue to be an erosion risk where streambanks and beds have been disturbed, which could continue into the operational phase of the Project at crossings that are difficult to stabilize (see section 4.3.2 for additional details on streambank stabilization). Effects would be similar to those described for construction, but in limited locations. The duration would be longer-term, which could lead to indirect habitat effects such as stream channel alterations, habitat shifts, and lowered productivity. These sites would be more likely to interfere with fish movement and use and, if proximate to important spawning and overwintering areas, could affect local productivity.

Stream channel alterations associated with prolonged erosion, sediment inputs, and any condition that alters the stream's ability to move bedload as it did prior to construction could change the stream type and alter geomorphic processes. Habitat quality could be degraded and fish use altered at the crossing location. Alterations of sensitive habitats, such as spawning and overwintering habitats, would cause longer-lasting, significant effects on fish.

To reduce the potential for erosion, AGDC would immediately stabilize cut slopes and restore streambanks according to the Project Plan, Procedures, and Revegetation Plan. To protect streambanks and streambeds from scour, AGDC would implement site-specific BMPs, such as seeding at streambanks and transplanting shrubs, based on scour and erosion potential at each site. AGDC would conduct routine inspections to identify and restore any areas of erosion.

Trench dewatering during construction either in or upstream of spawning areas could remove water from spawning gravels and kill eggs or larval fish, depending on installation timing. Dewatering could also result in an increased release of sediments, increased turbidity, and increased sedimentation in the immediate Project area, potentially resulting in decreased stream productivity during construction within the influence of the release. Trench water would be discharged into a dewatering structure or directed into stable, vegetated areas. Impacts during construction dewatering would be managed according to the Project Procedures, SWPPP, and SPCC Plan, which include installation of dewatering structures and erosion control devices to minimize any sediment laden water from entering streams. AGDC would complete its dewatering activities under the supervision of the Project's EIs. With implementation of these measures, we conclude there would not be significant impacts on fisheries from dewatering during construction.

Five Mainline Pipeline AWC waterbody crossings would be installed using the DMT method during the summer months. These crossings are the Middle Fork Koyukuk River (MP 211.1), Yukon River (MP 356.5), Tanana River (MP 473.0), Chulitna River (MP 641.8), and Deshka River (MP 704.7). While use of the DMT method would minimize impacts on fisheries and fish habitat within and adjacent to these waterbodies, there would be a risk of inadvertent surface releases of drilling fluid. An inadvertent release of drilling fluid into a stream would affect water quality and could smother fish eggs and degrade spawning habitat. Depending on the magnitude of drilling fluid loss and whether drilling fluids escape into the water column, sedimentation of substrates downstream from the release site could occur.

Permanent loss of fisheries habitat could occur if aboveground facilities are placed in waterbodies (see recommendation in section 4.3.2 for AGDC to provide additional information regarding waterbodies near compressor stations).

If an inadvertent release occurs, AGDC would implement the corrective action and cleanup measures outlined in its DMT Plan to minimize impacts on fishery resources. Cleanup measures would include the installation of berms, silt fence, and/or hay bales to prevent silt-laden water from flowing into waterbodies, and the use of vacuum trucks to remove the released drilling fluid. In the event of an in-water release, AGDC may install floating silt booms to isolate the drilling fluid, but containment and removal of drilling fluids in surface waters is generally impractical. Any impacts on fish and fish habitat from DMT construction would likely be localized and minor.

Overall, we conclude that the impacts on fish from summer in-stream construction and construction on frozen waterbodies with no overwintering habitat would not be significant. Impacts would be localized and short term because in-stream conditions and suspended sediment concentrations would return to background levels soon after in-stream construction has been completed. For winter construction across waterbodies with overwintering habitat, impacts on overwintering fish could be locally significant, if construction cut through a winter pooling area, However, Project effects would be avoided with implementation of our recommendation to avoid winter construction in waterbodies with known overwintering habitat.

Cook Inlet

During the crossing of Cook Inlet, AGDC would lay the majority of the Mainline Pipeline directly on the seabed with the exception of the shoreline approaches, where the pipeline would be trenched in, causing increased turbidity, risk of shoreline erosion, and habitat effects. To reduce these impacts, we have recommended that AGDC incorporate the use of the DMT continuation methodology for the shoreline crossings at Beluga Landing and Suneva Lake, or provide a site-specific justification demonstrating that this methodology is not feasible (see section 4.3.3). Use of the DMT continuation method would minimize sedimentation and impacts on nearshore fish species such as salmon, although there would be a risk of an inadvertent release of drilling fluid to marine waters.

Upper Cook Inlet has some of the most extreme tides in the world resulting in substantial turbulence and vertical mixing of the water column (COE, 2013b). These cycles are also reversing, meaning they are marked by a period of slack tide followed by an acceleration in the opposite direction (Mulherin et al., 2001). The incremental, temporary, and localized increase in turbidity from pipelay, anchor cable sweep, and a potential inadvertent release would not likely have a significant impact on any fish population in the area due to the existing turbid waters and high rate of exchange in Cook Inlet. Any effects from turbidity and sedimentation would be minor and short term.

Direct impacts from construction in Cook Inlet would include temporary and permanent loss of benthic habitat. There would be about 307 acres of benthic habitat permanently lost under the Mainline

Pipeline, Mainline MOF, and shoreline protection; and about 4 acres of benthic habitat temporarily affected from anchor drop scars across the Cook Inlet seafloor. Due to the temporary nature of most of the disturbance (with the exception of the habitat under the Mainline Pipeline and change in water depth), and limited loss of habitat, as well as the abundance of adjacent suitable habitat, we conclude that there would not be significant impacts on fish from construction or operation.

The construction and use of the Mainline MOF would cause temporary and permanent habitat loss in Cook Inlet for salmonid and other anadromous and marine species. The fish community of Upper Cook Inlet is characterized largely by migratory fish—eulachon, capelin, and Pacific salmon—returning to spawning rivers or outmigrating. Houghton et al. (2005) and other sources indicate that returning adult salmon tend to occupy shallow water. Welch et al. (2014) reported that returning Chinook salmon adults were at a median depth of 16 feet, while returning sockeye salmon adults were at a median depth of 6 feet. Construction activities along the shoreline for the Mainline MOF would occur between April and October of one season. Adult salmon could be using habitats near the facility during construction. Juvenile salmon densities tend to be higher on the north side of the inlet than the south side. Juveniles move relatively quickly out of Cook Inlet once they enter the marine environment, likely because of the highly turbid conditions and low productivity that is characteristic of Upper Cook Inlet (Moulton, 1997). Due to the limited amount of habitat that would be permanently lost to the Mainline MOF, and the temporary disturbance from construction, overall habitat impacts in Cook Inlet would be minor.

Material Sites

AGDC has identified 153 material sites as potential sources of gravel, sand, and stone for the Project. In addition to being in upland areas, material sites would be in or near floodplains and/or fish-bearing waters (see table 4.7.1-5). Material sites where blasting would be anticipated are listed in table 4.7.1-5 and discussed in the blasting section below. Ten material sites would be within a stream bed and banks, six of which would be within AWC (or nominated) streams. Ten material sites would be within 600 feet of AWC streams.

Material sites constructed within floodplains could have a variety of effects on fish. Material extraction sites studied in arctic and subarctic floodplains in Alaska have shown a variety of adverse and beneficial effects on fish and fish habitat (Ott et al., 2014). The effects are dependent on many factors, including the type and size of the river, the type of material extraction employed, the amount of material extracted, and the time of year that the material is extracted. Material site development can lead to destabilization of river channels, river channel diversion or migration, floodplain widening, and reduced water quality, which can all negatively affect fish habitats (Joyce et al., 1980). Ott et al. (2014) determined that active channel mining should be avoided as possible, particularly when important spawning or wintering habitats are nearby. Fish entrapment potential was also documented at sites where extraction sites left depressions in floodplains that later flooded at high water but then became isolated waters as water levels dropped.

Ott et al. (2014) also identified configurations where mining methods (e.g., limitations on gravel removed specific to stream type and size) and location of removal sites could enhance habitats and reduce the potential for stream altering processes to be initiated. Some benefits to local fish populations, including the creation of wintering habitats and productive feeding habitats, have been identified. Ott et al. (2014) summarizes fish use of several granular material sites, most constructed as pits that were subsequently connected to nearby drainages on Alaska’s North Slope. While some sites took many years to be used by appreciable numbers of fish, most were used for overwintering. In that study, extraction sites provided overwintering habitat that is in limited supply in the Arctic. Several of the sites studied had been rehabilitated primarily to provide for fish overwintering, but also had productive shallow water habitats incorporated in their design to foster both productivity and enhanced overwintering habitat.

TABLE 4.7.1-5

Material Sites Within or Adjacent to Waterbodies

Material Site	Near Milepost	Waterbody Name	Anadromous Waters Catalog Code
MS-17.81 [b]	17.9	Sagavanirktok River – West Anabranch	330-00-10361
65-9-026-2 [b]	25.5	Sagavanirktok River – West Anabranch	330-00-10361
65-9-040-2 [a]	47.0	Sagavanirktok River – Main Channel	330-00-10360
65-9-072-2-1 [a]	75.8	Sagavanirktok River – Main Channel	330-00-10360
65-9-072-2-2 [b]	75.8	Sagavanirktok River – Main Channel	330-00-10360
Alternate Site 34 Extra [b]	86.6	Sagavanirktok River	330-00-10360
Alternate Site 38 Extra [b]	136.9	Ed Creek	N/A
65-9-056-2 [b]	148.9	Vanish/Holden Creek	N/A
Alternate Site 41 Extra [b]	160.9	Unnamed Tributary to Who Creek	N/A
65-9-098-2 [a]	236.9	Marion Creek	334-40-11000-2125-3912-4112
Proposed Site 3 Extra [b]	244.0	Spring Slough	N/A
Alternate Site 43 Extra [a]	261.4	South Fork Koyukuk River	334-40-11000-2125-3740
Proposed Site 4 Extra 1 [a]	282.2	Prospect Creek	334-40-110000-2125-3740-4080-5030
Proposed Site 4 Extra 2 [a]	282.2	Prospect Creek	334-40-110000-2125-3740-4080-5030
Proposed Site 4 Extra 3 [a]	282.2	Prospect Creek	334-40-110000-2125-3740-4080-5030
2015-LF1 [a]	406.4	Tolovana River	334-40-11000-2490-3151
35-2-5007-1 [b]	666.2	Unnamed Tributary to Rabideux Creek	247-41-10200-2291-3049
2015-2 [a]	685.3	Unnamed stream	247-41-10200-2081-3050-4040
2015-3 [a]	692.9	Trapper Creek	247-41-10200-2081-3050
2015-13 [b]	749.6	Unnamed Tributary of Pretty Creek	Nominated

N/A = Not applicable

[a] Within 600 feet of material site and potential blasting.

[b] Material site is within the stream bed and banks.

The use of upland material sites could also potentially affect fish and fish habitats by mobilizing sediments at the material site into adjacent habitats. To reduce the potential for adverse effects, AGDC would implement the BMPs detailed in the Project Gravel Sourcing Plan and Reclamation Measures, which include setbacks and vegetative buffers from sensitive waterbodies (though these measures would not apply to material sites within streams (see table 4.7.1-5). Mining plans for material removal from eskers[73] within floodplains would include drainage mitigation measures to minimize impacts on hydrologic regime and water quality. In addition, the construction SWPPP would be used to manage surface water during mining operations, and the SPCC Plan would address potential spills and leaks from equipment. AGDC would comply with the ADF&G's Fish Habitat Permit conditions for granular materials extracted from below the ordinary high water level of any fish-bearing rivers, including timing limitations.

AGDC would establish a 50-foot buffer around streams near material sourcing sites, with no clearing or granular fill excavation within the buffer area. The exceptions would be the ten material sites where excavation could be conducted in the active floodplain if approved in the ADF&G Fish Habitat

[73] A long ridge of gravel and other sediment, typically having a winding course, deposited by meltwater from a retreating glacier or ice sheet.

Permit. Site selection and site-specific mining plan design would reduce the potential for adverse impacts and could enhance fish habitats in drainages. Due to the potential impacts on AWC or EFH species from material extraction during spawning, **we recommend that**:

- **<u>Prior to construction</u>, AGDC should develop measures to avoid extraction in material sites within or near waterbodies listed as AWC, including EFH, during sensitive spawning time periods, as determined in consultation with the ADF&G. These measures should be included as part of its Fisheries Conservation Plan.**

With the implementation of the above mitigation measures, impacts on fish from material site activities would not be significant.

USFWS requested that AGDC create a vegetated littoral zone in material sites south of the Brooks Range[74] that fill with water upon abandonment, to include:

- a 20- to 30-foot-wide shallow littoral zone (underwater shelves along the bank with slopes no steeper than 10H:1V);
- irregular shorelines and, if practicable, islands and peninsulas to maximize the shore-to-water interface;
- spreading of 2 to 4 inches of organic material along the shallow littoral shelf and shoreline to maximize natural revegetation and productivity; and
- at least a 25-foot-wide buffer of native vegetation around most, if not all, of the pond perimeter to help filter sediment and pollutants before they enter the pond (Henszey, 2018).

These habitats would benefit fish species, birds, and terrestrial wildlife. Further, if the ponded areas are hydrologically connected to streams with EFH species and filled with greater than 6 feet of water, they would create overwintering fish habitat, which is a limiting factor for many fish species within Alaska. AGDC would develop material sites that are hydrologically connected to streams listed as AWC or that have EFH or known populations of salmon, but has not committed to implementing the requests of the USFWS or making areas with potential overwintering habitat, which would mitigate long-term impacts on waterbodies from use of these material sites. Therefore, **we recommend that:**

- **<u>Prior to construction</u>, AGDC should develop measures in consultation with the USFWS and ADF&G to minimize long-term impacts from material sites south of the Brooks Range that are hydrologically connected to streams listed as AWC, including EFH, or that have known populations of Chinook, sockeye, coho, pink, and/or chum salmon. These measures should be included as part of its Fisheries Conservation Plan.**

<u>Water Temperature</u>

Potential impacts on fish habitats from operation of the buried pipeline would be mostly associated with frost bulb formation induced by chilled gas (see section 4.3.2). The formation of frost bulbs at waterbody crossings could affect water flow within the streambed, particularly in late winter at low flow streams. Additionally, downstream water temperatures could be lower for very-low-flow streams as a result of the chilled gas flow and frost bulb. Operation of a chilled Mainline Pipeline in the substrates of streams

74 Creating shallow ponded areas north of the Brooks Range would not be feasible due to soil composition.

could affect local water temperatures, resulting in lowered stream productivity during summer. Frost bulb or frost heave formation could also cause aufeis (see section 4.2.5) along the Mainline Pipeline right-of-way, which could block or restrict stream flow. Potential mitigation measures for aufeis are described in section 4.2.5; these measures would be expected to minimize the risks of stream flow disruption.

From MPs 0.0 to 180.0, pipeline temperature would be cooled and maintained below freezing throughout the year; therefore, thermal effects of pipeline operation could lead to lower water temperatures above the pipe. From MPs 180.0 to 567.0, the land surface would generally be underlain with discontinuous permafrost; the in-line temperature would be maintained at a 32°F year-round average. From MPs 567.0 to 806.6, in areas of predominantly warm, non-permafrost conditions, the natural gas temperature would be kept at above-freezing temperatures. Because the pipe could be either warmer or cooler than ambient conditions, operation could lead to minor changes in sediment temperature, and therefore, water temperature in either direction.

Winter water temperature reductions would pose a higher potential risk, particularly at stream crossings with low, but persistent, winter flows. On the North Slope, crossings of sensitive overwintering areas that remain just above freezing all winter could freeze during exceptionally cold winters with the added thermal drop associated with the below-freezing pipeline. Small drainages with persistent low flows of cool water during winter, most common in the construction spreads between the Brooks Range and the Alaska Range, would be most susceptible to winter reductions in water temperatures. If crossings should freeze solid, water would be forced to the surface as ice and downstream overwintering and spawning habitats could be dewatered. Appendix I identifies Mainline Pipeline and PTTL stream crossings with identified overwintering habitats in anadromous Pacific salmon spawning areas.

Frost bulb formation during Project operation would be minimized by controlling the pipeline temperature, installing periodic ditch plugs or water bars, and ensuring sufficient burial depth beneath streams, thereby minimizing the chances of altering freshwater stream habitats (see section 4.2.5 for additional details). Changes in the natural temperature regime could affect fish productivity by affecting bio-energetics. Studies show that fish respond to temperature through physiological and behavioral adjustments that depend on the magnitude and duration of temperature exposure. Fish species have temperature ranges within which they can survive, and optimum temperatures for growth that maximize their ability to convert food into tissue. At trenched crossings, the pipeline would be buried 5 feet below the streambed and concrete coated, minimizing any potential temperature effects on the stream water.

Streambank vegetation and structure, such as logs, rocks, and undercut banks, provide important habitat for fish. Construction through waterbodies (except with DMT) in forested areas would temporarily remove this habitat, which could displace fish to similar habitat upstream or downstream of the pipeline crossing. Streambank vegetation provides shade and cooler water temperatures locally for cool and coldwater fish, and so removal of vegetation adjacent to a stream could alter the temperature at the crossing location. The scale of change in temperature would be dependent on the stream width, stream flow, and vegetation cleared, but would be minor.

Overall, temperature changes associated with a buried pipeline would not have a significant effect on the quality of habitat for use by fish for feeding and reproduction. Minor temperature changes could occur at stream crossings, but the extent of the temperature change would be limited to a small area around the buried pipeline. If frost bulbs should form in sensitive habitats, such as spawning habitats, local impacts would be long term but minor due to the limited extent of impact.

<u>Blasting</u>

Two types of blasting are anticipated for the Project: material site blasting and trench blasting. Both would occur within and in the vicinity of fish-bearing waters and in floodplains. Specific sections of the Mainline Pipeline trench have been identified that could require the use of explosives for ditch construction. In-stream trench blasting could occur in 317 waterbodies, of which 174 have known occupied fish habitat and 58 are listed as AWC. Appendix I lists those fish-bearing waterbodies where blasting could occur in-stream. Material site blasting would occur in or within 600 feet of 20 waterbodies, 10 of which would be directly in-stream.

If in-stream blasting should be necessary, it would cause turbidity and downstream sedimentation and potentially harm fish directly in the blast zone. Use of explosives near occupied fish habitat could produce in-water overpressures and in-gravel particle velocities that could injure or kill fish and their eggs in spawning gravels. Sound-related behavioral effects could be caused by explosives used near fish-bearing waterbodies. AGDC has committed to implementing the Blasting Standard for trench blasting and material site blasting near and within anadromous waterbodies. Measures in the Blasting Standard that could be implemented to reduce impacts on fish from in-stream blasting include:

- scheduling blasting when fish, embryos, or other sensitive life stages are not present;
- removing or hazing fish from the area and blocking them from the zone of impact;
- scheduling blasting to avoid fish migrations;
- isolating or dewatering the work area; and
- surveying for debris and stream blocks after blasting and restoring fish passage.

AGDC stated that blasting would be scheduled when fish and embryos are not present, as practical. If blasting must be conducted when fish or embryos are expected to be present, AGDC would consult with the ADF&G and implement one or more of the following measures to minimize impacts on fish:

- remove the fish from the area and prevent their re-entry into the blasting zone;
- isolate or dewater the blasting zone; and/or
- create pressure wave interference.[75]

In addition, AGDC would develop site-specific measures in consultation with the ADF&G, as outlined in the Blasting Standard (Timothy, 2013). These measures would be determined during the permitting process and could be altered in the field in consultation with the ADF&G based on current conditions. Controlled blasting techniques following industry BMPs would be used.

The Project Blasting Plan does not include measures to monitor and prevent stream flow changes as a result of blasting prior to completion of in-stream construction activities. Blasting could alter stream flow by changing the stream morphology by redirecting flow out of the existing channel affecting fish-bearing streams. Therefore, **we recommend that**:

- **<u>Prior to construction</u>, AGDC should file with the Secretary, for the review and written approval of the Director of the OEP, an updated Project Blasting Plan with the following requirements for all fish-bearing streams where blasting would occur:**

  a. monitoring protocol of stream flow after blasting and prior to completion of in-stream activities;

  b. implementing contingency measures to remediate loss of stream flow caused by fracturing the rock or permafrost from blasting; and

  c. indicating the timeframe for response and implementation of contingency measures.

75 For example, using a bubble curtain to reduce spread of sound waves.

AGDC has committed to implementing the Alaska Blasting Standards (Timothy, 2013) to minimize impacts on fish from these activities. With implementation of these standards and our recommendation, we conclude that blasting impacts on fish would be localized and minor.

Liquefaction Facilities

Construction and operation of the Marine Terminal and Marine Terminal MOF would cause temporary and permanent habitat loss in Cook Inlet for salmonid and other anadromous and marine species; these impacts would be similar to those described above for the Mainline MOF. There would be about 49 acres of benthic habitat permanently lost under the Marine Terminal MOF and the PLF; and about 51 acres of benthic habitat temporarily affected from dredging. Construction and removal of the Marine Terminal MOF would disturb benthic habitats and cause a temporary increase in turbidity near the site. Upon removal of the MOF, the disturbed shoreline could erode due to the active nature of Cook Inlet and the large tidal range and vessel wake activity, causing a loss of fish habitat. AGDC has committed to monitor and stabilize the shoreline, if needed. Construction activities along the shoreline for the Liquefaction Facilities' Marine Terminal and MOF would occur year-round for 3 years. Adult salmon could be using habitats near the Marine Terminal during construction. Construction activities could also potentially displace capelin if any should move into the area to spawn in shallow habitats in late April. The Marine Terminal MOF at Nikiski would force migrating fish (e.g., salmon and capelin) into deeper water, possibly increasing their risk for predation. Due to the limited amount of habitat that would be permanently lost to facilities and the short-term disturbance from construction, overall habitat impacts in Cook Inlet would be minor.

Dredging in Cook Inlet would be completed at the Marine Terminal MOF during construction over 4 years (see section 2.1.5). In the short term, dredging could increase turbidity and release contaminated sediments from the seabed. Examination of sediment samples collected in Cook Inlet sites in the general area indicates that sediments do not contain high levels of contaminants. Therefore, release of contaminants during dredging would not be expected in Cook Inlet.

Dredging in Cook Inlet would result in a temporary increase in turbidity. Increased turbidity in the water column could result in physical impairment of fish species, causing potential turbidity-induced clogged gills (i.e., suffocation or abrasion of sensitive epithelial tissue) and alteration of foraging behavior for visual predators. Typically fish would avoid areas of increased suspended sediment (Wenger et al., 2017). The effects would be limited to the period during and immediately following dredging. Seabed sediments for Upper Cook Inlet are dominated by sand, granular material, and large stones with isolated areas of higher silt concentration; therefore, turbidity levels would rapidly return to background following active dredging.

Dredging would occur between April and October in Cook Inlet which is during the in-migration of spawning adult eulachon and migrating salmon smolts and the out-migration of adult salmon. Depending on timing, dredging could interfere with capelin spawning and egg survival because they spawn within the gravel/sand of the surf zone area (see figure 2.1.5-6). Larger, adult fish would be able to move to adjacent habitats during the short time when material would be excavated. However, fish eggs, larvae, juvenile fish, and some adult fish would be killed when entrained by suction-type dredge equipment (Wenger et al., 2017).

Dredged material placement would increase turbidity, cause avoidance by mobile fauna, and smother benthic prey. The locations of dredged material disposal sites are shown on figure 2.1.5-7. Turbidity would temporarily increase, but the suspended particles would be rapidly flushed out with the tides. AGDC evaluated the impacts of the Marine Terminal MOF construction dredging and disposal over four seasons on sedimentation and water quality using both near-field and far-field sediment transport modeling.[76] Based on all cases simulated, the maximum modeled sedimentation thickness was about 3.3 inches and would cover no more than 0.2 square mile. Disposal of dredged sediments would cause a localized, temporary increase in turbidity and sedimentation near the disposal site for the duration of disposal activities. Currents would then be expected to rapidly entrain and remobilize any sediments deposited. Adult salmon and benthic fish could be temporarily displaced from the disposal area, but these impacts would be minor due to the localized nature of sedimentation from Project activities.

Following placement, the disposal area would reach stasis and organisms would begin to recolonize. In general, arctic benthic organisms have a slow rate of growth and recolonization due to cold temperatures and slow organic matter input rates (MMS, 2008). Opportunistic species are quick to repopulate a disturbed area, but communities can take a decade to fully recover (Conlan and Kvitek, 2005; Konar, 2013; Newell et al., 1998). Due to the small size of the affected area relative to the entire inlet, along with the abundant adjacent suitable habitat and benthic organisms, we conclude that there would not be significant or long-term impacts on fish in the area as a result of dredging or dredged material placement.

4.7.1.8 Aquatic Nuisance and Nonindigenous Fish Species

Nonindigenous (or invasive) species can cause harm to ecological systems by upsetting natural balances and suppressing resident species. Invasive species can also upset commercial industries and subsistence and recreational fishing when they affect fisheries. The USGS has established a database to track and record the presence of nonindigenous aquatic species (NAS) throughout the United States. To combat the spread of invasive species and limit their impact on Alaska's ecosystems, the ADF&G developed the *Alaska Aquatic Nuisance Species Management Plan* in 2002 that focuses on nonindigenous species that have or could be introduced into Alaskan waters (ADF&G, 2002). The ADF&G has identified several fish aquatic nuisance species (ANS) of concern, identifying them as High Priority Threats. This designation means that the ANS is considered a significant threat to Alaskan waters and requires immediate or continued management action to minimize the impact on existing ecosystems.

The following six NAS and NAS/ANS fish species identified by the ADF&G as a High Priority Threat could be present in the Project area:

- Alaska blackfish (NAS);
- American shad (*Alosa sapidissima*) (NAS);
- arctic grayling (NAS);
- Atlantic salmon (*Salmo salar*) (NAS);
- northern pike (NAS and ANS); and
- rainbow trout (NAS).

Some of these fish species occur naturally within portions of the Project area but may have been legally stocked or illegally introduced into portions of the Project area where they did not naturally occur. Of the NAS that have been documented as present within the Project area, American shad, northern pike, and Atlantic salmon have been illegally or accidentally introduced; and rainbow trout and arctic grayling have been legally stocked in interior Alaska and the Kenai Peninsula by the ADF&G Department of Sport Fish (ADF&G, 2018i). A list of waterbodies that would be crossed by the Project with known NAS or ANS species is included in appendix I. Aquatic invasive invertebrate species are discussed in section 4.7.2.3.

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[76] AGDC's *Sediment Modeling Study – Material Offloading Facility Construction* was included in the response to information request No. 118 dated June 11, 2018 (Accession No. 20180611-5159), available on the FERC website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter 20180611-5159 in the "Numbers: Accession Number" field.

No ANS or NAS have been identified for the area associated with the Gas Treatment Facilities. Five NAS and/or ANS species could occur in waterbodies that would be crossed by the Mainline Pipeline: northern pike, American shad, rainbow trout, Atlantic salmon, and arctic grayling. Northern pike is a freshwater fish native to most of Alaska but was illegally introduced to freshwater rivers near Cook Inlet where they prey on native trout, salmon, and other fish (ADF&G, 2018k). Traditional knowledge workshop participants noted that invasive northern pike are a problem in the Susitna River watershed, negatively affecting native fish populations (Braund, 2016). They also noted that northern pike are the most prolific fish living in the Tanana River area (Braund, 2016).

American shad is an anadromous fish that was introduced in California in 1871 from the east coast of the United States where they are native. Since then, American shad have spread north along the coast and now occur in Cook Inlet and connected freshwater rivers (USGS, 2017c). Rainbow trout have been legally stocked in Alaska waters and could occur in Cook Inlet and connected freshwater rivers (USGS, 2017c). Rainbow trout can hybridize with native species and carry diseases that can be transmitted to native fish (USGS, 2017c). Atlantic salmon in Alaska have likely escaped from coastal fish farms further south in British Columbia and Washington State. These anadromous fish join native Pacific salmon as they migrate into Alaska waters (ADF&G, 2018k). Arctic grayling are native to most of Alaska, but current populations have largely been reintroduced across the state after overfishing and other threats (USGS, 2017c). Arctic grayling are found throughout Alaska freshwater rivers and lakes (USGS, 2017c).

Three NAS and/or ANS species could occur in Cook Inlet: American shad, rainbow trout, and Atlantic salmon. Northern pike could also be found in freshwater rivers and lakes on the Kenai Peninsula. These species are described above.

AGDC would implement its Invasives Plan (see table 2.2-1) to reduce the risk of introducing ANS or NAS fish species. Introduction of other non-native species, such as crabs or tunicates, could disrupt the ecological balance, thereby affecting fish by becoming prey for these species or competing with these species for prey. All vessels brought into the state of Alaska or federal waters would be subject to Coast Guard regulations (33 CFR 151, subpart D and 46 CFR 162.060 on *Standards for Living Organisms in Ships' Ballast Water Discharged in U.S. Waters; Final Rule* [77 FR 17254 (Mar. 23, 2012)] and *Navigation and Vessel Inspection Circular* 01-18), which are intended to reduce the transfer of aquatic invasive organisms. AGDC does not have the authority or control over independent vessels that would be used for construction and operation of the Project. However, the LNG carriers and marine barges to be utilized would be commercial maritime vessels obligated to meet the requirements of the Coast Guard and EPA VGP regulations (see section 4.3.3 and the Project BWM Plan for additional details). In addition to these federal requirements, vessels calling on Alaska ports must also comply with state ballast water exchange rules and laws (see section 4.3.3). Additionally, AGDC would require that visiting vessels possess documentation to demonstrate compliance with ballast water regulations prior to allowing any ballast water to be discharged into the Project's berthing areas. Adherence to these regulations and the Project BWM Plan would reduce the likelihood of Project-related vessel traffic introducing aquatic invasive organisms.

Introduction or transfer of aquatic invasive species from one waterbody to another is a risk when using the same equipment in multiple waterbodies or when equipment travels through multiple waterbodies. Invasive organisms can alter the local species composition and outcompete native species. AGDC would follow the Project Invasives Plan and ISPMP to prevent the spread of aquatic nuisance organisms during construction and restoration. Examples of measures that would be used to minimize the spread of aquatic invasive species include discharging hydrostatic test water back into its original watershed, as practicable, and implementing ballast water control measures, as described above. As discussed in section 4.5.8, given the concerns expressed by the USFWS and the potential presence of *Elodea* spp. at the Alexander Creek crossing, we have recommended that AGDC should clean construction equipment prior to entering and leaving the Alexander Creek crossing site.

4.7.2 Benthic Invertebrates

Benthic invertebrates include both infaunal (living within the sediment matrix) and epifaunal (living on or in close association with the seafloor) organisms (Gooday et al., 1990). In general, assemblages of benthic invertebrate species tend to vary with depth/distance from shore, sediment type, and organic richness (Miller, 2004). Common benthic invertebrates found in Alaskan waters include echinoderms, sipunculids, mollusks, polychaetes, copepods, and amphipods (BOEM, 2012). These species spend a portion of their lives (usually the adult stage) in association with the seafloor, and serve as an important trophic link between primary producers (i.e., plankton) and higher trophic level organisms in the ecosystem, including commercially important species (e.g., shellfish, crabs, and salmon) (Albers and Anderson, 1985). The seafloor community of invertebrates plays an important role in overall marine ecosystems, in particular fisheries production (Newell et al., 1998). Species in Arctic marine waters typically grow slowly and live longer than species in temperate and tropical environments (ADF&G, n.d.[d]). Additionally, there is a general gradient of lower species diversity in the Arctic than in lower latitudes (Josefson et al., 2013). As a result, the recovery of species in Arctic marine waters after disturbance takes longer than in temperate or tropical waters and/or favors opportunistic species that recover or recruit faster.

4.7.2.1 Prudhoe Bay

The Beaufort Sea bottom habitat consists mostly of silt, clay, and sand (BOEM, 2014). It supports benthic communities of numerous epifaunal and infaunal invertebrates, microalgae (diatoms), macrophytic algae, bacteria (MMS, 1996), and viruses (Suttle, 2007). Prudhoe Bay is a shallow coastal estuary just west of the Sagavanirktok River delta on the North Slope of Alaska in the Beaufort Sea. Prudhoe Bay is subject to salinity changes, ice scouring, storm surge, turbidity, and low concentrations of dissolved oxygen (COE, 1980). Storm surges can cause high turbidity and lead to smothering and burial of benthic organisms by sediment (Jewett et al., 1999). Bottom-fast ice freezes to the sediment and prevents access to the bottom environment from mid-winter through June (COE, 2017b). Ice scouring can occur in areas deeper than 6.6 feet (2 meters) where grounding ice plows the bottom sediment with similar effects as dredging and trawling (COE, 2017b). These conditions shape the species assemblages that inhabit the area, favoring highly mobile epifauna that can recolonize after disturbance, such as isopods, amphipods, and mysids (Gutt, 2001). Despite the severe conditions and a short open-water growing season, benthic assemblages in Prudhoe Bay do not differ in richness from other exposed, soft-bottom estuaries in more temperate regions, such as Lower Cook Inlet (MacGinitie, 1955). High variability and annual disturbances are a common feature of most estuarine environments.

Benthic assemblages in the Beaufort Sea region can be classified by depth as follows:

- **nearshore** environment, intertidal zone to 6.6 feet (2 meters) deep, bottom-fast ice zone that includes most of Prudhoe Bay;
- **inshore** environment, 6.6 to 65.6 feet (2 to 20 meters) in depth, includes areas around barrier islands; and
- **offshore** environment, greater than 65.6 feet (greater than 20 meters) in depth, extends out across the continental shelf (COE, 1980).

The Gas Treatment Facilities would require expansion of the West Dock Causeway and construction of Dock Head 4, as well as a temporary barge bridge, a turning basin, and navigation channel in Prudhoe Bay. Both the West Dock Causeway and temporary barge bridge would affect the nearshore and inshore benthic environments of Prudhoe Bay. Borehole data from the West Dock Causeway area indicate that the substrate consists of a 0.5- to 6-foot-thick layer of sandy and clayey silt at the seafloor, underlain by gravelly to silty sand. The fine sand silts of coastal Prudhoe Bay contain little organic matter with some gravel present west of the West Dock Causeway. Marine soft-bottom habitats, such as those near the West Dock Causeway, support infaunal communities of polychaete worms and small mollusks and epifaunal communities of isopods, nemerteans, and benthic arthropods (Broad et al., 1978).

Benthic organisms are extremely important in marine food chains, even when they are not directly used by humans (COE, 2017b). The food web in the Prudhoe Bay area is relatively simple (COE, 1980). Productivity in the water column is controlled by temperature, nutrients, light, land-based organic debris, and the amount of sea ice present. Benthic communities feed on detritus deposited from land and deposits of drifting particles (i.e., marine snow) of phytoplankton blooms, epontic organisms (i.e., associated with sea ice), and ice algae. Benthic–pelagic coupling is a key nutrient pathway into the benthos, where benthic invertebrate communities form the major link between primary production and secondary consumers, such as important fisheries resources (e.g., salmon species) and marine mammals (e.g., bearded seals and ringed seals) (COE, 1980).

The shallow habitat in the nearshore environment of Prudhoe Bay is characterized by low species diversity, density, and biomass with patchy habitat distribution determined by sediment type, ice stress, extreme bottom temperatures, and lower salinities due to freshwater inflow (COE, 1980). The nearshore benthic community is characterized by motile, opportunistic epifauna that can rapidly recolonize the area after ice recedes in the spring. Areas shallower than 1.6 feet (0.5 meter) have no infauna continual disturbance, but small infaunal organisms (e.g., oligochaete worms) that are able to overwinter below the bottom-fast ice or quickly recolonize are present farther from shore (Broad et al., 1978; 1979; COE, 1980). Ice gouging can disturb bottom sediments in the shear zone (from 50 to 70 feet [15 to 21 meters] water depth) where landfast ice and the moving ice pack meet (MMS, 1990). Each summer, the ice-affected areas in the nearshore environment are recolonized by mobile, opportunistic, epifaunal invertebrates (e.g., amphipods, mysids, cumaceans, and isopods).

Certain species may not be constantly associated with bottom habitat and may opportunistically leave the bottom sediments, usually during the spring, to become grazers or predators on epontic (within- or under-ice) communities composed primarily of diatoms and meiofauna (BOEM, 2014; Homer, 1979; Horner and Murphy, 1985). Pelagic larvae of some benthic polychaetes and mollusks spend part of their life cycle inside sea ice as members of the epontic community. Juveniles may comprise part of the zooplankton community in the water column before settling to the bottom habitat (see section 4.7.3). Benthic invertebrates in Prudhoe Bay were shown to increase in species diversity, density, and biomass with increasing distance from shore through the inshore and offshore environments, which are more stable than the nearshore environment regularly affected by ice scour (COE, 1980; MMS, 1990).

The benthic epifauna community in Prudhoe Bay consists primarily (greater than 75 percent) of echinoderms like brittle sea stars, sea stars, sea cucumbers, sea urchins, and sea lilies. Site-specific sample data are rare, but Houghton (2012) presented and summarized past and recent surveys of benthic infauna and epifauna at the Dock Head 4 construction area, the berthing and turning basin area, the former Alaska Pipeline Project potential dredged material disposal site, and reference areas within Prudhoe Bay. Houghton (2012) collected 25 epibenthic invertebrate taxa, with the mysid shrimp (otherwise known as opossum shrimp) of highest abundance and the large isopod, *Saduria entomon,* with the highest biomass (see table 4.7.2-1). Among crustaceans, the amphipod, *Monoporeia affinis,* was second-most abundant. All the mollusks documented in the study were bivalves; the most abundant was the Kurr propeller clam, and the second-most-common was the Baltic clam. Species present in low numbers include the hydrozoan, tall tubularia (*Tubularia indivisa*, also known as *Tubularia couthouyi*), the sea grape (*Rhizomolgula* *globularis,* also known as *Ascidia globularis*), the priapulid worm (*Priapulus caudatus),* and colonial bryozoans identified as *Alcyonidium* spp. and *Synnotum* spp. (Houghton, 2012). Trawl sampling performed in conjunction with the Project (at test trench sites 1 to 2 miles east of the West Dock Causeway) found that mysids and isopods (*Saduria* spp.) are the most abundant epibenthic invertebrates in this area. Benthic biomass in Prudhoe Bay is high for the Beaufort Sea region, but low compared to areas offshore of the western coast of Alaska in the Chukchi Sea (Smith, 2011).

Populations of benthic infauna are typically less abundant and diverse than epifaunal communities in the nearshore Beaufort Sea, and vary greatly both seasonally and annually. Polychaetes comprise 70 to 80 percent of the total infauna species in Prudhoe Bay. Polychaetes are a diverse group of marine worms that survive on or in the seafloor sediment. Some species burrow, others form and dwell in tubes, some are deposit feeders (taking in substrate, extracting nutrients, and depositing the remains in the soil), and still others are suspension feeders (obtaining nutrition by filtering water). Different groups of species may be associated with different substrate types, and most of the Beaufort Sea benthic environment consists of silty muds or sands (Miller, 2004). Benthic invertebrates play an important role in bioturbation, aerating the seafloor subsurface, and rotating nutrients through the sediments. Assessment of past and recent surveys of benthic infauna at the Dock Head 4 construction area, the berthing basin area, and the former Alaska Pipeline Project potential dredged material disposal area (Houghton, 2012) concluded that the polychaete, *Ampharete vega,* was the most abundant animal at eight of nine sample stations and was the most abundant single species in the infauna.

Farther offshore, the mud and silt substrates are interrupted with sporadic boulders that support arctic kelp beds (Barnes and Reimnitz, 1974). The "boulder patch" is an isolated rocky bottom habitat with soft sediments in Stefansson Sound dominated by macroalgae that is considered a unique biological community (Dunton et al., 2009). Rockier habitats like the boulder patch support diverse assemblages of epibenthic invertebrates, including motile crabs and sessile filter-feeders (COE, 1980). The boulder patch and other areas composed of similar hard substrate and diverse species assemblages are 12.4 miles northeast of Prudhoe Bay, and therefore are unlikely to be directly affected by Project activities (Dunton and Schonberg, 2000). The presence of a considerable amount of macroalgae (including some attached to pebbles) in benthic samples from Project disposal and reference areas, however, indicates possible boulder habitat in these areas (Houghton, 2012).

The Arctic Management Area encompasses marine waters in the U.S. EEZ north of the Bering Strait, including portions of the Chukchi and Beaufort Seas. Federal waters within the Arctic Management Area are closed to commercial fishing for any finfish, mollusks, crustaceans, or plant life by the North Pacific Fishery Management Council (NPFMC, 2009). Snow crab (*Chionoecetes opilio*) is the target management invertebrate species with exploitable biomass in the Beaufort Sea, but commercial harvesting is not allowed (Himes-Cornell et al., 2013; NPFMC, 2009). For sport fishing in the North Slope, catches of male tanner crab (*Chionoecetes bairdi),* Dungeness crab (*Cancer magister*), and king crab (*Parlithodes camtschaticus* and *Parlithodes platypus*) are allowed, as well as shrimp and clam fishing (ADF&G, 2018j). No fishing permits were held for any invertebrates or fish species, however, and only 89 sport fishing licenses were sold in Prudhoe Bay from 2000 to 2010 (Himes-Cornell et al., 2013). Data were not available on subsistence fishing during that period in Prudhoe Bay, but shellfish takes of Dungeness crab, king crab, tanner crab, shrimp, clams, abalone (*Haliotis* spp.), sea cucumbers, sea peaches (*Halocynthia aurantium*), and other shellfish for subsistence use are generally allowed in the North Slope (DOI, 2015). Subsistence use is discussed in section 4.14.

TABLE 4.7.2-1

Life History and Potential Sensitivity of Benthic Invertebrates Found in the Project Area

Species	Taxonomic Group	Habitat	Life Stages	Size	Density (no./m²)	Lifespan (years)	Seasonal Presence	Potential Sensitivity [a]
West Dock Causeway – Prudhoe Bay								
Tharyx spp. [b]	Polychaete worm	Burrows in soft sediments, rock crevices	All	Macrofauna 1.2–3.9 inch (3–10 cm)	457	3–5	Seasonal recolonization in the summer following ice retreat	Low – burrows in sediment
Ampharete vega [b]	Polychaete worm	Tubes in deposits of fine sand or mud, rock crevices	All	Macrofauna 0.4-1.2 inch (1–3 cm)	321	3–10	Seasonal recolonization in the summer following ice retreat	Medium – sediment dweller, tubes may be destroyed or damaged
Mysid shrimp Mysis litoralis [c]	Mysid crustacean	Coastal zone of the Arctic euryhaline	All	Macrofauna	0.06	1–3	Seasonal recolonization in the summer following ice retreat	Medium – mobile seafloor surface dweller
Saduria entomon [c]	Benthic isopod crustacean	Zostera beds and sandy substrate	All	Macrofauna 1.6–3.5 inch (4–9 cm)	0.04	1–3	Seasonal recolonization in the summer following ice retreat	Medium – mobile seafloor surface dweller
Monoporeia affinis [b]	Amphipod	Soft bottoms from surface to −262.5 feet (−80 meters)	All	Macrofauna 2.0–3.1 inch (5–8 cm)	124	1–3	Year-round in deeper areas that do not freeze	High – seafloor surface dweller/limited escape ability/sensitive to low dissolved oxygen
Kurr propeller clam, Cyrtodaria kurriana [b]	Bivalve	Soft sediments – nearshore and offshore	Unknown, likely all	Macrofauna <3.1 inch (<80 mm)	198	Long-lived	Anticipated to occur year-round in deeper areas that do not freeze	Medium – filter feeder/deep dweller
Marine Terminal Site – Eastern Cook Inlet [d]								
Leptochelia savignyi	Crustacean Tanaid	Intertidally in self-constructed tubes in submerged aquatic vegetation roots on rocks and in shallow sublittoral	All [e]	Macrofauna	28 [f]	NA	Expected to be present in the summer season [g]	Medium – seafloor surface or tube dwelling
Maricola	Marine planarian	Typical of solid substrates; found in the intertidal zone	All [e]	Macrofauna	24[f]	NA	Expected to be present in the summer season [g]	Medium – solid substrates, seafloor surface dwelling
Nematoda [h]	Roundworm	Ubiquitous in the estuarine and marine environment	All [e]	Meiofauna	19 [f]	Matures within 2–3 weeks	Expected to be present in the summer season [g]	Low – sediment dwelling
Syillidae	Polychaete worm	Shallow subtidal depths, in sandy and muddy sediments, among photophilic algae	All [e]	Macrofauna	18 [f]	1–3	Expected to be present in the summer season [g]	Low – sediment dwelling

TABLE 4.7.2-1 (cont'd)

Life History and Potential Sensitivity of Benthic Invertebrates Found in the Project Area

Species	Taxonomic Group	Habitat	Life Stages	Size	Density (no./m²)	Lifespan (years)	Seasonal Presence	Potential Sensitivity [a]
Tubulanus sp.	Nemertean worm (ribbon worm)	Low intertidal & subtidal; under stones in gravel, in mud, or among mussels or submerged vegetation	All [e]	Macrofauna	12 [f]	<2	Females have many eggs during summer, development is rapid and direct [g]	Low – sediment dwelling
Mainline MOF - Western Cook Inlet [d]								
Macoma balthica	Baltic clam (Bivalve)	Soft sediments – nearshore and offshore	Unknown, likely all	Macrofauna <3.1 inch (<80 mm)	3,145 [i]	long lived	Anticipated to occur year-round in deeper areas that do not freeze	Medium – filter feeder/ deep dweller

Sources: Animal Diversity Web, 2017; Encyclopedia of Life, 2017; ETI BioInformatics, 2017; Houghton, 2012; Marine Taxonomic Services, Ltd, 2016; MMS, 2003; Rosario Beach Marine Laboratory, 2017; SeaLifeBase, 2017; Vranken and Heip, 1986; Zeppilli et al., 2017

cm = centimeter; NA = Not available

[a] Sensitivity level based on feeding mechanisms and habitat use.

[b] Most abundant (cumulatively total 75 percent of all organisms) taxa during infaunal sampling at Stations 03B, 01F, 01L, density is number of individuals/10 square foot, 0.04 inch (1 mm) sieve.

[c] Most abundant (cumulatively total 85 percent of all organisms) taxa organisms in epifaunal trawl surveys. Total Invertebrate catch per 100 m^2 with Otter Trawl by station.

[d] Includes all taxa representing ≥5 percent of the organisms collected at 10 sampling stations (GP-1 through GP-10) in the proposed Marine Terminal dredged material area.

[e] Due to a short summer (ice-free) season available for development and estuarine nature of Cook Inlet, it is assumed that all life stages would potentially be present.

[f] Based on 10 samples of 1 square foot.

[g] Data from winter season for benthic invertebrates in Cook Inlet is not available; it is assumed that all life stages would be present during the summer (ice-free) period when Project construction would occur.

[h] Actual densities are likely much higher due to their typical dominance within the meiofaunal component of estuarine and marine benthos (Zeppilli et al., 2017).

[i] Based on winter samples conducted in nearshore mudflats predated by rock sandpiper (Ruthrauff et al., 2013).

4.7.2.2 Cook Inlet

Cook Inlet is one of the largest estuaries in Alaska, measuring 230 miles (370 km) long. The northern half, Upper Cook Inlet, is a shallow body of water (depths up to 115 feet [35 meters]) with one of the largest tidal ranges 29.5 feet (9 meters) in the world (Saupe et al., 2005). Upper Cook Inlet has variable salinity, high turbidity, and warmer temperatures due to substantial freshwater and suspended sediment influx from the Knik, Matanuska, Beluga, and Susitna Rivers that flow into its northern end. Upwelling near the entrance makes Lower Cook Inlet highly productive. The Cook Inlet watershed drains 38,610 square miles (100,000 km^2) that includes the largest urban area in Alaska and two-thirds of the state's population (Saupe et al., 2005).

The Liquefaction Facilities, the offshore section of the Mainline Pipeline, and the Mainline MOF are the Project components that would directly affect the Cook Inlet benthic environment. The Marine Terminal of the Liquefaction Facilities, including the temporary Marine Terminal MOF and PLF, is along the south-facing coastline of the Kenai Peninsula near Nikiski. The Mainline Pipeline would cross Cook Inlet from the western shore at Shorty Creek near Beluga to the eastern shore at Boulder Point on the north side of the Kenai Peninsula. The Project would include a permanent Mainline MOF to be built on the west side of Cook Inlet near Beluga to support pipeline and facilities construction activities (see figure 2.2.2-8 for an illustration of the Cook Inlet crossing).

The area near the Marine Terminal MOF is not noted to have sensitive shoreline habitats (e.g., sheltered tidal flats, sheltered rock shores, or exposed tidal flats) (NOAA, 2002). Coral reefs, seagrass beds, and kelp beds have not been identified in Cook Inlet, while rocky reefs occur far south of the Project area in Lower Cook Inlet (BOEM, 2016). Within the footprint of the Marine Terminal MOF, the sediments are a medium dense sand silt and sand overlying hard sandy clay. Cobbles and boulders of varying sizes up to 10 to 15 feet in diameter are also present (CH2M Hill, 2015a). The benthic habitat in deeper waters of Cook Inlet is characterized by unconsolidated sediments on a smooth bottom and strong tidal currents (BOEM, 2016). Benthic infaunal communities in the deeper areas are represented by two major infaunal groups: deposit feeders dominate muddy substrate and suspension feeders dominate sandy substrate (BOEM, 2016). The Cook Inlet benthic infaunal community is typical of soft sediment habitats and generally dominated by polychaete worms, gammarid amphipods, and clams (BOEM, 2016). Deeper sands are generally dominated by razor clams (*Siliqua* sp.) and muddy beaches are habitat for clams and echiurid worms (BOEM, 2016). Infaunal invertebrates within the deep subtidal benthic community primarily consist of mollusks, polychaetes, and bryozoans (BOEM, 2016). These subtidal infaunal organisms are important trophic links for crabs, flatfishes, and other important higher trophic level organisms (BOEM, 2016).

AGDC conducted benthic surveys and a macroinvertebrate species bioassessment as part of dredging studies at the Marine Terminal MOF on the eastern shore of Cook Inlet in September 2015. The sampling effort of five grab samples from two test pit sites identified 186 individuals of 37 taxa, primarily of Annelida (54 percent of individual abundance) and Crustacea (25 percent of individual abundance) (see table 4.7.2-1). The benthic infauna sampled near the Marine Terminal MOF was low in species abundance and diversity, which is not uncommon in Arctic environments. Strong tidal currents, low salinity, and high turbidity result in a local environment with low total organic carbon and a high proportion of fine sediment, placing a high level of stress on the infauna communities, presumably limiting abundance and diversity (CH2M Hill, 2016a). In addition, 15 species were found outside their typical range and 17 potentially undescribed species were documented, despite the low sample size collected for the Project. Such limited sampling is not representative of the species composition in the whole Project area nor across all seasons, but additional data on benthic communities in this area is not available.

Sampling conducted in 2008 by the Cook Inlet Regional Citizens Advisory Council (CIRCAC) collected previously undescribed species in Upper Cook Inlet, including new polychaetes *Leitoscoloplos* sp. N1, *Aphelochaeta* nr. *Tigrina*, and a new nemertean *Tubulanus* sp. A (CIRCAC, 2010). No nonindigenous species were collected in Upper Cook Inlet. The closest nonindigenous species were found at the northern end of Kalgin Island: a polychaete (*Microclymene caudata*) from Japan and an anemone (*Halcampa cf. duodecimcirrata*) from the North Atlantic Ocean (CIRCAC, 2010). In addition to the CIRCAC study, limited sampling by Wetzel and Reynolds (2014) was conducted in late fall and early spring 2012 near the proposed Mainline Pipeline route and dredged material disposal areas. These sampling efforts found that benthic organism biomass was low in the sampled areas; identified species included benthic fish (e.g., eulachon and Pacific tomcod [*Microgadus proximus*]), shrimp (e.g., sevenspine bay shrimp [*Crangon septemspinosa*], tunicates, bryozoans, and decorator crabs).

A recent study of the benthic infauna of Cook Inlet found an average abundance of 505 individuals per 1.1 ft^2 (0.1 square meter) grab sample (Fukuyama et al., 2012). After removing the outlier sample that captured over 13,000 individuals at one site, the average abundance at the remaining sites was 207 individuals per sample, which is five times higher than the average infauna abundance calculated from samples at the test pit sites near the Mainline MOF (37 individuals per 0.1 square meter grab sample). Fukuyama et al. (2012) concluded that there is a strong north–south gradient in increasing species diversity in Cook Inlet, with higher numbers of total individuals and greater diversity at non-industry stations in Middle and Lower Cook Inlet. Industrial activities in Upper Cook Inlet may explain lower benthic invertebrate abundance in addition to stressful environmental conditions that include strong tidal currents, low salinity, high turbidity, low total organic carbon, and a high proportion of fine sediment (Fukayama et al., 2012; CH2M Hill, 2016a).

The data collected for the Project showed that there was little to no overlap in taxonomic composition between sample sites, demonstrating that benthic infauna communities can change dramatically over short distances. This heterogeneity suggests either that: 1) the benthic communities are stressed and species presence/absence is constantly in flux, or 2) the bottom habitat is spatially complex and leads to a variety of benthic communities establishing near each other. Lees et al. (2013) found a pattern of abundance decreasing with increasing latitude (i.e., moving north) like that described by Fukuyama et al. (2012). Lees et al. (2013) concluded that the distribution and abundance of macroinfauna in Upper Cook Inlet are driven by tidal currents and wave action, turbidity, suspended and deposited nutrients, sediment texture and stability, larval settlement and recruitment success, and predation. In Cook Inlet, the nutrient supply decreases as distance from shore increases, resulting in decreased benthic productivity in deeper subtidal areas, which is the reverse of the pattern in Prudhoe Bay (BOEM, 2016). This complex interrelationship of environmental factors affecting distribution suggests that the heterogeneity of community composition found in the Project samples may be due to spatially complex bottom habitat. This is important to consider when evaluating disturbance impacts because different species and communities would be affected depending on where Project activities occur.

Commonly observed epibenthic invertebrate species identified by Lees et al. (2013) north of Kalifornsky Beach in Cook Inlet included the Baltic clam at seven of nine sites, a barnacle (*Semibalanus balanoides*) at five of nine sites, and an isopod at four of nine sites. Houghton et al. (2005) sampled benthic invertebrates in Upper Cook Inlet and found that crustaceans, (including a shrimp [*Crangon franciscorus*] and an amphipod [*Lagunogammarus setosus*]), were the most abundant epifauna. The Baltic clam was also abundant on the western shore of Upper Cook Inlet in a study conducted by Ruthrauff et al. (2013). They calculated mean Baltic clam densities of 3,145 individuals per meter squared (about 11 square feet) in the Susitna Flats near the Beluga River (Ruthrauff et al. 2013).

Historically, Cook Inlet supported commercial, recreational, and/or subsistence fisheries for clams, shrimp, octopus, and crabs. Since the late 1970s, there has been a regime shift in dominant epibenthic species from crustaceans to groundfish like pollock and Pacific cod (Rumble et al., 2016). Due to unknown or declining abundance, many invertebrate fisheries are closed or have reduced fishing seasons to aid conservation. Since the late 1990s and early 2000s, fisheries for blue mussels (*Mytilus edulis*), butter clam

(*Saxidomus giganteus*), Dungeness crab, green sea urchin (*Lytechinus variegatus*), hard shell clam (*Mercenaria mercenaria*), littleneck clam (*Protothaca staminea*), octopus, sea cucumber, and shrimp have been closed due to low abundance (Rumble et al., 2016). Currently, open fisheries in the Cook Inlet management area include:

- noncommercial (sport or subsistence) fishing of tanner crab, allowed from October through February (Cotton and Kelley, 2017);
- bycatch fishing of octopus up to 35,000 pounds per year (ADF&G, 2017c); and
- commercial and recreational fishing of razor clams (Rumble et al., 2016).

The Cook Inlet beach razor clam fishery dates back to 1919 with harvests ranging from zero to 500,000 pounds (Rumble et al., 2016). The eastern shore of Cook Inlet has been set aside exclusively for sport harvest since 1959, with no commercial fishing (Rumble et al., 2016). Both the eastern and western shores of Cook Inlet contain abundant razor clam beds; the nearest bed to the Project is Coho Beach in Kasilof, about 28 miles south of the Marine Terminal in Nikiski (Rumble et al., 2016). On the western shore, both commercial and recreational razor clamming occurs, particularly near the Polly Creek and Crescent River sandbar areas, which are over 75 miles south of Beluga and the Mainline MOF. Due to this distance, it is unlikely that these fisheries would be affected by Project activities.

During traditional knowledge workshops, subsistence users reported that populations of most benthic invertebrate species appear to be decreasing in the Kenai Peninsula region (Braund, 2016). The participants explained that the reduced abundance is due to over-harvest by humans and predation by the increased northern sea otter populations, which aligns with the synergistic serial depletion of prey species described by Salomon et al. (2007). In addition, traditional knowledge workshop participants noted that natural events like earthquakes and storms caused large die-offs, leading to gaps in the generational age classes (Braund, 2016). Subsistence users are particularly concerned about clams and have begun to rely more heavily on bidarkis (*Katharina tunicata*, also known as black leather chiton), which are now also declining (Braund, 2016; Salomon et al., 2007).

These population declines could make marine invertebrates in Cook Inlet more vulnerable to Project activity effects and less able to recover from impacts. Table 4.7.2-1 contains information on the life history and potential sensitivity of benthic invertebrates in Prudhoe Bay and Cook Inlet relative to Project activities that would affect the seafloor.

4.7.2.3 General Impacts and Mitigation

Direct mortality of benthic invertebrates can occur due to habitat disturbance from construction activities including dredging/screeding, trenching, backfilling, anchoring, pile-driving, water discharges, and spills.

Habitat Disturbance

Dredging and screeding (scraping to level the seafloor and move sediments aside) causes habitat disturbance and direct mortality of organisms within the dredging or screeding footprint. Construction and maintenance dredging, along with dredged material disposal, would occur for the Marine Terminal MOF in eastern Cook Inlet (no dredging is required for the PLF). These activities would directly affect about 1,251 acres of marine benthic habitat in Cook Inlet. In Prudhoe Bay, Dock Head 4 construction and West Dock Causeway expansion would involve screeding. The screeding would occur in the 650-foot-wide channel breach–bridge area and in front of Dock Head 4, disturbing about 14 acres of the seafloor. Maintenance dredging and screeding has occurred periodically since the 1990s along the West Dock approach channel, at Dock Heads 2 and 3, and at the Prudhoe Saltwater Treatment Plant intake. Additional Project activities would affect about 152 acres of marine benthic habitat in Prudhoe Bay for Dock Head 4 and the West Dock Causeway expansion. Refer to table 2.1.2-1 in section 2.1.2 and section 4.9 for additional details on the area affected by construction and operational activities.

Dredging/screeding would cause a direct effect of 100-percent mortality of non-mobile organisms within the dredging/screeding footprints and a high percentage of mortality, injury, or displacement of mobile organisms. Maintenance dredging has been shown to result in a 30- to 70-percent reduction of species diversity and a 40- to 95-percent reduction in the number of individuals in benthic communities (Newell et al., 1998). Studies that document responses to and tolerance of burial are highly species specific. Survival and emergence response from sediment burial is variable by species (Hendrick et al., 2016). In general, Arctic benthic organisms have a slow rate of growth and recolonization due to cold temperatures and slow organic matter input rates (MMS, 2008). Opportunistic species are quick to repopulate disturbed areas in regions affected by ice scour, but communities can take a decade to fully recover to a state of successional equilibrium or to 80 percent of the species and biomass prior to disturbance (Conlan and Kvitek, 2005; Konar, 2013; Newell et al., 1998). In addition, habitats that are permanently changed by dredging may become populated by a different group of organisms and fail to recover the original community composition (Conlan and Kvitek, 2005; Newell et al., 1998).

Nearshore benthic communities associated with soft sediments, as described in section 4.7.2.1, would be directly affected by construction and operation of the West Dock Causeway, including the temporary barge bridge and Dock Head 4 in Prudhoe Bay, and by Marine Terminal MOF construction and maintenance in Cook Inlet. Due to slow community recovery, these impacts would be long term but temporary as organisms would recolonize the disturbed habitats. If hard-bottom habitat is affected, the impact could be a permanent alteration from hard bottom to soft-bottom habitat. Hard-bottom habitat is not expected to occur in Cook Inlet, but this unique habitat has been found scattered in Prudhoe Bay, and the community it supports is more diverse than the ubiquitous soft-bottom habitat.

AGDC evaluated the impacts of the Marine Terminal MOF construction dredging and disposal over four seasons on sedimentation and water quality using both near-field and far-field sediment transport modeling (see figure 2.1.5-7 for the proposed dredged material disposal locations). Based on all cases simulated, the maximum modeled sedimentation thickness would be about 3.3 inches and would cover no more than 0.2 square mile. Disposal of dredged sediments would cause a localized, short-term increase in turbidity and sedimentation near the disposal site for the duration of disposal activities. Currents would then be expected to rapidly entrain and remobilize any sediments deposited. Benthic invertebrates could be smothered by disposal sediments.

Impacts from the permanent extension of the West Dock Causeway and Dock Head 4 include impeding near-shore circulation and affecting hydrographic conditions near the causeway, as described in section 4.3.3. Breaches would be expected to mitigate cross-causeway differentials in water temperature and salinity; thus, changes in water flow would be unlikely to occur and would not affect benthic invertebrates.

Impacts of dredging/screeding could include the release of contaminants from the seabed, increased turbidity, and increased sedimentation. Sediments in Prudhoe Bay were analyzed for 20 metals, acid-volatile sulfides, petroleum hydrocarbons, chlorinated pesticides, and polychlorinated biphenyls. Results of the sediment testing indicated sample levels were below recommended or threshold effects levels except for arsenic, copper, and nickel, which exceeded threshold effects levels but are known to be naturally high in the Beaufort Sea coastal area.[77] Overall, results indicated no evidence of contamination or trace metals beyond background levels; therefore, we conclude that no adverse effect from the release of contaminants would be expected.

We reviewed a previously conducted sediment analysis in Cook Inlet by the USGS, to account for sediment disturbance along the Mainline Pipeline in Cook Inlet. Sediments are unlikely to be heavily disturbed along the offshore portions of the pipeline because it would be laid on top of the inlet floor, rather than buried. The analysis results indicate sediments in the inlet may contain elevated concentrations of arsenic, chromium, copper, mercury, and nickel, with higher concentrations occurring near more urban areas (USGS, 2002). These concentrations could be released during dredging for the permanent Mainline MOF and trenching in the nearshore areas of the Mainline Pipeline. Chemical testing of sediment in the Marine Terminal area of Cook Inlet examined VOCs, semi-VOCs, PAHs, pesticides, polychlorinated biphenyl, trace metals, and total petroleum hydrocarbons (gasoline-range organics, diesel-range organics, and residual-range organics) (CH2M Hill, 2016c). No potential contaminant concentrations were identified above screening levels defined in the COE's *Dredged Material Evaluation and Disposal Procedures User's Manual* (COE, 2016), but concentrations of copper, nickel, and silver exceeded the NOAA SQuiRT threshold effects level values, and arsenic, chromium, nickel, and selenium exceeded the ADEC Method 2 Cleanup Levels for migration to groundwater (CH2M Hill, 2016c).

Increased heavy metal concentrations in suspended sediments could increase exposure and toxicity to benthic filter-feeders, causing reduced abundance and fecundity in highly sensitive species (Fleeger et al., 2003). In addition, reduced growth and development, deformities, or death of demersal eggs could occur if exposed to waterborne metals levels that exceed tolerable thresholds (Jezierska et al., 2009). Because species and life stages have wide ranges of heavy metal tolerance, increased contaminant concentrations over multiple years would likely reduce species diversity and shift the community assemblage to favor those species with higher tolerances to metal levels (Fleeger et al., 2003). Because of the high concentrations of heavy metals in sediment near the Marine Terminal in Cook Inlet, construction and maintenance dredging activities would cause localized effects on marine benthic invertebrates, which are long term (because of the multi-year impacts).

Sediment samples near the West Dock Causeway in Prudhoe Bay contained very fine silt (less than 0.0006 inch [0.015 millimeter] grain size) to fine sand (0.003 inch [0.088 millimeter] grain size), with over 50 percent of the samples on the smaller end of the grain size spectrum. Such small sediment particles can settle slowly; estimates of the area of increased turbidity range from 656 feet to 1.2 miles (200 meters to 2 km) from the point of discharge, depending on the model used, size of sediments, and local currents (Newell et al., 1998). Increased turbidity can affect more sensitive species, like larval stages and filter-feeders, which can experience clogged feeding and respiration apparatuses and dilution of food resources, requiring additional sorting and energy expenditure (Speckman et al., 2005; Todd et al., 2015). Higher turbidity can also lead to reduced predator responses (Essink, 1999). The deep burial of some bivalve species can lead to reduced condition and survival through starvation or suffocation (De Goeij and Luttikhuizen, 1998). Most bivalves in estuarine environments are adaptable to changes in turbidity and infauna are accustomed to burrowing through sediment and likely to be able to handle increased sedimentation without adverse effects (Newell et al., 1998).

Lab studies have shown that demersal eggs and larvae are sensitive to increased turbidity and sedimentation at levels of sedimentation greater than 1 millimeter, and that persistent suspended sediments can cause burial or abrasion to eggs and reduced swimming or settling ability in larvae (Berry et al., 2011; Wilbur and Clarke, 2001). Dredging is more lethal to sensitive demersal eggs and larvae; dredging could

[77] AGDC's *Sediment Chemical Analytical Data from West Dock Test Trench Sites* report was provided as appendix R of Resource Report 2 (Accession No. 20170417-5357), available on the FERC website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter 20170417-5357 in the "Numbers: Accession Number" field.

cause impacts on benthic organisms, particularly if sedimentation coincides with spawning and could cause increased mortality of these early life stages (Wenger et al., 2017). Effects of turbidity and sedimentation on mobile organisms include displacement from habitat, food source burial with sediment, and temporary reduction in visibility for visual predators due to increased turbidity. Due to the high ambient turbidity of Prudhoe Bay and Cook Inlet, effects of dredging/screeding and other construction activities on habitat quality for benthic invertebrates would be minor, given our current understanding of habitat types in the Project areas.

Project-specific and independent sampling in Cook Inlet and Prudhoe Bay indicate that much of the benthos in these areas supports relatively low abundances of species (CH2M Hill, 2016a), except for concentrations of some bivalves in tidal flat areas, like the Baltic clam beds on the west side of Cook Inlet. Most of the species present in the Project area are common to the region. Because of the limited number of samples and high variation between samples collected in the Project areas, however, predicting impact magnitude is difficult.

While rocky reefs do not occur in Upper Cook Inlet (BOEM, 2016), we received a comment during scoping that boulder habitat occurs near MP 793 of the proposed offshore Mainline Pipeline route as it crosses Upper Cook Inlet. As mentioned previously, the presence of a considerable amount of macroalgae (including some attached to pebbles) in benthic samples from Project disposal and reference areas indicates possible boulder habitat in these areas (Houghton, 2012). Boulder habitat can support diverse and productive benthic communities. In Prudhoe Bay, there could be small boulder patches near construction areas, which would likely be disturbed or destroyed during construction and would constitute a greater Project impact.

Since most of the known invertebrate species in the Project areas are common to the region and habitat disturbance would largely be limited to the construction phase, effects would likely be localized and only occur during construction. Because construction would occur for 5 or more years during the most productive seasons in Cook Inlet and Prudhoe Bay (spring-summer), however, recovery of benthic habitat and organisms could be limited resulting in long-term, potentially permanent impacts. Dredging-related impacts on marine benthic invertebrates would likely be localized and long term, and range from minor to major depending on the species present and dredging activity overlap with spawning (Wenger et al., 2017).

Vessels would be anchoring at the planned PBOSA about 5 miles north of West Dock Causeway and landward of Reindeer Island in Prudhoe Bay. In each of the 6 sealift years, about 11 to 18 tugs and barges would anchor temporarily in the PBOSA. Anchor scars and anchor cable sweep would likely kill all non-mobile benthic invertebrates living on the seafloor, but the effects would be limited to the construction phase, and these areas would eventually recolonize.

Construction activities for Dock Head 4 in Prudhoe Bay include 31 acres of seafloor disturbance for sheet pile installation and fill for expansion in which 100 percent of non-mobile benthic organisms would experience mortality, though the infill area would be in the same water depth (10 feet) that annual bottom-fast ice scour routinely occurs. Despite the multi-year recovery times for Arctic communities, the areas involved in construction activities occur in shallow, nearshore waters that regularly experience ice scour disturbance. The quick-growing, opportunistic species that thrive in such highly variable environments are naturally selected for a maximum rate of population increase and tend to recover quickly from disturbance (Newell et al., 1998).

AGDC would conduct pile driving, trestle construction, installation of aids to navigation, and construction of the temporary Marine Terminal MOF and permanent Mainline MOF during the construction phase. AGDC would remove these structures after construction is complete, except for the permanent Mainline MOF. Sheet piling and steel piling installation for the Marine Terminal MOF would require both vibratory and impact hammers over portions of three seasons (April to October) and affect a small area of benthic habitat in Cook Inlet (see table 4.7.2-2). Both a pier and RO/RO ramp, consisting of anchored sheet pile walls backed by granular fill, would be constructed at the Mainline MOF, which would remain in place over the life of the Project, but would not be used during operation. Tug support vessel anchoring and maneuvering, site characterization bottom sampling, and installation of scour control mats or other mitigation measures would also occur. Any of these activities could disturb benthic habitat.

TABLE 4.7.2-2

Pile Driving Affected Areas for Marine Benthic Habitat in Cook Inlet

	24-inch Piles		48-inch Piles		60-inch Piles		Sheet Piling		
Facilities	Number	Area [a] (ft^2)	Number	Area [a] (ft^2)	Number	Area [a] (ft^2)	Length (ft)	Area [b] (ft^2)	Total Area Affected by Piles (ft^2)
PLF	0	0	130	1,634	191	3,750	0	0	5,384
Marine Terminal MOF	94	295	28	352	35	687	5,976	330	1,664
Mainline MOF	0	0	0	0	0	0	1,400	70	70
Total	**94**	**295**	**158**	**1,986**	**226**	**4,437**	**7,376**	**400**	**7,118**

ft^2 = square feet

[a] Assumed circular piles, calculated area as $\pi(d \div 2)^2$ times number of piles of each size.

[b] Sheet piling area calculated by multiplying the length of sheet piling by 7.94 $inch^2$/foot, the cross-sectional area of PZ 27 Hot Rolled Steel Sheet Pile (Skyline Steel, n.d.)

Noise

Pile driving, vessel activity, and general construction activities would cause underwater noise. Research on the effects of noise on invertebrates is limited and no sound thresholds or injury criteria have been developed for them to date (Edmonds et al., 2016; Moriyasu et al., 2004). Since crustaceans lack gas-filled swim bladders, they are thought to be unaffected by sound that travels as pressure waves through water, but some species have been shown to be sensitive to low-frequency vibrations through the sediment (Roberts et al., 2016) and others have shown swimming behavior responses to sound (Radford et al., 2007). Some invertebrates produce explosive sounds themselves (e.g., snapping shrimp [*Alpheidae* spp.]); others use sound to orient toward reefs and settlement areas (coral and crab larvae); and others have shown delayed growth or metamorphosis, repressed burying and foraging, or increased respiration in response to anthropogenic underwater sound from tidal and wind turbines or shipping traffic (Edmonds et al., 2016). Boat noise has been shown to delay embryonic development and increase mortality in a gastropod species (Nedelec et al., 2014).

Despite a lack of research on exposure thresholds or complete understanding of potential effects, it has been established that noise can cause injury to some marine invertebrates, but most impacts are likely to be indirect or behavioral and population-level effects cannot be predicted. Because vessel traffic would be increased for the Project duration (30 years), the effects of noise and disturbance during operation would be regional and long term, but minor, because impacts would likely be indirect and behavioral rather than directly lethal to benthic invertebrates.

Water Discharges and Spills

Vessel activity, and in particular LNG carrier operations, could potentially affect benthic habitats and organisms in Cook Inlet through changes in water temperature and salinity from discharges and exotic species introduction from ballast water or from hull fouling. About 2.9 billion to 3.2 billion gallons of ballast water would be discharged per year from LNG carriers during loading operations at the Marine

Terminal. Based on LNG carrier design, with double hulls and ballast water stored in the outer hull under the water line, there would not be a significant difference in temperature between ballast water and the ambient waters of Cook Inlet (see section 4.3.3 for additional details). In addition, since water would be discharged within surface waters, direct effects of temperature changes on benthic invertebrates on the seafloor would be limited.

As described in section 4.7.1.7, LNG carriers and marine barges used for this Project would meet federal and state regulations for ballast water discharge (see section 4.3.3 and the Project BWM Plan for additional details). Additionally, AGDC would require that visiting vessels possess documentation to demonstrate compliance with ballast water regulations before allowing any ballast water to be discharged into the Project's berthing areas. Since vessels would adhere to federal and state ballast water exchange regulations, aquatic invasive species would be expected to have little to no effect on benthic organisms; therefore, the effects of ballast water discharge in Cook Inlet on benthic invertebrates would be negligible.

As described in section 4.3.3, accidental gas releases from the Mainline Pipeline would not be anticipated. During operation, the pipeline would employ industry standards for safety and pipeline monitoring, outlined in detail in sections 2.5.2 and 4.18.10, which would minimize the duration of an accidental release should one occur, resulting in brief and localized impact within marine waters.

Vessel traffic could affect intertidal habitats by increasing the risk of accidental oil and fuel spills. Immobile filter-feeders cannot avoid exposure to contaminants that can hinder respiration, mobility, digestion, growth, and reproduction (Earth Gauge, 2011). Bivalves cannot metabolize dissolved polycyclic aromatic hydrocarbons, which accumulate in body tissues. In contrast, crustaceans can eliminate hydrocarbons from their systems as body waste, and stress-tolerant polychaetes maintain abundance at oiled sites, so benthic invertebrates differ in their capacity to tolerate contaminants (Earth Gauge, 2011). AGDC would develop a comprehensive Project SPCC Plan to avoid and reduce the impacts of potential spills. In addition, LNG carriers are required to develop and implement a SOPEP, which includes measures to be taken when an oil pollution incident has occurred or is at risk of occurring. Minor releases of hydrocarbons could cause short-term, indirect, and direct adverse effects on benthic invertebrates. A major release would cause short-term, indirect, and direct adverse effects of greater magnitude (i.e., more widespread, higher mortality, larger population impact) because the larger volume of oil could lead to a longer exposure at higher concentrations of toxic components.

Shading

Vessel traffic and docking, as well as over-water structures at Dock Head 4 in Prudhoe Bay and the Marine Terminal and MOFs in Cook Inlet, could cause shading of the benthic environment. Benthos shading, from either coastal development or harmful algal blooms, has been shown to alter community structure and reduce primary production in a variety of habitats including nearshore salt marshes and associated benthic invertebrates (Logan et al., 2017; Struck et al., 2004), seagrass beds (Burdick and Short, 1999; Loflin, 1995; Shafer, 1999; Walker et al., 1989), rocky shores (Glasby, 1999; Pardal-Souza et al., 2016), and corals and other microphytobenthos on continental shelves (Okey et al., 2004). In addition, coastal infrastructure provides novel hard-structure habitat that can facilitate the establishment of nonnative species on the structures and in gaps on the seafloor created by shading when the original species present die out (Bulleri and Chapman, 2010). These same structures could act as artificial reefs for species that thrive in shade.

In a previous study of a rocky shore, shifts in community composition were observed, with oysters increasing, larval recruitment patterns changing, and barnacles and macroalgae biomass decreasing in shaded treatments (Pardal-Souza et al., 2016). A reduction in microphytobenthos production could shift a community from benthos- to plankton-based primary production reliance, potentially reducing a food source for benthic invertebrates, and affecting benthic-pelagic coupling and community dynamics (Blanchard and Montagna, 1995; MacIntyre et al. 1996). In Alaskan Arctic lakes, the chlorophyll *a* measured per area in the microphytobenthos was 62 to 105 times higher than that of phytoplankton, indicating the importance of benthic primary production in the food web (Whalen et al., 2013). As shading from vessels, West Dock Causeway expansion, Marine Terminal, and permanent Mainline MOF would be permanent changes to the coastal environment, impacts from shading to benthic invertebrates would be permanent but minor. Community assemblages would change, but it is not possible to know whether the changes would have an overall positive or negative effect at the local food web or ecosystem levels.

4.7.2.4 Facility-Specific Impacts and Mitigation

Except as discussed above, there would be no additional site-specific impacts on benthic resources from construction and operation of the Gas Treatment Facilities.

Mainline Facilities

Activities such as Mainline Pipeline installation in Cook Inlet would directly disturb benthic habitats. Pipelay, anchor drop, and anchor cable sweeps would temporarily disturb 5,070 acres, and placement of the pipeline on the bottom of Cook Inlet would cause the permanent loss of 330 acres of benthic habitat (see table 2.1.2-1). Vessel anchoring and Mainline Pipeline construction would remove the natural habitat and benthic species directly in the path of the pipeline and within anchor and cable sweep zones. Because trenching, anchoring, and pipelay activities could crush, bury, or entrain organisms, we expect mortality of benthic invertebrates in the direct path of the Mainline Pipeline in Cook Inlet to be 100 percent.

The offshore portion of the Mainline Pipeline would involve trenching in nearshore areas and laying pipe on top of the seafloor using pipelay vessels that would pull anchors and/or use support vessels to move. To reduce impacts associated with trenching, we have recommended that AGDC incorporate the use of the DMT continuation methodology for the shoreline crossings of Cook Inlet, or provide a site-specific justification demonstrating that this methodology is not feasible (see section 4.3.3). Use of the DMT method at the shorelines would reduce the impact on Cook Inlet benthic habitats near the shorelines.

Both a pier and RO/RO ramp, consisting of anchored sheet pile walls backed by granular fill, would be constructed at the Mainline MOF. These activities would disturb 6 acres of tidal flat habitat. This habitat supports Baltic clams in relatively high densities that are important prey for rock sandpipers and other coastal birds (see section 4.6.2). Mortality of sessile benthic invertebrates in the areas to be filled is expected to be 100 percent.

Liquefaction Facilities

For dredged material disposal impacts in Cook Inlet, Smit et al. (2008) estimated that mortality of 5 percent of benthic organisms (including mollusks, polychaetes, and crustaceans) occurs at burial depths of about 0.2 inch, and mortality of 50 percent occurs at average burial depths of about 2.1 inches (range of about 1.5 to 3.1 inches). Although many benthic infauna species within Cook Inlet have adapted to withstand high and variable amounts of natural sedimentation, 100-percent mortality of organisms (infauna and epifauna) in the dredged material disposal sites is likely because sedimentation would occur at a rate greater than the organisms could burrow through (Smit et al., 2008). Sediment transport modeling conducted for the Project predicted sedimentation thicknesses of about 1.1 inches in the Marine Terminal MOF area with disposal at either of the options (DP1 or DP2) for a disposal site. Sedimentation thicknesses were predicted to be 17.6 inches in the DP1 disposal site and 7.4 inches in the DP2 disposal site. The thicknesses in the disposal areas are much higher than the 2.1-inch threshold for 50-percent mortality.

Therefore, it is likely that the benthic invertebrates within and near the dredged material disposal area would experience greater mortality, while those within the Marine Terminal MOF area could experience lower mortality rates, nearer 5 percent as reported in Smit et al. 2008.

4.7.3 Plankton

Plankton includes organisms that inhabit the water column and drift or weakly swim. These organisms include phytoplankton (e.g., diatoms and green algae), zooplankton (e.g., copepods, ctenophores, and larval stages of invertebrates), pelagic fish eggs, and ichthyoplankton.

4.7.3.1 Prudhoe Bay

Prudhoe Bay is a shallow embayment (less than 10 feet [3 meters] deep at the deepest point) of the Beaufort Sea on the North Slope of Alaska that is fed by two freshwater river systems (Kuparuk and Sagavanirktok). It experiences wide ranges in salinity and largely wind-driven currents and is frozen for about 10 months of the year (September to June). Pelagic plankton communities in Prudhoe Bay occupy the near-surface layers of the water column during the open water season. These communities consist of phytoplankton, zooplankton, pelagic fish eggs, and ichthyoplankton.

Phytoplankton are single-celled algae that photosynthesize in the photic zone where enough light penetrates, with the highest primary production rates in the western Arctic Ocean occurring during the summer over shelf waters (Kirchman et al., 2009). In addition to pelagic phytoplankton communities, sea ice phytoplankton reside on, under, and within sea ice; these species are known as epontic phytoplankton. These algae grow rapidly under and within landfast ice during the spring and are flushed off the ice and into coastal waters in May. They represent the sole source of fixed carbon for consumers in ice-covered waters (Jin et al., 2006). As such, the productivity in the water column in the Prudhoe Bay region is primarily controlled by temperature, nutrients, light, and the concentration and thickness of sea ice. Phytoplankton productivity is highest in the summer in Prudhoe Bay, and abundance generally decreases from inshore to offshore areas, except in areas where upwelling is prevalent (BOEM, 2014). Nutrient inputs originating from river outflow and land-based nutrient inputs result in greater abundance of phytoplankton throughout the water column in nearshore environments than in offshore environments. Deposits of flocculated particles (i.e., adherence of plankton sediment particles) from plankton blooms and epontic algae contribute to the bottom habitat of Prudhoe Bay (BOEM, 2014). In addition to pelagic and epontic plankton, Prudhoe Bay and the Beaufort Sea contain numerous benthic microalgae species (MMS, 1996).

Zooplankton populations are closely tied to phytoplankton primary production in Arctic environments. In the Beaufort Sea, zooplankton communities consist of permanently planktonic species like copepods, radiolarians, larvaceans, and jellyfish (Ashijian et al., 2005) as well as temporary larval life stages of invertebrates such as crustaceans, barnacles, polychaetes, and mollusks (BOEM, 2014). Larvae of some benthic polychaetes and mollusks spend part of their life cycle inside sea ice as part of the epontic community. Recent data on zooplankton populations and species in Prudhoe Bay is limited.

Studies on zooplankton conducted to provide background information for oil and gas development in Prudhoe Bay in the late 1980s reported a total of 68 taxonomic categories of zooplankton (based on the lowest identification possible, including family, genus, and species) including 48 unique species (Horner and Murphy, 1985). Based on this research, the zooplankton community identified in the nearshore of the Beaufort Sea and in Prudhoe Bay included copepods from the genus *Pseudocalanus*, benthic copepods, polychaetes, the amphipod, *Hulirages mixius,* and numerous other zooplankton species. Calanoid copepods (*Pseudocalanus* sp.) were the dominant zooplankton population in the Prudhoe Bay region (Horner and Murphy, 1985). Inside Prudhoe Bay, the copepod, *Acartia clausi*, was the dominant species followed by the *Pseudocalanus* species. Between Prudhoe Bay and the Midway Islands, *Calanus glacialis* and *Pseudocalanus* species were reported as the dominant species.

A more diverse community occurred in the more oceanic area outside the barrier islands, including meroplanktonic larvae of decapods, polychaetes, barnacles, juvenile shrimp, and euphausiids. Calanoid copepods were found to be the dominant taxonomic group occurring under the ice in Prudhoe Bay. During the ice-free, late spring season in the Prudhoe Bay area, cyclopoid and harpacticoid copepods, hydrozoans, amphipods, larvaceans, and larval stages of planktonic and benthic invertebrate populations increased compared with winter and early spring population levels. Other species of zooplankton including *Atylus carinatus*, *Weyprechtia pinguis*, and *Anonyx nugax* reportedly declined as the sea ice melted (Horner and Murphy, 1985). During the winter, all groupings of zooplankton abundance and diversity declined.

Ichthyoplankton are the larval stages of pelagic and demersal fish species that primarily occupy surface waters. Bongo net sampling for plankton conducted in the nearshore (less than 164 feet deep) Canadian Beaufort Sea identified 14 fish larvae taxa that were split into coastal and estuarine assemblages (Paulic and Pabst, 2013). Sampling occurred from July 29 to August 26, 2005, at 20 stations ranging in depth from about 16 to 279 feet (5 to 85 meters) along transects perpendicular to shore near Mackenzie Bay and Kugmallit Bay. The study found arctic cod to be the most abundant and frequently caught larval species. Arctic cod is a pelagic spawner and represents the estuarine species assemblage that occupies stratified oceanic water masses. The second-most abundant larval species caught was Pacific herring, which is a demersal spawner and represents the coastal species assemblage that occupies water masses near freshwater river outflows. The occurrence of the two dominant species combined comprised 72 percent of all larvae captured. Arctic cod larvae dominated the estuarine assemblage of species associated with oceanic water mass, while Pacific herring larvae dominated a coastal assemblage of species associated with the freshwater plume of the Mackenzie River (Paulic and Pabst, 2013).

Age-0 arctic cisco are commonly observed in Prudhoe Bay and waters near the West Dock Causeway from late July to August. The arctic cisco larvae present in these waters during the summer mostly originate from the Mackenzie River and are key in the recruitment success of the Colville River cisco population, which also supports an important subsistence fishery (McCain and Raborn, 2016). Other ichthyoplankton species present in either coastal or estuarine groupings in the region during July through August include arctic alligatorfish (*Ulcina olrikii*), arctic sculpin (*Icelus* sp.), arctic shanny (*Stichaeus punctatus*), arctic staghorn sculpin (*Gymnocanthus tricuspis*), daubed shanny (*Leptoclinus maculatus*), gelatinous seasnail (*Liparis fabricii*), kelp snailfish (*Liparis tunicatus*), rainbow smelt, saffron cod, slender eelblenny (*Lumpenus fabricii*), and toothed cod (*Arctogadus borisovi*) (McCain and Raborn, 2016; Paulic and Pabst, 2013).

4.7.3.2 Cook Inlet

The offshore portion of the Liquefaction Facilities would be constructed on the eastern shore of Cook Inlet in the Nikiski area of the Kenai Peninsula. The Upper Cook Inlet region where the Liquefaction Facilities would be sited is characterized by high turbidity and a significant tidal range. Pelagic waters within Upper Cook Inlet are also influenced by riverine inputs resulting in freshwater lens and salinity gradients and horizontal mixing throughout the inlet. Sea ice coverage and thickness varies annually, generally forming in October and melting in May.

While data on phytoplankton species present in Upper Cook Inlet is limited, the pelagic habitat of Cook Inlet is known to be very productive. Phytoplankton blooms peak in spring corresponding with water column stratification and increased light levels (Piatt, 2002) and in the late summer (August) with warm water and air temperature (Batten and Welch, 2015). Productivity remains high during the summer as tidal flux and strong winds re-suspend nutrient-rich bottom sediments. The phytoplankton assemblage is dominated by diatoms and microflagellates (Sambrotto and Lorenzen, 1987). Phytoplankton species transition from west to east across the inlet due to sediment deposition differences as well as a documented seasonal succession of species (Piatt, 2002).

Multiple theories are offered regarding the primary driver of phytoplankton abundance, productivity, and distribution within Cook Inlet, including spatial variability in annual physical oceanic conditions, nutrient concentrations, and currents (Speckman et al., 2005; Eslinger et al., 2001). Annual primary production within Lower Cook Inlet has been estimated to be at least 0.06 pound of carbon per square foot (300 grams of carbon per square meter), peaking in the summer (Sambrotto and Lorenzen, 1987). Annual net primary productivity within Cook Inlet was estimated at 9.0 million tons of carbon between 1998 and 2009 (Balcom et al., 2011).

Cook Inlet zooplankton data have been collected using the continuous plankton recorder (CPR) transect method. The CPR samples the Alaskan shelf (waters less than 492 feet [150 meters] deep east of Kodiak Island) and crosses the continental slope into the Gulf of Alaska, providing a record of taxonomically resolved near-surface zooplankton and phytoplankton abundance over wide spatial scales. CPR data points collected from 2001 to 2015 in Upper and Lower Cook Inlet were between 3 and 37 miles (5 to 60 km) from the Project area (Batten and Welch, 2015). Small copepods were the most abundant zooplankton recorded, with large copepods, euphausiids (krill), chaetognaths (arrow worms), and cirripedes (larval barnacles) present in lower numbers.

Zooplankton abundance peaked in the late spring and summer, corresponding with seasonal peaks in phytoplankton abundance (CIRCAC, 2017; Piatt, 2002). Seasonal patterns for Cook Inlet indicate that meroplankton abundance peaks in May (cirripedes) and July (decapods–larval crabs and shrimp) in Upper Cook Inlet (Batten and Welch, 2015). Seasonal peaks of abundance in zooplankton in Cook Inlet are perhaps the highest occurring anywhere in the Gulf of Alaska (Piatt, 2002). Summer peak densities (mass) of zooplankton in Cook Inlet have been found to frequently exceed 10 ounces per cubic foot (1,000 milligrams per cubic meter) (Piatt, 2002). Barnacle nauplii and crab zoea[78] have been identified as dominant groups of the zooplankton community in Kachemak Bay and Lower Cook Inlet during late spring and summer (Cooney, 1987). Due to the Alaskan coastal current and high tidal flux, zooplankton communities in Cook Inlet comprise oceanic and coastal species (Piatt, 2002; Speckman et al., 2005) and are primarily dominated by copepods (Cooney, 1987; Incze et al., 1997; Liu et al., 2008; Sturdevant, 2001).

Fish species with larval stages present in Cook Inlet include capelin, chum salmon, eulachon, longfin smelt, Pacific herring, Pacific sand lance, and pink salmon (*Oncorhynchus gorbuscha*) (ADF&G, 2015b; Brown, 2002; Robards et al., 1999). Numerous salmonid species inhabit Cook Inlet as adults and Cook Inlet is designated EFH for all five species of Pacific salmon (see section 4.7.4). The smallest larval stages of salmonid species primarily use freshwater habitats where they hatch until they mature to either larger larvae or the juvenile stage. A study by Moulton (1997) found that ichthyoplankton and surface insects peaked in early July and decreased thereafter. The study found that the most abundant larval fish caught in tow-net samples taken during one season of sampling in Upper Cook Inlet were (in descending abundance): threespine stickleback (*Gasterosteus aculeatus*), Pacific herring, pink salmon, eulachon, and chum salmon. In 1993, five species comprised 90 percent of the total catch of all samples taken in June, July, and September (Moulton, 1997).

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78 Larval forms of barnacles and crab.

4.7.3.3 General Impacts and Mitigation

Turbidity and Contaminants

Primary phytoplankton production is tied to underwater light levels, which are affected by ice thickness and turbidity within the Project areas. Ice coverage generally affects the onset and end of primary productivity, with increased production occurring as ice melts and solar transmission underwater increases (typically in spring or summer seasons). Seasonal or artificial increases in turbidity affect the vertical and horizontal density of phytoplankton production via shading (Carmack et al., 2004). Project activities that influence water clarity (i.e., sediment plumes from dredging and screeding) would affect phytoplankton productivity. Since zooplankton life histories and community structures are directly tied to phytoplankton productivity as a prey resource, Project activities that affect phytoplankton abundance would also affect zooplankton abundance and consequently ichthyoplankton populations and higher trophic level species that feed on plankton communities (e.g., salmonids and bowhead whales).

Direct impacts from construction at the West Dock Causeway area would include using granular fill to expand the causeway and construct Dock Head 4, which would occur primarily in the summer. While this activity would not have a direct effect on plankton, turbidity would temporarily increase during widening of the causeway and turning basin and during Dock Head 4 construction. Screeding related to the West Dock Causeway expansion could increase turbidity in Prudhoe Bay and affect plankton communities through reduced primary productivity (i.e., food availability). Recent data on marine zooplankton and ichthyoplankton populations in the Prudhoe Bay area are limited for assessing potential impacts. Populations reportedly increase in the Prudhoe Bay area during the spring and summer, which would result in peak populations overlapping with construction, leading to short-term, minor impacts from increased turbidity. Potential impacts on marine plankton populations would be reduced during the winter construction phases due to decline of plankton populations with the return of sea ice in the winter (Horner and Murphy, 1985). Screeding is expected to have fewer impacts in terms of turbidity levels than dredging, and impacts on plankton would be expected to be short term and minor.

Dredging in Cook Inlet would result in a temporary increase in turbidity in the water column, which planktonic species would be unable to avoid. Increased suspended sediments are particularly damaging to pelagic eggs and could cause egg abrasion and mortality if persistent within the water column (Wilbur and Clarke, 2001). The effects would be limited to the period during and immediately following dredging since turbidity levels are anticipated to rapidly return to background following active dredging. TSS concentrations would be expected to range from 12 to 282 ppm for cutterhead dredging and 105 to 445 ppm for mechanical dredging (NMFS, 2017h). Suspended sediment concentrations in Upper Cook Inlet range from 100 to 2,000 ppm, increasing northward (MMS, 1995). Concentrations of TSS would likely be highest near the seafloor, and plumes above ambient concentrations in the lower water column could extend about 2,402 feet (732 meters) from the dredge bucket, while plumes in the upper water column could extend up to 600 feet (183 meters) (COE, 2015c). Plumes of increased TSS concentrations decrease light penetration into the water column and can reduce phytoplankton productivity or affect larval fish and invertebrate movement and feeding behavior. TSS and turbidity levels in the near-surface plume usually decrease exponentially with increasing time and distance from the active dredge due to settling and dispersion, quickly reaching ambient concentrations and turbidities. Most re-suspended sediments would resettle close to the dredge area within 1 hour (Anchor Environmental, 2003).

Sediment transport modeling conducted for the Project calculated depth-averaged turbidity values for the Marine Terminal MOF and the two disposal areas (DP1 and DP2) in Cook Inlet. The analysis compared turbidity against the lowest mean background measurement of 61 NTU at nearby mooring locations off Nikiski. A nephelometer is used to measure the intensity of white light scattered at 90 degrees to quantify turbidity in NTUs, which can be used to estimate TSS concentrations. The maximum NTU measurements at all three monitoring stations and two periods ranged from 420 NTU to 983 NTU. Depth-averaged turbidity impacts were modeled to exceed the mean background measurements of 61 NTU for 80 to 100 minutes and out 3.9 miles (6.2 km) from the source at either disposal site across both dredge scenarios combined. The highest maximum depth-averaged turbidity of any model location or scenario was 841 NTU, which was lower than the maximum measurement at nearby monitoring stations, indicating that increases in turbidity due to dredging could fall within the natural fluctuations that occur in the area and are likely not a concern.

Dredged spoils could also release contaminants into the water column that would in turn be easily absorbed by planktonic species. Examination of sediment samples collected in other Cook Inlet sites in the general area indicates that dredged sediments would not contain significant levels of contaminants. Suspended and bottom sediments from Cook Inlet offshore of the Marine Terminal site have been sampled and analyzed (CH2M Hill, 2016c). The sediments were generally found to contain metals concentrations at or near regional background concentrations. All samples were below screening level guidelines established for the Seattle Dredged Material Management Program (COE, 2016), which is used by the EPA and COE to evaluate dredged material in Alaska in lieu of an Alaska-specific program. Most of the sample constituents were also below ADEC's recommended sediment quality guidelines consisting of marine threshold effects levels developed by MacDonald et al. (2000) and NOAA SQuiRT values. Several metals (nickel, copper, chromium, and arsenic) exceeded ADEC threshold effects levels, but were below probable effects levels and within the range of background concentrations. Threshold effects levels are concentrations below which adverse effects would occur only rarely, while probable effects levels are concentrations at which toxic effects can be expected.

In general, phytoplankton have a low tolerance to heavy metals. Increased heavy metal concentrations can lead to toxicity, which reduces phytoplankton production rates and abundance (Nayar et al., 2004). Some zooplankton species also react negatively to increased heavy metals, while other species are less affected, which can lead to a shift in zooplankton community structure in affected areas (Fleeger et al., 2003; Nayar et al., 2004). Increased waterborne metals can adversely affect metabolic processes and development of eggs and larvae, which can result in slowed growth, deformities, or death of exposed individuals (Jezierska et al., 2009). Total petroleum hydrocarbon concentrations were low in all samples, indicating no evidence of petroleum contamination. Minor impacts on plankton are anticipated due to resuspension of sediments and associated contaminants and heavy metals.

Turbidity and sedimentation rates are naturally high in Upper Cook Inlet due to the abundance of glacial sediment inputs and strong tidal currents. Suspended sediment concentrations in Upper Cook Inlet range from 100 to 2,000 ppm (CH2M Hill, 2016b). Based on the naturally high TSS concentrations within Upper Cook Inlet, it is likely that biota are routinely exposed and adapted to high TSS levels. Therefore, no direct mitigation measures are planned to reduce the impact of dredging and sedimentation on planktonic species. The additional temporary sediment mobilization due to trenching for the Mainline Pipeline or dredging for the Marine Terminal and Marine Terminal MOF would have a negligible, short-term impact on plankton populations due to the naturally high turbidity in Cook Inlet (COE, 2017c). Anticipated increases in turbidity from dredging would fall within the maximum background ranges measured near Nikiski. Habitat displacement of plankton due to the physical actions of dredging and the associated increased turbidity would be minor, short term, and localized.

Water Withdrawals and Discharges

Hydrostatic testing of the two 63.4 million-gallon LNG tanks would require about 42 million gallons of Cook Inlet seawater over a 14- to 21-day period. Water withdrawals could lead to impingement and entrainment of phytoplankton, zooplankton, and, most significantly, ichthyoplankton. The source of the hydrostatic test water for the LNG tanks would be saltwater withdrawn from Cook Inlet.

In addition, about 10 million gallons of Cook Inlet seawater would be used to test the offshore portion of the Mainline Pipeline. The intake within Cook Inlet would be screened and the intake rate reduced as required by state and federal permits to mitigate the entrainment and impingement of marine life, including zooplankton and ichthyoplankton. We do not expect that these measures would be sufficient for preventing the entrainment and impingement of plankton, and 100-percent mortality of all affected organisms is assumed. Any plankton species drawn into the intake pipes would be affected by hydrostatic testing.

Prior to discharge to Cook Inlet, hydrostatic test water from LNG tank testing would be initially discharged into sediment basins to reduce the potential for scour, erosion, and sedimentation in accordance with the Project Procedures. The discharge additionally would comply with ADEC's APDES permit requirements and other applicable state water regulations and federal and state discharge requirements. Hydrostatic test water for the offshore Mainline Pipeline would be discharged into Cook Inlet in accordance with ADEC's APDES permit requirements.

Because the majority of hydrostatic testing in Cook Inlet is planned to occur during the summer or fall, AGDC does not propose to use test-water additives. Biocides could be used in test water sources that contain bacteria to ensure organisms do not settle on the walls of the equipment. Exposure to biocides and antifreeze chemicals can be lethal for planktonic organisms, including phytoplankton, zooplankton, and ichthyoplankton (UK Marine SACs, 2018). Hydrostatic test water would be tested and discharged back to Cook Inlet in accordance with APDES permit requirements. Because hydrostatic test water would be tested and treated before discharge to ensure minimal chemical exposure, impacts from chemicals on plankton would not be expected.

Discharges of hydrostatic test water could locally increase flows and temporarily alter water temperatures and turbidity in receiving waters. These changes in water quality could create thermal refugia for larval, juvenile, and adult fish, or lead to higher concentrations of prey resources, potentially affecting the original regional fauna distribution. Participants in traditional knowledge workshops note that the temperature in Cook Inlet is gradually getting warmer over time (Braund, 2016), so temporary effects from hydrostatic testing discharges during construction could be less over the life of the Project. Decreases in water quality associated with hydrostatic test water discharge could result in the mortality of plankton entrained in the discharge plume. For this Project, discharges would have to meet applicable water quality standards, which would minimize the potential discharge effects on plankton. All hydrostatic test water discharges would be supervised by a Project EI. Hydrostatic testing of the LNG tanks would occur during the summer of construction Year 6.

Operations at the PLF would require the intake and discharge of up to 8 million gallons of Cook Inlet seawater per vessel and for each call. The PLF would accommodate up to two LNG carriers at once, and there would be between 17 and 30 calls to the facility per month. In response to the limited data available to characterize ichthyoplankton and the potential effects of Project-related impingement and entrainment in Cook Inlet, a study was conducted to determine abundance and diversity of ichthyoplankton at various water depths near the PLF site during May to September. Ichthyoplankton were not caught during the month of September, so data represent catches from May through August.

Larvae of fish species identified in the survey included English and butter sole; eulachon; great, prickly, and fluffy sculpin; herring; spotted snailfish; starry flounder; stout eelblenny; and surf smelt.[79] Based on monthly catches of ichthyoplankton in the survey and an intake of 8 million gallons of seawater per call, most identified species are estimated to lose a couple hundred to a couple thousand individuals to impingement per LNG carrier call (see table 4.7.3-1). The exception is eulachon, where 39,000 individuals were caught in June. June was the month with the greatest total estimated injury for all species (comprising eulachon, unidentified ichthyoplankton, fish eggs, sculpins, and starry flounder), with about 42,000 total ichthyoplankton that could be entrained during a single LNG carrier call. The month of May showed the second highest abundance of ichthyoplankton, and had the highest diversity of species collected (comprising eulachon, flatfish, cod/pollock, English and butter sole, stout eelblenny, great and fluffy sculpin, and surf smelt). A seasonal average of about 14,000 ichthyoplankton per LNG carrier call would be entrained during water withdrawals. Assuming a similar larval-to-adult survival rate as Pacific sardine (*Sardinops sagax*, a small pelagic forage fish similar to herring and eulachon), a loss of up to 1.7 million ichthyoplankton per season could mean the loss of up to 1,000 age 2+ fish (Moulton, 1997; Barnthouse, 2004). This is a small loss of forage fish and likely to have a negligible impact. Since eulachon was by far the most abundant (about 75 percent of the catch), however, they would be disproportionately affected.

Enumeration and analysis of the other zooplankton organisms captured in the survey was conducted because of the importance of these species as prey to other species. Zooplankton accounted for the highest proportion of the samples collected, with high abundances recorded for crustaceans (e.g., copepods, barnacles, crab, and shrimp), polychaete worms, and echinoderm or sea cucumber larvae. Based on average zooplankton abundances captured in the survey across the ice-free months of May through September and an intake of 8 million gallons of seawater, approximately 50 million zooplankton could be entrained during the water withdrawal from one LNG carrier call. Given the short life span, high mortality rates, and dynamic seasonal shifts in zooplankton community structure, this level of mortality is not expected to result in the loss of more than a few individual reproductive adults (McKinstry and Campbell, 2017; Edvardsen et al., 2002). In addition, this would represent a small proportion of the available zooplankton given the size of Cook Inlet.

Operation of the Liquefaction Facilities would result in multiple operational discharges to the Cook Inlet receiving waters. The Liquefaction Facilities would discharge treated wastewater, boiler blowdown waters, reverse osmosis reject water, and site stormwater. Effluent and wastewater discharge could affect localized temperature and salinity conditions that affect plankton growth. Wastewater treatment at the Liquefaction Facilities in Cook Inlet and at the Gas Treatment Facilities at Prudhoe Bay would adhere to state and federal requirements in EPA UIC, Alaska's Water Use Act, APDES, and others. These requirements include using underground wells for disposal of discharge water with additives, ensuring all marine discharges are free from any additives via monitoring and sampling for contaminants, and informing authorities of all activities that would result in habitat disturbance or destruction. These requirements would minimize impacts on plankton in the region by reducing the chance of pollution and habitat disturbance.

Spills

As discussed earlier (see section 4.3.3), accidental gas releases from the Mainline Pipeline would not be anticipated. During operation, the pipeline would employ industry standards for safety and pipeline monitoring, outlined in detail in sections 2.5.2 and 4.18.10. These standards would minimize the duration of an accidental release, resulting in brief and localized impacts within marine waters.

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79 The *Nikiski Ichthyoplankton Study Report* was provided in the response to information request No. 187 dated October 2, 2017 (Accession No. 20171002-5256), which can be viewed on the FERC website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter 20171002-5256 in the "Numbers: Accession Number" field.

TABLE 4.7.3-1

Ichthyoplankton Density near Nikiski and Estimated Mortality from Impingement by LNG Carriers

Common Name	May		June		July		August		Seasonal Average Number of Individuals Impinged per LNG Carrier Call	Total Estimated Injury per Season [b]
	Density per meter^3	Injury (# ind.) [a]	Density per meter^3	Injury (# ind.)	Density per meter^3	Injury (# ind.)	Density per meter^3	Injury (# ind.)		
Eulachon (*Thaleichthys pacificus*)	0.0156	471	1.2942	39,193	0.0130	393	0	0	10,014	1,201,710
Unidentified ichthyoplankton	0.1994	6,040	0.0118	357	0	0	0.0214	646	1,761	211,290
Flatfish family	0.0521	1,578	0	0	0	0	0	0	395	47,340
Herring	0	0	0	0	0.0459	1,391	0	0	348	41,730
Cod/pollock family	0.0286	866	0	0	0	0	0	0	217	25,980
Sculpin family	0	0	0.0181	547	0	0	0	0	137	16,410
English sole (*Parophrys vetulus*)	0.0178	539	0	0	0	0	0	0	135	16,170
Butter sole (*Pleuronectes isolepis*)	0.0156	471	0	0	0	0	0	0	118	14,130
Stout eelblenny (*Anisarchus medius*)	0.0089	270	0	0	0	0	0	0	68	8,100
Great sculpin (*Myoxocephalus polyacanthocephalus*)	0.0065	197	0	0	0	0	0	0	49	5,910
Starry flounder (*Platichthys stellatus*)	0	0	0.0054	164	0	0	0	0	41	4,920
Prickly sculpin (*Cottus asper*)	0	0	0.0033	101	0	0	0	0	25	3,030
Surf smelt (*Hypomesus pretiosus*)	0.0022	67	0	0	0	0	0	0	17	2,010
Fluffy sculpin (*Oligocottus snyderi*)	0.0022	67	0	0	0	0	0	0	17	2,010

TABLE 4.7.3-1 (cont'd)

Ichthyoplankton Density near Nikiski and Estimated Mortality from Impingement by LNG Carriers

	May		June		July		August			
Common Name	**Density per meter^3**	**Injury (# ind.) [a]**	**Density per meter^3**	**Injury (# ind.)**	**Density per meter^3**	**Injury (# ind.)**	**Density per meter^3**	**Injury (# ind.)**	**Seasonal Average Number of Individuals Impinged per LNG Carrier Call**	**Total Estimated Injury per Season [b]**
Spotted snailfish (*Liparis callyodon*)	0	0	0	0	0.0015	44	0	0	11	1,320
Eggs	0	0	0.0487	1,475	0.0067	204	0	0	420	50,370
Total	**0.3489**	**10,566**	**1.3815**	**41,837**	**0.0671**	**2,032**	**0.0214**	**646**	**13,770**	**1,652,430**

Sources: Nikiski Ichthyoplankton Study Report

a (# ind.) = number of individuals impinged; assumes 100-percent mortality.

b Estimated based on 120 LNG carrier calls per season, the maximum number of 30 calls per month for 4 months.

Minor spills (e.g., diesel fuel, lubricants) from construction equipment or vessels could result in impacts on phytoplankton, zooplankton, fish eggs, and ichthyoplankton, including death or chronic effects. Incidental spills are those that can safely be controlled at the time of release, do not have the potential to become an emergency within a short time, and are of limited quantity, exposure, and potential toxicity. Incidental spills include normal vessel operational discharges, such as ballast or bilge water releases, that might contain oils or oily detergents from deck washdown. They include accidental releases of small volumes of hydraulic fluids, motor fuels, oils, and other fluids used in normal ship operations that are usually a result of overfilling tanks. Incidental spills can occur during vessel and transportation tank fueling at docks. The impacts of spills on plankton are caused by either the physical nature of the oil (physical contamination and smothering) or by its chemical components (toxic effects and bioaccumulation). Plankton present in the area of a spill would be incapable of avoiding the contamination. Fish eggs and ichthyoplankton have been found to be significantly more adversely affected by oil spills than adult fish and marine vertebrates (Carls et al., 1999; Hose et al., 1996; Short, 2003; Von Westernhagen, 1988).

Oil spill impacts would depend on the type of oil and depth of the spill. In a simulated release of Prudhoe Bay crude oil, within 10 days of the release, 10 percent of the oil evaporated, 57 percent remained at the surface, and 32 percent dispersed into the water column (MMS, 2003). Surface floating oil can affect eggs and phytoplankton near the surface, while the dispersed oil that dissolves in the water column could become bioavailable and toxic to zooplankton and ichthyoplankton. Whether effects are lethal or sublethal (e.g., behavioral, affecting feeding activity, metabolic rates, or reproduction success) depends on exposure time, dose, hydrocarbon mixture toxicity, and sensitivity of the life stages present. Potential effects of spills would be greatest during the high summer productivity season, which is also when phototoxicity activated by sunlight would be more of a problem (MMS, 2003). AGDC has developed a comprehensive Project SPCC Plan that would be implemented to reduce the potential for, and effects of, potential spills. In addition, LNG carriers are required to develop and implement a SOPEP, which includes measures to be taken when an oil pollution incident has occurred or is at risk of occurring. Minor releases and spills could result in short-term, indirect and direct, adverse effects on phytoplankton, zooplankton, fish eggs, and ichthyoplankton depending on the spill size, location, chemical composition, and season of the year.

Noise

The primary sources for underwater sound from Project construction that would potentially affect zooplankton and ichthyoplankton include pile driving associated with the construction of the PLF, the Marine Terminal MOF, and the Mainline MOF near Beluga, as well as tugs used for Mainline Pipeline placement. The duration of pile driving is a function of the desired depth and resistance to penetration, which are determined by substrate characteristics and the diameter of the pile (Rodkin and Pommerenck, 2014). Placement of a 24-inch-diameter temporary pile would require about 15 minutes of vibratory hammer and 1 hour of impact hammer. Pile-driving techniques have been shown to cause serious injury to nearby fish (Halvorsen et al., 2012; Popper and Hastings, 2009) (the distance varies depending on hammer type and weight, water depth, and substrate). Pile driving with a vibratory hammer produces continuous sound at lower frequencies (30 hertz), while impact hammers produce repeated bursts of much louder sound (<500 hertz; Popper et al., 2014). In addition, there is evidence that pile driving causes increased acute stress responses and repeated exposure reduces overall fitness of exposed fish (Debusschere et al., 2016).

Research on noise impacts on ichthyoplankton is very limited, and current guidelines state that direct impacts would include potential mortality/injury to ichthyoplankton within the zone of ensonification from sounds exceeding 210 dB re 1 μPa squared seconds (μPa^2-s) (sound exposure level (SEL) for areas where the activity is conducted in ice-free waters) (see table 4.7.3-2) (Popper et al., 2014). Sound levels approaching 150 dB re 1 μPa^2-s would affect ichthyoplankton behavior. Current research indicates that larval fish and eggs with swim bladders or gas bubbles, respectively, are most susceptible to negative impacts of pile driving noises, which can cause barotrauma (injury to the ear) (Popper et al., 2014). The egg and larval stages of fish species that are highly noise sensitive as adults, such as herring, may also be similarly sensitive.

TABLE 4.7.3-2

Sound Thresholds for Plankton

Organism Group	Sound Threshold	Source
Ichthyoplankton	>210 dB re 1 μPa^2-s SEL lethal effects	Popper et al., 2014
Zooplankton	Most thresholds unknown Mortality and impacts 0.7 mile (1.2 km) from seismic source	Normandeau, 2012 McCauley et al., 2017

Noise impacts on phytoplankton and zooplankton are generally unknown (Normandeau, 2012), though a recent study involving seismic survey air guns found significant mortality and negative impacts on zooplankton up to at least 0.7 mile (1.2 km) from the sound source (see table 4.7.3-2) (McCauley et al., 2017). If pile driving occurs over multiple years in the same area, the spawning distributions or survivorship of the offspring of local fish and invertebrate species could be negatively affected. Because pile driving activities would only occur for short durations (about 1 to 2 hours for each pile), and plankton populations in Cook Inlet are likely robust enough to withstand some additional mortality, impacts from increased noise during pile driving would likely be short term and minor.

4.7.3.4 Facility-Specific Impacts and Mitigation

There would be no specific impacts on plankton associated with the Gas Treatment Facilities or the Mainline Facilities.

During Liquefaction Facilities operation, water intake for cooling on LNG carriers would affect plankton in Cook Inlet. Cooling intake by LNG carriers at the Marine Terminal is estimated to remove 13.3 million gallons of water from Cook Inlet per vessel over a 24-hour period. In addition to intake water, 2.9 billion to 3.2 billion gallons per year of ballast water collected from international waters would be discharged into Cook Inlet. Based on LNG carrier design, a significant difference in temperature between ballast water and ambient waters of Cook Inlet is not anticipated (see section 4.3.3 for additional details). Plankton entrained in the discharge plumes could experience mortality due to the stress associated with pressure changes (Barker et al., 1981; Johnson et al., 2008).

Plankton entrainment during cooling and ballast water operations would not only result in the mortality of individuals entrained, but also remove biomass that would have been available and used by other organisms (Johnson et al., 2008; Rago, 1984). In addition, because increased vessel traffic would coincide with key spawning times and areas (spring and summer), these activities could have a negative impact on ichthyoplankton populations through reduced survivorship. These impacts could include shifts in species community and food web interactions, reductions in overall species productivity and abundance, or reductions in recruitment of fish species with planktonic life stages in the Project area. Accurately estimating the potential loss due to impingement and entrainment is not possible without the following details:

- duration of planktonic (egg and larval) stages by species;
- seasonal abundances of plankton species;
- seawater intake and discharge rates associated with construction and operation;
- survivorship table by life stage and age/size class (to include survivorship to age-1 and annual natural and fishing mortality for greater than 1-year-olds);

- age of entry into fishery (if applicable);
- average weight per individual in catch;
- total annual catch (broken out by commercial and recreational); and
- value of catch (commercial, recreational, forage, and non-use).

The impact from impingement and entrainment of plankton by LNG carriers from cooling water intake and ballast water discharge would not be expected to contribute to population level declines in species.

4.7.4 Essential Fish Habitat

Section 305(b)(2) of the MSA requires federal agencies to consult on all actions or proposed actions authorized, funded, or undertaken by that agency which could adversely affect EFH. The MSA defines EFH as "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity" (50 CFR 600). For the purposes of this definition, "waters" means aquatic areas and their associated physical, chemical, and biological properties; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and healthy ecosystem; and "spawning, feeding, and breeding" is meant to encompass the complete life cycle of a species (50 CFR 600). The NMFS, along with the ADF&G and other agencies, work together to identify and protect EFH for federally managed fish species. In Alaska, EFH is designated by Fisheries Management Councils in FMPs based on best available scientific information (NMFS, 2005).

Generally, the EFH consultation process includes the following steps.

1. Notification – The action agency should clearly state the process being used for EFH consultations (e.g., incorporating EFH consultation into an EIS).
2. EFH Assessment – The action agency should prepare an EFH Assessment that includes both identification of affected EFH and an assessment of impacts. Specifically, the EFH Assessment should include:
    a. a description of the proposed action;
    b. an analysis of the effects (including cumulative effects) of the proposed action on EFH, managed fish species, and major prey species;
    c. the federal agency's views regarding the effects of the action on EFH; and
    d. proposed mitigation, if applicable.
3. EFH Conservation Recommendations – After reviewing the EFH Assessment, NMFS should provide recommendations to the action agency regarding measures that can be taken by that agency to conserve EFH.
4. Agency Response – Within 30 days of receiving the recommendations, the action agency must respond to NMFS. The action agency may notify NMFS that a full response to the conservation recommendations would be provided by a specified completion date agreeable to all parties. The response must include a description of measures proposed by the agency to avoid, mitigate, or offset the impact of the activity on EFH. For any conservation recommendation that is not adopted, the action agency must explain its reason to NMFS for not following the recommendation.

FERC proposes to incorporate EFH consultation for the Project with the interagency coordination procedures required under NEPA. As such, we are requesting that NMFS consider this draft EIS as initiation of EFH consultation. A detailed description of EFH is included in the EFH Assessment (see appendix M); a summary is provided here. EFH has been designated in or near areas where Project activities would occur under the following FMPs:

- Arctic Management Area (Arctic FMP) (NPFMC, 2009);
- Groundfish of the GOA (GOA Groundfish FMP) (NPFMC, 2016); and
- Salmon Fisheries in the EEZ off the Coast of Alaska (Salmon FMP) (NPFMC et al., 2012).

The Alaska Scallop FMP, the Bering Sea and Aleutian Island Groundfish FMP, and the Bering Sea/Aleutian Island King and Tanner Crab FMP are crossed by Project vessel routes but would not be affected by transiting vessels. Therefore, EFH designated under these FMPs is not discussed further.

4.7.4.1 Essential Fish Habitat Resources

EFH occurs in portions of each Project component (see appendices M and I). The Project has components along the arctic coast, through the interior, and in Cook Inlet, and aspects of the Project have the potential to affect EFH in marine and freshwater waterbodies. Table 4.7.4-1 lists the Alaska FMPs and associated EFH species to identify where overlap occurs with the Project.

The Arctic FMP designated EFH for three species: arctic cod, saffron cod, and snow (or opilio) crab (*Chionoecetes opilio*). EFH for saffron cod and snow crab are not found in the Beaufort Sea east of Barrow. Therefore, saffron cod and snow crab EFH would not be affected by the Project. Designated arctic cod EFH encompasses all waters of the Beaufort Sea from the shoreline out to the seaward limits of the EEZ. Project components that would be within arctic cod EFH designated by the Arctic FMP would be:

- construction and use of the West Dock Causeway modifications; and
- screeding at Dock Head 4.

The GOA Groundfish FMP provides for the management of 24 groundfish species and 9 forage fish complexes. Spatial data does not exist for all the managed species in this area. The closest designated GOA Groundfish FMP EFH to the Project footprint would be walleye pollock EFH, which is more than 70 miles south of the Marine Terminal. The GOA Groundfish FMP would be crossed by the vessel routes; however, they would not be affected by these activities and are not discussed further. EFH is not defined for groundfish or forage fish species in Upper Cook Inlet near the Liquefaction Facilities or Mainline Pipeline crossing of Cook Inlet, but juveniles for some groundfish and all life stages of some forage fish can be assumed to occur in this area. Of the forage fish complex, eulachon and capelin are some of the more abundant in coastal Alaska, including within Upper Cook Inlet.

Marine and freshwater EFH are established for all five Pacific salmon species within the EEZ of Cook Inlet, the North Slope, and some freshwater streams along the Mainline Pipeline route, including all tidally submerged marine and estuarine habitat within Cook Inlet. Freshwater habitats documented as important for the spawning, rearing, and migration of salmon, as specified under AS 16.05.871, are also considered EFH. These habitats are directly managed by the ADF&G.

TABLE 4.7.4-1 **Essential Fish Habitat Species Associated with the Project**				
EFH FMP/ Waterbody	Species	Life Stage	Project Component	Effects Analysis
Arctic FMP				
Beaufort Sea	Arctic cod *(Boreogadus saida)*	Late juvenile, adults	Gas Treatment Facilities, vessel routes	Potential to affect
	Saffron cod *(Eleginus gracilis)*	Late juvenile, adults	Vessel routes	Unlikely to affect
GOA Groundfish FMP				
GOA	Alaska plaice (*Pleuronectes quadrituberculatus)*	Eggs, larvae, late juvenile, adults	Vessel routes	Unlikely to affect
	Arrowtooth flounder (*Atheresthes stomias)*	Larvae, late juvenile, adults	Vessel routes	Unlikely to affect
	Atka mackerel (*Pleurogrammus monopterygius)*	Larvae, adults	Vessel routes	Unlikely to affect
	Dover sole *(Microstomus pacificus)*	Eggs, larvae, late juvenile, adults	Vessel routes	Unlikely to affect
	Dusky rockfish *(Sebastes variabilis)*	Larvae, adults	Vessel routes	Unlikely to affect
	Flathead sole (*Hippoglossoides elassodon)*	Eggs, larvae, late juvenile, adults	Vessel routes	Unlikely to affect
	Northern rockfish (*Sebastes polyspinis)*	Adults	Vessel routes	Unlikely to affect
	Northern rock sole (*Lepidopsetta polyxystra)*	Larvae, late juvenile, adults	Vessel routes	Unlikely to affect
	Pacific cod *(Gadus macrocephalus)*	Eggs, larvae, late juvenile, adults	Vessel routes	Unlikely to affect
	Pacific Ocean perch (*Sebastes alutus)*	Larvae, late juvenile, adults	Vessel routes	Unlikely to affect
	Rex sole *(Glyptocephalus zachirus)*	Eggs, larvae, late juvenile, adults	Vessel routes	Unlikely to affect
	Rougheye and blackspotted rockfish (*Sebastes aleutianus* and *Sebastes melanostictus)*	Adults	Vessel routes	Unlikely to affect
	Sablefish *(Anoplopoma fimbria)*	Eggs, larvae, late juvenile, adults	Vessel routes	Unlikely to affect
	Sculpins	Juveniles, adults	Vessel routes	Unlikely to affect
	Shortraker rockfish (*Sebastes borealis)*	Adults	Vessel routes	Unlikely to affect
	Skates	Adults	Vessel routes	Unlikely to affect
	Southern rock sole (*Lepidopsetta bilineata)*	Larvae, late juvenile, adults	Vessel routes	Unlikely to affect
	Squid	Late juvenile, adults	Vessel routes	Unlikely to affect
	Thornyhead rockfish (*Sebastolobus altivelis)*	Larvae, early juvenile, late juvenile, adults	Vessel routes	Unlikely to affect

TABLE 4.7.4-1 (cont'd)				
Essential Fish Habitat Species Associated with the Project				
EFH FMP/ Waterbody	Species	Life Stage	Project Component	Effects Analysis
	Walleye pollock *(Gadus chalcogrammus)*	Eggs, larvae, late juvenile, adults	Vessel routes	Unlikely to affect
	Yelloweye rockfish (*Sebastes ruberrimus)*	Larvae, early juvenile, late juvenile, adults	Vessel routes	Unlikely to affect
	Yellowfin sole *(Limanda aspera)*	Eggs, larvae, late juvenile, adults	Vessel routes	Unlikely to affect
Cook Inlet	Arrowtooth flounder	Larvae, late juvenile, adults	Vessel routes	Unlikely to affect
	Dusky rockfish	Larvae	Vessel routes	Unlikely to affect
	Flathead sole	Eggs, larvae, late juvenile, adults	Vessel routes	Unlikely to affect
	Forage fish complex	Not defined	Liquefaction Facilities, vessel routes	Potential to affect
	Northern rockfish	Larvae	Vessel routes	Unlikely to affect
	Pacific cod	Late juvenile, adults	Vessel routes	Unlikely to affect
	Pacific Ocean perch	Larvae	Vessel routes	Unlikely to affect
	Rex sole	Eggs, larvae, late juvenile, adults	Vessel routes	Unlikely to affect
	Rock sole *(Lepidopsetta* spp.)	Larvae, late juvenile, adults	Vessel routes	Unlikely to affect
	Sablefish	Late juvenile, adults	Vessel routes	Unlikely to affect
	Shortraker rockfish	Late juvenile, adults	Vessel routes	Unlikely to affect
	Skates	Adults	Vessel routes	Unlikely to affect
	Thornyhead rockfish	Larvae	Vessel routes	Unlikely to affect
	Walleye pollock	All	Vessel routes	Unlikely to affect
	Yelloweye rockfish	Larvae	Vessel routes	Unlikely to affect
Pacific Salmon FMP				
Freshwater Streams and Rivers	Chinook salmon (*Oncorhynchus tshawytscha)*	Eggs, larvae, fry, returning adults	Mainline Pipeline crossings	Potential to affect
	Chum salmon (*Oncorhynchus keta)*	Eggs, larvae, fry, returning adults	Mainline Pipeline crossings, PTTL	Potential to affect
	Coho salmon (*Oncorhynchus kisutch*)	Eggs, larvae, fry, returning adults	Mainline Pipeline crossings	Potential to affect
	Pink salmon (*Oncorhynchus gorbuscha)*	Eggs, larvae, fry, returning adults	Mainline Pipeline crossings, PTTL	Potential to affect
	Sockeye salmon (*Oncorhynchus nerka)*	Eggs, larvae, fry, returning adults	Mainline Pipeline crossings	Potential to affect
Beaufort Sea	Chum salmon	Juveniles, adults	Gas Treatment Facilities	Potential to affect
	Pink salmon	Juveniles, adults	Gas Treatment Facilities	Potential to affect
Cook Inlet	Chinook salmon	Juveniles, adults	Liquefaction Facilities, Mainline Pipeline crossing	Potential to affect
	Chum salmon	Juveniles, adults	Liquefaction Facilities, Mainline Pipeline crossing	Potential to affect
	Coho salmon	Juveniles, adults	Liquefaction Facilities, Mainline Pipeline crossing	Potential to affect

TABLE 4.7.4-1 (cont'd) **Essential Fish Habitat Species Associated with the Project**				
EFH FMP/ Waterbody	Species	Life Stage	Project Component	Effects Analysis
	Pink salmon	Juveniles, adults	Liquefaction Facilities, Mainline Pipeline crossing	Potential to affect
	Sockeye salmon	Juveniles, adults	Liquefaction Facilities, Mainline Pipeline crossing	Potential to affect
GOA	Chinook salmon	Adults	Vessel routes	Unlikely to affect
	Chum salmon	Adults	Vessel routes	Unlikely to affect
	Coho salmon	Adults	Vessel routes	Unlikely to affect
	Pink salmon	Adults	Vessel routes	Unlikely to affect
	Sockeye salmon	Adults	Vessel routes	Unlikely to affect
Sources: NPFMC, 2009, 2011, 2014, 2016; NPFMC et al., 2012				

The Salmon FMP has designated all waters offshore of Alaska as EFH for the five Pacific salmon species. This EFH extends from the shoreline out to the seaward limits of the EEZ. The FMP also designates waters identified in the ADF&G AWC (Johnson and Blossom, 2017a,b,c) that are important for Pacific salmon as EFH. Project components that would be within Pacific salmon EFH designated by the Salmon FMP would be:

- construction and operation of the Marine Terminal in Cook Inlet, including uptake and discharge of ballast and cooling waters by LNG carriers and dredging;
- construction and operation of the Mainline Pipeline across Cook Inlet, including construction of the Mainline MOF;
- construction and use of the West Dock Causeway modifications;
- construction of the Mainline Pipeline and the PTTL in and near streams identified as freshwater EFH for Pacific salmon, including construction of pipeline waterbody crossings, access roads, hydrostatic testing, and material sites; and
- screeding associated with Dock head 4 in Prudhoe Bay.

The Mainline Pipeline would cross 70 streams containing freshwater EFH for Pacific salmon, access roads would cross 28 streams containing freshwater EFH for Pacific salmon, and the PTTL would cross 3 streams containing freshwater EFH for Pacific salmon. A total of 12 material sites would be within 600 feet of or within freshwater EFH streams. Surface waterbodies that could be water sources for Mainline Pipeline and PTTL construction include 44 stream segments with EFH. Based on our recommendation in section 4.3.2 for AGDC to file a comprehensive table of waterbodies that would be crossed, the number of waterbodies that would be affected by the Project is preliminary and would be updated upon receipt of the additional information requested.

Habitat Areas of Particular Concern are subsets of EFH that highlight specific areas with sensitive resources. These are defined within EFH and under FMPs. No Habitat Areas of Particular Concern would overlap with Project components; therefore, they have been eliminated from this analysis.

4.7.4.2 Summary of Effects on Essential Fish Habitat

Table 4.7.4-2 provides a summary of the potential effects of Project components on marine EFH. Table 4.7.4-3 provides a summary of the potential effects of Project components on freshwater EFH. With AGDC's implementation of the above measures and our recommendations described in section 4.7.1 regarding culvert design, water withdrawals, and time of year restrictions for in-stream activities, most activities would have a minor effect on EFH.

TABLE 4.7.4-2

Impact Summary for Marine Essential Fish Habitat

Essential Fish Habitat	Potential Effect	Proposed Mitigation	Impact Level
Gas Treatment Facilities			
Arctic cod and Pacific salmon	Habitat loss and alteration	Comply with Project Plan, Procedures, and Revegetation Plan. Maintain fish passage in barge bridge. Use directed, task-specific lighting with timers and motion-sensors, where appropriate.	Minor
	Water quality	Follow Project SPCC Plan, SWPPP, and Waste Management Plan. Adhere to ballast water regulations.	Minor
	Lethal and sub-lethal effects	Implement soft start/ramp up of impact pile drivers.	Minor
Mainline Pipeline and Liquefaction Facilities			
Pacific salmon and Forage Fish Complex	Habitat loss and alteration	Use DMT method at Cook Inlet shoreline crossing. Comply with Project Plan, Procedures, and Revegetation Plan. Use directed, task-specific lighting with timers and motion-sensors, where appropriate.	Minor
	Water quality	Follow Project SPCC Plan, SWPPP, Waste Management Plan, and SOPEP. Install shoreline armoring at Marine Terminal.	Minor
	Lethal and sub-lethal effects	Use fish screens on intake structures. Implement soft start/ramp up of impact pile drivers.	Minor

TABLE 4.7.4-3

Impact Summary for Freshwater Essential Fish Habitat

Essential Fish Habitat	Potential Effect	Proposed Mitigation	Impact Level
Mainline Pipeline			
Pacific salmon	Habitat loss and alteration	Follow Project Plan, Procedures, and Revegetation Plan. Design culverts and bridges to allow fish passage.	Minor
	Water quality	Maintain pipeline temperature to minimize impacts on permafrost. Follow Project Plan and Procedures, Revegetation Plan, SPCC Plan, and DMT Plan.	Minor
	Lethal and sub-lethal effects	Avoid constructing in-stream during sensitive periods for EFH species. Limit water withdrawals. Follow Alaska Blasting Standards.	Minor

4.7.5 Conclusion

Project construction and operation would result in temporary and permanent impacts on freshwater and marine fisheries and their habitats. Activities resulting in sedimentation and turbidity, alteration or removal of cover, introduction of pollutants, permafrost degradation, water depletions, or entrainment or impingement could increase rates of stress, injury, or mortality of fish. While impacts could result from any activity that harms fish or affects their behavior, most impacts would be minimized through implementation of AGDC's Project-specific plans, such as the Plan and Procedures, Revegetation Plan, site-specific waterbody crossing plans, Water Use Plan, Invasives Plan, SPCC Plan, and DMT Plan.

With implementation of our recommendations and AGDC's Project-specific plans, impacts on fishery resources would be reduced. Based on our review above and including the recommended mitigation measures, we also conclude that AGDC would not significantly affect Pacific salmon or other anadromous fish species, which are more sensitive to construction impacts or are held to a higher level of value or protection by state agencies and Alaska Natives.

Project construction and operational activities would affect EFH in marine and freshwater environments. Habitat impacts in the Beaufort Sea and Cook Inlet as a result of the Project would have minor impacts on EFH. With implementation of AGDC's Project-specific plans such as the BWM Plan, SPCC Plan, and other federal regulations, impacts on marine EFH would be minor. With implementation of our recommendations regarding culvert design, water withdrawals, and time of year restrictions for freshwater in-stream activities, most activities would have a minor effect on freshwater EFH.

4.8 THREATENED, ENDANGERED, AND OTHER SPECIAL STATUS SPECIES

Special status species are afforded protection by law, regulation, or policy by state and federal agencies. Special status species include the following:

- federally listed species and designated critical habitat protected under the ESA;
- species proposed or petitioned for listing under the ESA;
- species considered as candidates for listing under the ESA by the Services;
- species with special state or federal designations (e.g., species designated as sensitive by a federal land management agency for lands under that agency's jurisdiction); and
- species that are state-designated as special status.

The Project has the potential to affect federally listed, proposed, or candidate species (see section 4.8.1); sensitive or watch list species designated by the BLM (see section 4.8.2); and State of Alaska special status species (see section 4.8.3). Bald and golden eagles, which are protected under the BGEPA, are discussed in section 4.6.2.

To assist in compliance with Section 7 of the ESA, AGDC, acting as FERC's non-federal representative, informally consulted with the Services regarding federally listed species and designated critical habitat (or critical habitat) in the Project area. AGDC also consulted with the BLM to identify BLM-designated sensitive and watch list species and with the ADF&G to identify State of Alaska special status species known to occur in the Project vicinity. AGDC reviewed websites and publications of the Services, BLM (including the BLM-Alaska Special Status [Plant and Animal] Species List), and ADF&G (including the *Alaska Wildlife Action Plan*) to identify which special status species may occur in the Project area. Through review of these sources, 32 federally listed species (including proposed or candidate species, and DPSs[80] and Evolutionarily Significant Units [ESU][81]), 90 BLM sensitive or watch list species (including 5 species listed under the ESA), and 25 state special status species were identified. Traditional knowledge information collected from subsistence mapping, interviews, and/or workshops was also reviewed and incorporated into the analysis where applicable. Species-specific surveys were not required for the Project by the agencies.

4.8.1 Federally Listed Threatened and Endangered Species

Under Section 3 of the ESA, an endangered species is defined as any species in danger of extinction throughout all or a significant portion of its range. A threatened species is any species likely to become an endangered species within the near future throughout all or a significant portion of its range. A proposed species is a species found to warrant listing as either threatened or endangered, and for which listing has been officially proposed in the Federal Register. A candidate species is any species that has been announced in the Federal Register as undergoing a status review, but has not yet been listed. Critical habitat for federally listed threatened and endangered species is a specific geographic area (or areas) that contain physical or biological features essential to the conservation of the threatened or endangered species and may require management or protection.

Federal agencies, in consultation with the Services, are required by Section 7(a)(4) of the ESA (19 USC 1536(c)), as amended, to ensure that any actions authorized, funded, or carried out by the agency do not jeopardize the continued existence of a federally listed threatened or endangered species, or result in the destruction or modification of designated critical habitat of a federally listed species. The Services are responsible for managing federally listed species. As the lead federal agency, FERC is responsible for consulting with the USFWS and/or NMFS to determine whether any ESA-listed species or any designated critical habitats are near the Project, and to determine the Project's potential effects on those species or critical habitats.

For actions involving major construction activities with the potential to affect listed species or critical habitats, the lead federal agency must prepare a BA for those species that could be affected. The lead federal agency must submit its BA to the USFWS and/or NMFS and, if it is determined that the action could adversely affect a federally listed species, the lead agency must submit a request for formal consultation to comply with Section 7 of the ESA. In response, the USFWS and/or NMFS would issue a Biological Opinion as to whether or not the federal action would likely adversely affect or jeopardize the continued existence of a listed species, or result in the destruction or adverse modification of designated critical habitat. For the Project, we determine that federally listed species could be adversely affected, and are submitting a BA to the Services (see appendix O).

Thirty-one federally listed species, DPS, or ESU species and one previous candidate species were identified by the Services as potentially occurring in the Project area. Table 4.8.1-1 summarizes information on these species, their ranges, and habitat association. A full description of each federally listed species is provided in the BA (see appendix O).

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80 DPSs are defined as a portion of a species' or subspecies' population or range.

81 ESUs are defined as a Pacific salmonid stock that is substantially reproductively isolated from other stocks of the same species and that represent an important part of the evolutionary legacy of the species.

TABLE 4.8.1-1

Federally Listed Species

Species	Federal Status, Designated Critical Habitat (DCH)	Habitat in Alaska	Project Facility Association
U.S. Fish and Wildlife Service			
Birds			
Alaska-breeding Steller's eider [a] (*Polysticta stelleri*)	Threatened, DCH	Breeds in freshwater tundra ponds; winters in shallow marine waters	Gas Treatment Facilities, Mainline Pipeline, Marine Terminal and PLF, Vessel Traffic (Cook Inlet, Bering Sea, Chukchi Sea, Beaufort Sea), Liquefaction Facilities
Eskimo curlew (*Numenius borealis*)	Endangered [b]	Nests in arctic tundra; winters in grasslands of South America	None
Short-tailed albatross (*Phoebastria albatrus*)	Endangered	Nests in Japan; feeds in the North Pacific	Vessel Traffic (Cook Inlet, Bering Sea, GOA)
Spectacled eider [a] (*Somateria fisheri*)	Threatened, DCH	Breeds in tundra areas with many ponds or lakes; winters offshore, often along pack ice	Gas Treatment Facilities, Mainline Pipeline, Vessel Traffic (Beaufort Sea)
Mammals			
Northern sea otter, Southwest Alaska DPS (*Enhydra lutris kenyoni*)	Threatened, DCH	Coastal marine waters	Vessel Traffic (Cook Inlet, Bering Sea, GOA)
Pacific walrus [a, c] (*Odobenus rosmarus divergens*)	Currently not warranted for listing	Shallow ocean and coastal marine waters, often associated with ice	Gas Treatment Facilities, Vessel Traffic (Bering Sea, Chukchi Sea, Beaufort Sea)
Polar bear [a] (*Ursus maritimus*)	Threatened, DCH	Coastal (terrestrial), and nearshore marine waters	Gas Treatment Facilities, Mainline Pipeline, Vessel Traffic (Beaufort Sea)
Wood bison [a] (*Bison bison athabascae*)	Threatened; Experimental [d]	Meadows around lakes and rivers	None
National Marine Fisheries Service			
Mammals			
Bearded seal, Beringia DPS (*Erignathus barbatus*)	Threatened	Ice floes and pack ice in marine waters	Gas Treatment Facilities, Vessel Traffic (Bering Sea, Chukchi Sea, Beaufort Sea)
Blue whale (*Balaenoptera musculus*)	Endangered	Pelagic and ice edge marine waters	Vessel Traffic (GOA)
Bowhead whale (*Balaena mysticetus*)	Endangered	Shelf marine waters and often associated with ice	Gas Treatment Facilities, Vessel Traffic (Bering Sea, Chukchi Sea, Beaufort Sea)
Cook Inlet beluga whale (*Delphinapterus leucas*)	Endangered, DCH	Shallow, coastal waters of Cook Inlet, often near river deltas	Marine Terminal and PLF, Mainline MOF, Mainline Pipeline, Vessel Traffic (Cook Inlet)
Fin whale (*Balaenoptera physalus*)	Endangered	Deep, offshore marine waters	Vessel Traffic (GOA, Bering Sea, Chukchi Sea)
Gray whale, Western North Pacific DPS (*Eschrichtius robustus*)	Endangered	Shallow coastal marine waters	Gas Treatment Facilities, Vessel Traffic (Cook Inlet, GOA, Bering Sea, Chukchi Sea, Beaufort Sea)
Humpback whale, Western North Pacific DPS (*Megaptera novaeangliae*)	Endangered	Shallow, coastal, and shelf marine waters	Mainline Pipeline, Marine Terminal and PLF, Vessel Traffic (Cook Inlet, GOA, Bering Sea, Chukchi Sea, Beaufort Sea)
North Pacific right whale (*Eubalaena japonica*)	Endangered, DCH	Shallow and coastal marine waters	Vessel Traffic (GOA, Bering Sea)
Ringed seal (*Phoca hispida*)	Threatened	Ice floes and pack ice in marine waters	Gas Treatment Facilities, Vessel Traffic (Bering Sea, Chukchi Sea, Beaufort Sea)

TABLE 4.8.1-1 (cont'd)

Federally Listed Species

Species	Federal Status, Designated Critical Habitat (DCH)	Habitat in Alaska	Project Facility Association
Sei whale (*Balaenoptera borealis*)	Endangered	Deep oceanic waters at the continental shelf edge	Vessel Traffic (GOA and possibly Cook Inlet [e])
Sperm whale (*Physeter microcephalus*)	Endangered	Offshore, deep marine waters	Vessel Traffic (GOA, Bering Sea)
Steller sea lion, Western DPS (*Eumetopias jubatus*)	Endangered, DCH	Coastal, haulouts typically on beaches, ledges, or rocky reefs	Marine Terminal and PLF, Vessel Traffic (Cook Inlet, GOA, Bering Sea)
Fish			
Chinook salmon ESUs [f] (*Onchorhynchus tshawytscha*)			
Lower Columbia River Spring	Threatened	Coastal marine	Marine Terminal and PLF, Mainline Pipeline, Vessel Traffic (Cook Inlet, GOA, Bering Sea)
Upper Columbia River	Endangered	Coastal marine	Marine Terminal and PLF, Mainline Pipeline, Vessel Traffic (Cook Inlet, GOA, Bering Sea)
Puget Sound	Threatened	Coastal marine	Marine Terminal and PLF, Mainline Pipeline, Vessel Traffic (Cook Inlet, GOA, Bering Sea)
Snake River Fall	Threatened	Coastal marine	Marine Terminal and PLF, Mainline Pipeline, Vessel Traffic (Cook Inlet, GOA, Bering Sea)
Snake River Spring/Fall	Threatened	Coastal marine	Marine Terminal and PLF, Mainline Pipeline, Vessel Traffic (Cook Inlet, GOA, Bering Sea)
Upper Willamette River	Threatened	Coastal marine	Marine Terminal and PLF, Mainline Pipeline, Vessel Traffic (Cook Inlet, GOA, Bering Sea)
Steelhead Trout DPSs [e, f] (*Oncorhynchus mykiss*)			
Lower Columbia River	Threatened	Coastal marine	Marine Terminal and PLF, Mainline Pipeline, Vessel Traffic (GOA, Cook Inlet)
Middle Columbia River	Threatened	Coastal marine	Marine Terminal and PLF, Mainline Pipeline, Vessel Traffic (GOA, Cook Inlet)
Upper Columbia River	Endangered	Coastal marine	Marine Terminal and PLF, Mainline Pipeline, Vessel Traffic (GOA, Cook Inlet)
Puget Sound	Threatened	Coastal marine	Marine Terminal and PLF, Mainline Pipeline, Vessel Traffic (GOA, Cook Inlet)
Snake River Basin	Threatened	Coastal marine	Marine Terminal and PLF, Mainline Pipeline, Vessel Traffic (GOA, Cook Inlet)
Upper Willamette River	Threatened	Coastal marine	Marine Terminal and PLF, Mainline Pipeline, Vessel Traffic (GOA, Cook Inlet)

Sources: ADF&G, 2018h; Braund, 2016; Cornell Lab of Ornithology, 2017; USFWS, 2017a; NMFS, 2017g

[a] Also a BLM special status species.

[b] Considered extirpated in Alaska.

[c] Increasingly hauling out on BLM managed lands due to sea ice declines.

[d] Experimental populations are reintroduced populations established outside the species' current range, but within its historic range.

[e] Based on information provided during traditional knowledge workshops.

[f] Fish/stocks (ESU/ DPS) spawn on the West Coast outside Alaska, but could occur in Lower Cook Inlet, GOA, Aleutian Island, and Bering Sea waters during the marine phase of their life cycle.

One previous candidate, the yellow-billed loon, was recently determined not to warrant protection under the ESA; however, it is conserved as a BLM sensitive species and is included in section 4.8.2. In addition to ESA protection, Steller's eider, spectacled eider, and short-tailed albatross are federally protected under the MBTA (see section 4.6.2), and marine mammals are federally protected by the MMPA (see section 4.6.3). AGDC has applied for Incidental Take Authorizations for construction activities in Cook Inlet for takes of marine mammals. As discussed in section 4.6.3, the Project would be covered under the USFWS 2016-2021 Programmatic Beaufort Sea ITR for construction activities in Prudhoe Bay that may affect Pacific walrus and polar bears.

Although the Pacific walrus does not currently receive federal protection through the ESA, we considered the potential effects on this species and their habitat so that Section 7 consultation could be facilitated in the event the Pacific walrus becomes listed before or during Project construction. Should a federally listed or candidate species be identified during construction that has not been previously assessed through consultation, and Project activities could adversely affect the species, AGDC would be required to suspend the construction activity potentially affecting the species and notify FERC and the Services of the potential effect. The construction activity could not resume until FERC completes its consultation with the Services.

ESA species' presence and distribution within the Project area was supplemented by information collected through traditional knowledge surveys. AGDC conducted traditional knowledge workshops in 2015 in five communities comprised of 50-percent tribal members within 30 miles of the Project area (North Slope, Yukon River, Tanana River, south-central, and Kenai Peninsula) (Braund, 2016). AGDC set goals for these workshops to collect information associated with subsistence activities including species' ranges, seasonal timing, presence on the landscape, and observed behaviors. Where applicable, the knowledge gathered at these meetings has been incorporated into the analysis of resources in the Project area, and potential impacts and mitigation measures for listed species.

Because our consultation with the Services is ongoing, **we recommend that:**

- **AGDC should <u>not begin</u> construction <u>until</u>:**
  - **a. the FERC staff completes formal ESA consultation with the USFWS and NMFS; and**
  - **b. AGDC has received written notification from the Director of the OEP that construction or use of mitigation may begin.**

4.8.1.1 U.S. Fish and Wildlife Service Species

Birds

<u>Alaska-Breeding Steller's Eider</u>

The Alaska-breeding Steller's eider was listed as threatened in 1997. Steller's eiders are diving sea ducks that breed inland and spend the remaining year in marine waters (ADF&G, 2018h). Two breeding populations of Steller's eiders are recognized in Arctic Russia, and one breeding population is recognized in Alaska. Only the Alaska-breeding Steller's eider is listed as threatened under the ESA, and is addressed here (USFWS, 2011c). Steller's eider pair bonding occurs in the winter with pairs moving to arctic nesting grounds once the sea ice retreats. Females select coastal nest sites typically on islands or peninsulas in tundra lakes and ponds and build nests made from grass and lined with down. These diving ducks spend most of the year in shallow marine waters where they primarily feed on benthic invertebrates (i.e., mollusks and crustaceans) and aquatic plants in waters generally less than 33 feet (10 meters) deep (ADF&G, 2018h).

The historic nesting range of Alaska-breeding Steller's eiders overlaps the Gas Treatment Facilities near Prudhoe Bay where the species has been observed during the breeding season; however, nesting Steller's eiders have not been documented at Prudhoe Bay (Quakenbush et al., 2002). Alaska-breeding Steller's eiders' current breeding range includes the Arctic Coastal Plain, with concentrations near Barrow, but they are rarely found nesting east of the Colville River (USFWS, 2011c, 2018d). Non-breeding Steller's eiders are found in the Prudhoe Bay area and use waters of the Chukchi and Beaufort Seas. The breeding population of Alaska-breeding Steller's eiders is highly variable, but estimates range from 576 to 680 individuals (Sea Duck Joint Venture, 2016).

The winter range for Alaska-breeding Steller's eiders includes the Aleutian Islands, Alaska Peninsula, and the western GOA including Kodiak and Lower Cook Inlet (Larned, 2012). The migration in spring occurs along the Bristol Bay Coast of the Alaska Peninsula across Bristol Bay toward Cape Pierce, moving north along the Bering Sea Coast (Larned, 2012). The Alaska-breeding Steller's eiders population was listed under the ESA due to range contraction. Recent surveys have documented a declining population, which supports this listing (Larned, 2012).

Because of the population decline, critical habitat was designated for Alaska-breeding Steller's eiders in 2001. Critical habitat for the species includes breeding habitat on the Yukon-Kuskokwim Delta, and molting habitat in marine waters of Kuskokwim Shoals, Sea Islands, Nelson Lagoon, and Izembek Lagoon in western Alaska (ADF&G, 2018h). Primary constituent elements for critical habitat designated for molting and wintering of Alaska-breeding Steller's eiders include marine waters of up to 30 feet (9 meters) in depth, aquatic substrate and associated invertebrate fauna, and an underlying benthic community, including eelgrass beds. The Project footprint falls outside the currently known breeding range within the Arctic Coastal Plain for the species; however, during molting and wintering, Alaska-breeding Steller's eiders may occur in:

- the eastern shore of Upper Cook Inlet near Nikiski and near the Kachemak Bay staging/anchoring area during spring and winter;
- the southern end of the Mainline Pipeline crossing in Lower Cook Inlet; and
- Shelikof Strait and the Aleutian Islands, as well as potential marine transportation routes through the Shelikof and Bering straits, and the Bering, Chukchi, and Beaufort Seas.

Eskimo Curlew

The Eskimo curlew was listed as endangered in 1967. This species is a medium-sized shorebird that formerly migrated through eastern and northwestern Canada from wintering areas in South America to nest on the arctic tundra in Alaska and northwestern Canada (ADF&G, 2018h). The Eskimo curlew is likely extinct and no longer present in Alaska. Therefore, there would be no effect on the Eskimo curlew, and a detailed analysis of effects was not conducted for the species.

Short-Tailed Albatross

The short-tailed albatross was listed as endangered in 1970. Critical habitat has not been designated for the species. The short-tailed albatross is a large pelagic seabird. The species nests on four remote islands in the western Pacific; however, they spend most of their life at sea over the continental shelf edge foraging on shrimp, squid, crustaceans, and fish including bonitos (*Sarda* sp.), flying fishes (*Exocoetidae*), and sardines (*Clupeidae*) (USFWS, 2008d). Breeding begins in late fall, typically late October.

Short-tailed albatross typically spend most of their time in the open ocean in regions of upwelling and high productivity along the northern edge of the GOA, along the Aleutian Islands, and along the Bering Sea continental shelf break from the Alaska Peninsula out toward St. Matthew Island (Suryan et al., 2008; USFWS, 2009b). Known concentration areas for short-tailed albatross were recently used to establish eight avoidance areas in the Aleutians to ensure protection of the species (USFWS, 2014b). Short-tailed albatross are also known to occur near the entrance to Cook Inlet (USFWS, 2014b). Breeding individuals travel to the western North Pacific to lay eggs and rear young on islands south of Japan, typically from October through June (USFWS, 2001b).

Project-related vessel traffic would occur within the nonbreeding range of the short-tailed albatross. The greatest risk to short-tailed albatross would come from vessel spills along the Aleutian Island chain at Unimak Pass, Akutan Pass, and the approach to Dutch Harbor where concentrations of the species may be high (Det Norske Veritas and ERM West, Inc., 2010; USFWS, 2014b).

Spectacled Eider

The spectacled eider was listed as threatened in 1993. Spectacled eiders are large sea ducks. They spend most of their life on marine waters feeding primarily on clams. Spectacled eiders arrive at breeding grounds as pairs in late May or June (USFWS, 2010d). Females nest on tundra lake islands and peninsulas with young fledging in late August (USFWS, 2010d). Spectacled eiders feed on amphipods, crustaceans, insects, mollusks, and vegetation by diving and dabbling (USFWS, 2010d).

Spectacled eiders nest on tundra habitats on Alaska's Beaufort Coastal Plain and western Alaska, molt in coastal areas of the Chukchi and Bering Seas, and winter in polynyas (areas of persistent open water in sea ice) and open water leads in the Bering Sea. The breeding population departs from wintering areas in the Bering Sea following spring leads and openings in the Bering and Chukchi Seas, arriving on the Beaufort Coastal Plain in May and June (Sexson et al., 2014; 2011).

Established pairs migrate together to nesting grounds generally within 12 miles of the coast, where they use a variety of tundra habitat types (USFWS, 2010d); however, spectacled eider breeding habitat range has been documented further inland within the Arctic Coastal Plain (ACCS, 2016a). Spectacled eiders could nest as far south as MP 33 on the Mainline Pipeline.

After breeding, males move to nearshore marine waters in late June, undergoing a complete molt of their flight feathers in the eastern Siberian Sea. Nesting females remain on the coastal tundra until late August to early September and then congregate to molt. Female spectacled eiders breeding in Arctic Alaska primarily molt in Ledyard Bay. Nonbreeding females or those with failed nests arrive in molting areas in late July, while successfully breeding females arrive in late August and stay until October. Movement between nesting and molting areas takes several weeks as the eiders make several stops along the Beaufort and Chukchi seacoasts. Concentrations of migrant spectacled eiders along the central Beaufort Sea include areas near West Dock Causeway, Harrison Bay, and Smith Bay (Sexson et al., 2014; 2011). After molting, spectacled eiders travel to their wintering areas, where they remain from October through March.

Critical habitat for spectacled eiders was designated in 2001 for nesting on the Yukon-Kuskokwim Delta; for molting in Norton Sound and Ledyard Bay; and for wintering south of St. Lawrence Island (66 FR 9146; USFWS, 2001a). No critical habitat for nesting was designated on Alaska's North Slope (66 FR 9146). Spectacled eiders may occur at the Gas Treatment Facilities and the northern portion of the Mainline Pipeline in the Beaufort Coastal Plain, as well as in vessel transit routes in the Beaufort, Chukchi, and Bering Seas. Vessels may transit near the Ledyard Bay critical habitat unit.

Mammals

Northern Sea Otter

The northern sea otter, Southwest Alaska DPS, was listed as threatened in 2005. Critical habitat for the species was also designated encompassing 5,855 square miles of shallow coastal waters from Attu Island in the Aleutians to Redoubt Point in Cook Inlet (74 FR 51988). Critical habitat occurs in nearshore marine waters ranging from the mean high tide line seaward for a distance of 328.1 feet (100 meters), or to a water depth of 65.6 feet (20 meters). The primary constituent elements for northern sea otter critical habitat are:

- shallow, rocky areas where marine predators are less likely to forage (i.e., waters less than 6.6 feet [2 meters] deep);
- nearshore waters that may provide protection or escape from marine predators (i.e., waters within 328.1 feet [100 meters] from the mean high tide line);
- kelp forests that provide protection from marine predators (i.e., that occur in waters less than 65.6 feet [20 meters] deep); and
- prey resources within the areas identified by the first three primary constituent elements that are present in sufficient quantity and quality to support the energetic requirements of the species.

Critical habitat is divided into five habitat units. Vessel routes pass through Units 3 (South Alaska Peninsula), 4 (Bristol Bay), and 5 (Kodiak, Kamishak, Alaska Peninsula). Northern sea otters from either the Southwest Alaska DPS or the non-listed South-Central Alaska DPS may occur in the action area; these populations may both occur in Lower Cook Inlet (USFWS, 2012d).

Females give birth each year, usually in the late spring, in Alaska (ADF&G, 2018h). Sea otters feed on fish and invertebrates, including clams, octopus, crabs, and sea urchins, which they find in shallow coastal waters (ADF&G, 2018h).

Northern sea otter populations have been increasing since hunting has decreased (Braund, 2016). They have been spotted as far north as Turnagain Arm and Clam Gulch in Cook Inlet (Braund, 2016); however, they are not typically found in Upper Cook Inlet. Northern sea otters may occur in vessel traffic routes in the GOA, Aleutian Islands, and Cook Inlet. Vessels may transit through designated critical habitat for the sea otter in the Aleutian Islands, GOA, Shelikof Strait, and the entrance to Cook Inlet.

Pacific Walrus

Pacific walruses are managed by the USFWS under the MMPA, with co-management agreements between the USFWS and the Eskimo Walrus Commission, the Bristol Bay Native Association's Qayassiq Walrus Commission, and the State of Alaska allowing for, and monitoring, subsistence harvest. On February 10, 2011, the USFWS announced a 12-month finding on a petition to list the Pacific walrus as endangered or threatened and to designate critical habitat under the ESA (76 FR 7634). After review of the available scientific and commercial information, the USFWS determined that listing the Pacific walrus as endangered or threatened was warranted, but the listing was precluded by higher priority species and Pacific walrus was added to the candidate list (76 FR 7634). Based on a court settlement, the USFWS agreed to review and either propose a listing rule or remove the Pacific walrus from the candidate list. In May 2017, the USFWS developed a final species status assessment for the Pacific walrus (MacCracken et al., 2017).

On October 2, 2017, the USFWS determined the species does not warrant listing and will not receive protection under the ESA. Due to the potential for the Pacific walrus to be reviewed for listing again within the timeframe of this Project, however, we have included it in our analysis.

Pacific walrus are large pinnipeds that breed in January through March (ADF&G, 2018h). Females typically give birth every 2 years to one calf on ice floes in late spring (ADF&G, 2018h). Walrus consume a variety of soft invertebrates, including snails, clams, tunicates, and sea cucumbers (ADF&G, 2018h). Males occasionally prey on seabirds and seals (ADF&G, 2018h). Pacific walrus are social animals that winter on the Bering Sea pack ice, but when sea ice is not available, they will haul out on land in large groups (ADF&G, 2018h). In the spring, females and their calves migrate from the Bering Sea to the Chukchi Sea, while adult males migrate to Bristol Bay (ADF&G, 2018h). Return migrations to the Bering Sea occur in late fall ahead of the advancing sea ice (ADF&G, 2018h).

Walruses are occasionally seen as far east as Prudhoe Bay, but are rare visitors to this area (USFWS, 2011a). Walruses have been observed near Kaktovik, which is east of the action area (Braund, 2016). Walrus have been known to venture as far south as Clam Gulch near the community of Ninilchik in Cook Inlet; Native Alaskan observers noted that they were following food sources outside their typical range (Braund, 2016). Walrus have also been observed at the mouth of the Susitna River (Braund, 2016). Pacific walrus may occur along the West Dock Causeway (attracted to as a haul out site) as well occur in vessel traffic routes in the Bering, Chukchi, and Beaufort Seas.

Polar Bear

Polar bears were listed as threatened in 2008 with critical habitat designated along the Beaufort Sea coast and barrier islands. Primary constituent elements for polar bear critical habitat are listed below.

- Sea ice habitat used for feeding, breeding, denning, and movements, which is sea ice over waters 984.2 feet (300 meters) or less in depth that occurs over the continental shelf with adequate prey resources (primarily ringed and bearded seals) to support polar bears.
- Terrestrial denning habitat, which includes topographic features, such as coastal bluffs and riverbanks, with the following suitable macrohabitat characteristics:
    - steep, stable slopes (ranging from 15.5 to 50.0 degrees), with heights ranging from 4.3 to 111.6 feet (1.3 to 34 meters), and with water or relatively level ground below the slope and relatively flat terrain above the slope;
    - unobstructed, undisturbed access between den sites and the coast;
    - sea ice in proximity of terrestrial denning habitat prior to the onset of denning during the fall to provide access to terrestrial den sites; and
    - the absence of disturbance from humans and human activities that might attract other polar bears.
- Barrier island habitat used for denning, refuge from human disturbance, and movements along the coast to access maternal den and optimal feeding habitat. This includes barrier islands along the Alaska coast and their associated spits, within the range of the polar bear in the United States, and the water, ice, and terrestrial habitat within 1 mile (1.6 km) of these islands (no-disturbance zone).

Designated critical habitat for polar bears is mapped into four categories: 95-percent den habitat, feeding, no disturbance zone, and barrier islands. Preliminary calculations indicate the Project would affect the following acres of designated critical habitat for polar bears:

- about 1,700 to 2,500 acres of 95-percent den habitat would be affected during construction and 1,500 to 2,200 acres during operation;

- about 60 to 90 acres of feeding habitat would be affected during construction and 90 to 130 acres during operation;

- about 130 to 190 acres within the no disturbance zone would be affected during construction and 90 to 140 acres during operation; and

- vessels using the PBOSA for staging would occur within barrier island critical habitat.

Because acreages of impacts on polar bear designated critical habitat have not been provided **we recommend that:**

- **<u>Prior to the end of the draft EIS comment period</u>, AGDC should file with the Secretary acreages of designated critical habitat for polar bear that would be affected by Project facilities. Acres should be separated by facility (including but not limited to access roads, ATWS, compressor stations, camps, yards, and helipads), by temporary and permanent impacts, and by the four categories of critical habitat (feeding, no disturbance zone, barrier islands, and denning habitat) defined by the USFWS.**

Polar bears breed from March through May (ADF&G, 2018h). Females typically reproduce every 3 years, creating dens in October and November and giving birth to cubs in December or January (ADF&G, 2018h). Cubs emerge from natal dens by late March or early April (ADF&G, 2018h). They primarily feed on ringed seals, but they will also consume bearded seals, walruses, and beluga whales (ADF&G, 2018h). Polar bears are circumpolar and typically remain with the northern hemisphere pack ice as it seasonally advances and recedes; however, polar bears along the Beaufort Sea coast come on land to rest until shore-fast ice develops in late fall and they follow the pack ice south when it becomes suitable again for hunting (ADF&G, 2018h).

The number of polar bears spotted near Point Thomson during summer months has increased in recent years (Braund, 2016). Polar bears have also been seen near Kaktovik along the coast and are known to den there in the springtime (Braund, 2016). Polar bears may occur in vessel traffic routes in the Beaufort Sea, near the West Dock Causeway, and on land near the Gas Treatment Facilities and the Mainline Pipeline.

<u>Wood Bison</u>

Wood bison were listed in 1973 as endangered and reclassified as threatened in 2012. The species historically was found throughout Alaska, but declined due to overhunting. Individuals are now being reintroduced to Alaska by the ADF&G from populations in Canada. The populations in Alaska are classified as a nonessential experimental population (USFWS, 2014d). Within the nonessential experimental population area and outside National Parks or Wildlife Refuges, reintroduced wood bison are considered a proposed species under ESA 10(j); within National Parks or Wildlife Refuges, they are protected as a threatened species. The Project does not cross National Parks or Wildlife Refuges where the bison have been reintroduced.

Wood bison are a subspecies of American bison. Wood bison are found in meadows, near lakes and rivers, or near recent burn areas. Cows and young bison live in large groups grazing primarily on forbs, grasses, and sedges. Females give birth to a single calf every 3 years, with calves born between April and August (ADF&G, 2018h). The nearest location where wood bison have been introduced is the lower Innoko/Yukon River site. Individuals would not be expected to range into the action area. The Project is expected to have no effect on the wood bison; therefore, no further discussion of wood bison is provided.

4.8.1.2 National Marine Fisheries Service Species

Mammals

Bearded Seal, Beringia DPS

The bearded seal was listed as threatened in 2012. In 2014, the U.S. District Court for the District of Alaska determined the listing decision was arbitrary and capricious. The court vacated the rule, and remanded the rule back to NMFS for reconsideration. NMFS filed with the Federal Appeals Court in 2015. In early 2018, the U.S. Supreme Court left intact a lower court ruling such that the bearded seal remains listed as threatened. Critical habitat has not been designated for the species.

The bearded seal, Beringia DPS, is found off the coast of Alaska over continental shelf waters in the Bering, Chukchi, and Beaufort Seas. Bearded seals are closely associated with sea ice, in particular, pack ice, and their movements typically follow the ice. Bearded seals will move north in late spring and summer as the ice retreats, and move south in the fall as sea ice forms (NMFS, 2018b). Ice is important for critical life history periods, such as molting and reproduction. The seals prefer ice that has natural openings of open water for access to foraging habitat. A small number of bearded seals, mostly juveniles, can be found on land near the coast in the summer months, and the seals have been observed traveling up rivers. Females give birth and nurse young on the broken pack ice in winter and spring (Cameron et al., 2010).

Bearded seals feed primarily on benthic organism such as invertebrates and fish (Cameron et al., 2010; ADF&G, 2018h). They generally feed in waters less than 650 feet deep (ADF&G, 2018h). Bearded seals are generally solitary (ADF&G, 2018h).

Bearded seals may occur along vessel transit routes through the Bering, Chukchi, and Beaufort Seas. Bearded seals would be expected to occur near the West Dock Causeway year-round, but their abundance is lessened during the summer and fall months. Bearded seals would be nursing young on broken pack ice when Project vessels are in transit to West Dock during the spring months. Ice breaking vessels have been reported to affect ice-breeding seals, such as bearded seals, by directly striking seals on ice or by separating mothers and pups (Hauser et al., 2018).

Blue Whale

The blue whale was listed as endangered in 1970. Critical habitat has not been designated for the species. The Eastern and Western North Pacific (or Eastern and Central) stocks of blue whale intermix in Alaskan waters. Blue whales may travel alone or in pairs in pelagic waters, as well as occur near the ice edge while migrating. Blue whales use baleen plates to filter feed primarily on euphausiids (small shrimp-like crustaceans also referred to as krill). Blue whales breed and give birth primarily in winter in southern regions off Mexico, Central America, and California. The GOA, along the Aleutian Islands, and the Bering Sea are used as summer feeding grounds (NMFS, 2017g).

Typically, blue whales move poleward in spring to feed, and in the fall move toward the subtropics to conserve energy and reproduce (ADF&G, 2018h). Although blue whales are found in coastal waters, they are typically associated with the edges of continental shelves (ADF&G, 2018h). Blue whales may occur in vessel traffic routes in the GOA.

Bowhead Whale

The bowhead whale was listed as endangered in 1970. Critical habitat has not been designated for the species. Bowhead whales likely mate in the Bering Sea during late winter and spring (NMFS, 2017g; ADF&G, 2018h). Females typically have one calf every 3 to 4 years, giving birth between April and early June (NMFS, 2017g; Alaska Fisheries Science Center, 2015). Bowhead whales use baleen plates to consume zooplankton (i.e., crustaceans), other invertebrates, and fish (NMFS, 2017g).

Bowhead whales overwinter in the central and western Bering Sea (Rugh et al., 2003). As sea ice begins to retreat in April, bowhead whales begin migrating north to the Chukchi and Beaufort Seas. Most bowhead whales continue to migrate eastward into the Beaufort Sea from April through June and remain at summer foraging grounds until late August or early September before migrating westward again toward the Bering Sea (Rugh et al., 2003; Hannay et al., 2013). Bowhead whales occupying the Arctic Ocean and surrounding seas spend winters associated with the southern limit pack ice and move north in the spring, following the ice and using leads to reach their summer feeding grounds in the Beaufort Sea (NMFS, 2017g; Hannay et al, 2013).

BIAs for feeding have been identified near Saint Lawrence Island from November through April, and throughout the Beaufort Sea from September through October (NMFS, 2017b). BIAs for migration have been identified northward through the Bering Sea from March through June; northward and eastward through the eastern Chukchi and Alaskan Beaufort Seas from April through May; and westward through the Alaskan Beaufort Sea from September through October (NMFS, 2017b). BIAs for bowhead whale reproduction include the Alaskan Beaufort Sea during September and October, the eastern Alaskan Beaufort Sea during July and August, and the Barrow Canyon region during April through June (NMFS, 2017b).

Bowhead whales may occur in vessel traffic routes in the Bering, Chukchi, and Beaufort Seas. They are likely to be affected by traffic and construction noise during their fall migration through the Beaufort and Chukchi Seas.

Cook Inlet Beluga Whale

The Cook Inlet beluga whale was listed as endangered in 2008. A BIA for the small and resident population of the species occurs in Upper Cook Inlet and along the western coast of Cook Inlet (NMFS, 2017b). In 2011, NMFS designated critical habitat for Cook Inlet beluga whales (76 FR 20180) in the two areas of Cook Inlet as described below.

- Area 1: All marine waters of Cook Inlet north of a line from the mouth of Threemile Creek (61°08.5′ N, 151°04.4′ W) connecting to Point Possession (61°02.1′ N, 150°24.3′ W), including waters of the Susitna River south of 61°20.0′ N, the Little Susitna River south of 61°18.0′ N, and the Chickaloon River north of 60°53.0′ N.
- Area 2: All marine waters of Cook Inlet south of a line from the mouth of Threemile Creek (61°08.5′ N, 151°04.4′ W) to Point Possession (61°02.1′ N, 150°24.3′ W) and north of 60°15.0′ N, including waters within 2 nautical miles seaward of mean high water along the western shoreline of Cook Inlet between 60°15.0′ N and the mouth of the Douglas River (59°04.0′ N, 153°46.0′ W); all waters of Kachemak Bay east of 151°40.0′ W; and waters of the Kenai River below the Warren Ames Bridge at Kenai, Alaska.

The waters off Joint Base Elmendorf-Richardson and the Port of Anchorage were excluded from the designation under the provisions of Section 4(b)(2) of the ESA.

Mating of Cook Inlet beluga whales is believed to occur between late winter and early spring. Most calves are born between May and August, but calving season can extend into October (NMFS, 2016a).

In Cook Inlet, beluga whales feed extensively on spawning eulachon in spring, shifting to salmon as eulachon runs diminish and salmon runs begin in the summer months. Winter prey is not well known; however, it is presumed that Cook Inlet beluga whales forage more on benthic fish and invertebrates at that time of year (NMFS, 2016a).

Although beluga whales may be found throughout Cook Inlet at any time of year, they generally spend the ice-free months in Upper Cook Inlet and expand their distribution south and into more offshore waters of Upper Cook Inlet in winter. These seasonal movements appear to be related to changes in the physical environment from sea ice and currents and to shifts in prey resources (NMFS, 2016a). Shallow water habitats in Upper Cook Inlet may be important for calving because they provide warmer water for newborn calves and refuge from killer whale predation. While specific calving areas in Cook Inlet have not been identified, newborn calves have been observed in Upper Cook Inlet (Susitna River Delta, Knik Arm, Chickaloon Bay/Southeast Fire Island, Turnagain Arm), as well as the lower Kenai River and delta (NMFS, 2008a). From the Beluga River to the Little Susitna River is a vital location for Cook Inlet beluga whales to give birth, nurse, and rear their young, as well as a significant area for feeding on eulachon and salmon runs during the summer months (NMFS, 2018d).

Nearly the entire population (up to 83 percent) of Cook Inlet beluga whales is found in the Susitna Delta area in June and July (NMFS, 2018f; McGuire et al., 2014). On the eastern side of Cook Inlet near the Kenai and Kasilof Rivers, Cook Inlet belugas are found in small groups during fish runs in spring and fall (NMFS, 2018f). Beluga whales rear their young in Knik Arm and come to eat the salmon and hooligan (eulachon) in Cook Inlet in the spring (Braund, 2016). Overall, however, the population in Cook Inlet is decreasing; beluga whales previously were abundant (in the thousands), following the herring in the spring. Additionally, Cook Inlet beluga whales previously were found near the Kenai River, but are no longer regularly observed there (Braund, 2016). Beluga whales are commonly seen near the mouth of the Susitna River, and are found upriver when the water levels are high (Braund, 2016). Beluga whales have been reported as far upriver as the Deshka River and Alexander Creek in the Susitna River (Braund, 2016).

Noise is a key factor in beluga health and distribution patterns. It has been suggested that the decline of beluga populations is due to shipping traffic; belugas tend to travel in bays and other areas where it is too shallow for them to avoid the noise and commotion present in the deep-water shipping lanes (Braund, 2016). The minimum population estimate of Cook Inlet beluga whales is 287 (Muto et al., 2018). Cook Inlet beluga whales are likely to be encountered by vessel traffic in Cook Inlet, and during construction and operation of the Liquefaction Facilities and the offshore pipeline and Mainline MOF of the Mainline Facilities.

Fin Whale

Fin whales were listed as endangered in 1970. Critical habitat has not been designated for the species. Fin whales are a migratory species typically travelling in groups of 6 to 10 animals in deep offshore waters (ADF&G, 2018h; NMFS, 2017g). Females give birth to one calf every 2 to 3 years in tropical and subtropical areas in the winter (ADF&G, 2018h; NMFS, 2017g). Fin whales are baleen whales foraging on krill, squid, and small schooling fish, but they fast during winter migrations (NMFS, 2017g). The GOA, along the Aleutian Islands, the Bering Sea, and the Chukchi Sea are used as summer feeding grounds (ADF&G, 2018h).

A fin whale BIA for feeding occurs at the mouth of Cook Inlet in the GOA. This area is used by fin whales from June through August (NMFS, 2017b). A second BIA for fin whales occurs in the Bering Sea. Fin whales use this area for feeding from June through September (NMFS, 2017b). Fin whales may occur in vessel traffic routes in the GOA, Bering Sea, and Chukchi Sea during summer months.

Gray Whale

Gray whales, Western North Pacific DPS, were listed as endangered in 1970. Critical habitat has not been designated for the species. Gray whales often travel in groups of two to three in coastal shallow waters over the continental shelf (ADF&G, 2018h). Western North Pacific DPS gray whales feed in the summer and fall off the coast of Russia and the eastern Bering Sea; however, some studies have shown tagged individuals along the western U.S. coast in winter and spring months (Allen and Angliss, 2015; ADF&G, 2018h; Weller et al., 2013). Due to the potential overlap with the Eastern North Pacific DPS in Alaska in winter and spring, the Western North Pacific DPS is treated as potentially occurring in the winter off the coast of Alaska.

Females give birth in shallow lagoons and bays in January or February to a single calf every 2 or more years (ADF&G, 2018h). Gray whales are baleen whales, feeding primarily by dredging through the mud and filtering out bottom-dwelling crustaceans (e.g., amphipods) (ADF&G, 2018h).

Gray whales are occasionally seen in Cook Inlet, though these are likely the delisted Eastern North Pacific stock (Braund, 2016). A gray whale BIA for migration occurs at the mouth of Cook Inlet in the GOA. This area is used by gray whales traveling south from November through January and traveling north from March through May (NMFS, 2017b). A BIA for gray whale migration also occurs in the Bering Sea; gray whales use this area from June through December (NMFS, 2017b). A gray whale BIA for migration occurs in the southern Chukchi Sea from June to October (NMFS, 2017b). An additional BIA occurs around the Alaska Peninsula where gray whales are known to feed from April through July, and where they migrate south from November through January and north from March through May (NMFS, 2017b). Gray whales from the Western North Pacific DPS may occur in vessel traffic routes in Cook Inlet; in the GOA; in the Bering, Chukchi, and Beaufort Seas; and near the Gas Treatment Facilities.

Humpback Whale

Humpback whales, Western North Pacific DPS, were listed as endangered in 1970. Critical habitat has not been designated for the species. Humpback whales are usually found alone or in temporary small groups (ADF&G, 2018h). During migration, they are found at the ocean surface; while feeding and calving, they are typically found in shallow waters (NMFS, 2017g). Humpback whales spend summers in temperate and subpolar waters (ADF&G, 2018h). Breeding and calving take place in tropical and subtropical waters during the winter months (ADF&G, 2018h). Humpback whales are baleen whales, feeding primarily on euphausiids (e.g., krill) and small schooling fish; they rarely feed during winter and while migrating (ADF&G, 2018h). Humpback whales tend to concentrate in several areas to feed, including the Barren Islands at the mouth of Cook Inlet and along the Aleutian Islands. Humpback whales are found as far north as the Chukchi Sea during their summer feeding, although there were reports of humpback whales in the Beaufort Sea east of Barrow in 2007 (ADF&G, 2018h).

A humpback whale BIA for feeding occurs around Kodiak Island in the GOA. Humpback whales are known to feed in this area from July to September (NMFS, 2017b). Another humpback whale BIA occurs around the Aleutian Islands where humpback whales feed from June through September (NMFS, 2017b). Humpback whales may occur in vessel traffic routes near Cook Inlet, in the GOA, the Bering Sea, and the Chukchi Sea; they are rare but could also be found in the Beaufort Sea east of Barrow. They may also be found near the Kachemak Bay staging/anchoring area in the summer.

North Pacific Right Whale

The North Pacific right whale was listed as endangered in 1970. Critical habitat for North Pacific right whale has been designated in the southeastern Bering Sea and in the GOA south of Kodiak Island (NMFS, 2017g). Primary constituent elements for right whales are dense concentrations of prey (NMFS, 2017g). North Pacific right whales occur in pelagic and coastal shallow waters, with nursery areas typically in shallow coastal waters (NMFS, 2017g). Calves are born at lower latitudes during winter (NMFS, 2017g). North Pacific right whales are baleen whales, feeding primarily on zooplankton (e.g., krill and copepods) by skimming through schools with their mouths open; they generally forage in the spring and fall (ADF&G, 2018h). While migration patterns are unclear, they are thought to feed during the summer in high latitudes and move to temperate areas in the winter (ADF&G, 2018h). Their movements are largely tied to prey locations (NMFS, 2017g). Their summer range in Alaska includes the southern Bering Sea and GOA (ADF&G, 2018h).

A North Pacific right whale BIA for feeding occurs in the GOA southeast of Kodiak Island. North Pacific right whales use this area for feeding from June through September (NMFS, 2017b). Critical habitat for North Pacific right whales (also a BIA for feeding) occurs in the Bering Sea north of the Alaska Peninsula (NMFS, 2017b). North Pacific right whales may occur in vessel traffic routes in the GOA and Bering Sea.

Ringed Seal

The ringed seal (arctic subspecies) was listed as threatened (effective February 26, 2013) because ice projection models predict a reduction in sea ice habitat in the latter half of the century and snow prediction models predict a reduction in snow accumulation, which could compromise the ability of the seals to construct subnivean (under snow) lairs (77 FR 76706). The reduction of available suitable ice habitat is expected to result in adverse demographic effects.

On December 3, 2014, NMFS announced their proposal to designate critical habitat for the ringed seal to include marine waters from the coastline to the U.S. EEZ in the northern Bering, Chukchi, and Beaufort Seas (79 FR 71714). On March 11, 2016, the U.S. District Court for the District of Alaska determined that the NMFS listing decision was arbitrary and capricious. The District Court vacated the listing rule and remanded the rule back to NMFS for reconsideration. A notice of appeal of the District Court decision was filed on May 3, 2016. On February 12, 2018, the U.S. Court of Appeals reversed the 2016 decision that vacated the rule. Due to the status and potential for the ringed seal to be, or remain, listed under the ESA, we are including the species in the BA for this Project. Critical habitat has not been designated for the ringed seal.

Ringed seals are circumpolar in distribution, occupying the Bering, Chukchi, and Beaufort Seas in Alaska. Adults breed in heavy shorefast ice and juveniles migrate south to the ice edge for the winter. Throughout their range, ringed seals are typically tied to ice-covered waters and are well adapted to occupying both shorefast and pack ice (NMFS, 2017g; Kelly et al., 2010). They remain in contact with ice most of the year, and use it as a platform for pupping and nursing in late winter to early spring, for molting in late spring to early summer, and for resting at other times of the year (Lowry, 2016).

In Alaskan waters, during winter and early spring, ringed seals are abundant in the northern Bering Sea, Norton and Kotzebue Sounds, and throughout the Chukchi and Beaufort Seas. Ringed seals occur year-round in the Chukchi Sea (Hannay et al., 2013). Ringed seals in Alaska rarely haul out on land (Lowry, 2016). Ringed seals in Alaska waters belong to the Alaska stock, which includes the arctic subspecies that is found in the Bering, Chukchi, and Beaufort Seas (Allen and Angliss, 2014). Ringed seals may occur along vessel transit routes through the Bering, Chukchi, and Beaufort Seas. Ringed seals would be expected to occur near the West Dock Causeway year-round, but their abundance is lessened during the summer and fall months.

Sei Whale

The sei whale was listed as endangered in 1970. Critical habitat has not been designated for this species. Sei whales are typically found in small groups near the continental shelf edge and slope over deeper waters (NMFS, 2017g). Sei whales are baleen whales that primarily feed on plankton, small schooling fish, and squid (NMFS, 2017g).

Sei whales are found in the GOA and south of the Aleutian Islands in the summer where they feed (typically June through August). They migrate south out of Alaska waters to lower latitudes for winters where they give birth (NMFS, 2011b). According to participants at the traditional knowledge workshops, Sei whale populations are increasing in Cook Inlet (Braund, 2016). Sei whales may occur along vessel transit routes in the GOA and Cook Inlet.

Sperm Whale

The sperm whale was listed as endangered in 1970. Critical habitat has not been designated for this species. Sperm whales are typically found offshore in waters deeper than 655 feet (200 meters) (ADF&G, 2018h). Sperm whales feed on large squid, sharks, skates, and fish (NMFS, 2017g).

In Alaska, male sperm whales can be found in the summer in the GOA, Bering Sea, and the Aleutian Islands where they come to feed (ADF&G, 2018h). Females and young typically stay further south in temperate and tropical waters. Males rejoin the females and young in winter in more temperate and tropical waters (ADF&G, 2018h). Male sperm whales may occur along vessel transit routes in the GOA, Bering Sea, and through the Aleutian Islands.

Steller Sea Lion

The Steller sea lion, Western DPS, was listed as endangered in 1997. Critical habitat for the Steller sea lion is defined by NMFS as "a 20 nautical mile buffer around all major haulouts and rookeries, as well as associated terrestrial, air, and aquatic zones, and three large offshore foraging areas" (NMFS, 2017g). In addition, NMFS also "designated no-entry zones around rookeries [and] a complex suite of fishery management measures designed to minimize competition between fishing and the endangered population of Steller sea lions in critical habitat areas" (NMFS, 2017g).

Steller sea lions feed primarily on fish and cephalopods. Single pups are typically born in June and suckle for 1 to 3 years (ADF&G, 2018h). Steller sea lion haulouts and rookeries are found on beaches, ledges, and reefs for resting and breeding (NMFS, 2017g). Offshore rookeries are used for breeding during summer months; haulouts used in winter are typically in more protected areas (ADF&G, 2018h). Flat Island, near the community of Nanwalek, is an important habitat for Steller sea lions as both a haulout and a rookery throughout the year (Braund, 2016). Vessels in transit would pass this significant rookery. Steller sea lions may also be found in vessel transit routes in the GOA, the entrance to Cook Inlet, and through the Aleutian Islands; these vessels would pass through critical habitat surrounding haulout or rookery locations.

Fish

<u>Chinook Salmon</u>

Six Chinook salmon ESUs spawn on the West Coast outside Alaska, but occur in the action area during the marine phase of their life cycle: Lower Columbia River Spring, Upper Columbia River, Puget Sound, Snake River Fall, Snake River Spring/Fall, and Upper Willamette River. These ESUs are listed as either threatened or endangered (see table 4.8.1-1). Critical habitat for Chinook salmon does not occur in Alaska; therefore, it would not be affected by Project activities.

Chinook salmon are anadromous fish (migrating from a marine environment to freshwater streams and rivers to spawn); once they mate in freshwater, they die (NMFS, 2017g). Chinook salmon runs can vary depending on the stream or river to which they migrate; they can migrate in spring, summer, fall, late fall, or winter to freshwater spawning areas (NMFS, 2017g). While in marine environments, they feed on other fish, and while in freshwater or estuarine environments, they feed on terrestrial and aquatic insects and crustaceans (NMFS, 2017g). Chinook salmon from any of the ESUs may be found in vessel transit routes in the GOA, Cook Inlet, the Aleutian Islands, and the Bering Sea year-round.

<u>Steelhead Trout</u>

Six steelhead trout DPSs spawn on the West Coast outside Alaska, but occur in the action area during the marine phase of their life cycle: Lower Columbia River, Middle Columbia River, Upper Columbia River, Puget Sound, Snake River Basin, and Upper Willamette River. These DPSs are listed as either threatened or endangered (see table 4.8.1-1). Critical habitat for steelhead trout does not occur in Alaska; therefore, it would not be affected by Project-related activities.

Steelhead trout are anadromous fish; however, unlike Chinook salmon, steelhead trout can mate more than once (NMFS, 2017g). Steelhead trout can mature in the ocean or in freshwater rivers (NMFS, 2017g). Young fish feed on zooplankton, and adults feed on aquatic and terrestrial invertebrates, mollusks, crustaceans, fish eggs, and other fish (NMFS, 2017g). Steelhead trout runs occur in either winter or summer, depending on the DPS. Steelhead trout from any of the DPSs may be found in vessel transit routes in the GOA and Cook Inlet during any time of year.

4.8.1.3 Impacts and Mitigation

A detailed description of impacts and avoidance, minimization, and mitigation measures for construction and operation-related impacts on each federally listed or candidate species is included in the BA (see appendix O); a summary is provided below and in tables 4.8.1-2 and 4.8.1-3.

Northern sea otter, Pacific walrus, polar bear, bearded seal, bowhead whale, Cook Inlet beluga whale, gray whale, ringed seal, and Steller sea lion are subsistence resources for Alaska Natives. Access to these resources could be affected by Project-related construction activities. Impacts on subsistence resources are discussed in section 4.14.

TABLE 4.8.1-2

Summary of Potential Construction Impacts and Mitigation Measures for Federally Listed Species

Action	Potential Impact – Species [a]	Baseline Condition	Activity Description	Avoidance, Minimization, and/or Mitigation Description [b]
Gas Treatment Facilities				
Ice road construction	Habitat loss – Polar bear, spectacled eider, Alaska-breeding Steller's eider Nest Destruction – Spectacled eider Human disturbance – Polar bear, spectacled eider, Alaska-breeding Steller's eider Spills – Polar bear, spectacled eider, Steller's eider	Arctic Coastal Plain, with some existing industry use	Use water from local waterbodies to build ice roads for construction (GTP, PTTL, and PBTL).	Implement the Project Polar Bear and Walrus Avoidance and Interaction Plan. Consult with USFWS if any site preparation and/or construction activities occur between June 1 and July 31 on the tundra. Conduct polar bear active den surveys and implement avoidance procedures. Comply with measures as described in the USFWS *Beaufort Sea ITR Biological Opinion*. Comply with the Project SPCC Plan.
West Dock Causeway modifications and screeding	Habitat loss/alteration – Bearded seal, Pacific walrus, polar bear, ringed seal Nest Destruction – Spectacled eider Noise – Bearded seal, bowhead whale, gray whale, North Pacific right whale, Pacific walrus, polar bear, ringed seal, spectacled eider, Alaska-breeding Steller's eider Turbidity – Ringed seal	Existing causeway with dock heads	Install dock head, vessel berth, and barge bridge installation	Provide PSOs. Marine mammal exclusion zones during pile driving and screeding. Implement pile driving soft-start and shutdown procedures. Implement the Project Polar Bear and Walrus Avoidance and Interaction Plan. Comply with measures as described in the USFWS *Beaufort Sea ITR Biological Opinion*. Consult with USFWS if any site preparation and/or construction activities occur between June 1 and July 31 on the tundra. Conduct ringed seal lair surveys. Dock Head 4 piles and sheet piles would be installed from June through August, avoiding sensitive bowhead whale periods.
Air traffic	Noise – Polar bear Human disturbance – Polar bear Strikes – Spectacled eider, Alaska-breeding Steller's eider	Existing airstrip	Install helipad; existing airstrip that would not require modifications	Maintain aircraft flying altitudes of 1,500 feet or more and stay inland of the coasts to avoid breeding areas. Comply with measures as described in the USFWS *Beaufort Sea ITR Biological Opinion*.
Vehicle traffic	Human disturbance – Polar bear Collisions – Polar bear Spills – Polar bear	Arctic Coastal Plain, with some existing industry use	Construction and use of access roads	Implement the Project Polar Bear and Walrus Avoidance and Interaction Plan. Comply with measures as described in the USFWS *Beaufort Sea ITR Biological Opinion*. Conduct polar bear active den surveys and implement avoidance procedures. Conduct ringed seal lair surveys. Comply with the Project SPCC Plan.

TABLE 4.8.1-2 (cont'd)

Summary of Potential Construction Impacts and Mitigation Measures for Federally Listed Species

Action	Potential Impact – Species [a]	Baseline Condition	Activity Description	Avoidance, Minimization, and/or Mitigation Description [b]
Vessel traffic	Noise – Bearded seal, bowhead whale, fin whale, gray whale, humpback whale, North Pacific right whale, Pacific walrus, polar bear, ringed seal, sperm whale, Steller sea lion Strikes – Bearded seal, bowhead whale, fin whale, gray whale, humpback whale, North Pacific right whale, Pacific walrus, polar bear, ringed seal, short-tailed albatross, spectacled eider, sperm whale, Steller sea lion, Alaska-breeding Steller's eider Spills – Bearded seal, bowhead whale, fin whale, gray whale, humpback whale, North Pacific right whale, Pacific walrus, polar bear, ringed seal, short-tailed albatross, spectacled eider, sperm whale, Steller sea lion, Alaska-breeding Steller's eider	Existing dock with existing vessel offload traffic	Cargo barge use during 6 Project sealifts/seasons. Vessel staging at the PBOSA.	Sealift barging would be completed outside of bowhead whale migration and fall subsistence whaling periods. Comply with the Project SPCC Plan. Vessels would not anchor on Reindeer Island while at the PBOSA. Downcast lighting and window shades on vessels anchored at the PBOSA. Comply with measures as described in the USFWS *Beaufort Sea ITR Biological Opinion*. Provide PSOs on all Project vessels. Follow the Project Transit Management Plan for vessels and NMFS (2008b) vessel guidance.
Facility lighting	Habitat alteration – Spectacled eider, Alaska-breeding Steller's eider	Arctic Coastal Plain, with some existing industry use	Lighting at facility, camps, and roads on shore, and on West Dock Causeway	Comply with the FAA and USFWS guidance on lighting for birds.
Waste generation	Attract predators to site – Polar bear, spectacled eider, Alaska-breeding Steller's eider	Arctic Coastal Plain, with some existing industry use	Waste generation from construction activities, particularly food waste from camps	Implement the Project Waste Management Plan and Polar Bear and Walrus Avoidance and Interaction Plan. Comply with measures as described in the USFWS *Beaufort Sea ITR Biological Opinion*.
Human interaction	Disturbance and hazing or human defense – Polar bear	Arctic Coastal Plain, with some existing industry use	Additional human presence in occupied habitat increases the chance for human encounters	Implement the Project Polar Bear and Walrus Avoidance and Interaction Plan. Comply with measures as described in the USFWS *Beaufort Sea ITR Biological Opinion*.
PBTL and PTTL	Habitat loss – Bearded seal, polar bear, ringed seal, spectacled eider Nest Destruction – Spectacled eider Spills – Bearded seal, polar bear, ringed seal, spectacled eider	Arctic Coastal Plain, with some existing industry use	Construction of pipelines and associated infrastructure	Implement the Project Polar Bear and Walrus Avoidance and Interaction Plan. Comply with measures as described in the USFWS *Beaufort Sea ITR Biological Opinion*. Consult with USFWS if any site preparation and/or construction activities occur between June 1 and July 31 on the tundra. Conduct polar bear active den surveys and implement avoidance procedures. Conduct ringed seal lair surveys. Comply with the Project SPCC Plan.

TABLE 4.8.1-2 (cont'd)

Summary of Potential Construction Impacts and Mitigation Measures for Federally Listed Species

Action	Potential Impact – Species [a]	Baseline Condition	Activity Description	Avoidance, Minimization, and/or Mitigation Description [b]
Mainline Facilities				
Land-based pipeline construction	Habitat loss – Polar bear, Alaska-breeding Steller's eider Nest Destruction – Spectacled eider Noise – Polar bear, Alaska-breeding Steller's eider Human disturbance – Polar bear, Alaska-breeding Steller's eider Spills – Polar bear, Alaska-breeding Steller's eider	Partially collocated with the Dalton highway and TAPS pipeline.	779.3-mile natural gas pipeline with 65- to 185-foot right-of-way width. Also includes associated facilities.	Implement the Project Polar Bear and Walrus Avoidance and Interaction Plan. Conduct polar bear active den surveys and implement avoidance procedures. Comply with measures as described in the USFWS *Beaufort Sea ITR Biological Opinion*. Consult with USFWS if any site preparation and/or construction activities occur between June 1 and July 31 on the tundra. Comply with the Project SPCC Plan.
Offshore pipeline construction	Habitat loss – Cook Inlet beluga whale, Alaska-breeding Steller's eider Noise – Cook Inlet beluga whale, Alaska-breeding Steller's eider Vessel strikes – Cook Inlet beluga whale, northern sea otter Spills – Cook Inlet beluga whale, northern sea otter, Alaska-breeding Steller's eider	Cook Inlet is a tidal estuary with existing commercial and recreational use.	27.3-mile pipeline crossing of Cook Inlet; pipe would be laid on the bottom of Cook Inlet, except near shoreline where it would be below ground.	Provide PSOs for anchor handling and pile driving. Implement marine mammal exclusion zones during pile driving. Implement pile driving soft-start and shutdown procedures. Comply with the Project SPCC Plan. Vessels would avoid boating through flocks of Steller's eiders. Use the DMT construction methodology for the shoreline crossings at Beluga Landing and Suneva Lake, if feasible.
Mainline MOF construction and use	Habitat loss – Cook Inlet beluga whale, Alaska-breeding Steller's eider Noise – Cook Inlet beluga whale, Alaska-breeding Steller's eider Vessel strikes – Cook Inlet beluga whale, northern sea otter Spills – Cook Inlet beluga whale, northern sea otter, Alaska-breeding Steller's eider	Western side of Cook Inlet near Beluga has an existing Beluga barge landing facility near the Mainline MOF	Construction of a permanent facility; pier and ramp for ship deliveries.	Comply with Project SPCC Plan. Vessels would avoid boating through flocks of Steller's eiders.
Air traffic	Noise – Cook Inlet beluga whale, polar bear, spectacled eider, northern sea otter, Alaska-breeding Steller's eider	Two existing airstrips in vicinity of listed species	2 new helipads and 1 airstrip that requires modifications in vicinity of listed species	Maintain aircraft flying altitudes of 1,500 feet or more and stay inland of the coasts to avoid breeding areas.
Waste generation	Attract predators to site – Polar bear, spectacled eider, Alaska-breeding Steller's eider	Some existing industry use	Waste generation from construction activities, particularly food waste from camps	Implement the Project Waste Management Plan.

TABLE 4.8.1-2 (cont'd)

Summary of Potential Construction Impacts and Mitigation Measures for Federally Listed Species

Action	Potential Impact – Species [a]	Baseline Condition	Activity Description	Avoidance, Minimization, and/or Mitigation Description [b]
Liquefaction Facilities				
Marine Terminal pile driving	Habitat loss – Cook Inlet beluga whale, Steller sea lion, Alaska-breeding Steller's eider Noise – Cook Inlet beluga whale, Steller sea lion, Alaska-breeding Steller's eider Turbidity – Cook Inlet beluga whale, Steller sea lion, Alaska-breeding Steller's eider	Cook Inlet is a tidal estuary with existing commercial and recreational uses. The Terminal would be near Nikiski, on a partially developed site.	LNG Plant	Provide PSOs. Implement marine mammal exclusion zones during pile driving. Implement pile driving soft-start and shutdown procedures.
Vessel traffic	Noise – Chinook salmon, Cook Inlet beluga whale, northern sea otter, steelhead trout, Steller sea lion, Alaska-breeding Steller's eider Strikes – Cook Inlet beluga whale, northern sea otter, short-tailed albatross, Steller sea lion, Alaska-breeding Steller's eider Spills – Chinook salmon, Cook Inlet beluga whale, northern sea otter, short-tailed albatross, steelhead trout, Steller sea lion, Alaska-breeding Steller's eider	Vessel traffic (vessels greater than 300 gross tons) in Cook Inlet is about 486 vessel trips annually.	1,243 vessel round trips to the Marine Terminal Facilities, Mainline, and Mainline MOF during construction	Comply with the Project SPCC Plan. Comply with the Aleutian Islands Areas to be Avoided (Nuka, 2015b). Vessels would avoid boating through flocks of Steller's eiders. Follow Project Transit Management Plan for vessels and NMFS (2008b) vessel guidance.
Dredging Marine Terminal MOF	Habitat loss – Cook Inlet beluga whale, Steller sea lion, Alaska-breeding Steller's eider Noise – Cook Inlet beluga whale, Steller sea lion, Alaska-breeding Steller's eider Spills – Cook Inlet beluga whale, Steller sea lion, Alaska-breeding Steller's eider	MOF area is not known to be dredged.	Dredging at the marine terminal	Comply with the Project SPCC Plan and Project Dredging Plan. Provide PSOs for dredging. Implement marine mammal exclusion zones during dredging.
Marine Terminal lighting	Habitat alteration – Alaska-breeding Steller's eider	Cook Inlet is a tidal estuary with existing commercial and recreational uses.	Lighting for work areas, security, and communication tower	Comply with the FAA and USFWS Guidance for Lighting for birds.

Source: Nuka, 2015b

[a] Eskimo curlew and wood bison were not included as Project activities would be expected to have no effect on these species.

[b] Avoidance, minimization, and/or mitigation measures that would be implemented for the spectacled eider would be protective of any Alaska-breeding Steller's eiders that happened to occur in the action area.

TABLE 4.8.1-3

Summary of Potential Operational Impacts and Mitigation Measures for Federally Listed Species

Action	Potential Impact – Species [a]	Baseline Condition	Activity Description	Avoidance, Minimization, and/or Mitigation Description
Gas Treatment Facilities				
Permanent access roads	Habitat loss – Polar bear, spectacled eider, Alaska-breeding Steller's eider Human disturbance – Polar bear, spectacled eider, Alaska-breeding Steller's eider Spills – Polar bear, spectacled eider, Steller's eider	Arctic Coastal Plain, with existing industry uses	New permanent access roads to facility	Implement the Project Polar Bear and Walrus Avoidance and Interaction Plan. Comply with Project SPCC Plan. Comply with measures as described in the USFWS *Beaufort Sea ITR Biological Opinion*.
Vehicle traffic	Human disturbance – Polar bear Collisions – Polar bear Spills – Polar bear	Arctic Coastal Plain, with existing industry use	Use of permanent access roads during operation	Implement the Project Polar Bear and Walrus Avoidance and Interaction Plan. Comply with the Project SPCC Plan. Comply with measures as described in the USFWS *Beaufort Sea ITR Biological Opinion*.
Facility lighting	Habitat alteration – Spectacled eider, Alaska-breeding Steller's eider	Arctic Coastal Plain, with existing industry use	Lighting at facility, camps, and roads on shore.	Comply with the FAA and USFWS Guidance for Lighting for birds.
Flares	Collision – Spectacled eider, Alaska-breeding Steller's eider	Arctic Coastal Plain, with existing industry use	2 flares at the GTP	Use free standing flares with no guy wires.
Waste generation	Attract predators to site – Polar bear, spectacled eider, Alaska-breeding Steller's eider	Arctic Coastal Plain, with existing industry use	Waste generation from operational activities, particularly food waste from permanent camp	Implement Project Waste Management Plan and Polar Bear and Walrus Avoidance and Interaction Plan. Comply with measures as described in the USFWS *Beaufort Sea ITR Biological Opinion*.
Human interaction	Disturbance and hazing or human defense – Polar bear	Arctic Coastal Plain, with existing industry use	Increased human presence in occupied habitat increases the chance for human encounters	Implement the Project Polar Bear and Walrus Avoidance and Interaction Plan. Comply with measures as described in the USFWS *Beaufort Sea ITR Biological Opinion*.
PBTL and PTTL	Habitat loss – Bearded seal, polar bear, ringed seal, spectacled eider Spills – Bearded seal, polar bear, ringed seal, spectacled eider	Arctic Coastal Plain, with existing industry use	Operation and maintenance of pipelines	Implement the Project Polar Bear and Walrus Avoidance and Interaction Plan. Comply with the Project SPCC Plan. Comply with measures as described in the USFWS *Beaufort Sea ITR Biological Opinion*.

TABLE 4.8.1-3 (cont'd)

Summary of Potential Operational Impacts and Mitigation Measures for Federally Listed Species

Action	Potential Impact – Species [a]	Baseline Condition	Activity Description	Avoidance, Minimization, and/or Mitigation Description
Mainline Facilities				
Permanent right-of-way and access roads	Habitat loss – Polar bear, spectacled eider Noise – Polar bear, spectacled eider Human disturbance – Polar bear, spectacled eider Spills – Polar bear, spectacled eider, Alaska-breeding Steller's eider	Partially collocated with the Dalton Highway and TAPS pipeline.	Permanent right-of-way and access roads	Implement the Project Polar Bear and Walrus Avoidance and Interaction Plan. Comply with Project SPCC Plan. Comply with measures as described in the USFWS *Beaufort Sea ITR Biological Opinion*.
Offshore pipeline operation in Cook Inlet	Habitat loss/prey availability – Cook Inlet beluga whale, Steller sea lion Spills – Cook Inlet beluga whale, Steller sea lion, Alaska-breeding Steller's eider	Cook Inlet is a tidal estuary with existing commercial and recreational uses.	Pipeline crossing of Cook Inlet; pipe would be laid on the bottom of Cook Inlet, except near shoreline where it would be below ground.	Comply with Project SPCC Plan.
Air traffic for pipeline inspections	Noise – Cook Inlet beluga whale, polar bear, spectacled eider, Alaska-breeding Steller's eider	2 existing airstrips in vicinity of listed species	Air-based pipeline inspections	Maintain aircraft flying altitudes of 1,500 feet or more and stay inland of the coasts to avoid breeding areas
Liquefaction Facilities				
Marine Terminal Facilities	Habitat loss – Cook Inlet beluga whale, Steller sea lion, Alaska-breeding Steller's eider	Cook Inlet is a tidal estuary with existing commercial and recreational uses. The terminal would be near Nikiski.	Permanent Marine Terminal Facilities in-water.	None
Dredging Marine Terminal MOF	Habitat loss – Cook Inlet beluga whale, Steller sea lion, Alaska-breeding Steller's eider Noise – Cook Inlet beluga whale, Steller sea lion, Alaska-breeding Steller's eider Spills – Cook Inlet beluga whale, Steller sea lion, Alaska-breeding Steller's eider	The marine terminal area is not known to be regularly dredged.	Maintenance dredging at the marine terminal	Comply with Project SPCC Plan. Provide PSOs for dredging. Implement marine mammal exclusion zones during dredging.
Removal of Marine Terminal MOF	Habitat disturbance – Cook Inlet beluga whale, Steller sea lion, Alaska-breeding Steller's eider Noise – Cook Inlet beluga whale, Steller sea lion, Alaska-breeding Steller's eider Turbidity – Cook Inlet beluga whale, Steller sea lion, Alaska-breeding Steller's eider	Cook Inlet is a tidal estuary with existing commercial and recreational uses. The terminal would be near Nikiski.	Marine Terminal MOF would be removed prior to operation, after its use for construction	Monitoring shoreline, post removal of marine terminal MOF. Provide PSOs for Marine Terminal MOF removal. Implement marine mammal exclusion zones during Marine Terminal MOF removal.

TABLE 4.8.1-3 (cont'd)

Summary of Potential Operational Impacts and Mitigation Measures for Federally Listed Species

Action	Potential Impact – Species [a]	Baseline Condition	Activity Description	Avoidance, Minimization, and/or Mitigation Description
Vessel traffic	Noise – Cook Inlet beluga whale, blue whale, fin whale, gray whale, humpback whale, northern sea otter, North Pacific right whale, sei whale, sperm whale, Steller sea lion, Alaska-breeding Steller's eider Strikes – Chinook salmon, Cook Inlet beluga whale, blue whale, fin whale, gray whale, humpback whale, northern sea otter, North Pacific right whale, sei whale, sperm whale, steelhead trout, Steller sea lion, Alaska-breeding Steller's eider Spills – Chinook salmon, Cook Inlet beluga whale, blue whale, fin whale, gray whale, humpback whale, northern sea otter, North Pacific right whale, sei whale, sperm whale, steelhead trout, Steller sea lion, Alaska-breeding Steller's eider	Vessel traffic (vessels greater than 300 gross tons) in Cook Inlet is about 486vessel trips annually.	About 17 to 30 LNG carrier visits monthly to Marine Terminal Facilities	Provide a Ship Strike Avoidance Measures Package to all shippers. Comply with the Project SPCC Plan. Vessels would avoid boating through flocks of Steller's eiders. Follow Project Transit Management Plan for vessels and NMFS (2008b) vessel guidance.
Terminal lighting	Habitat alteration – Alaska-breeding Steller's eider	Cook Inlet is a tidal estuary with existing commercial and recreational uses. The terminal would be near Nikiski.	Lighting for work areas and security, as well as a communication tower	Comply with the FAA and USFWS Guidance for Lighting for birds.
Flares	Collision – Alaska-breeding Steller's eider	Some existing industry use	2 flares at LNG Plant	Use free standing flares with no guy wires.

[a] Eskimo curlew and wood bison were not included, as Project activities would be expected to have no effect on these species.

An action area is defined by the ESA as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). The Project's action area spans the state of Alaska from Cook Inlet to Prudhoe Bay on the North Slope, including marine areas crossed by LNG carrier routes from Cook Inlet through Shelikof Strait or the GOA, and through the Aleutian Islands and southern Bering Sea; and by HLV routes through the Bering, Chukchi, and Beaufort Seas, as well as through the GOA and Cook Inlet. The transit routes of construction and operational support vessels and LNG carriers are analyzed from the Mainline MOF, Liquefaction Facility, or West Dock Causeway through Cook Inlet, the GOA, the Chukchi Sea, Bering Sea, and Beaufort Sea where known listed resources may occur.

The geographic extent of the Project's action area includes those areas in which the Project activities have a potential to directly or indirectly affect threatened, endangered, or candidate species and their critical habitats, which includes a 1-mile buffer around all land based facilities and a 6-mile buffer on marine facilities (seaward) and vessel routes. A 1-mile buffer is used around the Project footprint to account for potential effects on denning polar bears; this is the buffer distance from active dens typically recommended by the USFW for construction and operational activities (USFWS, 2012d). This area also encompasses the 200-meter (656-foot) distance the USFWS uses to assess indirect impacts from disturbance to nesting Steller's and spectacled eiders (USFWS, 2011c).

Impacts on federally listed species include construction activities in Prudhoe Bay and Cook Inlet that could disturb marine mammals and birds with noise, increased turbidity, effects on prey, and habitat disturbances and loss. In addition, activities associated with land-based construction, such as air traffic and lighting could affect federally listed species. Vessel traffic for construction and operation could interact with marine mammals and birds in the Beaufort Sea, Chukchi Sea, Bering Sea, GOA, and Cook Inlet, causing noise disturbances and potentially striking individuals. Some activities have the risk of a spill occurring on land or in-water that could affect federally listed species. AGDC proposes several measures to minimize impacts on federally listed species and their habitats, which are discussed in the BA, described below, and summarized in tables 4.8.1-2 and 4.8.1-3.

Removal of the Marine Terminal MOF could cause noise levels to reach NMFS Level B harassment (disturbance) thresholds. AGDC has committed to providing a mitigation plan for impacts on marine mammals from removal of the Marine Terminal MOF during the ITR rule making process with NMFS and USFWS.

Section 101(a)(5)(A) and (D) of the MMPA authorizes the Secretary of the Interior to authorize incidental taking of small numbers of marine mammals, upon request. The USFWS and/or NMFS can issue Incidental Harassment Authorizations for 1 year for harassment only (injury or disturbance), or an LOA for activities that would result in harassment over multiple years or activities that would result in serious injury or mortality. For takes of marine mammals, AGDC has applied to NMFS and the USFWS for Incidental Take Authorizations for construction activities in Cook Inlet, and has indicated that they have applied to NMFS for Incidental Take Authorizations for construction activities in Prudhoe Bay.[82] The Project would be covered under the USFWS 2016–2021 Programmatic Beaufort Sea ITRs for construction activities in Prudhoe Bay that could affect polar bears and Pacific walrus. AGDC has committed to providing a final Polar Bear and Pacific Walrus Avoidance and Interaction Plan in accordance with the 2016–2021 Beaufort Sea ITR developed in consultation with USFWS.

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[82] AGDC's *Petition for Incidental Take Regulations for Construction of the Alaska LNG Project in Cook Inlet, Alaska, Revision 4* was submitted to NMFS on October 1, 2018. This was included in AGDC's response to information request No. 119 dated October 22, 2018 (Accession No. 20181022-5218), available on the FERC website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter 20181022-5218 in the "Numbers: Accession Number" field. AGDC also submitted a joint *Petition for Incidental Take Regulations for Oil and Gas Activities in Cook Inlet, Alaska* with Hilcorp Alaska, Harvest Alaska, and Alaska Gasline Development Corporation on June 28, 2018.

AGDC has applied for Level A takes of humpback whales and Level B takes of humpback whales, Cook Inlet beluga whales, and northern sea otters (non-ESA-listed species are discussed in section 4.6.3) for underwater noise during construction. AGDC's application to NMFS for Incidental Take Authorizations for construction activities in Prudhoe Bay would cover Level A and Level B harassment of bearded seals and ringed seals for underwater noise during construction. If a maintenance or operational activity is determined to have the potential to generate underwater sound at levels that exceed Level A or B harassment thresholds, AGDC would apply for an Incidental Take Authorization from NMFS and/or the USFWS. NMFS and the USFWS would review each operational maintenance activity according to MMPA regulatory requirements, and mitigation measures would be developed, applied, and implemented as warranted and required under the authorization. During the MMPA authorization process, NMFS may require additional mitigation or alterations to proposed mitigation measures identified in this analysis or AGDC's application to minimize or avoid impacts on marine mammals, ESA-listed species, or critical habitat.

Vessels would be contractually required by AGDC to comply with NMFS (2008b) guidance regarding vessel strike avoidance and reporting. In addition to the NMFS guidance, the following measures would be implemented for vessels in the Beaufort Sea in transit to the West Dock Causeway to reduce impacts on whales and the risk of marine mammal strikes:

- implement slow vessel speeds if whales are spotted during transit;
- avoid groups of whales where possible;
- remain landward of Cross Island;
- maintain vessel traffic near established navigation routes where feasible;
- restrict pile driving from occurring during the blackout period (August 25 through September 15); and
- position observers at West Dock Causeway during pile driving.

AGDC has committed to developing a Transit Management Plan to decrease noise and possible strikes. This plan would include decreased speeds and course change minimizations. A Ship Strike Avoidance Measures Package would also be provided to LNG carriers. This package would include the measures proposed by NMFS for avoidance of marine mammals, which would further reduce the likelihood of adverse effects on these species. The measures included in this package would also reduce the risk of vessels striking Alaska-breeding Steller's eiders in Cook Inlet. Potential measures are listed below.

- AGDC would provide training materials to vessel crews, including a reference guide, such as the *Marine Mammals of the Pacific Northwest, including Oregon, Washington, British Columbia, and South Alaska* (Folkens, 2001). This pamphlet would be provided to vessels calling on the terminal and would be included as part of the terminal use agreement to the shippers.
- AGDC would provide a copy of the NMFS compact disc-based training program *A Prudent Mariner's Guide to Right Whale Protection* (NMFS, 2009) as part of a Ship Strike Avoidance Measures Package to all vessels calling on the terminal. While this training program is specific to right whales, NMFS has stated that the guidance and avoidance measures are also applicable to fin, humpback, and sperm whales.

- Vessel masters would provide reports of marine mammal sightings while in the EEZ and report to AGDC representatives upon docking. This reporting request would be included in the Ship Strike Avoidance Measures Package provided to each vessel, and compliance with the measures and reporting would be included in all service agreements with shippers.

AGDC has committed to conducting surveys for polar bears and ringed seals. AGDC would conduct forward-looking infrared radar surveys during the denning period (November to May) in USGS mapped potential polar bear den habitat within 1 mile of the GTP. If a den is identified, a 1-mile no activity buffer would be observed around the den until the mother and cub emerge. Ringed seal lair surveys would be conducted with traditional hunters or specially trained dogs for any marine construction activities in Prudhoe Bay after March 1 in previously undisturbed areas in waters deeper than 10 feet (3 meters) to identify and avoid ringed seal structures by a minimum of 492 feet (150 meters).

As described in section 4.6.3 and the BA (appendix O), AGDC has committed to implementing shutdown, harassment, and mitigation zones for noise generating activities, including pile driving and anchor handling. We have recommended that AGDC file revised shutdown distances for all underwater noise-generating activities or commit to conducting a Sound Source Verification during construction to establish appropriate harassment and shutdown zones based on observed underwater noise levels (see section 4.6.3).

As described in section 4.6.3, in Cook Inlet, PSOs would be employed during anchor handling operations and pile driving. In Prudhoe Bay, PSOs would be employed during pile driving. AGDC has not proposed using PSOs during dredging, dredged material disposal, or screeding activities in either Cook Inlet or Prudhoe Bay; however, based on the potential for Level B takes, we have recommended PSOs be employed for dredging and screeding activities and Mainline Pipeline shoreline installation (see section 4.6.3). PSOs would be used to monitor construction activities and to ensure marine mammals would not be exposed to sound in excess of NMFS thresholds for injury. PSOs would be given the authority to immediately stop activities and/or lower noise levels when marine mammals are visible within exclusion zones. To ensure appropriate coverage for noise activity monitoring, we have recommended that AGDC use additional PSOs for pile driving and anchor handling activities, and include PSOs for pile driving and screeding activities because they could generate Level B harassment (disturbance) (see section 4.6.3). AGDC would install portions of the sheet piling (about 600 feet) at the Mainline MOF during low tide to minimize underwater noise impacts.

Nearly the entire population of Cook Inlet beluga whales is found on the western side of Cook Inlet near the Susitna River delta and the Project in June and July (see figure 7.4.1-3 in appendix O). Pile driving for construction of the Mainline MOF and anchor handling for the Mainline Pipeline pipelay could occur during this time and would generate noise that would reach Level A harassment (injury) and/or Level B harassment (disturbance) thresholds for Cook Inlet beluga whales. AGDC has committed to providing PSOs to monitor and implement shut down zones to reduce the risk of Cook Inlet beluga whales experiencing Level A or Level B harassment during pile driving activities. PSOs would be provided for anchor handling, but would not be able to shut down activities if a whale entered the shutdown zone. NMFS has recommended that any activities in Cook Inlet within the Susitna Delta Exclusion Zone be avoided from April 15 through October 15; however, AGDC can only complete in-water marine construction when the area is free of sea ice (May through October). Based on discussions with NMFS concerning this species, the importance of the habitat to Cook Inlet beluga whales for feeding and reproduction in June and July, and to further reduce impacts, **we recommend that:**

- **<u>Prior to construction</u>, AGDC should file with the Secretary its commitment to restrict pile driving activities for construction of the Mainline MOF during the months of June and July, to minimize noise impacts on the Cook Inlet beluga whale population.**

To minimize impacts on bowhead whale feeding and migration in Prudhoe Bay, sealift barging at West Dock Causeway would be completed outside bowhead whale migration (April, May, September, and October) and fall subsistence whaling periods (Nuiqsut and Kaktovik). In addition, West Dock Causeway piles and sheet piles would be installed between June and August, outside the federally listed bowhead whale sensitive periods.

As part of the Beaufort Sea ITR, the following measures would be implemented to reduce impacts on Pacific walrus and polar bears.

(a) "Mitigation measures for all LOA: Holders of an LOA must utilize policies and procedures to conduct activities in a manner that minimizes to the greatest extent practicable adverse impacts on polar bears and/or Pacific walruses, their habitat, and the availability of these marine mammals for subsistence uses. Adaptive management practices, such as temporal or spatial activity restrictions in response to the presence of marine mammals in a particular place or time, or the occurrence of polar bears and/or Pacific walruses engaged in a biologically important activity (e.g., resting, feeding, denning, or nursing, among others) must be used to avoid interactions with and minimize impacts on these animals and their availability for subsistence uses.

(1) "All holders of an LOA must:

(i) "cooperate with the Service's [USFWS] Marine Mammals Management Office and other designated federal, state, and local agencies to monitor and mitigate the impacts of their activities on polar bears and Pacific walruses;

(ii) "designate trained and qualified personnel to monitor for the presence of polar bears and/or Pacific walruses, initiate mitigation measures, and monitor, record, and report the effects of their activities on polar bears and/or Pacific walruses;

(iii) "have an approved polar bear and/or Pacific walrus safety, awareness, and interaction plan on file with the Service's Marine Mammals Management Office and available on site have key personnel undergo polar bear awareness training. Interaction plans must include:

(A) "the type of activity and where and when the activity will occur (i.e., a summary of the plan of operation);

(B) "a food, waste, and other "bear attractants" management plan;

(C) "personnel training procedures, procedures, and materials;

(D) "site specific polar bear and/or walrus interaction risk evaluation and mitigation measures;

(E) "polar bear and walrus avoidance and encounter procedures; and

(F) "polar bear and walrus observation and reporting procedures.

(2) "All LOA applicants must contact affected subsistence communities and hunter organizations to discuss potential conflicts caused by the proposed activities and provide the Service documentation of communications as described in 50 CFR 18.124.

(b) “Mitigation measures for onshore activities. Efforts to minimize disturbance around known polar bear dens: holders of an LOA must take efforts to limit disturbance around known polar bear dens.

(1) “Efforts to locate polar bear dens. Holders of an LOA seeking to carry out onshore activities in known or suspected polar bear denning habitat during the denning season (November through April) must make efforts to locate occupied polar bear dens within and near proposed areas of operation, utilizing appropriate tools, such as Forward Looking InfraRed surveys and/or polar bear scent-trained dogs. All observed or suspected polar bear dens must be reported to the Service prior to the initiation of activities.

(2) “Exclusion zone around known polar bear dens. Operators must observe a 1.6-km (1-mile) operational exclusion zone around all known polar bear dens during the denning season (November through April, or until the female and cubs leave the areas). Should previously unknown occupied dens be discovered within 1.6 km (1 mile) of activities, work must cease and the Service contacted for guidance. The Service will evaluate these instances on a case-by-case basis to determine the appropriate action. Potential actions may range from cessation or modification of work to conducting additional monitoring, and the holder of the authorization must comply with any additional measures specified.

(3) “The use of den habitat map developed by the USGS. A map of potential coastal polar bear denning habitat can be found at: http://alaska.usgs.gov/science/biology/polar_bears/pubs.html. This measure ensures the location of potential polar bear dens is considered when conducting activities in the coastal areas of the Beaufort Sea.

(4) “Restrict the timing of the activity to limit disturbance around dens.

(c) “Mitigation measures for operational and support vessels.

(1) “Operational and support vessels must have dedicated marine mammal observers on board to alert crew of the presence of polar bears and walruses and initiate adaptive mitigation responses.

(2) “At all times, vessels must maintain the maximum distance possible from concentrations of polar bears or walruses. Under no circumstances, other than an emergency, should any vessel approach within an 805-meter (0.5-mile) radius of polar bears or walruses observed on land or ice.

(3) “Vessel operators must take every precaution to avoid harassment of concentrations of feeding walruses when a vessel is operating near these animals. Vessels should reduce speed and maintain a minimum 805-meter (0.5-mile) operational exclusion zone around feeding walrus groups. Vessels may not be operated in such a way as to separate members of a group of walruses from other members of the group. When weather conditions require, such as when visibility drops, vessels should adjust speed accordingly to avoid the likelihood of injury to walruses.

(4) “Vessels bound for the Beaufort Sea ITR Region may not transit through the Chukchi Sea prior to July 1. This operating condition is intended to allow walruses the opportunity to move through the Bering Strait and disperse from the confines of the spring lead system into the Chukchi Sea with minimal disturbance. It is also intended to minimize vessel impacts upon the availability of walruses for Alaska Native subsistence hunters. Exemption waivers to this operating condition may be issued by the Service on a case-by-case basis, based on a review of seasonal ice conditions and available information on walrus and polar bear distributions in the area of interest.

(5) “All vessels shall avoid areas of active or anticipated polar bear or walrus subsistence hunting activity, as determined through community consultations.

(6) “The use of trained marine mammal monitors associated with marine activities. USFWS may require a monitor on the site of the activity or on board drill ships, drill rigs, aircraft, icebreakers, or other support vessels or vehicles to monitor the impacts of the Project’s activity on polar bear and Pacific walruses.

(d) “Mitigation measures for aircraft.

(1) “Operators of support aircraft should, at all times, conduct their activities at the maximum distance possible from concentrations of polar bears or walruses.

(2) “Under no circumstances, other than an emergency, should aircraft operate at an altitude lower than 457 meters (1,500 feet) within 805 meters (0.5 mile) of polar bears or walruses observed on ice or land. Helicopters may not hover or circle above such areas or within 805 meters (0.5 mile) of such areas. When weather conditions do not allow a 457-meter (1,500-foot) flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below 457 meters (1,500 feet). However, when aircraft are operated at altitudes below 457 meters (1,500 feet), the operator must avoid areas of known polar bear and walrus concentrations and should take precautions to avoid flying directly over or within 805 meters (0.5 mile) of these areas.

(3) “Plan all aircraft routes to minimize any potential conflict with active or anticipated polar bear or walrus hunting activity, as determined through discussions with local communities.

(e) “Mitigation measures for sound producing offshore activities. Any offshore activity expected to produce constant or pulsed underwater sounds with received sound levels ≥160 dB re 1 μPa will be required to establish and monitor acoustically verified mitigation zones surrounding the sound source and implement adaptive mitigation measures as follows:

(1) “Mitigation zones.

(i) “A walrus mitigation zone where the pulsed or constant received sound level would be ≥ 160 dB re 1 μPa;

(ii) “A walrus mitigation zone where the received pulsed sound level would be ≥ 180 dB re 1 μPa; and

(iii) “A polar bear or walrus mitigation zone where the received pulsed sound level would be ≥ 190 dB re 1 μPa.

(2) "Adaptive mitigation measures.

(i) "Ramp-up procedures. For all sound sources, including sound source testing, the following sound ramp-up procedures must be used to allow polar bears and walruses to depart the mitigation zones:

(A) "Visually monitor the mitigation zones and adjacent waters for polar bears and walruses for at least 30 minutes before initiating ramp-up procedures. If no polar bears or walruses are detected, ramp-up procedures may begin. Do not initiate ramp-up procedures when mitigation zones are not observable (e.g., at night, in fog, during storms or high sea states, etc.).

(B) "Initiate ramp-up procedures by activating a single, or least powerful, sound source, in terms of energy output and/or volume capacity.

(C) "Continue ramp-up by gradually increasing sound output over a period of at least 20 minutes, but no longer than 40 minutes, until the desired operating level of the sound source is obtained.

(ii) "Power down. Immediately power down a sound source when:

(A) "One or more walruses is observed or detected within the area delineated by the constant sound ≥ 160 dB re 1 μPa walrus mitigation zone;

(B) "One or more walruses is observed or detected within the area delineated by the pulsed sound ≥ 180 dB re 1 μPa walrus mitigation zone; and

(C) "One or more polar bear or walruses are observed or detected within the area delineated by the pulsed sound ≥ 190 dB re 1 μPa polar bear or walrus mitigation zone.

(iii) "Shut down when:

(A) "If the power down operation cannot reduce the received constant sound level to < 160 dB re 1 μPa (walrus) or received pulsed sound level to < 180 dB re 1 μPa (walrus) or < 190 dB re 1 μPa (walrus or polar bear), the operator must immediately shut down the sound source.

(B) "If observations are made or credible reports are received that one or more polar bears or walruses within the area of the sound source activity are believed to be in an injured or mortal state, or are indicating acute distress due to received sound, the sound source must be immediately shut down and the Service contacted. The sound source will not be restarted until review and approval has been given by the Service. The ramp-up procedures must be followed when restarting.

(f) "Monitoring requirements. Holders of an LOA will be required to:

(1) "Develop and implement a site-specific, Service approved, marine mammal monitoring and mitigation plan to monitor and evaluate the effectiveness of mitigation measures and the effects of activities on polar bears, walruses, and the subsistence use of these species.

(2) "Provide trained, qualified, and Service-approved on-site observers to carry out monitoring and mitigation activities identified in the marine mammal monitoring and mitigation plan.

(3) "For offshore activities, provide trained, qualified, and Service-approved observers on board all operational and support vessels to carry out monitoring and mitigation activities identified in the marine mammal monitoring and mitigation plan. Offshore observers may be required to complete a marine mammal observer training course approved by the Service.

(4) "Cooperate with the Service and other designated federal, state, and local agencies to monitor the impacts of oil and gas activities on polar bears and walruses. Where insufficient information exists to evaluate the potential effects of proposed activities on polar bears, walruses, and the subsistence use of these species, holders of an LOA may be required to participate in joint monitoring and/or research efforts to address these information needs and insure the least practicable impact on these resources.

(g) "Reporting requirements. Holders of an LOA must report the results of monitoring and mitigation activities to the Service's Marine Mammals Management Office via email at: FW7_MMM_REPORTS@FWS.GOV."

Other proposed mitigation, monitoring, and reporting requirements are explained on pages 36663 to 36701 of the Proposed Rule (81 FR 36663).

4.8.1.4 Determination of Effects

Based on our analysis summarized in this section and included in more detail in the BA (see appendix O), we have made a determination of effect for each of the federally listed species (see table 4.8.1-4). We determined that Project construction and operation would have no effect on two species, is not likely to adversely affect 23 species (DPSs or ESUs), and is likely to adversely affect six species (spectacled eider, polar bear, bearded seal, Cook Inlet beluga whale, humpback whale, and ringed seal). We also determined that the Project is not likely to adversely affect designated critical habitat for five species and is likely to adversely affect designated critical habitat for two species (polar bear and Cook Inlet beluga whale). Justifications for our likely to adversely affect determinations are provided in the BA and briefly summarized in table 4.8.1-5. With this draft EIS and BA, we are initiating formal consultation with the Services.

TABLE 4.8.1-4

Determinations of Effect for Federally Listed Species

Species	Federal Status, Designated Critical Habitat	Determination of Effect (Species/Critical Habitat)
U.S. Fish and Wildlife Service		
Birds		
Alaska-breeding Steller's eider	Threatened, Designated Critical Habitat	Not Likely to Adversely Affect/ Not Likely to Adversely Affect
Eskimo curlew	Endangered	No effect
Short-tailed albatross	Endangered	Not Likely to Adversely Affect
Spectacled eider	Threatened, Designated Critical Habitat	Likely to Adversely Affect/ Not Likely to Adversely Affect
Mammals		
Northern sea otter, Southwest Alaska DPS	Threatened, Designated Critical Habitat	Not Likely to Adversely Affect/ Not Likely to Adversely Affect
Pacific walrus	Currently not warranted for listing	Not Applicable
Polar bear	Threatened, Designated Critical Habitat	Likely to Adversely Affect/ Likely to Adversely Affect
Wood bison	Threatened, Experimental	No effect
National Marine Fisheries Service		
Mammals		
Bearded seal	Threatened	Likely to Adversely Affect
Blue whale	Endangered	Not Likely to Adversely Affect
Bowhead whale	Endangered	Not Likely to Adversely Affect
Cook Inlet beluga whale	Endangered, Designated Critical Habitat	Likely to Adversely Affect/ Likely to Adversely Affect
Fin whale	Endangered	Not Likely to Adversely Affect
Gray whale, Western North Pacific DPS	Endangered	Not Likely to Adversely Affect
Humpback whale, Western North Pacific DPS	Endangered	Likely to Adversely Affect
North Pacific right whale	Endangered, Designated Critical Habitat [c]	Not Likely to Adversely Affect/ Not Likely to Adversely Affect
Ringed seal	Threatened	Likely to Adversely Affect
Sei whale	Endangered	Not Likely to Adversely Affect
Sperm whale	Endangered	Not Likely to Adversely Affect
Steller sea lion, Western DPS	Endangered, Designated Critical Habitat	Not Likely to Adversely Affect/ Not Likely to Adversely Affect
Fish		
Chinook salmon ESUs		
Lower Columbia River Spring	Threatened	Not Likely to Adversely Affect
Upper Columbia River	Endangered	Not Likely to Adversely Affect
Puget Sound	Threatened	Not Likely to Adversely Affect
Snake River Fall	Threatened	Not Likely to Adversely Affect
Snake River Spring/Fall	Threatened	Not Likely to Adversely Affect
Upper Willamette River	Threatened	Not Likely to Adversely Affect
Steelhead Trout DPSs		
Lower Columbia River	Threatened	Not Likely to Adversely Affect
Middle Columbia River	Threatened	Not Likely to Adversely Affect
Upper Columbia River	Endangered	Not Likely to Adversely Affect
Puget Sound	Threatened	Not Likely to Adversely Affect
Snake River Basin	Threatened	Not Likely to Adversely Affect
Upper Willamette River	Threatened	Not Likely to Adversely Affect

TABLE 4.8.1-5 **Justifications for Likely to Adversely Affect Determinations**	
Species/Designated Critical Habitat	Justifications for Likely to Adversely Affect Determinations
Species	
Spectacled eider	• Construction and operational activities would affect spectacled eider breeding and molting habitat and result in the permanent removal of nesting habitat (e.g., from fill and excavation) and would disturb and displace individuals. • An increase in vessel, air, and vehicle traffic, as well as buildings, flares, and communication towers, would result in injury or mortality from collisions and spills or fuel releases could affect spectacled eiders health.
Polar bear	• Construction and operational activities would disturb denning polar bears on land and would cause polar bear–human interactions, which could lead to harassment or fatalities of polar bears for protection of human life.
Bearded seal	• The Project would cause Level A and Level B harassment of bearded seals from underwater noise. • Vessel traffic could cause injury to adult seals and pups.
Cook Inlet beluga whale	• The Project would result in Level A and Level B harassment of Cook Inlet beluga whales from underwater noise; would permanently affect Cook Inlet beluga whale habitat; and would increase the risk of vessel strikes on Cook Inlet beluga whales.
Humpback whale	• There is a high risk of vessel strikes on humpback whales from Project vessel traffic.
Ringed seal	• The Project would cause Level A and Level B harassment of ringed seals from underwater noise. • Vessel traffic could cause injury to denning seals.
Designated Critical Habitat	
Polar bear	• There would be temporary and permanent losses of denning habitat for polar bear.
Cook Inlet beluga whale	• Permanent loss of critical habitat would occur. • Project activities in Cook Inlet and anadromous streams could negatively affect beluga whales and their prey.

4.8.2 Bureau of Land Management Sensitive and Watch List Species

The BLM maintains obligations under *BLM Manual H-6840–Special Status Species Management* (BLM, 2008a) and the FLPMA to designate sensitive species (e.g., sensitive and watch list species) and enact measures to conserve these species and their habitats on BLM lands. BLM lands affected by the Project are described in section 4.9.4. BLM watch list species[83] are those that may be added to the BLM Sensitive Species List in the future, but for which current data is insufficient for listing. For watch list species, appropriate inventory or research efforts are considered a management priority. The BLM Alaska Special Status Species List was used in this analysis (BLM, 2019). The BLM reevaluates the Special Status Species List (BLM, 2008a) about every 3 to 5 years; therefore, the list of sensitive and watch list species discussed here may change over the lifespan of the Project. Any updates or changes to the Special Status Species List would be coordinated with the BLM, and the BLM would address changes to the Special Status Species List in its right-of-way grant and its Notice to Proceed for the Project. All federally designated

[83] Note that only "Sensitive" has official BLM status under 6840 policy. The "Watch List" is a list of species that were candidates for "Sensitive" and did not warrant inclusion, but are recorded to document that process, raise awareness, and retain them for the next Special Status Species List review process" (BLM, 2019).

candidate, proposed, and delisted species within the 5 years following their delisting are conserved as BLM special status species.

The BLM identifies special status native plants known to occur on BLM-managed lands in Alaska and implements measures to protect certain species and their habitats through a BLM Sensitive Plant List (BLM sensitive plants) and Watch List Plants (BLM watch list plants), as mandated under BLM 6840 Manual direction (BLM, 2019) and the FLPMA. The general objective is to provide proactive protection of species by minimizing or eliminating threats on federally managed lands, thus reducing the chances of federal listing under the ESA.

Some areas under BLM management designated as ACECs contain areas within public lands where special management consideration is required to protect and prevent damage to historic, cultural, or scenic values as well as fish and wildlife resources or other natural systems or processes, and to protect life and safety from natural hazards (43 CFR 1601.0-5) (see figure 4.9.2-1). Two adjoining ACECs (Toolik Lake Research Natural Area and Galbraith Lake Outstanding Natural Area [ONA]) are crossed by the Mainline Pipeline. In addition, the Project footprint would be within 1 mile of the BLM-managed Sukakpak Mountain ACEC and Snowden Mountain ACEC. ACECs are described in section 4.9.5 (see figure 4.9.5-1). BLM sensitive plants and animals may occur within the ACECs as they are important locations for native species and natural habitats.

Construction and operation of the Gas Treatment Facilities and Liquefaction Facilities would not affect BLM-managed lands; therefore, the analysis focuses on the Mainline Facilities.

4.8.2.1 Species Descriptions

BLM sensitive and watch list species include avian, mammalian, invertebrate, fish, and plant species and 89 species were considered based on their potential association with the Mainline Facilities. Six of the BLM sensitive and watch list species are also federally listed and considered BLM special status species (Alaska-breeding Steller's eider, Eskimo curlew, spectacled eider, northern sea otter, polar bear, and wood bison). These species, and the Pacific walrus, are addressed in section 4.8.1 and in the BA (see appendix O). Table P-1 in appendix P summarizes BLM sensitive and watch list species, their descriptions, subregion occurrence, and habitat associated with the Mainline Facilities.

4.8.2.2 Impacts and Mitigation

Impacts on special status species, including those identified as BLM sensitive and watch list species, would be similar to those described in sections 4.5.7 (unique, sensitive, and protected vegetation), 4.6.1 (terrestrial wildlife), 4.6.1 (furbearers and small mammals), 4.6.2 (avian resources), and 4.7.1 (fisheries). Effects on special status species may be greater than effects on other wildlife and vegetation because these species may be more sensitive to disturbance and use more limited habitats. Additionally, special status species could be less able to move to unaffected suitable habitat since such habitat may not be available within a reasonable proximity, may not be available at all, or may exist in small tracts. Construction and operational activities associated with the Project could affect BLM sensitive and watch list species throughout the Project area. As discussed in section 4.6.2, habitat disturbance leading to permanent displacement for avian resources could lead to long-term impacts or otherwise resonate throughout the life cycle as carry-over effects (Norris, 2005; Sexson et al., 2014). Events that occur in one season and could influence individual success the following season could play an important role in migratory bird population dynamics (Norris, 2005). Potential impacts that could affect the conservation needs of a species or decrease the viability of a population through habitat fragmentation, loss, or degradation; decreased breeding or nesting success; increased predation or decreased food sources; and injury or mortality. Sensitive resources identified by the BLM may have a higher risk of being affected by construction and operational activities association with the Project. While there are no specific measures to reduce impacts on BLM-listed species, measures that would minimize impacts on other wildlife (sections 4.5.2, 4.6.1, 4.6.2, and 4.7.1) would also generally minimize impacts on BLM-listed species, and are summarized below.

Construction activities, such as clearing, grading, pile driving, blasting, dredging, and trenching, and activities supporting infrastructure construction (e.g., construction camps, roadways, airstrips, and vessel traffic) could affect BLM sensitive and watch list resources throughout the Project area on BLM-managed lands. Routine operational activities that could affect BLM-listed species include pipeline maintenance and inspection, vehicle traffic, human activity, right-of-way maintenance, and operational noise from compressor stations and other Project facilities. Potential impacts on BLM sensitive and watch list resources from Project construction and operational activities include construction or collision mortality, noise disturbance, habitat disturbance or loss, mortality or habitat loss due to contamination, an increase in hunting and/or predation, spills, and human disturbance. These impacts are further discussed in this section.

AGDC has developed mitigation measures to avoid, minimize, or mitigate impacts on BLM-listed species. In addition to the Project Plan and Procedures, AGDC prepared other plans (e.g., the Migratory Bird Conservation Plan, Lighting Plan, Invasives Plan, ISPMP, and Waste Management Plan) that would be implemented to reduce environmental impacts (see table 2.2-1).

Habitat Effects

<u>Birds</u>

Construction and operational activities throughout the Project region, including BLM-managed lands, could cause permanent and temporary habitat loss and alteration for avian species leading to long-term impacts. Associated impacts on avian resources, including BLM-listed species, from these disturbances are discussed in section 4.6.2. As discussed in section 4.5.2, Project construction and operation would affect forests, scrub, and herbaceous vegetation. Acreages of vegetation affected by the Project are in table 4.5.2-1. In general, impacts would be greatest for forested habitats, which would take the longest time to recover in the temporary construction workspace (25 to 100 years), and in some instances, would be permanently converted to herbaceous and scrub communities, resulting in permanent impacts on BLM-listed avian resources (including raptors and passerines) using those communities (ADF&G, 2001b). Habitat loss would be permanent for BLM-listed birds (e.g., waterfowl and shorebirds) in areas that are filled with granular fill and/or where full vegetation recovery is not possible, including functional losses to underlying wetlands. Species such as Hudsonian godwit and red-throated loon that use wetlands for breeding or foraging would be forced to find alternative habitats. Permanent habitat loss for birds would also result from wetlands conversion during construction, within the operational corridor, and within permanent facility footprints. In general, effects would be minimized by implementing the BMPs described in the Project Plan and Procedures, and Project Revegetation Plan. We have also recommended additional measures to minimize impacts on birds, as described in section 4.6.2.

The construction right-of-way would cross the Alaska Range Foothills IBA, which is adjacent to BLM land near Mainline Pipeline MP 530. This area is within the Alaska Range Subregion where BLM sensitive and watch list birds, including high densities of nesting golden eagles and other bird species (e.g., gray-cheeked thrush, Hudsonian godwit, red-throated loon, Townsend's warbler, and trumpeter swan) occur. On the adjacent BLM land, these species would be expected to occur and could be affected by Project activities. ADF&G lists trumpeter swans as one of the SGCN. Trumpeter swan habitat occurs in over 55 percent of the Mainline Pipeline route south of the Brooks Range Subregion between MPs 200.0 and 796.0. The 2005 trumpeter swan surveys conducted by the USFWS indicated that 27 trumpeter swan pairs could nest within 0.5 mile (0.8 km) of the Project from MPs 432.0 to 796.0, and that summer construction activities could disturb 16 breeding trumpeter swan pairs (Conant et al., 2007). Impacts on BLM-listed birds, including trumpeter swans, would include temporary habitat displacement and permanent loss of foraging and nesting habitat once trees and vegetation are removed. The measures that AGDC would implement to avoid, minimize, and mitigate impacts on birds and their habitat, including BLM sensitive and watch list species, along with our additional recommendations are discussed in section 4.6.2.

Birds and Small Mammals

Construction activities would affect prey availability and/or access to foraging habitat. Prey availability for birds and small mammals would be temporarily affected by right-of-way and facility construction due to habitat loss and disturbance. Pipeline crossings of waterbodies would result in temporary increases in sedimentation and turbidity, affecting aquatic prey and making these waterbodies unusable by birds and mammals during construction. As discussed in section 4.6.1, the DMT method would be used to install the Mainline Pipeline beneath some river crossings (e.g., Middle Fork Koyukuk River) avoiding surface impacts by drilling under the waterbodies (see section 4.3.2). Riparian vegetation at each crossing would remain intact and would not be lost or modified, and connectivity along the waterbody would remain during Project operation.

Mammals

Impacts and disruptions to BLM sensitive and watch list terrestrial wildlife (e.g., Kenai marten) could result from a variety of Project construction and operational activities including habitat disturbance or loss (e.g., clearing, grading, permanent Project features), trenching and backfilling, blasting, human disturbance, spills, and waste generation. In general, effects on BLM sensitive and watch list terrestrial wildlife from Project activities and facilities would not be significant, and would be minor and short term, as Project activities and facilities would affect few organisms.

Open trenches could create hazards for mammals and barriers to movement. The Mainline Pipeline would be constructed in sequences to limit the time an open trench is exposed. Trench crossing areas such as trench breaks would be created and escape ramps would be provided, especially in known areas of wildlife migration corridors. In addition, while the trench is open, construction activities and heavy equipment operations would be underway, and this high level of activity would likely reduce small mammal activity near the construction area. While these measures are not specific to BLM-listed species, they would minimize the impacts of an open trench on BLM-listed mammals if they occurred on BLM-owned lands crossed by the Project.

Terrestrial wildlife, including small mammals such as the arctic ground squirrel and northern bog lemming, could be affected by indirect impacts associated with long-term habitat alteration from habitat loss and fragmentation. Habitat loss would result in the reduction of available land for foraging, cover, breeding, and prey availability. Habitat fragmentation could affect the movement and dispersal of small mammals. Construction activities that permanently affect wetland habitats (e.g., granular fill placement) throughout the Mainline Pipeline would present short-term or permanent impacts on northern bog lemming, a BLM watch list species that inhabit sphagnum bogs, wet meadows, and moist mixed and coniferous forests as well as mossy stream sides (ACCS, 2017b). Direct impacts associated with construction activities of the Mainline Pipeline could result in injury and/or mortality due to land clearing and excavations. In general, where their habitat is affected, small mammals would be displaced by construction or permanent Project facilities.

Fish

The Alaskan brook lamprey, a BLM sensitive species, is primarily documented in western Alaska Peninsula waterbodies but also has been reported in interior Alaska and Kenai Peninsula waterbodies and lakes (ADF&G, 2004, 2018a; Sutton, 2016). Alaskan brook lamprey observations have not been documented during Project fish surveys in waterbodies crossed by the Project. Based on historical observations, however, the species could be present in waterbodies crossed by the Project in the Chatanika River and Yukon River drainages (Bradley et al., 2015; Sutton et al., 2011; ADF&G, 2004). Findings by Bradley et al. (2015) support the presence of either the arctic lamprey (*Lethenteron camtschaticum*) or the Alaskan brook lamprey within the Yukon and Tanana Rivers, as is indicated by the fact that larval stages for these species are morphologically indistinguishable. In addition, Sutton et al. (2011) suggest the Yukon River drainage lamprey populations share common genetics and are not isolated.

Table 4.8.2-1 provides Mainline Pipeline stream crossings in the range of the Alaskan brook lamprey and proposed construction crossing methods on BLM-managed lands. Waterbody crossings for the Project are summarized in section 4.3.2, and waterbodies affected by Project facilities are provided in appendix I. Based on a recommendation in section 4.3.2 for AGDC to file a complete waterbody crossing dataset, this waterbody list is preliminary and will be updated upon receipt of the additional information requested.

TABLE 4.8.2-1

Project Stream Crossings in the Alaskan Brook Lamprey Range Associated with the Mainline Facilities on BLM-Managed Lands

Milepost	Waterbody Name	Flow Regime	FERC Class [a]	Construction Season	Bank Width (feet)	Construction Wetted Width (feet) [b]	Crossing Method [c]
354.8	Woodchopper Creek (Yukon Tributary)	Intermittent	Minor	Winter	12	0	Frozen-cut
355.6	Burbot Creek (Yukon Tributary)	Intermittent	Minor	Winter	8	0	Frozen-cut
356.5	Yukon River	Perennial	Major	Summer	2,400	2,000	DMT

[a] Based on *Wetland and Waterbody Construction and Mitigation Procedures* (FERC, 2013) definitions.
[b] Preliminary construction wetted width for waterbodies with perceptible flow at time of crossing. Waterbodies dry or frozen to bed would be crossed using standard upland construction techniques in the Project Plan and Procedures.
[c] Waterbody crossing methods are described in section 2.2.2.

To minimize impacts on the Alaskan brook lamprey, two of the waterbody crossings identified in table 4.8.2-1 would be constructed during winter months outside the sensitive spawning period or by a frozen-cut method, which would avoid in-stream impacts. As described in section 4.3.2, using the frozen-cut method during winter would minimize turbidity and sedimentation due to frozen soil conditions and lack of flowing water. The crossing of the Yukon River near MP 356.5 would occur during the summer using the DMT method, which would avoid in-stream work, and therefore, impacts on the Alaskan brook lamprey, if present. There would be a risk of an inadvertent release of drilling fluid into the river, but with implementation of the DMT Plan, impacts would be reduced (see section 4.7.1). Impacts on the Alaskan brook lamprey associated with Project construction and operation would be minor and short term.

The types of temporary, short-term, and permanent impacts on BLM-listed fish species would generally be the same as for other fish (see section 4.7). Sedimentation and turbidity, alteration or removal of in-stream and streambank cover, streambank erosion, introduction of water pollutants, water depletions, and entrainment of small fishes during water withdrawals resulting from Project activities could increase stress, injury, and mortality of fish in the Project area. Winter habitats are of substantial importance to arctic freshwater and anadromous fish, such as the BLM watch list chum and Chinook salmon (see section 4.7.1). The ADF&G has recommended construction timing windows to minimize impacts on sensitive fishery resources. In addition to mitigation measures described in section 4.7.1, impacts on BLM-listed fish would be minimized by following recommendations outlined in section 4.7.1, including the development of a Fisheries Conservation Plan, avoiding in-stream construction in the winter in waterbodies with known overwintering habitat for Pacific salmon species, and conducting in-stream construction in the timeframes provided by the ADF&G.

Plants

Eighteen BLM sensitive and 25 watch list plant species are potentially associated with the Mainline Facilities (see table P-1 of appendix P). BLM sensitive and watch list plants including Muir's fleabane and windmill fringed gentian occur adjacent to the Mainline Pipeline construction footprint at about MPs 65 and 474, respectively. Muir's fleabane is endemic to arctic Alaska where it inhabits alpine slopes, ridges, outcrops, and bluffs. There are 16 known occurrences in Alaska, and at least 2 are locally common with 500 to 1,000 individuals (ACCS, 2017b). The windmill fringed gentian is found in central Alaska within the Beringia Boreal Ecoregion where there are at least 19 known occurrences (ACCS, 2017b). Therefore, these plant species have a likelihood of occurring in the Project area and being affected, given their proximity. The BLM (2019) commented that the BLM-sensitive species, Bostock's miner's lettuce, is known to occur in the Toolik Lake RNA in the Brooks Foothills Subregion, which would be crossed by the Project (see section 4.6.1) (also see Carroll et al., 2003).

Generally, the types of temporary and permanent impacts on BLM-listed plant species would be the same as for other vegetation (see section 4.5). Impacts from ground disturbance activities in occupied habitat could directly affect BLM sensitive and watch list plant species, if present. These potential effects on rare plant populations could range from minor to significant depending on the proportion of the plant populations affected, their ability to recover from disturbance, and the species' conservation status. Direct impacts could include the loss of individual plants or plant populations due to right-of-way clearing and long-term degradation or alteration of suitable habitat. Indirect construction impacts could include off-site sedimentation due to stormwater runoff and fugitive dust, which could degrade habitat, damage individual plants, and reduce productivity. Additional impacts and mitigation are discussed in sections 4.5.2 and 4.5.3. Impacts on BLM-listed plant species would be reduced by AGDC's adherence to its Project Invasives Plan, ISPMP, and Revegetation Plan during construction and operation, and its implementation of our recommendations in sections 4.5.2, 4.5.5, and 4.5.8. For work within BLM ACECs, including the Galbraith Lake ONA and Toolik Lake RNA, BLM could require special status plant surveys and setbacks from known or discovered populations of special status plants.

Project construction and operation would result in the permanent loss of vegetation on BLM-managed lands from permanent Project infrastructure, granular fill, and excavation, and the short-term to permanent alteration of vegetation due to clearing, disturbance, and fragmentation. BLM-listed plant species have no documented occurrences in the Project area; therefore, impacts would not likely be significant.

Invertebrates

Impacts on BLM-listed aquatic invertebrates such as the Alaska sallfly and mayfly would be similar to those described for BLM-listed fish. In-stream impacts from pipeline crossings could affect insects in the water by disturbing their habitat or causing injury to individuals. Increases in turbidity could temporarily reduce water quality for aquatic invertebrates, but these impacts would be minor and temporary. Impacts on BLM-listed terrestrial invertebrates (e.g., bumblebees and butterflies) could occur from the clearing of vegetation used as food sources and from destruction of overwintering burrows for female bumblebees. As described in section 4.5 and for BLM-listed plant species, impacts would range from temporary to permanent, while some habitats may not fully recover, particularly forested habitats and habitats affected by granular fill. Loss of overwintering bumblebees would be limited to locations where grading would occur in the winter; therefore, impacts on bumblebees from grading would be limited and temporary.

Noise

Construction and operational activities would generate noise disturbance that could affect BLM sensitive and watch list bird and mammal species during all Project phases. Birds could react to noise created from vehicle traffic, airplanes, helicopters, blasting, and human activity associated with Project construction activities. Sources could include single impulse sounds (e.g., blasting), multiple impulses (e.g., jackhammers, pile driving), and non-strike continuous noise (e.g. construction sounds). Continuous sounds would also be associated with operational facilities and activities such as compressor stations, MLVs, and camp use. Noise generated from operation of the compressor stations would not reach the 93-dBA level for temporary threshold shifts (i.e., behavioral effects) for birds outside of the facility footprint (Dooling and Popper, 2016). Birds that enter the footprints of these facilities could experience behavioral and energetic effects. As described in section 4.6.1, in order to reduce effects on wildlife from noise at compressor stations, AGDC would implement measures such as burying piping outside the compressor building underground, engineering all aboveground exterior piping to inhibit sound radiation, and installing the compressor units in an acoustically designed building.

BLM sensitive and watch list birds could become displaced from their nesting habitat if construction activities (e.g., pile driving and blasting) are initiated early in the nesting season. Noise from blasting activities associated with construction could disturb nesting BLM sensitive or watch list birds. As discussed in section 4.6.2, disturbance and nest abandonment could result in inadvertently damaging eggs (e.g., egg knuckling) of raptor species, including eagles. Noise impacts on golden eagles and associated mitigation measures to minimize impacts on eagles and their nesting habitat are described in section 4.6.2. Noise can lead to fitness costs, either directly or indirectly (Francis and Barber, 2013), including energetic costs expended in responding to disturbance (e.g., flushing and increased stress). Behavioral responses to disturbance can include reduced feeding, increased vigilance, and a reduction in parental care.

Impacts on wildlife range from mild to severe and include damage to the auditory system, masking of sounds important to survival and reproduction, imposition of chronic stress and associated physiological responses, startle responses, interference with mating, and population declines (Schroeder et al., 2012; Blickley and Patricelli, 2010). Noise associated with Mainline Facilities construction, including blasting, during sensitive seasons could temporarily displace BLM sensitive or watch list small mammals, such as the Kenai marten, that may breed, reproduce, forage, winter, or den near the Mainline Pipeline right-of-way. Terrestrial wildlife could suffer temporary or permanent hearing loss due to exposure to loud sound pressure levels; however, most terrestrial wildlife would be capable of avoiding construction sounds that could be physically damaging. To reduce noise disturbance impacts on birds and small mammals from blasting, AGDC committed to performing non-lethal hazing to clear areas of wildlife prior to blasting (see section 4.6.1).

Noise associated with operation could permanently displace wildlife around facilities such as compressor stations. Additional details on operational noise impacts on wildlife and birds are found in sections 4.6.1 and 4.6.2, respectively.

Noise impacts would be short term (construction) and long term (operation); however, noise impacts would not be significant due to the limited extent of the noise disturbance.

Lighting

Artificial lighting would be used during construction and operational activities throughout the Project area and would have impacts on BLM-listed species. Sources providing artificial lighting that could pose risks for injury to BLM-listed birds (e.g., bar-tailed godwit, Hudsonian godwit, and red knot) include facility lighting, tower or antenna lighting, lighting on docks or anchored marine barges and vessels, and flare tower operations. Ground-level artificial lights can disturb bird migration by disrupting their natural navigation and attracting them to structures that increase collision risk (Watson et al., 2016). Artificial lighting could also reduce foraging activity (Longcore and Rich, 2004) and increase predatory risk for some bird species, as well as small mammals (e.g., Kenai marten). Section 4.6.2 presents additional lighting impacts on birds and mitigation measures AGDC would implement to reduce those impacts. Examples of avoidance, minimization, and mitigation measures that would be implemented to reduce lighting impacts on birds, which would also reduce impacts on small mammals, include:

- use of localized task lights (e.g., use of light hoods to reduce outward radiating lights);
- avoid use of steady-state red lights on structures;
- use of white (preferable) or red strobe lights for tower lighting and set at the minimum number of flashes per minute allowable by the FAA (if possible, solid red or pulsating red warning lights at night should be avoided); and
- use of down-shielded lighting on buildings, freestanding lighting, or security lighting for on-pad facilities and equipment to reduce excess light in habitats.

With implementation of these measures, lighting impacts would not be significant.

Collisions

BLM sensitive and watch list birds, including the golden eagle, short-eared owl, and trumpeter swan, would be susceptible to collisions with buildings, towers, and/or guy wires associated with Project facilities. Project-related vehicular traffic could increase collision risks for birds and mammal species. However, most birds would be able to avoid construction equipment. Small mammals such as the Kenai marten may occur near construction activities and could be killed or injured by vehicles.

Because aircraft would be used to transport personnel during Project construction and operation, there would be an increase in air traffic. BLM sensitive and watch list bird species could collide with planes during landing and takeoff. In addition, low-level overflights could be disruptive to colonial-nesting waterfowl and seabirds. BLM sensitive and watch list species vulnerable to these impacts include the bar-tailed godwit, buff-breasted sandpiper, red-throated loon, and yellow-billed loon.

Measures to minimize the potential for bird collisions with Project facilities (e.g., designing communication towers to avoid lattice and guy wires and reducing surfaces on building where birds could roost or nest), and minimize impacts on bald and golden eagles and nesting habitat, are addressed in section 4.6.2. Measures to avoid, minimize, and/or mitigate impacts from collisions on terrestrial wildlife are addressed in section 4.6.1 and include maintaining roadway visibility through vegetation trimming, limiting travel speeds on new project roads, and training construction personnel regarding wildlife hazards while driving. With implementation of these measures, collision impacts would not be significant.

Water Withdrawals

Water withdrawals from surface waters would not be expected to affect BLM-listed aquatic invertebrates because the pumps would be submerged and the insects would fly away when disturbed by activities associated with placement of the pump in the waterbody.

For hydrostatic testing of the Mainline Pipeline, AGDC would withdraw water from the Yukon River where Alaskan brook lamprey may occur. Based on a recommendation to reduce impacts on sensitive fish species (see section 4.7.1), withdrawals from the Yukon River would be limited to no more than 20 percent of current flow; no more than 0.5-foot-per-second water withdrawal velocities would be used; water withdrawal pumps would be raised from the streambed; and a maximum of 0.25- or 0.1-inch screening would be used. Implementation of these measures would minimize impacts on Alaskan brook lamprey.

Spills and Waste

Mainline Facilities construction would involve transport, handling, and storage of large and small quantities of hazardous materials, including diesel fuel and gasoline. Spills and leaks of oil or wastewater from Project activities that reach wildlife habitats could result in direct impacts on the health of BLM sensitive and watch list species. Spills could originate from fuel trucks, improperly maintained equipment, and the improper use and storage of fuels, lubricants, and other hazardous materials. Oil spills could affect BLM sensitive and watch list species through direct ingestion or contact as well as inhalation or absorption through gills. As discussed in section 4.6.2, birds could be susceptible to hypothermia once their feathers are coated with oil and they no longer provide insulation from the cold. Similarly, if the fur of small mammals contacts oil, it could lose its insulating properties, which could result in hypothermia. Additionally, birds could have a difficult time finding food and escaping predators if their plumage is oiled (Ober, 2013).

Activity associated with spill cleanup efforts could also disturb and displace individuals in their habitats. All waste, including oily wastes, contaminated soils, and absorbent materials would be stored and disposed of following state and federal regulations as well as methods outlined in the Project SPCC and Waste Management Plans. Storage containers, for example, may require approval by ADEC and secondary containment. Additional agencies requiring regulations for oil and hazardous substances pollution control, discharge reporting, cleanup, and disposal include the EPA and Coast Guard. State and federal agencies and regulations are further discussed in the Project Waste Management and SPCC Plans.

All construction waste would be handled in accordance with the Project Procedures as well as the Project Waste Management Plan minimizing impacts on BLM sensitive and watch list species. Accidental spills would be temporary but could result in direct and indirect impacts on BLM sensitive and watch list species. Implementation of the Project SPCC Plan, SWPPP, Project Procedures, and Project Waste Management Plan would reduce the likelihood of spills and the magnitude of impacts on BLM sensitive and watch list species if spills should occur.

Human Presence

The construction and use of camps along the Mainline Facilities would create the potential for wildlife–human interactions and changes in wildlife behavior or habitat use (see sections 4.6.1 and 4.6.2). Construction activities and associated human disturbance could have an impact on BLM sensitive and watch list species and result in displacement of wildlife from the area. Human disturbance from vehicular and pedestrian traffic could affect bird activity and have negative impacts on nest density and success.

Impacts on BLM sensitive and watch list bird and mammals species could also include an increase in hunting pressure from humans and predators because of new access roads and cleared right-of-way.

Wildlife could be attracted to construction camps and food odors. BLM sensitive and watch list species, including nesting trumpeter swans, could be affected by an increase in predators. The Alaskan brook lamprey could be affected by human activity and exposure to waste around construction camps. Project facilities along the Mainline Pipeline would contribute to an increase in noise and light from human activities in the area and could result in displacement of BLM sensitive species for the duration of the activity. Measures in the Project Wildlife Avoidance and Interaction Plan would include measures to reduce interactions between humans and wildlife. With implementation of these measures, as well as those in the Project Waste Management Plan and Project Procedures, human disturbance impacts would not be significant.

4.8.3 State of Alaska Special Status Species

ADF&G is responsible for determining and maintaining a list of potentially vulnerable species listed as threatened and endangered species in Alaska under AS 16.20.109. The Alaska State Endangered Species List includes the federally listed short-tailed albatross, Eskimo curlew, blue whale, humpback whale, and right whale, which are discussed in section 4.8.1. In addition, ADF&G uses the 2015 Wildlife Action Plan (ADF&G, 2015a) as a guide to prioritize SGCN. Criteria for determining species considered as SGCN include at least one of the following (ADF&G, 2015a):

- at-risk species;
- stewardship species;
- culturally important species;
- economically important species;
- ecologically important species; and/or
- sentinel species.[84]

4.8.3.1 Species Descriptions

Alaska's SGCN list includes over 375 species including freshwater and marine invertebrates, marine zooplankton, terrestrial arthropods, and vertebrates (ADF&G, 2015a, 2018h). Vertebrate groups included on the SGCN list include 58 fish, 5 amphibians, 192 birds, and 71 mammals (ADF&G, 2015a). Excluded species from Alaska's list of SGCN include plants, hunted and trapped species, numerous marine aquatic species, reptiles, and peripheral species (e.g., rare or accidental occurrences) (ADF&G, 2015a). Alaska's *Wildlife Action Plan* previously adapted the Alaska Species Ranking System (Gotthardt et al., 2012) to reflect the taxonomic standing for mammal species, and followed Gibson and Withrow (2015) for the inventory of species and subspecies of Alaska birds. Table P-2 in appendix P lists 26 high priority SGCN (20 avian species and 6 marine mammals) that could occur in the Project area.

4.8.3.2 Impacts and Mitigation

Construction and operational activities associated with the Project could affect the SGCN identified in table P-2 in appendix P. Impacts on, and avoidance, minimization, and mitigation measures for, avian

[84] Sentinel species are organisms, often animals, used to detect risks to humans by providing advance warning of a danger. Sentinel species are used as indicators of ecosystem health or environmental change (ADF&G, 2015a; Pearce and Venier, 2005; Caro and O'Doherty, 1999). Indicator or sentinel species are often long-lived predators at the top of the food web, and are often of great public interest including marine mammals as sentinel species for oceans and human health (Bossart, 2006).

resources, marine mammals, and federally listed species are discussed in sections 4.6.2, 4.6.3, and 4.8.1, respectively.

Construction and operational impacts and disturbances on avian resources discussed in section 4.6.2 would also apply to SGCN avian species. Habitat effects would have the greatest effect on State of Alaska special status avian species. Construction would cause the loss and degradation of a variety of vegetated habitats including forested, scrub/shrub, and herbaceous vegetation communities. The temporary and permanent loss of habitats associated with construction and operational activities could present a long-term impact for State of Alaska special status avian species that depend on these habitat types. Project construction and operational impacts, including noise, lighting, collisions, and human disturbance, are discussed in section 4.6.2.

Construction and operational impacts and disturbances on marine mammals discussed in sections 4.6.3 and 4.8.1.3 would apply to SGCN marine mammals. Noise and related underwater activities would have the greatest effect on State of Alaska special status marine mammal species. Construction would cause habitat degradation from underwater noise in Prudhoe Bay and Cook Inlet. Longer-term impacts on suitable and occupied habitat could occur from permanent marine facilities. Project construction and operational impacts including prey availability, vessel strikes, water quality, human disturbance, and invasive species are discussed in sections 4.6.3 and 4.8.1.3.

4.8.4 Conclusion

We determined that Project construction and operation would have no effect on 2 federally listed species and is not likely to adversely affect 23 federally listed species. We determined that six federally listed species (spectacled eider, polar bear, bearded seal, Cook Inlet beluga whale, humpback whale, and ringed seal) and critical habitat for two species (polar bear and Cook Inlet beluga whales) is likely to be adversely affected. Permanent loss of suitable habitat and effects from spills and human activities would be limited, and AGDC would minimize these impacts by implementing Project construction plans. Vessel traffic and noise impacts from pile driving, anchor handling, dredging, and screeding, however, may result in the take of some species.

Project construction and operation would not significantly affect BLM sensitive and watch list species as impacts primarily would be short term and minor. Permanent habitat loss would be small in comparison to other habitat available for use. AGDC would minimize species and habitat impacts by implementing the Project construction and restoration plans. Impacts on BLM sensitive and watch list species would not contribute to federal listing and would not be significant.

Project construction and operation is also not expected to result in significant effects on SGCN avian resources and marine mammals because impacts primarily would be short term and minor. Permanent habitat loss would be small in comparison to other habitat available for use. AGDC would minimize species and habitat impacts by implementing the Project construction and restoration plans. The exception is the potentially significant impact on Cook Inlet beluga whales from placement of, and activities associated with, the MOF in sensitive critical habitat. Impacts on State of Alaska special status species would not contribute to federal listing and would not be significant.

4.9 LAND USE, RECREATION, AND SPECIAL INTEREST AREAS

This section provides a discussion of existing conditions for land use, recreation, and special interest areas, and the potential impacts of construction and operation of the Project on those resources. These descriptions and analyses address a range of topics, including land use, land ownership, planned development, recreation areas (including special use areas [SUA]), special interest areas, and hazardous waste sites.

4.9.1 Land Use / Land Cover

Land use classifications were made in the Project area using data from the National Land Cover Database (NLCD) 2011 (USGS, 2015c) with land use types assigned based on the dominant vegetative cover and/or use of the land (e.g., forested land). Six primary land use/land cover types identified in the Project area are described below.[85]

- **Agricultural Land**: Agricultural lands include actively cultivated cropland and pasture/hay fields. Cultivated cropland areas are those used for the production of annual crops and orchards, while pasture/hay fields areas are those areas where grasses and/or legumes are planted for livestock grazing or the production of hay crops.

- **Commercial/Industrial Land**: Commercial/industrial lands are highly developed areas, including power or utility stations, manufacturing or industrial plants, commercial or retail facilities, roads, military restricted areas, and oil and gas developments.

- **Forested Land**: Forested lands include tracts of upland or wetland deciduous, evergreen, or mixed forest, dominated by trees generally greater than 16.4 feet (5 meters) tall. Additional information concerning forested lands crossed in the Project area is provided in section 4.5.

- **Open Land**: Open lands include non-forested areas of barren land and areas of dwarf scrub/shrub, grasslands, sedges, emergent herbaceous wetlands, lichens, and/or mosses. Additional information concerning wetland vegetation crossed in the Project area is provided in section 4.4.

- **Open Water**: Open water includes traditional open water areas and areas with perennial ice and snow coverage. Permafrost areas are discussed in more detail in section 4.2.2 and waterbodies in section 4.3.

- **Residential Land**: Residential lands include lawns in residential subdivisions and single-family housing units, multi-family housing units, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

4.9.1.1 Existing Land Use

Table 4.9.1-1 summarizes existing land uses within the Project's construction and operational footprints. These land use classifications are based on interpretation of large-scale imagery from the NLCD database. While the NLCD database is the best available dataset applicable to the Project facilities, it does not provide the precise locations and extent of waterbodies and wetlands. Sections 4.3 and 4.4 provide information on waterbodies and wetlands, respectively.

[85] Maps of land use/land cover types were included as appendix 8A to Resource Report 8 in AGDC's FERC application (Accession No. 20170417-5345). These maps are available on the FERC website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter 20170417-5345 in the "Numbers: Accession Number" field.

TABLE 4.9.1-1

Land Use Types Affected by Construction and Operation of the Project Facilities (acres)

	Agricultural Land		Industrial/ Commercial Land		Forested Land		Open Land		Open Water		Residential Land [a]		Total [b]	
	Cons.	Oper.	Cons.	Oper.	Cons.	Oper.	Cons.	Oper.	Cons.	Oper.	Cons.	Oper.	Cons.	Oper. [c]
Gas Treatment Facilities														
GTP	0	0	4	4	0	0	271	271	9	9	0	0	284	284
West Dock Causeway	0	0	2	0	0	0	204	0	47	0	0	0	253	0
Gravel Mine	0	0	0	0	0	0	140	140	1	1	0	0	141	141
Water Reservoir	0	0	0	0	0	0	30	30	5	5	0	0	35	35
PBTL	0	0	<1	<1	0	0	7	7	0	0	0	0	7	7
PTTL	0	0	20	8	0	0	1,985	595	40	7	0	0	2,045	610
Additional Work Areas	0	0	60	60	0	0	233	223	30	30	0	0	323	313
Gas Treatment Facilities Total	**0**	**0**	**88**	**72**	**0**	**0**	**2,870**	**1,266**	**132**	**52**	**0**	**0**	**3,090**	**1,391**
Mainline Facilities														
Mainline Pipeline														
Onshore right-of-way	<1	<1	0	0	5,813	2,317	6,324	2,583	40	16	310	98	12,488	5,013
Offshore right-of-way	0	0	0	0	0	0	0	0	5,070	330	0	0	5,070	330
Aboveground Facilities	0	0	0	0	130	128	141	138	0	0	2	0	272	266
Additional Work Areas	2	0	3	0	5,851	293	5,378	260	224	0	871	83	12,329	636
Mainline Facilities Total	**3**	**<1**	**3**	**0**	**11,794**	**2,738**	**11,843**	**2,981**	**5,333**	**346**	**1,183**	**181**	**30,159**	**6,244**
Mainline Facilities Total Excluding Offshore Right-of-Way	**3**	**<1**	**3**	**0**	**11,794**	**2,738**	**11,843**	**2,981**	**264**	**16**	**1,183**	**181**	**25,090**	**5,915**
Liquefaction Facilities														
LNG Plant	0	0	9	9	473	473	159	159	1	1	260	260	902	902
Marine Terminal Facilities	0	0	0	0	0	0	27	<1	73	19	0	0	100	19
Additional Work Areas	0	0	0	0	38	0	14	<1	1,218	0	29	0	1,299	0
Liquefaction Facilities Total	**0**	**0**	**9**	**9**	**511**	**473**	**183**	**159**	**1,292**	**20**	**289**	**260**	**2,301**	**921**
Project Total	**3**	**<1**	**100**	**82**	**12,305**	**3,211**	**14,896**	**4,406**	**6,757**	**418**	**1,472**	**442**	**35,550**	**8,556**
Percent of Total	<1%	<1%	<1%	1%	35%	38%	42%	51%	19%	5%	4%	5%	100%	100%
Project Total Excluding Offshore [d]	**3**	**<1**	**100**	**82**	**12,305**	**3,211**	**14,896**	**4,406**	**488**	**88**	**1,472**	**442**	**30,481**	**8,226**
Percent of Total Excluding Offshore	<1%	<1%	<1%	1%	40%	39%	49%	54%	2%	1%	5%	5%	100%	100%

[a] Based on a review of aerial imagery of the Project,[86] the areas designated by NLCD as residential in the PBU for the GTP, PTTL, PBTL, and Mainline Facilities are actually industrial in character and are specifically developed for oil and gas activity. The category of land use prior to acquisition is reflected for the Liquefaction Facilities site, not the current ownership by the Project.

[b] The totals shown in this table may not equal the sum due to rounding.

[c] Acreage of a facility is not included in the total when it occurs within the construction or operational footprint of another facility (e.g., MLVs, meter stations). This includes PTTL MLVs (0.3 acre), PTTL meter stations (0.2 acre), MLVs (23.7 acres), Mainline meter stations (0.5 acre), and compressor station camps (27.3 acres).

[d] Excludes open-water acreage associated with Mainline Pipeline's offshore right-of-way and the offshore dredged material disposal area (1,200 acres) for the Liquefaction Facilities.

[86] Aerial imagery of the Project area was provided in appendix A of Resource Report 1 (Accession No. 20170417-5343), which is available on the FERC website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter 20170417-5343 in the "Numbers: Accession Number" field.

In total, about 35,550 acres of land and water are within the Project's construction footprint, including the offshore area to install the pipeline across Cook Inlet. Excluding offshore areas in Cook Inlet, the construction footprint is predominantly open land (49 percent) and forested land (40 percent). Residential and industrial/ commercial lands each account for 5 percent or less of the total construction footprint. A total of about 8,556 acres would be affected during operation. Excluding the offshore Mainline Pipeline crossing, existing land use within the Project's permanent operational footprint is predominantly open land (54 percent) and forested land (39 percent).

4.9.1.2 Impacts and Mitigation

Table 4.9.1-1 shows the land use types affected by the Project. Overall, open water, open land, and forested land account for about 96 percent of the Project's construction footprint and 94 percent of the operational footprint. The Project would have fewer impacts on agricultural, industrial/commercial, and residential lands.

Gas Treatment Facilities

The Gas Treatment Facilities would be within the PBU on land designated by the state for oil and gas production facilities and operations. The construction footprint of the Gas Treatment Facilities would be about 3,090 acres. This comprises about 1 percent of the PBU's total land and water area (254,264 acres) and about 2 percent of the PBU's total land area (175,432 acres) (ADNR, 2006b; USGS, 2015c). The operational footprint of the Gas Treatment Facilities would permanently convert about 1,391 acres of land (about 1 percent of the PBU's total land area) to industrial land use (USGS, 2015c). The primary land use affected by construction and operation of the Gas Treatment Facilities would be open land, accounting for 93 percent of the construction footprint and 91 percent of the operational footprint.

No agricultural, forested, or residential lands are within the Gas Treatment Facilities footprint; therefore, Gas Treatment Facilities construction and operation would have no impact on agricultural land.

<u>Industrial/Commercial Land</u>

Gas Treatment Facilities construction would affect 88 acres of existing industrial/commercial land. Access roads would be the primary source of impacts on industrial/commercial land during construction and operation.

One commercial building is within 200 feet of the Gas Treatment Facilities, about 57 feet from the PTTL workspace near PTTL MP 54.9. This structure is associated with existing oil and gas production. Project construction would add new oil and gas infrastructure to areas with similar existing infrastructure. Accordingly, Gas Treatment Facilities construction and operation would have minor, permanent impacts on industrial/commercial land.

<u>Open Land</u>

About 93 percent of the construction footprint and 91 percent of the operational footprint would be open land. New industrial land associated with the Gas Treatment Facilities would be similar to conversions associated with existing oil and gas infrastructure in the PBU. Accordingly, the Gas Treatment Facilities would have minor permanent impacts on open land.

Open Water

Gas Treatment Facilities construction would affect 132 acres of open water, less than 1 percent of the 76,335 acres of open water in the PBU, which includes Prudhoe Bay and a small portion of the Arctic Ocean (USGS, 2015c). Gas Treatment Facilities operation would permanently convert 52 acres of open water to industrial land. There would also be a permanent expansion of the existing causeway between Dock Head 3 and the Seawater Treatment Plant. The causeway would be expanded by about 35 to 60 feet on the eastern side. Because the Gas Treatment Facilities would affect a small area of the total open water within the PBU, the Gas Treatment Facilities would have minor permanent impacts on open water.

Mainline Facilities

Except where stated otherwise, the description of land use impacts from the Mainline Facilities refers only to the onshore portion of the Project, and excludes the offshore crossing and dredged material disposal area of Cook Inlet. As shown in table 4.9.1-1, construction and operation of the Mainline Facilities would primarily affect open land and forested land.

Agricultural Land

Mainline Facilities construction would affect about 3 acres of agricultural land, less than 1 percent of the agricultural land in Alaska (USGS, 2015c), of which less than 1 acre would be within the Mainline Facilities permanent right-of-way. During construction, the use of farming equipment and cultivation of row crops would likely not be possible in affected agricultural acres. Additionally, there is potential for soil erosion and damage to irrigation systems. The agricultural land affected by the Project is primarily surrounded by forested land.

AGDC would implement its Project Plan to minimize impacts on agricultural lands. According to its Plan, AGDC would monitor soil compaction in agricultural areas to determine if corrective action is needed and ensure imported soils are clean. In agricultural lands, the Mainline Pipeline would be installed via conventional trenching methods, along with topsoil segregation. During construction, AGDC would maintain natural surface water flow patterns by providing breaks in stockpiles of topsoil and subsoil. In addition, flow would be maintained in drainage systems to prevent ponding in adjacent undisturbed areas. Based on the temporary nature of impacts and the mitigation measures described above, construction of the Mainline Facilities would have minor and temporary impacts on agricultural land.

Industrial/Commercial Land

Construction of the Mainline Facilities would affect about 3 acres of industrial/commercial land, less than 1 percent of the 369,700 acres of developed land in Alaska (USGS, 2015c). Operation of the Mainline Facilities would not affect industrial/commercial land. There are 13 industrial or commercial buildings or properties within 200 feet of the Mainline Facilities construction footprint, including one building within the footprint, and six other buildings within 50 feet of the Mainline Facilities footprint (see table 4.9.1-2). These nearby industrial and commercial facilities are in Coldfoot, the area near the DNPP known as McKinley Village (sometimes referred to as Glitter Gulch), an area near MP 560.0, and at Byers Lake Campground in Denali State Park, near MP 630.1.

The Mainline Facilities would not cross driveways or access roads for the industrial or commercial lands listed in table 4.9.1-2. AGDC would obtain agreements for construction activities for the Mainline Pipeline, construction camp, and pipe storage yard adjacent to the commercial properties in Coldfoot (near MP 243.1). The Project would increase construction noise and traffic in Coldfoot, the industrial and commercial facilities in Coldfoot operate as a commercial truck stop. Project construction would not block access to the Coldfoot businesses, and would generally be consistent with existing commercial uses. AGDC states that the construction camp and pipe storage yard at Coldfoot would be converted to an expanded gravel parking area following construction, and that this expanded parking area would be conveyed to the operators of the existing commercial facilities as part of a construction use agreement. All other workspaces would be restored to pre-construction conditions. Therefore, impacts on commercial and industrial land use in Coldfoot would be minor and permanent.

TABLE 4.9.1-2

Industrial/Commercial Buildings Within 200 Feet of the Mainline Facilities Footprint

Proposed Facility	Nearest Mainline Pipeline Milepost	Commercial Building Description	Distance from Edge of Construction Work Area, Property Boundary, or Access Road (feet)	Direction to Nearest Edge of Footprint
Access road	241.3	Coldfoot Hotel	25	South
Access road	241.3	Coldfoot Garage	20	South
Access road	241.3	Coldfoot Restaurant	25	East
Access road	526.6	Hotel	144	North
Access road	529.7	Denali Recreational Vehicle Park and Motel	141	Northeast
Access road	536.1	Commercial building	190	Northwest
Mainline Pipeline, ATWS, access road	536.2	Commercial building	155	North
Mainline Pipeline, ATWS, access road	536.2	Commercial building	25	East
Mainline Pipeline, ATWS, access road	536.2	Commercial building	123	North
Mainline Pipeline, ATWS, access road	536.2	Commercial building	171	Northeast
Material site	560.0	River Tour Operator Site	0	South
Material site	630.1	Byers Lake Campground	50	East
Access road	630.7	Byers Lake Campground Cabin	20	North

To minimize construction impacts, including construction traffic and pipe lay, on commercial businesses near McKinley Village and MP 536.2, AGDC would schedule pipe lay outside of the peak tourist season and would implement its Traffic Mitigation Plan for work that occurs during the tourist season. Preparation for pipe lay would occur in the spring and fall when commercial activity is present. Project-related trucks and employee buses would create traffic congestion in and near McKinley Village, which could affect commercial activity. Impacts on commercial and industrial land use in McKinley Village would be minor and temporary.

A river tour operator uses the property within the material site footprint at MP 560.0 as a destination for bus tours. This property would be closed for the duration of material site activities. AGDC states that it would develop a site-specific material site activities schedule to minimize disruption, although a specific schedule has not been provided. Impacts on the river tour operation and commercial land use at this site would be temporary but potentially significant.

AGDC states that the material site near MP 630.1 and Byers Lake Campground is an alternate material site that would only be used with state approval. The Byers Lake cabin within the park would be adjacent to the access road leading to the material site, while a portion of the campground would be within the material site itself. If this material site should be used by AGDC, public access to the cabin and the campground would be restricted during construction, and the portion of the campground within the material site would be permanently removed.

AGDC has committed to providing a detailed schedule of construction activities within Byers Lake Campground and at the river tour operator site. Given the potential impact on public access to these areas, **we recommend that:**

- **<u>Prior to construction within Byers Lake Campground (MP 630.1) and the river tour operator site (MP 560.0)</u>, AGDC should file with the Secretary, for the review and written approval of the Director of the OEP, and provide to the ADNR Division of Parks and Outdoor Recreation and the affected river tour operator, as appropriate, a detailed schedule of construction activities within Byers Lake Campground and the river tour operator site.**

Assuming execution of a use agreement for the area adjacent to the Coldfoot businesses, Project construction overall would have a minor temporary impact on most commercial/industrial land uses within the Project area. The Project would have a minor but permanent impact on the Byers Lake Campground if the alternate material site is used; a temporary, but potentially significant, impact on the river tour operator site; and no impact on other commercial/industrial lands. The impacts on the river tour operator site would last for the duration of activities at the material site near MP 560.

<u>Open Land</u>

Construction of the Mainline Facilities would affect 11,843 acres of open land, less than 1 percent of the more than 230 million acres of open land in Alaska (USGS, 2015c). Operation of the Mainline Facilities would affect 2,981 acres of open land, also less than 1 percent of open land in Alaska (USGS, 2015c). Open land within the construction right-of-way would be cleared in the season prior to its construction and would remain unvegetated until construction is completed. After final construction cleanup, AGDC would restore the Mainline Facilities footprint, except for the aboveground facilities. Restoration would be consistent with AGDC's Revegetation Plan and would include backfilling the right-of-way with native materials and imported granular fill and allowing non-forested vegetation to grow over the right-of-way.

Construction and operation of the aboveground facilities would permanently convert about 138 acres of open land to industrial land. This permanent change in land use would have a minor and permanent impact on land use.

<u>Forested Land</u>

Mainline Facilities construction would affect 11,794 acres of forested land, less than 1 percent of the more than 85 million acres of forested land in Alaska (USGS, 2015c). This includes about 1,583 acres of forested land within state-owned or managed areas. Alaska's plant communities provide timber and non-timber forest products. Timber products include lumber, energy wood products such as wood pellets and firewood, tonewood for musical instruments, and novelty items like bowls, spoons, mugs, and knife handles (Berg et al., 2011). Section 4.11.2 discusses the economic aspects of the timber industry in Alaska, while section 4.5.1 discusses forest communities.

There are no lands in the Project area owned or managed by timber companies. Other entities such as private landowners and Alaska Native corporations may harvest forested resources, but active commercial harvests are not known to occur in the Project footprint. Areas along the Mainline Pipeline right-of-way include forests that could be available for timber production. These areas include BLM lands and state lands that have been designated as forest resources by the ADNR, including the Tanana Valley State Forest, lands elsewhere in the Tanana Valley, and lands farther south in the Susitna Valley and on the Kenai Peninsula (Hanson, 2012, 2013, and 2014). The Environmental Impact Statement for BLM's (1991)

RMP for the Utility Corridor states that there are no indications that commercial harvesting of timber would occur during the life of the Project on BLM lands.

Clearing of forested land within the construction right-of-way would occur during site preparation. Where feasible, AGDC states that it would identify salvaged timber from cleared lands that could be made available for sale or donation, as appropriate. In its comments on AGDC's application, BLM requested that downed trees be made available to local residents for firewood. Such provisions, along with other stipulations for removing timber from workspaces on BLM land, would be addressed in permits or licenses issued to AGDC by the BLM (or ADNR for state forest land). AGDC states that it will prepare a Timber Management Plan as part of BLM right-of-way lease and grant permitting activities. Although AGDC states that the Alaska Forest Resources and Practices Act (AS 41.17) is not applicable to the Project, AGDC would nonetheless implement BMPs designed to prevent adverse impacts on fish habitat and water quality—consistent with the intent of the state act and its associated regulations found in 11 AAC 95.

The Mainline Pipeline construction footprint would remain unvegetated until construction is completed. After Project construction, previously forested areas within the construction right-of-way, but outside the permanent right-of-way, would revert to pre-construction conditions. While reversion to pre-construction conditions would not necessarily be required by regulatory agencies, it is anticipated that the area would take many years to return to pre-construction conditions. As discussed in sections 4.5.3 and 4.5.2, full regrowth of trees and reestablishment of forest in the construction right-of-way would take several decades, depending on species, soil quality, and location. Forests in the northern part of Alaska and at higher altitudes where permafrost occurs would recover at a slower rate. Forests in the southern part of the state and at lower altitudes in non-permafrost areas would recover more quickly. As a result, based on the Project's nominal 30-year design life (see section 2.1), and the quantity of forest vegetation cleared, Mainline Facilities construction would have significant permanent impacts on forests.

Maintenance of the Mainline Pipeline right-of-way would permanently convert forest communities to scrub and herbaceous communities within a 10- to 30-foot-wide corridor centered on the pipeline (see section 4.5.2). As a result, operation of the Mainline Facilities would affect 2,738 acres of forested land, less than 1 percent of the more than 85 million acres of forested land in Alaska (USGS, 2015c). Of that total, about 2,559 acres would be permanently converted to open land. This includes about 528 acres of forested land within state-owned or managed areas. The remaining permanently converted 179 acres within the Mainline Facilities permanent footprint would be aboveground Mainline Facilities (about 128 acres), permanent access roads (about 49 acres), or helipads (about 2 acres). AGDC would conduct vegetation mowing or clearing in upland portions of the permanent right-of-way no more frequently than every 3 years.

While the forested land affected by the Mainline Facilities would be small compared to the amount of forested land in Alaska, the forested land lost and the conversion of forested land to industrial land (i.e., the aboveground facilities) would be permanent due to the time it would take for forested land to be restored to pre-construction conditions.

<u>Residential Land</u>

Construction of the Mainline Pipeline would affect 1,183 acres of residential land. About 871 acres (74 percent) of this total is affected by additional workspace associated with Mainline Pipeline construction. Construction impacts on residential buildings near the Mainline Pipeline would be temporary and would include blocked access, noise, dust, and other visual impacts.

AGDC would implement the general mitigation measures below to reduce the impacts of Mainline Pipeline construction on residences within 200 feet.

- Before construction begins, AGDC would conduct field surveys to confirm the location of buildings relative to the Mainline Pipeline, ascertain whether the buildings are occupied residences, and, if so, whether the residences house businesses and are seasonal or permanent.

- AGDC would identify and implement site-specific measures to control dust, noise, remove trash, secure the workspace, and reduce visual impacts.

AGDC has identified only one residence within 50 feet of Mainline Pipeline right-of-way; a second residence is within 50 feet of an access road (see table 4.9.1-3). However, field surveys could identify additional residences. For residences within 50 feet of construction work areas, AGDC would implement the following general mitigation measures:

- perform construction activity (excavation, installation, and backfilling) within 50 feet of a residence during daylight hours and in the same day, and ensure that open ditches are barricaded, plated, or fenced off when construction activities are not in progress;

- avoid removal of mature trees and landscaping within the construction work area unless necessary for safe operation of construction equipment, or as specified in landowner agreements;

- fence the edge of the construction work area for a distance of 100 feet on either side of the residence; and

- restore all lawn areas and landscaping immediately following cleanup operations, or as specified in landowner agreements.

In addition to these general measures, AGDC would maintain access to the residence at MP 471.9, would coordinate construction across the residence's driveway with the owner before construction, and would repair and return the driveway to its pre-construction condition. Before beginning work near this residence, AGDC would have materials, equipment, and workers on hand to trench, place the pipe, and backfill.

During operation, the Mainline Facilities would permanently affect 181 acres of residential land. Permanent impacts on residential areas would include 98 acres of permanent right-of-way for the buried Mainline Pipeline, and 83 acres of residential land converted to permanent access roads (shown in table 4.9.1-1 as additional work areas). Landowners would not be able to complete any subsurface construction (i.e., construction of building foundations) in the permanent right-of-way.

Project construction and operation would affect residential land, but with implementation of the mitigation measures, construction would have short-term, minor impacts on residential land. No residences would be affected by operation of the Mainline Facilities.

Open Water

Construction of the onshore Mainline Facilities would affect 264 acres of open water, including 16 acres of open water within the permanent right-of-way. This open water primarily consists of rivers, lakes, and creeks that would be crossed or affected by Mainline Pipeline construction. Following pipeline construction, previous open water areas would revert to pre-construction uses, including 16 acres that would remain as open water within the permanent right-of-way. During operation, open water areas would not be impeded by the buried pipeline. Section 4.3.2 describes the waterbody crossings, construction method, construction timing, and anticipated impacts of the onshore portion of the Mainline Facilities on waterbodies. Overall, impacts of the onshore portion of the Mainline Facilities on open water use would be minor and temporary.

TABLE 4.9.1-3

Residential Buildings Within 200 Feet of the Mainline Facilities

Facility	Nearest Mainline Pipeline Milepost	Building Description	Distance to Edge of Construction Work Area, Property Boundary, or Access Road (feet)	Direction to Nearest Edge of Facilities
Access road	236.4	Residence	177	Northeast
Access road	241.1	Residence	100	South
Access road	241.1	Residence	150	West
Mainline Pipeline	438.8	Residence	189	Northwest
Access road	470.7	Residence	98	Northwest
Mainline Pipeline	471.9	Residence	48	North
Mainline Pipeline	472.0	Residence	181	North
Material site	566.0	Residence	161	East
Material site	566.0	Residence	142	West
Mainline Pipeline	556.5	Residence	149	North
Access road	566.5	Residence	25	North
Access road	566.7	Residence	128	South
Access road	566.7	Residence	182	South
Trapper Creek pipe storage yard	664.7	Residence	160	East
Mainline Pipeline	727.8	Residence	182	South
Mainline Pipeline	797.2	Residence	179	South
ATWS	805.4	Residence	200	West

Construction of the offshore Mainline Pipeline would affect 5,070 acres of open water, less than 1 percent of the more than 5.1 million acres of open water in Cook Inlet (Inletkeeper, 2017). In-water work would include trenching of the shoreline approaches, installation of the pipeline, burying, and cleanup. Between the shoreline approaches, the pipeline across Cook Inlet would be laid on the bottom using a lay barge. The majority of the ocean bottom within the offshore construction right-of-way area would not be disturbed, because the right-of-way includes the breadth of the anchor spread for the pipeline lay barge (up to 1 mile on either side of the lay barge). Areas outside of anchor locations and the pipeline route itself would not be disturbed.

During operation of the offshore Mainline Pipeline, about 330 acres of ocean floor, listed in table 4.9.1-1 as open water, would be within the permanent right-of-way (less than 1 percent of open water in Cook Inlet). Within Cook Inlet, the pipeline would either be sitting on the seabed or buried at the shoreline crossings, but would not convert open water to any other land use. As a result, from a land use perspective, impacts on open water from offshore Mainline Pipeline construction would be temporary and minor, while there would be no impacts from operation.

There is no open water within the footprint of the aboveground Mainline Facilities; therefore, construction and operation of these facilities would have no impact on open water.

Liquefaction Facilities

As shown in table 4.9.1-1, construction and operation of the Liquefaction Facilities would primarily affect forested land, residential land, and open water. There are no agricultural lands within the construction or operational footprint of the Liquefaction Facilities.

Industrial/Commercial Land

Construction and operation of the Liquefaction Facilities would affect about 9 acres of existing industrial/commercial land. There are 15 industrial or commercial buildings within the footprint of the LNG Plant, including the Nikiski Gas to Liquids facility, a gas station, a bar/restaurant, a laundromat, and several industrial service businesses. AGDC would purchase commercial and industrial land holdings within the LNG Plant footprint and remove those commercial and industrial structures prior to construction. The Liquefaction Facilities site is in an area of industrial/commercial development, including heavy industry such as the Kenai LNG facility, the Agrium fertilizer plant, and the Arctic Slope Regional Corporation Energy Services, LLC (ASRC) fabrication facility, and rig tenders dock. As such, construction of the LNG Plant and Marine Terminal would not change the type of existing land uses, and would have no impact on industrial/commercial land use.

Open Land

Construction of the Liquefaction Facilities would affect 183 acres of open land. This includes about 159 acres of open land that would be permanently converted to industrial uses. Open land within the Liquefaction Facilities footprint generally consists of non-contiguous patches of grasses or shrubs adjacent to existing industrial/commercial lands or stands of trees (see Forested Lands below) rather than contiguous areas. Due to the scattered nature of open lands, as well as the small amount of open land within the LNG Plant footprint (compared to the total open land within the Kenai Peninsula Borough), Liquefaction Facilities construction and operation would have permanent and minor impacts on open lands.

Forested Land

Liquefaction Facilities construction would affect 511 acres of forested land with about 473 acres permanently disturbed on the LNG Plant footprint and about 38 acres temporarily disturbed as LNG construction camp, construction laydown, and contractor yards. The previously forested land temporarily disturbed would be allowed to revert to forest, a process that would take decades. The remaining 473 acres of forested land within the LNG Plant footprint would be permanently converted to industrial land. Existing forested land within and near the LNG Plant footprint is fragmented by existing industrial/commercial lands. As a result, and based on the amount of forested land outside the Project footprint in the Kenai Peninsula Borough, impacts on forested land would be permanent and minor.

Residential Land

LNG Plant construction would affect 289 acres of residential land, of which 260 acres would be permanently converted to industrial uses and 29 acres would be temporary (e.g., within the footprint of the LNG construction camp). Ten residences are within the LNG Plant footprint. No other residential structures are within 200 feet of the LNG Plant footprint. AGDC would purchase residential land holdings and remove the residences prior to construction.

The closest residential development to the Liquefaction Facilities (aside from the residences within the footprint itself) is the community of Salamatof (0.4 mile south of the edge of the Liquefaction Facilities workspace), with about 300 residences. AGDC would implement the following mitigation measures to reduce the impacts of construction dust and visual effects on residences:

- notify landowners of the Project work schedule and activities;
- implement dust control measures such as water suppression, covering truckloads during transit, and limiting on-site vehicle speed (per the Project Fugitive Dust Control Plan); and
- ensure that construction lighting is shielded and directed toward the construction areas and away from neighboring residential areas.

The primary potential impact on nearby residential areas would be related to the lighting and noise associated with Project construction and operation as well as potential impacts on nearby residential land values. As discussed in section 4.10.2, the Liquefaction Facilities would have minor visual impacts on existing residents and employees and moderate visual impacts on recreational visitors.

As discussed in section 4.16.3, construction noise would likely be audible in nearby residential areas. AGDC has identified several potential noise mitigation measures, but has not yet committed to implementing these measures. Therefore, we are recommending that AGDC file a construction noise mitigation plan for the Liquefaction Facilities (see section 4.16.3). As discussed in section 4.16.4, the noise attributable to Liquefaction Facilities operation would be lower than FERC's sound level thresholds at the nearest noise sensitive area. As stated in section 4.11.5, construction and operation of the Liquefaction Facilities would not be expected to affect residential property values in the Project area.

Due to the nearby heavy industry and the acquisition of residential land within the Liquefaction Facilities footprint, and with the exception of the noise and visual impacts as described above, construction and operation of the Liquefaction Facilities would have minor but permanent impacts on residential land uses.

<u>Open Water</u>

Liquefaction Facilities construction would affect about 1,292 acres of open water in Cook Inlet, which is less than 1 percent of the more than 5.1 million acres of open water in the inlet (Inletkeeper, 2017). This includes about 1,200 acres of sea floor used as the Liquefaction Facilities offshore dredged material disposal area. Other sections of this document describe the impacts on fisheries, wildlife, transportation, and other resources affected by the in-water construction of the Liquefaction Facilities. Construction of the Marine Terminal and its MOF as well as the Mainline Pipeline would displace open water users (particularly commercial fishing vessels and recreational vessels).

During Project operation, 20 acres of open water in Cook Inlet would be permanently converted to industrial use associated with permanent infrastructure (i.e., mooring and breasting dolphins, fenders, the marine operations platform, and the access trestle). As described in section 4.12.2, LNG carriers in transit and docked at the Marine Terminal would have a 1,000-yard security zone (about 650 acres), within which other vessels are prohibited without prior authorization by the Coast Guard. Commercial fishing vessels operating in Cook Inlet routinely receive approval to fish within the security zone of LNG carriers calling on the existing Kenai LNG dock and would likely receive similar approval to fish within the security zones of LNG carriers calling at the Liquefaction Facilities. Recreational vessels would be less likely to obtain authorization. The Marine Terminal and LNG carrier security zone would occupy a small area of Cook Inlet; therefore, impacts on the availability of open water use would be minor and permanent.

4.9.2 Land Ownership and Easement Requirements

4.9.2.1 General Impacts and Mitigation

Land affected by Project construction and operation is owned or managed by the federal government, State of Alaska, one of the state's boroughs or cities, Alaska Native corporations or other Alaska Native entities, or private landowners. Table 4.9.2-1 summarizes the acreage of land ownership affected by Project construction and operation. Figure 4.9.2-1 depicts the boundaries of federal and state lands.[87] Table 4.9.2-2 summarizes the linear miles of land ownership crossed by the Mainline Pipeline, PTTL, and PBTL.

TABLE 4.9.2-1

Land Ownership (Acres) Affected by Construction and Operation of the Project Facilities

	Federal		State		City/Borough		Native		Private		Total [a]	
	Const	Oper	Const	Oper	Const	Oper	Const	Oper	Const	Oper	Const	Oper
Gas Treatment Facilities												
GTP	0	0	284	284	0	0	0	0	0	0	284	284
West Dock Causeway	0	0	251	0	0	0	2	0	0	0	253	0
Gravel mine	0	0	139	139	0	0	2	2	0	0	141	141
Water reservoir	0	0	33	33	0	0	2	2	0	0	35	35
PBTL	0	0	7	7	0	0	0	0	0	0	7	7
PTTL	0	0	2,040	608	0	0	0	0	5	2	2,045	610
Additional work areas	0	0	321	261	0	0	2	2	0	0	323	263
Gas Treatment Facilities Total	**0**	**0**	**3,077**	**1,332**	**0**	**0**	**8**	**6**	**5**	**2**	**3,090**	**1,341**
Mainline Facilities												
Mainline Pipeline	3,490	1,482	12,588	3,241	685	290	603	248	191	81	17,558	5,342
Aboveground facilities and additional work areas	3,088	66	7,496	769	637	51	684	16	696	<1	12,601	902
Mainline Facilities Total	**6,578**	**1,547**	**20,084**	**4,010**	**1,322**	**340**	**1,287**	**263**	**887**	**81**	**30,157**	**6,242**
Liquefaction Facilities Total	**0**	**0**	**1,349**	**52**	**63**	**61**	**80**	**0**	**810**	**807**	**2,301**	**921**
Project Total	**6,578**	**1,547**	**24,510**	**5,394**	**1,384**	**401**	**1,375**	**270**	**1,702**	**891**	**35,548**	**8,504**
Percent of Project Total	19%	18%	69%	64%	4%	5%	4%	3%	5%	10%	100%	100%

Const = Construction; Oper = Operation

[a] The totals shown in this table may not equal the sum due to rounding.

[87] Mapping of land ownership was included as appendix 8B to Resource Report 8 in AGDC's FERC application (Accession No. 20170417-5345). These maps are available on the FERC website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter 20170417-5345 in the "Numbers: Accession Number" field.

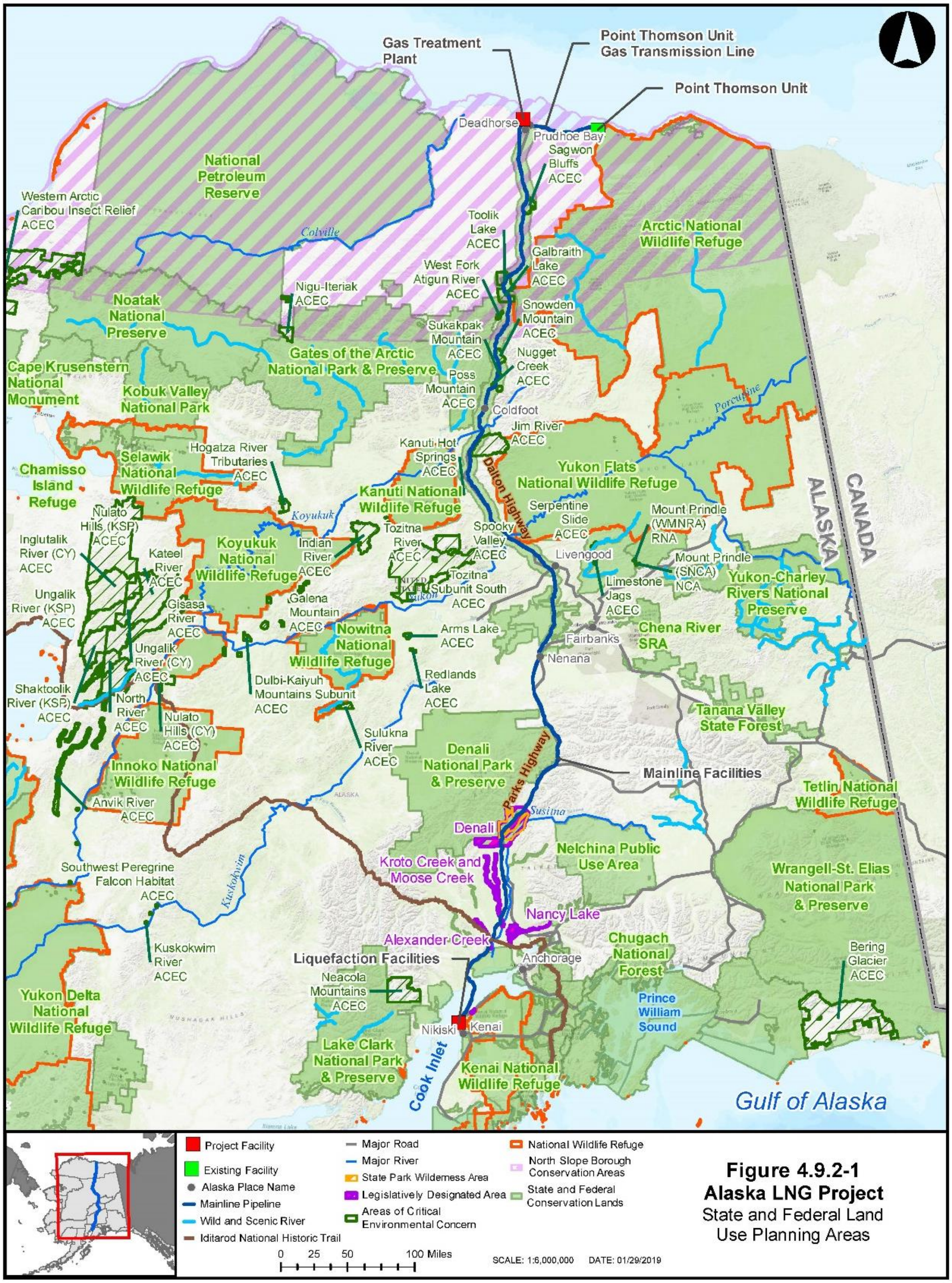

Figure 4.9.2-1
Alaska LNG Project
State and Federal Land Use Planning Areas

TABLE 4.9.2-2 **Land Ownership/Management Crossed by the Mainline Pipeline, PBTL, and PTTL Centerlines**								
	Crossing Length (miles)				Percent of Total Project Length			
Ownership [a]	Mainline Pipeline	PBTL	PTTL	Total [b]	Mainline Pipeline	PBTL	PTTL	Total [b]
Federal lands	230.8	0	0	230.8	29	0	0	27
State land	480.1	1.0	62.5	543.6	60	100	100	63
City/Borough land	45.0	0	0	45.0	6	0	0	5
Private land	12.4	0	0	12.4	2	0	0	1
Native land	38.3	0	0	38.3	5	0	0	4
Project Total	**806.6**	**1.0**	**62.5**	**870.1**	**100**	**100**	**100**	**100**

[a] Does not include land ownership affected by associated facilities or ATWS.
[b] The totals shown in this table may not equal the sum due to rounding.

4.9.2.2 Facility-Specific Impacts and Mitigation

Gas Treatment Facilities

The Gas Treatment Facilities would be almost entirely on state land. Exceptions include about 2 acres of Alaska Native allotment affected by construction and operation of GTP associated infrastructure, and 5 acres of private land affected during construction of the PTTL (of which 2 acres would be permanently affected during operation). AGDC would lease state lands for the duration of Project operation, which would grant AGDC permanent use of the leased surface area. The state would retain ownership of the underlying surface and subsurface rights. Therefore, construction and operation of the Gas Treatment Facilities would have minor, permanent impacts on land ownership.

Mainline Facilities

As shown in table 4.9.2-1, state lands (24,514 acres) comprise 69 percent of the lands affected by Mainline Facilities construction, including 5,070 acres of state-owned seafloor in Cook Inlet (see table 4.9.1-1), which accounts for about 17 percent of the total Mainline Facilities construction acreage. Federal lands (6,578 acres) would comprise about 19 percent of the Mainline Facilities construction footprint, while municipal/borough lands (1,384 acres) would comprise about 4 percent of the construction footprint.

State lands (5,394 acres) would comprise 64 percent of the lands affected by operation of the Mainline Facilities. Federal lands (1,547 acres) would comprise about 25 percent of the Mainline Facilities operational footprint, while municipal lands (401 acres) would comprise about 5 percent of the operational footprint.

Native lands would comprise 4 percent of the lands affected by construction of the Mainline Facilities and about 3 percent of the permanent operational footprint. Private lands would comprise 5 percent of the lands affected by construction of the Mainline Facilities and about 10 percent of the permanent footprint.

Land in the construction footprint, but outside the permanent right-of-way, would only be used during construction and would be returned to federal, state, or municipal management after construction is complete. Mainline Facilities authorization would grant AGDC permanent use of the operational right-of-way. AGDC would be authorized to operate, maintain, inspect, and test the Mainline Facilities in the designated easement, but the federal or state governments, Alaska Native corporations or other Alaska Native entities, or private landowners would retain surface and subsurface land ownership.

AGDC would negotiate easement agreements with private landowners and Alaska Native corporations. AGDC filed the Project under Section 3 of the NGA, which does not convey eminent domain authority; therefore, easement agreements would be completed with each affected private landowner. Section 4.11.8.3 discusses the Project's impacts on property values. In cases where easement agreements between AGDC and a landowner cannot be reached, local courts would determine compensation for an easement.

With state, federal, and private easements, construction and operation of the Mainline Facilities would have minor permanent impacts on land ownership.

Liquefaction Facilities

Construction of the Liquefaction Facilities would primarily affect state and private land. As shown in table 4.9.2-1, a total of 1,349 acres of state land (59 percent of the construction footprint) would be affected by construction, including 1,200 acres of seafloor that would be used as the offshore dredged material disposal area. The Marine Terminal is on state-owned lands within Cook Inlet. Private lands would comprise 810 acres (35 percent) of the construction footprint, of which 807 acres (88 percent of the total) would be part of the operational footprint. State, municipal, and Alaska Native land would comprise few acres of the construction and operational footprint. The Liquefaction Facilities would not affect any federal land.

AGDC is in the process of acquiring private property within the Liquefaction Facilities footprint; AGDC would acquire the remaining private, state, and Kenai Peninsula Borough lands prior to construction. Construction and operation would result in the permanent transfer of 807 acres of private land, 52 acres of state land, and 61 acres of Kenai Peninsula Borough land to AGDC ownership. As discussed in section 4.11.5, the Liquefaction Facilities would not be expected to affect residential or commercial property values in the Project area.

4.9.3 Planned Developments

Planned residential or commercial/business developments encompass "any development that is included in a master plan or is on file with the local planning board" or local government. There are no planned residential or commercial/business developments within 0.25 mile of the Gas Treatment or Liquefaction Facilities. AGDC identified three planned developments within 0.25 mile of the Mainline Facilities, as discussed below.

The Franklin Bluffs construction camp and pipe storage yard would be adjacent to the Icewine #1 and Icewine #2 exploration wells near MP 43.7. These wells and the proposed Project facilities would be accessed from the Dalton Highway via existing gravel access roads. Project construction and the presence of the camp and pipe storage yard would be separate from, and would not restrict access to, the well pads. Therefore, the Mainline Facilities would have no impact on the exploration wells.

The Mainline Facilities would be within 0.25 mile of the planned Chuitna Coal Mine near MP 766.0. This proposed surface coal mine would include extraction infrastructure and Port Facilities. While mine construction and operation could occur within the same timeframe as Project construction and operation, there would be no overlap in the footprints of the two projects. Therefore, Project construction and operation would have no impact on the Chuitna Coal Mine.

Installation of Long Range Discrimination Radar at Clear Air Force Station (AFS) (Brehmer, 2016) would occur within 0.25 mile of the construction footprint for the Mainline Facilities near MP 493.5 (access to Clear AFS is from the Parks Highway, which diverges from the Mainline Pipeline route at about MP 499.3). Construction of the radar system at Clear AFS would be completed by the end of 2018 before any planned Project activity in this area (AGDC, 2017).[88] Therefore, the Project would have no impact on the planned radar development at the AFS.

AGDC states that Project construction would not require aircraft activity near Clear AFS, though a helipad would be installed at MLV 14 at MP 493.0. The nearest airstrip proposed for Project use is Nenana Municipal Airport, about 17 miles to the north. AGDC states that it would coordinate with Clear AFS representatives to address traffic and other concerns and to avoid or mitigate impacts on Clear AFS during Project construction and operation.

For any additional planned developments identified within 0.25 mile of the Mainline Pipeline or other Project facilities, potential impacts from Project construction and operation could include increased traffic and transportation safety concerns, increased human presence in sparsely populated areas, competition for use of local public services, and restricted access during construction. In particular, Project construction traffic could conflict with or cause delays for traffic associated with the planned developments (see section 4.12.2 for further details on traffic). These impacts would be more likely near road repairs and material sites used by other planned developments.

The following mitigation measures would reduce construction-phase impacts on planned developments within 0.25 mile of the footprint of the Mainline Pipeline or other Project facilities:

- maintain contact with proponents of development projects regarding construction schedules;
- notify affected landowners where developments would occur prior to the initiation of construction across their properties, including notifying those landowners if construction would interrupt access to their properties, and provide alternative access during construction as needed; and
- allow representatives of planned development activities to be on site during construction when necessary.

With implementation of these mitigation measures, impacts on planned developments from Project construction would be minor and temporary. Impacts on planned developments during Project operation would not be anticipated since new structures, foundations, or other subsurface disturbance associated with planned developments would be prohibited within the Project permanent rights-of-way and aboveground facility sites. Therefore, the Project would not significantly affect planned developments.

88 FERC's correspondence with the Department of Defense (Accession No. 20170301-4005) is available on the FERC website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter Accession No. 20170301-4005 in the "Numbers: Accession Number" field.

4.9.4 Recreation Areas

Recreation areas include land managed by federal, state, or other government entities for recreational activity (e.g., hiking, camping, sightseeing, hunting, and fishing) or where recreational activity is a common or expected use, regardless of management provisions. This section describes recreation areas within 1 mile of temporary and permanent Project facilities. Table 4.9.4-1 summarizes the acreage of recreation and SUAs affected by the Project. Appendix Q provides a listing of recreation and special interest areas within the Project's permanent and temporary footprints.

TABLE 4.9.4-1

Recreation and Special Interest Areas Affected by Project Construction and Operation

	Area Affected (acres)	
Recreation or Special Use Area	Construction	Operation
Land and Water Conservation Fund (LWCF) lands	1,067	245
National Historic Trail	2	<1
Scenic Byways	456	46
State Game Reserves	1,010	289
Special Use Areas	8,608	2,649
State Recreational River lands	79	22
State Forest	1404	391
Total [a]	**12,627**	**3,641**

[a] The totals shown in this table may not equal the sum due to rounding.

4.9.4.1 Federal Resources

This section describes the federally managed recreation lands—including lands under the jurisdiction of the USFWS, NPS, or BLM—that would be crossed by or within 1 mile of Project facilities. The Project would require right-of-way grants and leases from the BLM to use federally managed recreation lands. By adhering to the requirements in these permits, the Project would comply with the relevant management plans for BLM lands.

AGDC and its construction contractors would communicate area-specific construction schedules through a coordinated public outreach and public involvement process. AGDC would also provide construction schedule updates, coordinate with local communities and recreation and tourism businesses, and use signage at construction locations to provide detour information for public access. AGDC plans to maintain access to public areas as much as possible and in accordance with lease stipulations.

Arctic National Wildlife Refuge

ANWR consists of about 19.6 million acres of land and water in northeastern Alaska. It is maintained by the USFWS as a unit of the NWR System. With the exception of Dalton Highway, there are no roads within the refuge. ANWR is open to visitors year round and receives 1,200 to 1,500 visitors per year with the majority of visits occurring in June, July, and August (USFWS, 2014a). Visitors include those who are transported to and guided within ANWR by commercial guide services, those who are only commercially transported to but are self-guided within the refuge, and those whose access to and within the refuge is entirely self-guided (USFWS, 2010c). Common recreational activities include river floating, hiking, backpacking, camping, mountaineering, dog mushing, hunting, fishing, wildlife observation, and photography (USFWS, 2010c). The PTTL would start about 6 miles west of the refuge, while the Mainline Pipeline would be about 0.3 mile west of the refuge at its closest points, near MPs 144 and 146.

Changes in the landscape visible from, but not within ANWR could affect recreational users who visit the refuge. Because the attention of ANWR visitors is assumed to be focused on the refuge itself, and because views of the Mainline Facilities would be limited by topography, impacts on recreation due to changes in landscape appearance would not be significant (see section 4.10.2). Project traffic on the Dalton Highway could affect access for visitors to ANWR. These impacts, which would not be expected to be significant, are discussed in detail in section 4.12.2. The Project would have no other impacts on recreation in this area.

Denali National Park and Preserve

DNPP encompasses about 6 million acres of land in and around the Alaska Range, including North America's highest peak, Denali. The NPS, which administers the DNPP, reports that the park received about 600,000 visitors in 2016 (NPS, 2017). DNPP is accessible from the Parks Highway by Denali Park Road, a 92-mile gravel road that in the winter is only open to mile 3 (park headquarters) . Visitors to the DNPP participate in a variety of outdoor recreational opportunities, including backpacking, hiking, camping, and mountain climbing, which includes mountaineers seeking to summit Denali.

The Mainline Pipeline would be outside the eastern boundary of the DNPP, although it would be within about 0.3 mile of the DNPP between MPs 532.1 and 536.2 and about 0.1 mile at its closest point between MPs 534.7 and 536.2. From this location, the Mainline Pipeline right-of-way would be visible from portions of the DNPP. The Consolidated General Management Plan for the DNPP describes "Outstanding views of natural features, including mountains, glaciers, faults, and rivers inside the park" as one of the park's principal characteristics. Trails and other recreational facilities within the DNPP are often sited specifically to take advantage of views (NPS, 2016a). As discussed in section 4.10.2, Project construction and operation would have high visual contrast and potentially significant visual impacts on visitors within the DNPP. Construction during summer months could produce dust that is visible to recreational visitors in the DNPP. As discussed in section 4.15.4, AGDC's Fugitive Dust Control Plan would address dust through watering, vehicle access and speed, and application of dust suppressants. To the degree that the Project degrades the quality of views (even if the landscape being viewed is outside the DNPP), it could affect the value of the recreational experiences in the DNPP.

Increased traffic associated with Project construction could make it more difficult for visitors to access the DNPP. As discussed in section 4.12.2, Project construction would add an average of 116 vehicle trips per day to the Parks Highway, about 5 percent of the existing 2,120 vehicles per day on the Parks Highway (ADOT&PF, 2018b). AGDC would work with the USFWS and NPS during construction to minimize impacts on access to resources and recreation opportunities within the DNPP. Additionally, AGDC would work with USFWS and NPS to develop a construction schedule and site-specific coordination plans to mitigate for potential impacts.

Construction noise would occur over the length of the Mainline Pipeline route. Construction of the pipeline in areas adjacent to the DNPP could increase noise within the park. As described in section 4.16.4, construction and operation of the Healy Compressor Station, which would be near the DNPP, would not be expected to generate noise within the park.

Construction impacts, including visual impacts, traffic, and noise, would be short term, lasting up to 4 years (the maximum length of pre-construction and pipe lay activities in any one location, as described in section 2.3.1). These impacts would not prevent the use of the DNPP, but visitors to the park would perceive high visual impacts at some viewing locations. Visual impacts during operation, including lighting from the Healy Compressor Station, would be permanent, lasting for the entire operational life of the Project. Section 4.10.2 discusses visual impacts and recommended mitigation measures, including measures applicable to lighting at the Healy Compressor Station.

George Parks Highway National Scenic Byway

The Parks Highway runs from Wasilla in south-central Alaska to Fairbanks in north-central Alaska. This 230-mile highway, which was built in 1971, provides views of, and access to, various recreational activities, such as rafting, sightseeing, and skiing in the DNPP, Denali State Park, and other public lands (Federal Highway Administration [FHWA], 2017). The segment of the road from the southern boundary of Denali State Park to Fairbanks is designated as the Parks Highway National Scenic Byway, as established in 23 USC 162. The National Scenic Byways Program, which is coordinated nationwide by the FHWA, was established to help recognize and preserve historic roads across the United States (FHWA, 2017). The ADOT&PF administers the Parks Highway National Scenic Byway as part of the Alaska Scenic Byways Program according to the *Corridor Partnership Plan* for the byway (ADNR, 2008a).

The Mainline Pipeline would be near, and generally parallel to, the Parks Highway National Scenic Byway for about 210 miles between MPs 465 and 675. The Healy Compressor Station, Hurricane Construction Camp, and four MLVs would also be within 0.25 mile of the byway, while material sites would be immediately adjacent to (or accessed from) the byway. The Mainline Pipeline would cross the Parks National Highway Scenic Byway at 10 locations using the conventional horizontal bore method, which would avoid direct impacts on the highway. During Project construction, AGDC proposes to close lanes from MPs 532.1 to 536.2 on the Parks National Highway Scenic Byway (the Nenana River Gorge) where the Mainline Pipeline would be in close proximity to the road. AGDC and its construction contractors would develop a schedule of lane closures as part of construction execution plans. Section 4.12.2 describes the traffic impacts of these closures in more detail.

The construction impacts described above would be short term, lasting up to 4 years. Project construction would have minor impacts on the actual use of the byway, while Project operation would have no impact on byway use. Impacts on access to recreational resources from the byway are discussed throughout section 4.9.4. As described in section 4.10.2, Project construction and operation would have moderate impacts on scenic views where Project facilities would be visible from the byway. Impacts during operation would be permanent, lasting for the Project's entire operational life.

Iditarod National Historic Trail

The INHT extends about 2,000 miles within a corridor between Seward and Nome. The INHT Comprehensive Management Plan (BLM, 1986c) is a congressionally mandated plan for the collection of INHT resources. Recognizing that no single agency manages the entire trail, the INHT Comprehensive Management Plan calls for cooperative trail management. The BLM, U.S. Forest Service, USFWS, and ADNR Division of Parks and Outdoor Recreation cooperatively manage the trail, along with the nonprofit Iditarod Historic Trail Alliance and other community groups (Iditarod Historic Trail Alliance, 2018). The NRHP-eligibility of the trail is addressed in section 4.13.

The INHT is best known for the annual races it hosts, including the Iditarod Trail Sled Dog Race, the Iron Dog Snowmobile Race, and the Iditarod Trail Invitational, each of which take place during the winter and attract recreational participants and spectators (Iditarod Historic Trail Alliance, 2018). The Mainline Pipeline would cross the INHT primary trail at MP 724.3 and an INHT-connecting trail at MP 720.8 (along the Yentna River) in the Susitna River Valley. In the area of the crossings, AGDC states that local residents from the village of Skwentna and other nearby recreational cabin owners use the INHT for travel, freighting of supplies and building materials, and recreation. AGDC also states that the connecting trail along the Yentna River is used more than the primary trail in winter and spring, when the river is frozen. No readily available data exists regarding use of the INHT segments near the Mainline Pipeline crossings (BLM, 2008b).

Project construction would affect about 0.2 acre of land associated with the INHT. AGDC states that construction would occur during the winter, due to the timing of construction on adjacent segments of the Mainline Pipeline. Winter crossing would coincide with the heaviest reported use of the INHT. If the Mainline Pipeline crossing of the INHT should occur during the Iditarod, Iron Dog, or other major race, it would result in recreational and economic impacts.

Regarding trail crossings, including the INHT, AGDC states that the closure duration of any specific cut area for trails would likely be measured in hours, but could be as high as a day or two depending on local conditions at the trail. To mitigate the short-term impacts of the INHT crossings, AGDC would communicate construction dates to recreational users and property owners in the vicinity, including residents of the village of Skwentna and owners of nearby recreational cabins. Because the pipeline would be buried at the INHT crossings and the area restored to pre-construction condition, land use impacts on the trail during Project operation would not be expected.

AGDC filed a site-specific crossing plan for the INHT on November 19, 2018.[89] The plan does not address how or when AGDC would coordinate with local residents, trail managers, or other stakeholders to communicate construction information; address scheduling conflicts with other trail uses such as the winter races; or provide alternate access to the trail. Therefore, **we recommend that:**

- **<u>Prior to construction across the INHT</u>, AGDC should file with the Secretary, for the review and written approval of the Director of the OEP, a revised site-specific crossing plan for the INHT—developed in consultation with the ADNR, BLM, USFWS, U.S. Forest Service, and the Iditarod Historic Trail Alliance—that identifies the locations of detours, signs, or alternate access to the trail, and provides for public notice of construction dates and any required trail closures.**

With implementation of the measures described above and our recommendation, we find that the Project would have minor, temporary impacts on the INHT, and would be consistent with the INHT Comprehensive Management Plan.

Bureau of Land Management Lands

Under the FLPMA, the BLM manages about 70.2 million surface acres of federal public land throughout Alaska for multiple purposes, including, but not limited to, outdoor recreation. Under Section 503 of the FLPMA, the BLM designates right-of-way corridors and considers national and state land-use policies, environmental quality, economic efficiency, national security, and good engineering and technological practices. Under the MLA, an applicant must have a BLM grant for an oil or gas pipeline or related facility to cross federal lands.

BLM manages the Dalton Highway Utility Corridor from the Yukon River near MP 357.7 to near MP 120.9. The Utility Corridor RMP designated portions of the Utility Corridor as a Special Recreation Management Area. BLM manages these lands for recreation as a primary purpose (BLM, 1991). The corridor includes multiple waysides and overlooks, four campgrounds, two visitor centers, and two administrative areas, all of which are accessible only via the Dalton Highway. The Utility Corridor attracts

[89] AGDC filed a site-specific plan for crossing the Iditarod National Historic Trail (INHT) in its response to Information Request No. 147 (Accession No. 20181119-5181), which is available on the FERC website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter 20181119-5181 in the "Numbers: Accession Number" field.

commercial tours (including sport fishing and hunting and commercial game guides, pursuant to BLM Special Recreation Permits) and independent visitors. The BLM states that the Arctic Circle wayside is the single most visited site on the Dalton Highway; however, the Mainline Facilities would be more than 2.0 miles from this area and about 1.6 miles from the Arctic Circle Campground, also a popular location. Due to these distances, construction and operation of the Mainline Facilities would not affect the Arctic Circle wayside or campground.

The Mainline Pipeline would be near multiple BLM management campgrounds along the Dalton Highway Utility Corridor. The Mainline Pipeline would cross the access road for the Marion Creek Campground near MP 236.7 and would be within 0.25 mile of the Yukon River 60 Mile Campground (MP 353.5). The Galbraith Lake Camp, pipe storage yard, and a material site would be adjacent to the Galbraith Lake Campground near MP 143.0. Changes in the landscape visible from the highway could discourage some recreational users from traveling the Dalton Highway. Additionally, nighttime lighting associated with construction activities, camps, and aboveground facilities could detract from increasingly popular Northern Lights tours along the Dalton Highway.

As part of the Project, multiple aboveground facilities would be on BLM land. These facilities include MLVs 5 through 9; Galbraith Compressor Station and Camp; Atigun Camp; Dietrich Camp; Man Camp; Ray River Compressor Station and Camp; Five Mile Camp; and every pipeline storage yard, material site, access road, and ATWS from MPs 121.0 to 356.9. A BLM right-of-way permit would be required for facilities on BLM land. As discussed in section 4.16.4, sound levels during Project operation would be at or near existing background levels within about 0.5 to 1.0 mile of the Galbraith Lake and Ray River Compressor Stations. Recreationists within 0.5 to 1.0 mile of these compressor stations would perceive increased noise, and could choose to avoid these areas. Additionally, while not on BLM land, the Coldfoot Compressor Station would increase noise at the Arctic Interagency Visitor Center, which is on BLM land.

Construction impacts on the Marion Creek and 60-Mile (Yukon River) Campgrounds would be short term and minor due to temporary access restrictions, noise, and dust during construction activities. Construction impacts near the Galbraith Lake Campground would be long term, lasting for the entire construction period, but of minor intensity. The impacts of Project operation, including noise impacts, would be minor but permanent, lasting for the Project's entire operational life. Project construction and operation on BLM lands would be subject to a BLM right-of-way grant and lease, which would ensure consistency with applicable BLM Resource Management Plans.

4.9.4.2 State Resources

This section describes the state-managed recreation lands crossed by or within 1 mile of the Project. The Project would require right-of-way permits from ADNR, ADF&G, and/or other relevant management agencies to use lands within state-managed recreation areas. By adhering to the requirements in these permits, the Project would comply with the relevant management plans for state lands.

AGDC and its construction contractors would communicate area-specific construction schedules through a coordinated public outreach and public involvement process. AGDC would also provide construction schedule updates, coordinate with local communities and recreation and tourism businesses, and use signage at construction locations to provide detour information for public access. AGDC plans to maintain access to public areas as much as possible and in accordance with lease stipulations.

Game Management Units

The ADF&G manages hunting through statewide regulations, with specific regulations for hunting on public lands in each of the state's 26 GMUs. Each GMU typically has multiple sub-units, each of which has its own specific hunting regulations such as the list of harvestable game species, permitted hunting methods, timing of hunting seasons, and bag limits (see table 4.9.4-2)). Lands within GMUs and sub-units are only open for hunting during specific portions of the year (ADF&G, 2017q). The Project footprint intersects portions of 12 game management sub-units, as shown in table 4.9.4-2 (ADF&G, 2017q). GMUs have restricted access or area closed for periods throughout the year.

TABLE 4.9.4-2

Alaska Game Management Sub-units Crossed by the Project

Mainline Pipeline				
Start Milepost	End Milepost	GMU Sub-unit	Project Facilities Present	Notable Regulatory Provisions
0	169.9	26B	GTP, GTP associated infrastructure, PTTL, PBTL, Mainline Facilities	No hunting allowed in and around Prudhoe Bay and Deadhorse
169.9	177.3	25A	Mainline Facilities	None
177.3	315.0	24A	Mainline Facilities	None
315.0	324.7	25D	Mainline Facilities	None
324.7	394.0	20F	Mainline Facilities	None
394.0	472.7	20B	Mainline Facilities	None
472.7	476.1	20C	Mainline Facilities	None
476.1	489.1	20A	Mainline Facilities	None
489.1	532.2	20C	Mainline Facilities	None
532.2	560.2	20A	Mainline Facilities	None
560.2	641.6	13E	Mainline Facilities	None
641.6	720.9	16A	Mainline Facilities	None
720.9	780.0	16B	Mainline Facilities	None
780.0	806.6	15A	Liquefaction Facilities, Mainline Facilities	None

Source: ADF&G, 2017q

Hunting is restricted in portions of GMUs 26B, 25D, 24A, and 20F, which are within 5 miles of the Dalton Highway and within the PBU. The Gas Treatment Facilities are within GMU 26B. The portion of GMU 26B around Deadhorse and Prudhoe Bay is permanently closed for hunting (ADF&G, 2017q). The PTTL right-of-way east of Prudhoe Bay (PTTL MPs 0 to about 50) would be in areas where hunting is allowed.

For GMU crossings, construction could occur in winter or summer and would last from 6 to 12 weeks at any one location (see section 2.3.1). While Project construction would not block access to any GMU, it could result in longer trips for hunters and other visitors (e.g., if individuals can only cross the Mainline Pipeline right-of-way at certain locations). Construction noise and human activity could temporarily displace game species from areas near the Mainline Facilities. Such effects could lead to longer trips for GMU users, and could result in decreased hunting success. These impacts would be minor and short term.

Noise impacts on terrestrial wildlife are discussed in section 4.6.1, while impacts on subsistence activities (including hunting) are discussed in section 4.14.2.

Denali State Park

Denali State Park encompasses 325,240 acres along the Parks Highway National Scenic Byway and forms a portion of the southeast boundary of the DNPP. Denali State Park is managed by the ADNR Division of Parks and Outdoor Recreation. The park provides a variety of formal and informal camping, fishing, hiking, and other recreational opportunities (ADNR, 2014a). The Mainline Facilities would cross through Denali State Park between MPs 609.1 and 646.9, generally within 0.5 mile of the Parks Highway National Scenic Byway. This includes MLV 21 and associated helipad. Other Project facilities within Denali State Park would include access roads, material sites, disposal sites, and the Horseshoe pipe storage yard (see appendix C). The Mainline Pipeline within Denali State Park would cross 12 waterbodies, including the Chulitna River, the Parks Highway National Scenic Byway (four crossings), and one state trail—the Lower Troublesome Creek Trail. Developed recreation areas in the park around Byers Lake, including trails, picnic, and parking areas, would be within 1 mile of the Mainline Pipeline near MP 630. A total of 459 acres would be affected by the Project in Denali State Park (less than 1 percent of the park's total area).

Denali State Park is the only state recreational property crossed by the Project that receives funding under the federal Land and Water Conservation Fund (LWCF). Under Section 6(f) of the LWCF Act (16 USC 4601), no property acquired or developed with LWCF assistance can be converted to a use other than public outdoor recreation without the prior approval of the Secretary of the Interior. Alaska Senate Bill 70 (enacted in 2015) allows the state to exempt portions of Denali State Park within the Mainline Pipeline footprint from designation as a special purpose site, thus allowing the state to lease a corridor of the park to AGDC for construction and operation as long as recreational access is maintained during operation.

The Mainline Pipeline would cross the Chulitna River using the DMT method during summer (see section 2.2.2). This crossing method would avoid impacts on use of the river itself, but construction would occur along the riverbanks. Public access to the riverbanks within the construction footprint would be restricted during the construction period, which would last about 6 to 12 weeks (see section 2.3.1).

The Mainline Facilities, including permanent and temporary workspaces associated with route bends and the Troublesome Creek waterbody crossing, would cross the Lower Troublesome Creek Trail, just south of Troublesome Creek, at about MP 641.1. The trail is part of the Alaska State Trails Program, which is managed by the ADNR in conjunction with the Alaska State Parks program. The Recreational Trails Program, part of the ADNR Division of Parks and Outdoor Recreation, provides grants for trail development, repair, and environmental protection (ADNR, 2018c). AGDC would obtain permission to cross trails as part of the ADNR permits for the Project.

The Project would cross Lower Troublesome Creek Trail using an open-cut trench. In its application, AGDC states it would keep the trail open during construction through use of trench bridging or minor trail rerouting within the Project construction right-of-way. AGDC further states that the closure duration for the trail could be as long as 2 days. AGDC has committed to providing a site-specific crossing plan for the trail, but has not filed it yet. Therefore, **we recommend that:**

- **<u>Prior to construction</u>, AGDC should file with the Secretary, for the review and written approval of the Director of the OEP, a site-specific crossing plan for the Lower Troublesome Creek Trail, including the locations of the temporary bridge or trail reroute.**

The Mainline Pipeline would not cross through developed recreation areas on the west side of Byers Lake, although the pipeline would be about 0.3 mile west of picnic and parking areas on the west side of Byers Lake. While Project construction would not block access to this recreation area, it could result in travel delays for park users on the Parks Highway. Construction noise and human activity could also disturb recreational activities near Byers Lake. As discussed in section 4.16.3, noise associated with the Chulitna River DMT site would likely be noticeable at the Upper and Lower Troublesome Creek trailheads. Noise impacts would generally be temporary, and would primarily occur during construction.

As discussed above, AGDC identified an alternate material site near MP 630.1 that would encompass a portion of the Byers Lake Campground in Denali State Park. If the material site should be developed by AGDC, public access to the campground would be restricted during construction and a portion of the campground would be permanently removed. To minimize impacts, we are recommending that AGDC file a detailed schedule of construction activities within Byers Lake Campground prior to construction in this area (see section 4.9.1).

AGDC would implement the following mitigation measures to address potential impacts on recreation in Denali State Park:

- schedule major construction activities such as road building and waterbody crossings outside key tourism and recreation periods and areas, and schedule preliminary work from mid-September through November, after the high-use summer tourism season;

- avoid new public vehicular access to remote areas by identifying potential alternate public access locations to key recreation areas, blocking temporary and permanent access roads with berms or gates, and reducing off-road vehicle use associated with Mainline Facilities construction;

- block or re-contour access to the right-of-way to prevent off-road vehicles from traveling the right-of-way following construction; and

- restore the right-of-way with native vegetation and restore native drainage patterns per state right-of-way agreements.

Except where installed by DMT, Mainline Pipeline construction and operation through Denali State Park would result in a cleared corridor through a predominantly forested area. The vegetation removal would change the park's visual character and vegetation patterns and could change wildlife behavior. Such changes could lead to differences in recreational activities near the Mainline Pipeline. Visitors to the park might not see the wildlife they had previously seen and could experience a different kind of hike due to removed vegetation.

By avoiding peak tourist season and implementing the above mitigation measures, Project construction would have minor, short-term impacts on recreational use of Denali State Park, mainly due to longer access routes, noise, dust, and traffic. Project operation would have minor, permanent impacts due to the presence of a cleared corridor and resultant effects on vegetation and wildlife. Visual impacts on Denali State Park are discussed in section 4.10.2.

Nenana River Gorge Special Use Area

SUAs in Alaska are places that have been designated according to 11 Alaska Administrative Code 96.014 as having scenic, historic, archaeological, scientific, biological, recreational, or other special resource values that warrant additional protections and special requirements. The Nenana River Gorge

SUA includes about 1,400 acres on the east bank of the Nenana River within 0.5 mile of the Parks Highway right-of-way (ADNR, 1993), across from the DNPP between about the intersection of the Denali Park Road with the George Parks Highway Scenic Byway, and extending north to the Moody Bridge over the Nenana River. The Nenana River Gorge SUA serves as the northern gateway to the DNPP, connecting the DNPP and McKinley Park to Healy, Nenana, and Fairbanks. The SUA is managed by the DMLW. The area requires a permit for setting up and using a camp for either personal or commercial purposes (ADNR, 1993). The Mainline Pipeline would cross through the Nenana River Gorge SUA and its McKinley Subdivision from MPs 534.7 to 537.6. Project facilities would include construction workspaces, access roads, and one MLV and associated helipad.

The footprint of the Mainline Facilities would include about 16 acres of the Nenana River Gorge SUA (about 1 percent of the total area). Construction within the Nenana River SUA would require a permit from the DMLW, because pipeline or utility line construction is typically not allowed on special use land. In this area, the Mainline Pipeline would be less than 0.1 mile from (and often immediately adjacent to) the Parks Highway. Construction of the Mainline Pipeline through the Nenana River Gorge SUA would require closure of the northbound lane of the Parks Highway, with pilot cars used to escort traffic through Nenana Canyon. In addition, pull offs and parking areas, many with associated trails leading to the Nenana River, near MPs 532.1 (Nenana River), 532.8 (Dragonfly Creek), 533.1 (Eagle Creek), and 534.3 (Grizzly Creek) would be within or adjacent to the Mainline Pipeline workspaces. An area along the Nenana River near MP 534.7, which is used by recreational vehicles (RVs), would be used as ATWS for the Mainline Facilities.

AGDC states that construction of the Mainline Facilities segment from MPs 532.1 to 536.2 would occur in the fall of Year 1, after the peak tourist season, while construction from MPs 536.2 to 538.6 would occur during the summer and fall of Year 1. Public access in this area would be maintained along the Parks Highway within Nenana Canyon by phasing construction to avoid simultaneous disruption of the entire workspace within the SUA. Individual recreation access points (such as the pulloff south of the Moody Bridge over the Nenana River), however, would remain closed for the duration of construction on this segment of the Mainline Facilities. The closures could last for up to 2.5 years. Although construction and lane closures would occur outside the peak tourist season, they would nonetheless cause delays for visitors from interior Alaska to McKinley Park, the DNPP (which is open year-round), Denali State Park, and other recreation resources in the area.

AGDC would implement the following mitigation measures to address impacts on recreation in the Nenana River Gorge SUA:

- phase work to avoid disturbance to the entire workspace within the SUA;
- schedule construction after peak tourist season when most businesses are expected to be closed, while still maintaining access to these businesses (specifically, pipelay would occur between September and November);
- use flaggers and pilot cars in areas where construction would result in closure of a lane of the Parks Highway;
- use appropriately sized civil crews and pipelay crews to install the pipe;
- reduce off-road vehicle use in remote areas associated with Mainline Facilities construction activities; and
- avoid creating new public vehicular access to remote areas by blocking temporary and permanent access roads with berms or gates.

With implementation of these mitigation measures, Project construction would have minor, temporary impacts on the Nenana River Gorge SUA, and would avoid most recreational tourism activity. Project operation would have no impact on recreation in the Nenana River Gorge SUA.

North Slope Special Use Area

As described above, SUAs in Alaska are those that have been designated according to 11 AAC 96.014 as having scenic, historic, archaeological, scientific, biological, recreational, or other special resource values that warrant additional protections and special requirements. The North Slope SUA includes all state lands in the Umiat Meridian (essentially, the area north of 68 degrees latitude). Under 11 AAC 96.014, "a permit is required for motorized vehicle use [in the North Slope SUA], unless that use is for subsistence."

The entirety of the Gas Treatment Facilities would be in the Umiat Meridian, as would the Mainline Pipeline from MPs 0 to 182.3. The Gas Treatment Facilities would affect about 2,372 acres of North Slope SUA land (including 1,730 acres associated with the PTTL right-of-way), while the Mainline Facilities would affect about 3,161 acres of North Slope SUA. AGDC would obtain necessary permits for motorized vehicle use in these areas.

State Game Refuges

The Project would cross two SGRs; the Minto Flats SGR and the Susitna Flats SGR as described below. The terrestrial wildlife that inhabit these areas are described in section 4.6.

The Minto Flats SGR, established in 1988 and managed by the ADF&G and DMLW, encompasses about 500,000 acres of land. The refuge is about 35 miles west of Fairbanks between the communities of Minto and Nenana. The Minto Flats SGR is a popular spot for fishing and hunting for Athabaskan Indians and Fairbanks residents and is open for public use. ADF&G regulations allow utility corridors and pipelines to be sited within refuge lands if those facilities are determined to be compatible with the purposes for which the refuge was established. Whether these facilities are compatible is determined by policies identified in the management plan to ensure compatibility with the protection of fish and wildlife, their habitats, and public use of the refuge (ADF&G, 1992). The Mainline Pipeline would cross through the Minto Flats SGR (in a non-continuous manner) from MPs 430.9 to 468.6. Other Project facilities within the refuge would include access roads, material sites, disposal sites (see appendix C), and MLV 13 and associated helipad. The Mainline Facilities would affect about 632 acres in the Minto Flats SGR (less than 1 percent of the total SGR acreage). Section 3.6.3 describes the potential impacts of the Fairbanks Alternative on the Minto Flats SGR.

The Susitna Flats SGR encompasses about 300,800 acres between the Beluga River and Point MacKenzie on the western side of Cook Inlet (ADF&G, 1988). It is managed by the ADF&G and DMLW to conserve fish and wildlife populations, particularly waterfowl nesting, feeding, and migration; moose calving areas; spring and fall bear feeding areas; and salmon spawning and rearing habitats. It also provides public access for fishing and hunting (particularly waterfowl, moose, and bear hunting); wildlife viewing; photography; and general public recreation.

New utilities could cross the refuge where no feasible off-refuge alternative exists, using existing corridors wherever possible and consistent with refuge goals and objectives (ADF&G, 1988). Two major utility lines cross Susitna Flats: the Chugach Electric Association, Inc., electric transmission line and the ENSTAR natural gas pipeline (ADF&G, 1988). Seven segments of the Mainline Facilities would cross the Susitna Flats SGR between MPs 737.3 and 752.4, including the Theodore River heater station (and MLV) and construction camp. Other Project facilities within the refuge would include the Sleeping Lady construction camp and pipe storage yard, access roads, disposal sites, and material sites (see appendix C). The Mainline Facilities would affect about 118 acres in the Susitna Flats SGR (less than 1 percent of the total SGR acreage).

Construction at any one location within the SGRs could occur in winter or summer and would typically last 6 to 12 weeks. While Project construction would not block access to portions of either SGR, it could result in longer trips for hunters and other visitors (e.g., if those individuals can only cross the Mainline Pipeline right-of-way at selected locations). Construction noise and human activity could temporarily displace game species from areas near the Mainline Facilities. Such effects would also lead to longer trips for SGR users due to the temporary displacement of game species from their typical locations, and could result in decreased hunting success. Noise impacts on terrestrial wildlife are discussed in section 4.6.1, while subsistence activities (including hunting) near the Mainline Facilities are discussed in section 4.14.2.

To reduce potential impacts on SGRs, AGDC states that it would maintain existing corridors across construction areas by balancing summer and winter construction and phasing construction activities to avoid simultaneous disruption of the Minto Flats and Susitna SGRs. Mainline construction in the Minto Flats SGR would occur during the winter to minimize impacts on wetlands, rivers, and stream crossings, except where summer construction has been requested to protect aquatic species. As part of the state right-of-way lease permitting process, AGDC would develop specific mitigation measures to reduce impacts on SGRs in coordination with the ADNR and ADF&G and with input from other affected stakeholders, local communities, and the public.

During operation, the Mainline Pipeline permanent right-of-way would remain cleared of trees. Cleared rights-of-way could become new access routes into and through the SGRs. Game or other species could choose to avoid (or could be drawn to) the cleared rights-of-way; however, Project operation would not likely change game species availability for hunters in the SGRs.

Project construction would have minor, short-term impacts on recreational use of SGRs due to longer access routes, noise, dust, and traffic. Project operation would have minor, permanent impacts due to the presence of a cleared corridor and resultant effects on wildlife.

Dalton Highway Scenic Byway

In addition to the Parks Highway National Scenic Byway (described above), the Project's footprint would include the Dalton Highway. The entire length of the Dalton Highway is the state-designated Dalton Highway Scenic Byway. State scenic byways are designated through the Alaska Scenic Byways program (AS 19.40.010) and are administered by ADOT&PF. Recreational activities within the Dalton Highway Scenic Byway corridor are extensive, and include hunting, fishing, camping, hiking, northern light tours, and wildlife and scenery viewing, among other activities.

The Dalton Highway Scenic Byway includes (all mileposts are for the Dalton Highway):

- five campgrounds: 60-Mile Campground near MP 60, Arctic Circle Campground near MP 115, Coldfoot Campground near MP 175, Marion Creek Campground near MP 180, and Galbraith Lake Campground near MP 275;
- 15 designated scenic viewpoints;
- a boat launch and BLM visitor contact station at the Yukon River crossing (MP 56); and
- the Arctic Interagency Visitor Center at Coldfoot (MP 175).

Other recreational activities available along the Dalton Highway Scenic Byway corridor include hiking, hunting, fishing, canoeing, rafting, and recreational gold-panning (BLM, 2017c).

The Dalton Highway provides business and tourist access to the northern and most remote region of the state. As the only state highway link between northern Alaska and Fairbanks (and points south), the Dalton Highway is an important corridor for access to federal and state recreation lands in the northern part of the state, such as the ANWR, Gates of the Arctic NPP, and multiple GMUs. The *Dalton Highway Scenic Byway: Corridor Partnership Plan* (Dalton Corridor Partnership Plan) guides the management, protection, and enhancement of the Dalton Highway Scenic Byway's scenic qualities (ADNR, 2010). While the Dalton Corridor Partnership Plan does not have regulatory authority, it provides information for use in the evaluation of scenic resources along the Dalton Highway Scenic Byway "corridor," generally defined (based on federal guidelines) as "the road or highway right-of-way and the adjacent area that is visible from and extending along the highway" (ADNR, 2010). The Dalton Corridor Partnership Plan does not provide defined boundaries of the Dalton Highway Scenic Byway corridor, but implies that it extends up to several miles on either side of the highway. As described in section 4.10.1, BLM considers that landscape details are visible within about 5 miles of a given point.

At its closest point, the GTP would be about 0.9 mile from the Dalton Highway Scenic Byway corridor and about 5.8 miles north of the northern terminus of the road itself. The PTTL, at about PTTL MP 54.0, would be about 4.4 miles northeast of the Dalton Highway northern terminus. The Gas Treatment Facilities would be about 105 miles north of the BLM-managed portions of the Dalton Highway Scenic Byway corridor. AGDC proposes to construct the PTTL during the winter months, when tourist-related traffic on the Dalton Highway and recreational activity in the Dalton Highway National Scenic Byway corridor is minimal.

The Mainline Facilities would be almost entirely within, and would be visible from most locations on the Dalton Highway Scenic Byway corridor between MPs 20 (south of Deadhorse) and 400 (at the Dalton Highway's southern terminus), and would cross the Dalton Highway 24 times. Mainline Facilities within the Dalton Highway Scenic Byway corridor would include construction workspaces, 4 compressor stations, and 19 MLVs with associated helipads, access roads, construction camps, pipe storage yards, and material sites.

The Sagwon, Galbraith Lake, Coldfoot, and Ray River Compressor Stations would affect a total of about 121 acres within the Dalton Highway Scenic Byway corridor. The Mainline Pipeline would cross the Dalton Highway using the conventional horizontal bore method, and thus would not affect use of the road itself. Although listed as a scenic byway, the Dalton Highway's primary purpose is industrial (see section 4.12.1). The Mainline Pipeline right-of-way would be a new visual feature in a landscape where such features, notably TAPS, are common. The Project impacts on visual resources are discussed in section 4.10.2. Based on the existing industrial development within the byway corridor (and visible from the byway), the visual changes resulting from construction and operation of the Mainline Pipeline would be unlikely to meaningfully change recreational use of the Dalton Highway Scenic Byway.

As discussed in section 4.10.2, new compressor stations would result in high visual contrast and major visual impacts, particularly in the southern Brooks Range. The high-visual contrast facilities could cause visually sensitive visitors to avoid areas within sight of compressor stations. These changes in recreational behavior would not be expected to have significant impacts on recreational use of the Dalton Highway Scenic Byway.

Impacts on recreational resources accessed from the Dalton Highway are discussed throughout section 4.9.4. Impacts on other recreational activities within the Dalton Highway Scenic Byway corridor, such as hunting, fishing, camping, etc., would vary according to distance from the Mainline Facilities.

During construction, workspaces would be off-limits to recreational visitors, and the noise and human activity could temporarily cause wildlife to avoid the construction workspace. Project construction would generate as many as 82 new heavy truck trips (i.e., 41 round trips) per day on the Dalton Highway. As discussed in section 4.12.2, this represents up to a 51-percent increase in existing Dalton Highway traffic (147 to 294 total vehicles per day). This increased Project construction traffic could dissuade recreational travelers from driving on or accessing recreation resources from the Dalton Highway, particularly for individual recreational travelers not familiar or comfortable with heavy vehicle traffic on the Dalton Highway.

Based on low existing and Project-related traffic volumes (see sections 4.12.1. and 4.12.2), Project construction would have short-term (lasting up to 4 years in any location), minor impacts on recreation activity along the Dalton Highway Scenic Byway. Individual recreational travelers unfamiliar or uncomfortable with heavy vehicle traffic on the Dalton Highway could perceive these impacts as potentially significant.

AGDC developed a right-of-way agreement with the BLM, which states that Project requirements would likely be similar to those identified in the ASAP right-of-way agreement. These requirements would include maintaining a vegetative buffer between the Dalton Highway and new material sites, provisions for temporary and permanent erosion control, maintaining construction buffers at stream crossings and public access along existing roads and trails, and a requirement that site specific crossing plans be provided for review and approval before construction.

During operation, the Mainline Pipeline right-of-way would be a permanent change in vegetation. These changes would affect about 4,261 acres within the Dalton Highway Scenic Byway corridor. Section 4.5.8 discusses the potential impacts of NNIS introductions that could be caused by Project construction.

Alaska Railroad Scenic Byway

The Alaska Railroad, a rail-only scenic byway, is designated a state scenic byway by the Alaska Scenic Byways program (AS 19.40.010). It is administered by ADOT&PF. The Alaska Railroad provides passenger service between Seward and Fairbanks, passing through Anchorage and the DNPP. Tourism is an important component of railroad ridership and includes scheduled service using Alaska Railroad passenger cars, as well as private tour railcars hauled by Alaska Railroad engines owned by cruise lines whose vessels call at Seward (ADOT&PF, 2016). The Mainline Pipeline would cross the Alaska Railroad Scenic Byway four times and would generally be within about 5 miles of the railroad byway from MPs 455 to 609 and MPs 671 to 709. As stated in section 4.12.2, AGDC would cross the railroad using the horizontal bore method to minimize impacts on rail traffic, and would obtain permission from the Alaska Railroad before boring beneath the rail line or connecting new rail spurs to the existing rail line. Project facilities within this area would include construction workspaces, compressor stations, MLVs and associated helipads, access roads, construction camps, pipe storage yards, and material sites.

As discussed in section 4.10.2, portions of the Mainline Facilities, including the Mainline Pipeline corridor, permanent access roads, and aboveground facilities would be visible from the Alaska Railroad. The visual impacts of these facilities would be permanent, and would vary from minor to major, with higher impacts near the DNPP. High visual impacts could cause visually sensitive visitors to avoid using the Alaska Railroad, but these changes in recreational behavior would not be expected to be widespread due to the intermittent nature of views of Project facilities from the Alaska Railroad. The Project would have no other impacts on recreational use of the Alaska Railroad.

Recreation Rivers Management Areas

The Project would cross two State Recreation Rivers management areas, Susitna Basin and Alexander Creek, which are overseen by the DMLW. These areas provide a variety of year-round recreational opportunities, including camping, fishing, boating, snow machining, skiing, dog mushing, and wildlife viewing.

The Susitna Basin Recreation Rivers Management Area encompasses six State Recreation Rivers, including land and bodies of water designated under the Recreation Rivers Act (AS 41.23.500A), which was established for the maintenance and enhancement of land and water for recreation (ADNR, 2017f). The Mainline Facilities would cross the Lower Deshka River Management Subunit (part of the Deshka River Management Unit within the overall management area) from MPs 704.0 to 705.8 and 707.1 to 707.5. This subunit encompasses 3,020 acres of land (including 2,084 acres of state land, 686 acres of MSB land, and 254 acres of private land), and provides "fishing, camping, powerboating, and floating opportunities in a moderately accessible natural setting. In winter, the subunit is used by snowmachiners, dog mushers, and skiers" (ADNR, 1991).

The Mainline Pipeline (including construction workspaces and an access road) would cross the Alexander Creek State Recreation River Management Area between MPs 727.3 and 728.5. Alexander Creek is a slow, meandering stream that originates in Alexander Lake and flows south to the Susitna River, about 20 miles away. The State Recreation River designation begins at Alexander Lake and extends to a point 3.5 miles above the confluence with the Susitna River. The ADNR, MSB, and private owners own the Alexander Creek Management Unit, which includes the State Recreation River along with 22,636 acres of surrounding land. The unit consists of 19,995 acres of state land, 2,260 acres of MSB land, and 381 acres of private land. It is a popular recreation area for fishing, hunting, and trapping (ADNR, 2017e).

The Mainline Facilities footprint would include the following within State Recreation River management areas:

- about 2.2 miles and 39 acres of the Lower Deshka River subunit within the Deshka State Recreation River Management Area (about 1 percent of the total Lower Deshka River subunit acreage) from MPs 704.0 to 705.8 and MPs 707.1 to 707.5; the construction corridor would cross the Deshka River at MP 704.7, and include ATWS for the waterbody crossing, topsoil and excavated material storage, and bends in the pipeline corridor; and

- about 1.2 miles and 25 acres of the Alexander Creek State Recreation River Management Area (less than 1 percent of the total management area acreage) between MPs 727.3 and 728.5; the construction corridor would cross Alexander Creek at MP 727.8 and include ATWS for the waterbody crossing, topsoil and excavated material storage, and pipeline bends.

Project construction would result in temporary land disturbance in the State Recreation River management areas. The Mainline Pipeline would cross Alexander Creek in the winter construction period using frozen-cut methods and the Deshka River in the summer construction period using the DMT method (see section 4.3.2). As a result, these two crossings would not prevent use of the rivers during free flowing (summer) conditions, but there would be restrictions to winter users of the river based on the construction schedule. Access to the riverbanks adjacent to construction would be restricted during the construction period, which would last from about 6 to 12 weeks (see section 2.3.1).

During operation, the Mainline Pipeline permanent right-of-way would remain cleared of trees. Cleared rights-of-way would create new views to and from the recreation rivers and could become new access points and routes to the rivers. The break in vegetation could also alter the behavior of game or other species (including fish). Overall, the permanent right-of-way would not limit recreational use of the rivers, riverbanks, or upland areas.

As part of the state right-of-way lease permitting process, AGDC would identify potential alternate locations for public access to recreation areas, schedule construction during the recreation and tourism off-season as practicable, allow public crossings of the construction area at designated gates, and maintain existing use corridors during construction while staying consistent with the State Recreation Rivers management plans. Project construction would therefore have a short-term, minor impact on recreational use of State Recreational Rivers, while Project operation would have a permanent, minor impact due to changes in vegetation and species behavior.

Tanana Basin Planning Area

The Tanana Basin is a 15 million-acre area of state-managed land along the Tanana River and its tributaries, from the Canadian border to the Chitanana River west of Fairbanks. The Tanana Basin Planning Area (planning area) (excluding state and federal lands, such as the DNPP, Tanana Valley State Forest, etc., which are addressed by other plans) is managed by the DMLW. Within this planning area are more than 4.2 million acres of land designated partly or entirely for public recreation. The recreational goal for the Tanana Basin Plan includes the provision of "the full spectrum of accessible, developed, and undeveloped recreation opportunities for Alaskans and visitors" (ADNR, 2009b). The Mainline Pipeline would cross through the Tanana Basin Planning Area between about MPs 400 and 575. Other Project facilities within this area would include construction workspaces, compressor stations, construction camps, MLVs and associated helipads, access roads, construction camps, pipe storage yards, disposal sites, and material sites.

Construction of the Mainline Facilities would temporarily affect about 13 acres of publicly managed recreation land within the Tanana Basin Planning Area, less than 1 percent of the planning area's total acreage. While Project construction would not block access to the planning area, it could require recreational visitors to detour around construction workspaces to reach their destinations. Construction noise and human activity could also temporarily displace wildlife or disturb recreational activity.

During operation, the Project would include a cleared right-of-way within the Tanana Basin Planning Area. As with other recreation areas discussed in this section, the cleared right-of-way would change views, could alter wildlife behavior, and could become a new access corridor for areas within the planning area. As a whole, however, Project operation would not reduce or prevent recreational activity on publicly managed lands within the Tanana Basin Planning Area, and would thus have no impact on recreation.

Tanana Valley State Forest

Tanana Valley State Forest (state forest) encompasses 1.8 million acres of land along the Tanana River and its tributaries. It extends 265 miles from near the Canadian border to Manley Hot Springs. Timber production is the state forest's major commercial activity. The state forest also offers many recreational opportunities, including hunting, fishing, trapping, camping, hiking, dog mushing, cross-country skiing, wildlife viewing, snowmachining, gold panning, boating, and berry picking (ADNR, 2013b). The DMLW manages timber sales from state forested land in consultation with the ADNR Division of Forestry. The Mainline Pipeline would cross through forested land in five segments of the forest between MPs 407.7 and 454.6. Other Project facilities within the forest would include construction workspaces; the Minto Compressor Station, construction camp, and MLV; access roads; pipe storage yards; disposal sites; and material sites.

The Mainline Facilities footprint would include about 561 acres of the Tanana Valley State Forest, which is less than 1 percent of the state forest's total acreage. Construction at any one location in state-managed forest land could occur in winter or summer and would typically last from 6 to 12 weeks. Construction would occur between the fourth quarters of Years 3 and 5 (see section 2.3.1).

AGDC states that the ADNR would determine the appropriate mitigation measures for areas affected by construction, but that these measures would likely include coordination with the ADNR and USFWS following ADNR's regulations for protecting natural resources, maintaining public use of recreation areas, and installing temporary or permanent access to barrier gates on roads. AGDC would apply the restoration measures outlined in the Project Revegetation Plan and the Project Plan. Proposed mitigation measures include phasing the work to reduce disruption to public access, reducing Mainline Pipeline pre-construction activity during high-use periods; maintaining access to businesses, residences, and recreation sites; and reducing the creation of new public vehicular access and gate access roads. AGDC notes that State of Alaska land managers would decide the final mitigation measures required for the right-of-way lease.

Project construction could result in longer trips for forest visitors who must detour around construction workspaces to access specific lands. Construction noise and human activity could also temporarily displace wildlife species from areas near the Mainline Facilities. Noise impacts on terrestrial wildlife are discussed in section 4.6.1. During operation, the Project would include a cleared right-of-way within the Tanana Valley State Forest. This right-of-way could alter wildlife behavior and become a new access corridor for areas within the forest, but the cleared right-of-way would not reduce or prevent recreation activity within the Tanana Valley State Forest.

Project construction would have minor, short-term impacts on recreational use of the Tanana Valley State Forest due to longer access routes, noise, dust, and traffic. Project operation would have minor, permanent impacts due to the presence of a cleared corridor and resultant effects on wildlife.

Other Recreation Areas

The Project footprint overlaps with commercial and recreational fishing areas, including four shore fishery leases within the Mainline Facilities construction footprint in Cook Inlet. Commercial fishing in these lease areas includes set net fishing and drift-net fishing. Through negotiations with leaseholders and the ADNR, AGDC would identify mitigation measures to address fishing restrictions and ways to accommodate fishing activities during Project construction (e.g., safety setbacks and permanent exclusion areas).

As described in section 4.7.1, recreational fishing in Alaska includes sport and personal use fisheries in fresh and marine waters throughout the state. Sport fishing is important to the Alaskan economy as many people come to Alaska to fish in its rivers and along its coasts; personal use fishing is limited to Alaska residents, subject to special regulations. As listed in Table I-1 in appendix I, the Mainline Pipeline would cross 59 waterbodies identified as recreational fisheries. The pipeline would also cross major roads, such as the Dalton and Parks Highways, that provide access to recreational fishing waters. Section 4.7.1 describes the species and fishing methods associated with recreational fishing.

Project construction activities would displace recreational fishing at waterbody crossings and could temporarily prevent or complicate access to individual recreational fishing waterbodies, but would not meaningfully reduce the overall extent of available recreational fishing locations at any given time. With implementation of the mitigation measures discussed in section 4.7.1, the Project's impacts on fisheries (including recreational fisheries) would generally be localized and temporary and therefore not significant.

The Cook Inlet beach within the Liquefaction Facilities site is accessible to the public via Salamatof Road, about 1 mile north of the Liquefaction Facility property. The beach is not formally maintained by state or local governments as a recreation facility, but it is used for recreational purposes. During public scoping meetings, participants expressed concern about whether the Project would limit access to the beach (referred to at scoping meetings by participants as "North Beach"). While no data exist regarding the type and frequency of beach use by the public, participants at the October 27, 2015, public scoping meeting in Nikiski referred to beach-based fishing (commercial and recreational), agate hunting, and general recreational beach use. The Marine Terminal MOF and PLF components of the Liquefaction Facilities would be on the shoreline and would block existing access to the Cook Inlet beach from Salamatof Road.

AGDC states that development of a plan to construct an alternate public beach access point, including consultation with the ADNR, Kenai Peninsula Borough, and private landowners, would occur prior to construction. Any alternate access point would be south of Miller Loop Road. The plan for public beach access would address pedestrian and vehicular access, traffic and parking, signage, and construction methods to maintain bluff integrity, as well as ownership, management, and maintenance of beach access.

4.9.5 Special Interest Areas

Special interest areas include state or nationally managed land having scenic, historic, archaeological, scientific, biological, recreational, or other special resource values that warrant additional protections and special requirements. Lands managed specifically or primarily for recreation (or lands where recreation is an expected use) are discussed in section 4.9.4 above. This section describes special interest areas within 1 mile of Project facilities. Table 4.9.5-1 lists these special interest areas and summarizes the acreage of the Project's construction and operational footprint within these areas.

TABLE 4.9.5-1

Special Interest Areas Affected by Project Construction and Operation

	Area Affected (acres)	
Special Interest Area	Construction	Operation
Alaska Native Claims Settlement Act 17(b) easement	22	5
Area of Critical Environmental Concern	770	171
Revised Statute 2477 rights-of-way	72	6
Total [a]	**864**	**181**

[a] The totals shown in this table may not equal the sum due to rounding.

4.9.5.1 Federal Resources

Alaska Native Claims Settlement Act

Section 17(b) of the ANCSA (Public Law 92-203; 43 USC 1601 et seq.) authorizes the federal government to reserve easements on lands that would be conveyed to Alaska Native Corporations to allow public access to public land and water. Uses allowed under a 17(b) easement are described in the conveyance document issued to a Native Corporation (ADNR, 2018a). Any use other than what is described in the conveyance document requires permission from the ANCSA corporation owner of the underlying lands, as well as coordination with the agency managing the easement, to minimize impacts on public use of the easement. The Project footprint would intersect 11 ANCSA Section 17(b) easements, including nine easements that would be crossed by the Mainline Facilities (see table 4.9.5-2), and two 17(b) easements that would be within the construction footprint of the Liquefaction Facilities.

The Mainline Facilities crossings listed in table 4.9.5-2 would affect about 2 acres with ANCSA 17(b) rights-of-way during construction. Impacts would include land disturbance during pipeline trenching and burial and the use of 17(b) rights-of-way as access roads and for construction camps, material sites, and pipe storage yards. Following construction, access to these special interest areas would be restored to pre-construction conditions. While Section 17(b) easements are not designated as recreational trails, we assume that the duration of construction across the easements would be about the same amount of time and that the easements would be treated in the same way as trail crossings. Regarding trail crossings, AGDC states that the closure duration of any specific cut area for most trails would be measured in hours, but could be as high as a day or two depending on the trail or byway. As a result, impacts on users of Section 17(b) facilities would be temporary and minor.

TABLE 4.9.5-2

Alaska Native Claims Settlement Act 17(b) Rights-of-Way Crossed by the Mainline Facilities

ANCSA 17(b) Right-of-Way Number	Closest Mainline Facilities Milepost	Mainline Facility
21	547.3	Construction right-of-way
17a	551.2	Construction right-of-way
16	556.4	Construction right-of-way
15	559.6	Construction right-of-way
30	574.1	Construction right-of-way, access road
5h	570.9	Construction right-of-way
100	581.9	Construction right-of-way
6b	581.9	Construction right-of-way
5	794.5	Construction right-of-way

Two additional Section 17(b) easements (Nos. 10 and 11), including a road access easement and an oil and gas pipeline access easement, are within the Liquefaction Facilities construction camp. The road access easement, which is along the eastern edge of the construction camp property, would not be affected by use of the camp. The construction camp would be removed following completion of construction of the Liquefaction Facilities. As a result, construction and operation of the Liquefaction Facilities would have minor, temporary impacts on Section 17(b) easements.

Wild and Scenic Rivers Act

As discussed in section 1.6.13, the WSRA established the National WSR System for preserving rivers that "possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or similar values." Under the WSRA, a river (or portion of a river) may be designated as wild, scenic, or recreational (or a combination of those characteristics). Within Alaska, 3,210 river miles have at least one such designation, constituting about 1 percent of the total river miles within the state (USFWS, 2014c). Within the WRSA, federal agencies must seek to avoid or mitigate actions that would adversely affect rivers included on the NRI. Rivers on the NRI are free flowing and possess one or more ORVs based on the river's hydrology and inventory of its natural, cultural, and recreational resources (16 USC 28.1271). The Project would cross three NRI or NRI-eligible waterbodies: the Atigun and Deshka Rivers and Alexander Creek.

As part of the Comprehensive Conservation Plan for the ANWR, the USFWS evaluated the segment of the Atigun River and its tributary streams within the ANWR for WSR designation. It determined that the segment of the Atigun River known as Atigun River Gorge is eligible and suitable for inclusion in the federal WSR System due to its wild and outstandingly remarkable recreation and geologic values. The WSR-eligible segment of the Atigun River has "some of the most challenging road-accessible whitewater in northern Alaska" (USFWS, 2015a). Hiking and other land-based recreation activities are also popular in the Atigun River Gorge (USFWS, 2015a). The Mainline Pipeline would cross the Atigun River at multiple points, including at MP 145.2, which is near but outside of Atigun River Gorge, and between MPs 166.3 and 168.6. The Atigun River is accessible from the Atigun 2 boat put-in adjacent to the west side of the Dalton Highway at about MP 145.2, less than 1 mile (by river) upstream from the WSR-eligible segment of the river (USFWS, 2015a).

The Mainline Pipeline would cross the Atigun River east of the Dalton Highway between the Atigun 2 boat put-in and the WSR-eligible segment of the Atigun River. This crossing would be accomplished using the dry ditch method during the winter when recreational use of the river is not possible due to ice. During summer, increased Project construction traffic could dissuade some recreational travelers from accessing the Atigun River via the Dalton Highway. As described in section 4.9.4.2, however, Project construction would generate limited additional traffic on the Dalton Highway. As a result, Project construction would not prevent access to the WSR-eligible segment of the Atigun River. Potential impacts on water quality in the Atigun River from sedimentation due to runoff are addressed in section 4.3.2.6.

As discussed in more detail in section 4.3.2, Project facilities would cross two NRI waterbodies, the Deshka River at MP 704.7 and Alexander Creek at MP 727.8. The Deshka River was listed on the NRI in 1993 as having ORVs for cultural, recreational, and fish resources. Many archeological sites are at the lower section of this river. In the winter, the area provides valuable moose habitat and is a popular recreation area for snowmachines, dog mushing, and cross-country skiing (NPS, 2018d). The river is also primary habitat for Chinook salmon and supports chum, coho, pink, and sockeye salmon. AGDC would use DMT to cross the Deshka River (summer construction), which would avoid impacts on river uses and adjacent areas and would not adversely affect ORVs, including recreation. No impacts on recreational uses of the Deshka River during Project operation would be anticipated.

Alexander Creek was listed on the NRI in 1995 as having ORVs for cultural, recreational, scenic, and fish and wildlife resources. The lower part of the river has native archeological sites, historical roadhouses, and the INHT. The area is popular for anglers hoping to catch Chinook and coho salmon. Additionally, the creek has relatively calm water and is a popular spot for floaters. As discussed in section 4.3.2, AGDC would install the pipeline across Alexander Creek in winter using a dry-ditch construction method, which would avoid impacts on summer-related ORVs, including recreation. Construction would affect winter recreation activities, such as snow machining, but impacts would be temporary and limited to one season. No impacts on recreational uses of Alexander Creek during Project operation are anticipated.

Project construction would have minor, short-term impacts on recreational uses of WSR-eligible and NRI waterbodies. Based on consultation with the NPS, impacts on the Deshka River and Alexander Creek would be adequately mitigated such that the NRI status of these waterbodies would not be affected. With implementation of the measures described in section 4.3.2, Project operation would not affect recreational use of WSR-eligible and NRI waterbodies.

Areas of Critical Environmental Concern

The Mainline Pipeline would cross two adjoining BLM managed ACECs: Toolik Lake RNA and Galbraith Lake ONA. In addition, the Project footprint would be within 1 mile of Sukakpak Mountain ACEC, Snowden Mountain ACEC, Jim River ACEC, and Nugget Creek ACEC. The BLM would be responsible for issuing right-of-way permits for the Project. These areas are described below and shown on figure 4.9.5-1.

- Toolik Lake RNA: The Toolik Lake RNA encompasses about 82,800 acres (BLM, 2018c) and was established in 1975 by the University of Alaska Fairbanks Institute of Marine

Science (Toolik Field Station, 2018). Toolik Lake RNA was designated to protect a natural land and tundra biome used for arctic natural resources research, primarily associated with the Toolik Field Station through the University of Alaska Fairbanks. The BLM's RMP aims to protect data and research projects in the area as much as possible, but acknowledges that energy transportation is a primary function of this corridor (BLM, 1991). The Mainline Pipeline would cross the Toolik Lake RNA and Toolik Lake between MPs 121.0 and 138.2.

- Galbraith Lake ONA: The Galbraith Lake ONA ACEC occupies about 56,000 acres (BLM, 2018c), and is the largest of the five ACECs within the BLM's Central Yukon Field Office region (BLM, 2009). It encompasses the Atigun River Valley and portions of the mountains on both sides of the valley. The Galbraith Lake ONA ACEC also includes Galbraith Lake and several drainages that feed the lake. The area is managed to protect historical and archaeological sites, critical wildlife habitat, paleontological and geological sites, scenic values, and any rare and sensitive plants that could be present. The BLM's Utility Corridor Proposed RMP states that ACEC management would not restrict existing or future energy transportation systems (BLM, 1989). The Mainline Pipeline would cross the Galbraith Lake ONA between MPs 139.2 and 150.5, and would cross multiple tributaries to Galbraith Lake.

- Snowden Mountain ACEC: The Snowden Mountain ACEC occupies about 28,000 acres on the southern slopes of the Brooks Range within the Dietrich River drainage immediately east of the Dalton Highway, TAPS, and Gates of the Arctic NPP (BLM, 2018c). This rugged area was designated as an ACEC to protect sheep habitat. It contains a variety of undisturbed habitats supporting healthy populations of wildlife, including Dall sheep. The Mainline Facilities would be about 0.2 mile from Snowden Mountain ACEC at MP 199.1, and would generally be less than 1.0 mile away from the Project from MPs 191.0 to 203.0.

- Sukakpak Mountain ACEC: The Sukakpak Mountain ACEC, which encompasses about 2,944 acres, was designated in 1990 (BLM, 2018c, 1988). Sukakpak Mountain ACEC was designated to protect unique geologic buildings, folds, and faults, as well as views of the geologic processes of mountain building and erosional forces. Rare plant species are also present. The area is accessible to the public via the Dalton Highway. The Mainline Facilities would not cross Sukakpak Mountain ACEC but would be about 0.1 mile from the ACEC at MP 211.9, and would be less than 1.0 mile away from the ACEC between MPs 209.0 and 213.0.

- Jim River ACEC: The Jim River ACEC, which encompasses about 203,000 acres in the headwaters of the Jim River and Prospect Creek, was designated in 1991 (BLM, 2018c, 1988). The Jim River ACEC was designated to protect "chum and king [Chinook] salmon spawning habitat, overwintering habitat for resident and anadromous fish species, sport fishing use, raptor habitat, scenic and recreation values, and archaeology" (BLM, 1988). The Mainline Facilities would not cross the Jim River ACEC but would be about 0.6 mile from the ACEC at MP 281.7.

- Nugget Creek ACEC: The Nugget Creek ACEC, which encompasses about 3,345 acres on the west bank of the Middle Fork Koyukuk River, was designated in 1991 (BLM, 2018c, 1988). Nugget Creek ACEC was designated to protect "Dall sheep lambing habitat and mineral licks" (BLM, 1988). The Mainline Facilities would not cross the Nugget Creek ACEC but would be about 0.5 mile from the ACEC at MP 219.2.

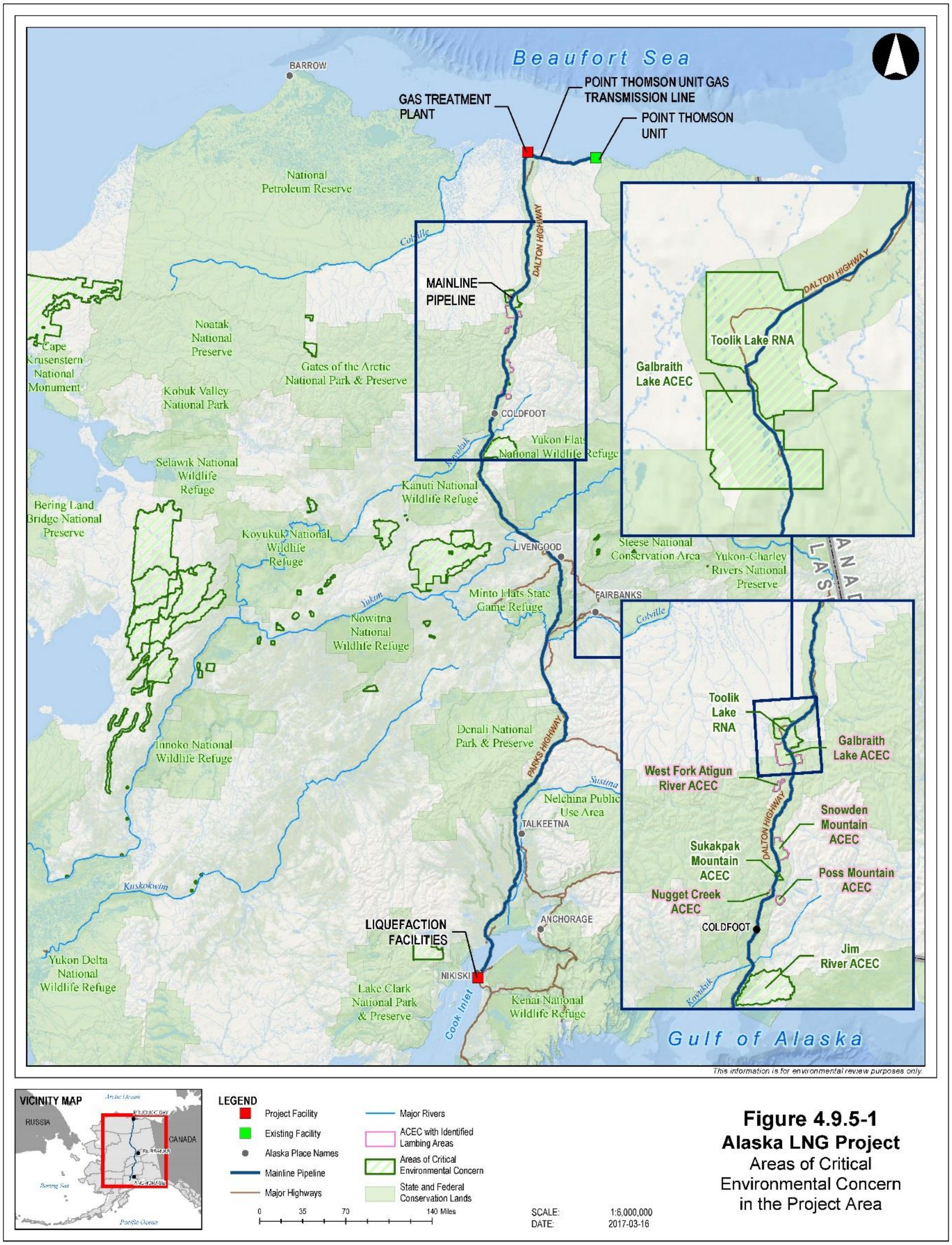

Figure 4.9.5-1
Alaska LNG Project
Areas of Critical Environmental Concern in the Project Area

Mainline Facilities construction across Toolik Lake RNA, Galbraith Lake ONA, and Sukakpak Mountain and Snowden Mountain ACECs would require a BLM right-of-way permit. For Toolik Lake RNA, Project representatives would work with the BLM to ensure that any ongoing research projects are protected effectively.

Construction activities in these areas would not block access to any ACEC, however it could result in longer trips for visitors (e.g., if those individuals can only cross the Mainline Pipeline right-of-way at selected locations). Construction noise and human activity could also cause wildlife species of interest to recreational visitors to avoid areas near the Mainline Facilities. During operation, the permanent right-of-way would not reduce or prevent recreation activity within the ACEC areas. Section 4.6.1 discusses impacts on terrestrial wildlife in ACECs.

Military Facilities

Military facilities include any location owned and operated by the military for active military operations, as well as personnel, administrative, and storage functions. There are nine military facilities in Alaska, of which only Clear AFS is within 1 mile of Project facilities. At its southwest corner, Clear AFS is about 0.5 mile from the Mainline Pipeline at MP 495.8. As described in section 4.9.3, the Project would have no impacts on existing military activities and planned development at Clear AFS.

4.9.5.2 State Resources: Revised Statute 2477 Easements

Revised Statute (RS) 2477 was a federal statute (part of Section 8 of the Mining Law of 1866) stating "The right-of-way for the construction of highways over public lands, not reserved for public uses, is hereby granted." In the terminology of the 1866 law, "highway" referred to "foot trails, pack trails, sled dog trails, crudely built wagon roads" (ADNR, 2013c). The intent of the statute was to promote development of the western United States without requiring federal action for establishment of every new travel route. The FLPMA (Public Law 94-579; 43 USC 1701 et seq.) repealed RS 2477, but the pre-existing rights attributable to easements established under RS 2477 remain in effect and are managed by the state. RS 2477 easements provide ongoing access rights to many rural destinations for snowmachines, dogsled teams, and all-terrain vehicles, and could provide recreational hiking opportunities.

The PTTL would cross the Bullen-Staines River RS 2477 right-of-way (Revised Statute Trail [RST] 1043) three times at PTTL MPs 1.9, 2.4, and 8.1, affecting about 4 acres during construction. Impacts would include land disturbance during pipeline construction, and could result in partial or full closure of the RS 2477 right-of-way. As described in section 2.1.3, the PTTL would be an aboveground pipeline elevated a minimum of 7 feet above the ground surface. Following construction, the use of RS 2477 rights-of-way would be restored. The pipeline's elevation above the ground surface would allow passage by right-of-way users, and thus, would not permanently affect use of RST 1043. The construction footprint of the remainder of the Gas Treatment Facilities would not cross or be within 1 mile of any identified SUAs, and would therefore have no impact on SUAs.

The Mainline Facilities footprint would intersect 22 RS 2477 easements as listed in table 4.9.5-3. These crossings would affect about 11 acres within RS 2477 rights-of-way during construction. Impacts would include land disturbance during pipeline trenching and burial and the use of RS 2477 easements as access roads and for construction camps, material sites, and pipe storage yards. Following construction, access to special interest areas would be restored to pre-construction conditions. As a result, Project construction would have minor, short-term impacts on RS 2477 easements, while Project operation would have no impacts.

TABLE 4.9.5-3 **Revised Statute 2477 Rights-of-Way Crossed by the Mainline Facilities**		
Revised Statute 2477 Right-of-Way Number	Closest Mainline Facilities Milepost	Mainline Facility Activity
RST 450	62.8	Construction right-of-way
RST 254	218.7	Construction right-of-way, material site study area
RST 9	241.2	Construction right-of-way, ATWS, Coldfoot Camp, access roads
RST 412	241.2	Construction right-of-way, ATWS, Coldfoot Camp, access roads
RST 412	255.5	Construction right-of-way
RST 450	301.5	Construction right-of-way, access roads
RST 468	400.6	Construction right-of-way, ATWS, access road, Livengood Camp
RST 66	401.8	Construction right-of-way, access road, material site study area
RST 66	438.6, 439.4	Construction right-of-way, ATWS, material site study area
RST 66	449.7	Material site study area
RST 66	451.3	Construction right-of-way
RST 66	454.6	Construction right-of-way
RST 1595	455.9	Construction right-of-way, access road
RST 346	473.8	Construction right-of-way, disposal site, access road, Nenana Pipe Storage Yard
RST 345	497.3	Construction right-of-way
RST 343/491	498.1	Construction right-of-way, material site study area
RST 340	523.2	Construction right-of-way, ATWS
RST 709	527.0	Construction right-of-way, ATWS, access road
RST 625	566.5	Construction right-of-way, ATWS, access roads
RST 199	723.5	Construction right-of-way
RST 1862	751.5	Construction right-of-way, ATWS
RST 200	766.2	Construction right-of-way, ATWS, Beluga Marine Camp Pipe Storage Yard, access roads

4.9.6 Landfills, Mines, and Hazardous Waste Sites

This section addresses the locations and potential effects on the environment posed by hazardous waste sites, including landfills, mines, and terrestrial spill/release sites, inside and near the Project area during construction and operation due to the presence of contaminants. The release of contaminants to the environment through interaction with existing contamination or through construction and operational activities conducted as part of this Project could create effects that are harmful to human health, public safety, and environmental resources including fish, wildlife, and vegetation. The potential for adverse impacts due to Project activities on existing contaminated sites has been analyzed based on the proximity, type, and regulatory status of existing sites. Existing contaminated sites are defined as those that have been inventoried by regulatory agencies as potential or known sources of contaminants. Section 4.2 addresses contaminated soils and marine sediments, and section 4.3 addresses contaminated water resources.

4.9.6.1 Regulatory Framework

Contaminants include substances designated as toxic or hazardous under a number of federal laws, including RCRA, the Comprehensive Environmental Response, Compensation, and Liability Act

(CERCLA), the CWA, the Solid Waste Disposal Act, and the Toxic Substances Control Act as defined in 40 CFR 261.20 and 302.40, and 40 USC 103. Substances designated as hazardous waste under RCRA must be handled according to RCRA standards and disposed of at a RCRA waste treatment, storage, and disposal (TSD) facility. State-regulated contaminants under the Alaska Contaminated Sites Remediation Program (CSRP) include petroleum products, such as diesel fuel, gasoline, and fuel oil, as defined in 18 AAC 78.

To evaluate potential sources of contamination in the Project area, AGDC inventoried documented privately operated landfills, active and inactive mines, and spill/release sites. We have included an assessment of landfills and mines in this section due to the potential for contaminants to occur at these facilities. The inventory includes all properties managed under CERCLA, RCRA, the CSRP, and the Alaska Solid Waste Program (SWP). Mine sites administered through the DMLW and BLM are also included, as summarized below.

Comprehensive Environmental Response, Compensation, and Liability Act

CERCLA, also known as Superfund, is a federal law that addresses the cleanup of hazardous waste sites. The EPA is the primary agency with CERCLA-enforcement authority, but other federal and state agencies have been delegated authority to implement CERCLA cleanup actions. The EPA identifies CERCLA sites when a release or threatened release of a toxic or hazardous substance to the environment has been documented, and addresses any resulting contamination either through a removal action, which usually involves a relatively quick response, or remedial action, which could involve long-term cleanup activities. For purposes of this document, a hazardous waste site's CERCLA regulatory status is identified by the categories below.

- Active: CERCLA investigation or remediation is ongoing.

- Closed: The EPA has issued a No Further Remedial Action Planned status for the site. Contamination may remain at the site, but the EPA has determined that further remedial planning is not warranted based on current and/or projected future land use. Many No Further Remedial Action Planned sites have institutional controls that regulate future land use and disturbance.

Resource Conservation and Recovery Act

RCRA is the federal law that provides for management controls on generators and transporters of RCRA hazardous waste and owners of RCRA TSD facilities. RCRA applies mainly to active facilities that generate and manage RCRA hazardous wastes. RCRA also contains provisions for corrective action when contaminants have been released to the environment from a RCRA-regulated facility. The EPA administers the RCRA program in Alaska. RCRA site status is identified by the categories listed below.

- Active: The EPA regulates the site as a RCRA TSD facility.
- Corrective Action: RCRA corrective actions are being performed at the facility.
- Closed: Corrective action was performed and the EPA issued a site closure.

Hazardous waste sites only include sites with documented contamination; licensed hazardous waste generators with no documented contamination are not assessed in this section.

Alaska Contaminated Sites Remediation Program

The Alaska CSRP monitors contaminated sites and manages the cleanup of contaminated soil and groundwater sites that are not led by a federal agency (i.e., state-lead sites). The CSRP, administered by

ADEC, addresses non-CERCLA hazardous substance release sites and LUST sites. Under the CSRP and LUST programs, site status is identified by the categories listed below.

- Open: Activities to investigate, monitor, or remediate site conditions are ongoing.
- Cleanup Complete: Cleanup efforts have achieved the state cleanup standards and/or the possibility of human exposure to residual contamination is unlikely.
- Cleanup Complete with Institutional Controls: Contaminants remain in the environment, but CSRP has established conditions or restrictions on land use at the site that require compliance by current or future landowners or operators.

Alaska Solid Waste Program

The Alaska SWP regulates municipal solid waste landfills and other solid waste disposal facilities associated with oil and gas development, mining, timber, construction, fishing, and tourism industries. The program establishes requirements for solid waste facility design, permits and authorizations, inspections, monitoring, compliance assistance, and closure. Potential hazards from landfills include methane gas, an explosion hazard, and industrial or previously unregulated wastes that could leach contaminants into the soil or groundwater. The program is administered by ADEC. Under the Alaska SWP, site status is identified by the categories listed below.

- Active: Active landfilling is being performed.
- Retired: ADEC received final closure reports and records in accordance with permit conditions.

Division of Mining, Land, and Water and Department of the Interior

The DMLW manages the mineral exploration, development, and leasing programs on nearly 92 percent of the 91 million acres of state lands. The DMLW manages the reclamation of abandoned mines on state lands that are a public health or safety hazard. The Department of the Interior, through several bureaus, performs the same function on federal lands. Most of the active and closed federal mines in Alaska are managed by the BLM. The databases include active mines, closed mines, and mining prospects/claims (no active mining but a mining claim is maintained). AGDC reviewed available ADNR, Alaska Resource Data Files, and BLM databases to identify active and closed mines near the Project area. Section 4.1.2 provides a summary of mining claims found within 0.5 mile of the Project area. Appendix R presents known contamination from mining activities as spill/release sites. In addition, section 4.9.6 and appendix R include those mines AGDC identified as having the potential to have discharged contaminants toward the Project route.

Potential contaminants associated with current or historic mining claims include fuel hydrocarbons, acids, and heavy metals, which can enter the surrounding environment in a process known as acid mine drainage (see section 4.1.2). The majority of the mines in Alaska are placer operations, which are infrequently a source of acids and heavy metals. Settling ponds are used to treat water in modern placer gold mining, and reclamation of disturbed areas is required, reducing the potential for a release. In a small percentage of mines, historic placer gold mine tailings could contain mercury residue that could be encountered during construction if the Project intersects a historic gold mining area. In addition, mining sites are typically situated in areas with high natural mineralization and elevated levels of naturally occurring heavy metals. These naturally occurring metals in and near mining sites could be released to the environment through ground disturbing activities (see sections 4.1.1 and 4.1.3 for further details).

Oil and gas wells are another source of potential contamination in the Project area. In particular, mud recirculation pits associated with older, unregulated wells could have contaminants. AGDC reviewed ADNR oil and gas data to locate oil and gas wells and leases near the Project area. Section 4.1.2 provides a summary of oil and gas wells within 0.25 mile of the Project area, and appendix R presents known contamination from oil and gas wells as spill/release sites.

4.9.6.2 Status and Locations of Landfills, Mines, and Spill/Release Sites

AGDC completed a desktop review to locate landfills and spill/release sites within 0.25 mile[90] that could be sources of contamination in the Project area, which we supplemented with a geospatial analysis using the EPA's EnviroMapper database (EPA, 2017a). AGDC also located a number of mines further than 0.25 mile away; these mines would be potential sources of contamination based on their placement along a waterbody directly upstream of the Project. This review process identified 123 landfill and spill/release sites within 0.25 mile of the Project area and seven mines directly upstream of the Mainline Pipeline right-of-way as potential sources of contamination (see appendix R). AGDC provided detailed maps of landfills, mining claims, and spill/release sites near the Project area.[91]

This analysis included the following data sources:

- ADEC Contaminated Sites database (ADEC, 2016c), which includes a listing of federal facilities undergoing cleanup actions, CERCLA sites, and RCRA corrective action sites;
- ADEC LUST Program database (ADEC, 2016c);
- ADEC Solid Waste Information Management System (ADEC, 2017e);
- ADNR databases (2014d, 2015a,e,g), including data for oil and gas development, proposed oil and gas lease sales, and state mining claims;
- USGS Alaska Resource Data File (2015a), which provides descriptions of mines, prospects, and mineral occurrences;
- BLM Spatial Data Management System (2016b), which provides spatial data for federal mining claims in Alaska;
- EPA RCRA database (EPA, 2017c), which lists active RCRA sites in Alaska;
- EPA's EnviroMapper® database (EPA, 2017a), which includes information from EPA environmental databases that contain information about environmental activities that could affect air, water, and land, including air releases, water discharge permits, toxic releases, hazardous wastes, and Superfund sites in the United States; and
- EPA's Superfund Enterprise Management System database (EPA, 2018d), which includes information on National Priorities List sites.

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[90] Sites were assessed within 0.25 mile of the Project footprint based on guidelines in FERC's Guidance Manual for Environmental Report Preparation, which we determine is adequate for this Project based on the proposed Project design (e.g., trench depth). Any contamination encountered during construction or operation would be handled in accordance with the Project Unanticipated Contamination Discovery Plan (see section 4.9.6.3).

[91] See figure 4.1.2-1 for a map of mining claims. Landfills and spill/release sites can be viewed in appendix C of Resource Report 8 of AGDC's application (Accession No. 20170417-5345), available on FERC's website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter 20170417-5345 in the "Numbers: Accession Number" field.

The evaluation results for each Project facility are provided in appendix R and summarized in table 4.9.6-1.

TABLE 4.9.6-1

Landfills, Mines, and Spill/Release Sites Identified as Potential Sources of Contamination in the Project Area [a]

Project Facility	Number of Landfills, Mines, and Spill/Release Sites near the Project Area [b] and (in the Project Footprint)
Gas Treatment Facilities	10 (0)
Mainline Facilities	106 (21)
Liquefaction Facilities	14 (7)

[a] See appendix R for a complete list of sites.

[b] Numbers include landfills and spill/release sites within 0.25 mile of the Project and mines directly upstream of the Project. Values in parentheses indicate the sites within the Project footprint.

4.9.6.3 Impacts and Mitigation

Project-Generated Waste

In addition to the potential for the Project to encounter contaminated waste from existing known or unknown contaminated sites, Project construction and operation have the potential to release contaminants by generating solid waste and other forms of waste that require management, such as petroleum products (used oil), spent batteries, and other miscellaneous chemicals and construction consumables, as listed in the Project Waste Management Plan. Sections 4.2, 4.3, 4.4, 4.5, 4.7, 4.8, and 4.18 address potential impacts on resources from potential spills of contaminants, while section 4.11.6 addresses the management of Project-generated waste.

AGDC has developed a Project Waste Management Plan that establishes the processes for handling and disposing of hazardous and non-hazardous waste generated by Project construction and operation. This plan includes the following major components:

- measures to avoid or reduce contamination;
- waste segregation, consolidation, storage, and disposal procedures, including procedures for transporting any waste disposed of off site; and
- documentation and recordkeeping.

Implementation of the Project Waste Management Plan would reduce the potential for the inadvertent release of contaminants to the environment during construction and operation. In addition, the Project Procedures include measures to protect wetlands and waterbodies, such as a 100-foot set-back from wetlands and waterbodies for parking, fueling, and hazardous materials storage; the SOPEP includes measures to prevent the release of contaminants from vessels into marine waters. EIs and FERC CMs would ensure construction is carried out in compliance with approved construction procedures and measures intended to protect ecologically sensitive areas against the release of hazardous materials or petroleum products (see section 2.4). Should a release of petroleum products or hazardous materials occur due to construction or operational activities, AGDC would implement a facility-specific SPCC Plan to minimize impacts. AGDC would coordinate with the applicable non-hazardous waste landfill facilities (as listed in the Project Waste Management Plan) to ensure that the timing of disposal and necessary disposal capacity are compliant with the facility operating requirements and permit conditions. For RCRA hazardous waste disposal, AGDC would coordinate transportation and disposal requirements and protocols with the permitted RCRA TSD facilities, which are outside Alaska. Wastes generated by releases of regulated substances not covered under RCRA would be addressed using general mitigation procedures described in the Unanticipated Contamination Discovery Plan (see below).

Landfills, Mines, and Spill/Release Sites

The analysis of environmental consequences evaluates if Project construction and/or operation and maintenance would cause an adverse effect on the environment due to potential or known sources of contamination. Specifically, the analysis considers if Project construction or operation could:

- impede on-going or planned future site characterization or cleanup activities at a known contaminated site; or
- cause a new release or expand a release of contaminants to the environment from a contaminated site that would have an adverse effect on:
  - surface and groundwater;
  - vegetation and wildlife (see sections 4.5 through 4.8); and/or
  - the public.

We conducted an evaluation of the potential for Project construction or operation to encounter or disturb contaminated media from a landfill, mine site, or spill/release site based on the site's proximity to the Project area, local hydrogeologic conditions, facility type, and site regulatory or operating status (e.g., open/active or closed), as described below. Project activities would be more likely to encounter contamination at the following landfills, mine sites, and spill/release sites:

- active or open landfills, mine sites, and spill/release sites inside the Project footprint;
- spill/release sites that have been cleaned up with institutional controls in place inside the Project footprint since contaminants could have been left in place;
- retired landfills and inactive mines inside the Project footprint, since landfill- or mine-related hazardous materials or contaminants, such as methane gas (an explosion hazard) from landfills, or mercury from gold mine tailings, could be present; and
- active or open landfills, spill/release sites, and mines outside the Project footprint with surface water and groundwater flow toward the Project footprint and a groundwater depth within 10 feet of the ground surface; contaminants would have a greater likelihood to have migrated into the Project area in soil or groundwater that could be disturbed by construction and operational activities.

Project activities would have some potential, but be less likely, to encounter contamination at the following landfills, mine sites, and spill/release sites:

- contaminated sites that have been cleaned up without institutional controls inside the Project footprint; and
- contaminated sites that have been cleaned up with or without institutional controls in place, as well as retired landfills and inactive mines, outside the Project footprint.

Based on the criteria described above, the Project would have a greater likelihood of encountering contamination at or near 34 landfills, mine sites, or spill/release sites (see appendix R for a full listing of sites and site details), including:

- 1 site near the Gas Treatment Facilities;
- 28 sites along and near the Mainline Facilities; and
- 5 sites at or near the Liquefaction Facilities.

Of these sites, 23 would occur inside the Project footprint and 11 outside the Project footprint. As discussed below, AGDC would implement mitigation measures to reduce or eliminate adverse effects from contaminants at these sites as well as previously undocumented contaminants that could be present in the Project area (see the mitigation discussion below).

AGDC would consult with the relevant regulatory agencies and property owners on the nature and status of regulated contaminated sites known to occur within the Project area, including the contaminated media control measures that it would implement during construction and operation. AGDC would also work with the relevant parties to coordinate Project construction and operational activities around the timing of site investigations or cleanup activities for open sites. AGDC would adhere to the land use and contaminated media management requirements and site institutional controls stipulated by the ADEC regulatory program, where applicable, and would coordinate with owners of active and retired landfills and mines to ensure construction and operational activities do not compromise waste containment or monitoring infrastructure.

In the event construction and operational activities encounter unanticipated contaminants in soil, groundwater, or surface water, AGDC would implement the Project Unanticipated Contamination Discovery Plan, which provides general guidance on responding to an initial release, characterizing the affected area, and carrying out remediation of the contaminated site from the point of discovery to site closeout. The plan includes the following major components:

- indicators of potential contamination during excavation activities;

- initial response and notification procedures when contamination is encountered;

- contaminant/waste identification, characterization, and hazard assessment procedures;

- a mechanism for developing a preventive action plan to ensure the problem would not be aggravated and to minimize liability;

- a mechanism for developing closure specifications related to groundwater treatment or filtration systems, ventilation systems, ongoing site monitoring, and contaminated material disposal or reuse options; and obtaining site closure verification and concurrence by regulatory agencies; and

- record-keeping guidelines to document steps involved from initial discovery through final disposition and written approval by regulatory agencies.

Along with the information listed above, the Project Unanticipated Contamination Discovery Plan includes an Emergency Medical Services Directory listing contact information for fire departments and rescue services. However, AGDC did not include a number of other emergency numbers we recommend for effectively responding to an emergency caused by unanticipated contamination, which AGDC had previously provided in their response to an environmental information request by FERC.

In addition, while AGDC has stated that the Project Unanticipated Contamination Discovery Plan would be implemented during operation, operational activities are not specifically included in the purpose and scope of this plan. In addition, AGDC has not specified that FERC would be notified of any incidents involving off-site migration of contaminants (outside the permitted Project area) resulting from Project activities. Therefore, to ensure that the Project Unanticipated Contamination Discovery Plan providing all appropriate emergency response information and a FERC contact would be implemented during construction and operation, and that we would be able to evaluate whether contaminated media control measures had been effective in eliminating any off-site environmental threat from contamination, we recommend that:

- **Prior to construction, AGDC should file with the Secretary, for the review and written approval of the Director of the OEP, an updated Project Unanticipated Contamination Discovery Plan that addresses operation and maintenance activities and includes phone numbers for applicable emergency responders (e.g., Alaska state troopers, BLM fire dispatch) and a FERC notification requirement for any discovery or release of contamination outside the permitted Project area resulting from Project activities. The notification requirement should include copies of the associated regulatory agency correspondence regarding the off-site contamination.**

The Project Unanticipated Contamination Discovery Plan incorporates a number of resources to guide the management of unanticipated contamination. One of these resources is a Project Health and Safety Plan (HASP), which describes the contaminated media and worker safety requirements for a project. AGDC has developed a Project Health, Safety, Security, and Environment Plan that provides the Project-wide health and safety objectives and performance criteria for construction contractor compliance. AGDC stated that detailed HASPs that comply with the Health, Safety, Security, and Environment Plan would be developed by the construction contractors for Project implementation.[92]

With the measures specified in the plans and construction techniques described above, as well as our recommendations, potential adverse effects posed by landfills, mine sites, and spill/release sites, as well as Project-generated waste, would be reduced to less than significant levels.

4.9.7 Conclusion

Project construction and operation would have both temporary and permanent impacts on land use. Some land uses would be permanently converted to industrial use, specifically open land and forest within the Gas Treatment Facilities, Mainline aboveground facilities, and the Liquefaction Facilities. Other land uses, such as forest and residential or commercial structures, would be prohibited within the operational right-of-way for the pipeline. Based on the extent of impacts, and with implementation of the proposed mitigation measures and recommendations described in this section, the Project would not significantly affect land use.

AGDC would lease the federal, state, municipal, borough, and Alaska Native lands affected by the Project and abide by the conditions of leases, easement agreements, and associated permits for these lands.

[92] Figure 2 of the Project Unanticipated Contamination Discovery Plan shows the ADEC Flow Chart for Contaminated Site Process, including associated resources. This document was provided on May 3, 2019 in response to information request No.153, dated October 2, 2018 (Accession No. 20190503-5051). The Project Health, Safety, Security, and Environment Plan was provided on May 3, 2019, in response to information request No. 151, dated October 2, 2018 (Accession No. 20190503-5051). The documents can be viewed on the FERC website at http://www.ferc.gov. Using the “eLibrary” link, select “Advanced Search” from the eLibrary menu and enter 20190503-5051 in the “Numbers: Accession Number” field.

Easement agreements for private lands would be completed with each affected private landowner. As a result, the Project would not significantly affect land ownership.

AGDC identified three planned developments within 0.25 mile of the Mainline Pipeline. Construction and operation of the Project would have no impact on the Icewine #1 and #2 wells, the Chuitna Coal Mine, or activities at Clear AFS. There are no known planned developments in the vicinities of the Gas Treatment Facilities and Liquefaction Facilities.

Construction and operation of the Project would have both temporary and permanent impacts on recreation. Project construction could make it more difficult for recreational users to access portions of some designated recreation areas. This would occur in recreation areas crossed by the Project, such as Denali State Park and BLM lands, as well as nearby recreation areas, such as the DNPP, where Project construction would affect traffic on major travel routes. During operation, the Project's permanent impacts would include the presence of a cleared pipeline corridor and the resulting effects on scenery, vegetation, and wildlife—elements often associated with recreational activity in Alaska—on recreation lands crossed by the pipeline. Temporary noise during construction and permanent noise near compressor stations could also affect recreational activity. Based on the extent of impacts, and with implementation of the proposed mitigation measures, the Project would not significantly affect recreation areas.

The mainline pipeline would be installed across the INHT in two locations. Construction across the INHT would occur during winter, which is the heaviest season of use of the trail. Winter activities along the trail include annual dog sled and snowmobile races, freighting of supplies and travel by local residents, and other recreational activities. With implementation of our recommendation that AGDC file a site-specific crossing plan for the INHT, to include coordination with trail managers, impacts on the INHT would be temporary and minor.

Project construction would have both temporary and permanent impacts on special interest areas. Project construction could temporarily block or restrict access to RS 2477 and ANCSA 17(b) easements as well as WSR-eligible and NRI waterbodies. Project construction could also affect wildlife in and access to ACECs. Project operation would not reduce or prevent recreational activity within these special interest areas. As a result, and with implementation of the proposed mitigation measures, the Project would not significantly affect special interest areas.

There are 34 landfills, mines, or spill/release sites within and adjacent to the Project area that would be more likely to have contaminants that could be encountered by Project construction and operation. In addition, Project construction and operation would generate hazardous and regulated waste, such as used oil and other miscellaneous chemicals. Measures specified in the Unanticipated Contamination Discovery Plan, HASP, Project Waste Management Plan, SPCC Plan, Project Procedures, and SOPEP would reduce adverse effects from existing contaminated sites and Project-generated waste to less than significant levels.

4.10 VISUAL RESOURCES

Visual resources are the composite of natural and cultural features of the landscape that can potentially be viewed and that influence the visual appeal of an area for viewers. Impacts on visual resources could occur during construction when large equipment, excavation activities, spoil piles, staging and laydown areas, and construction materials are visible to viewers, and during operation to the extent that facilities or portions of facilities and their lighting are visible to viewers. The degree of visual impact resulting from a proposed project is typically determined by the level of contrast it produces relative to the visual character and quality of the existing landscape, as well as the effects that this contrast could have on viewers. This section describes the existing visual environment, visual impacts, and mitigation associated with Project construction and operation. Visual impacts on federal Class I and Sensitive Class II areas due to Project emissions are discussed in section 4.15.

The primary concern with regard to visual resources is the impact of Project construction and operation on views of or from sensitive visual resource areas (SVRA), such as the DNPP, scenic highways, and state lands that support recreational use. Project activities that could generate these impacts include clearing and grading, post-construction maintenance of pipeline rights-of-way, access roads, cut and fill slopes, and aboveground facilities.

4.10.1 Existing Visual Environment

4.10.1.1 Regulatory Background

This section describes the existing visual environment of the overall analysis area. Table 4.10.1-1 lists the federal and state agency management plans that include guidelines and objectives for managing visual resources on lands affected by the Project. AGDC would obtain permits and operate the Project in compliance with relevant provisions of these management plans.

4.10.1.2 Bureau of Land Management Visual Resource Management System

Descriptions of visual conditions in the analysis area are consistent with the terminology used in BLM's VRM system, including distance zones and analysis area, landscape character and scenic quality, visual sensitivity, and KOP. These terms are defined in the following sections. For each Project facility, the general landscape character and features of views are described, along with an assessment of the scenic quality and visual sensitivity of views.

Distance Zones and Analysis Area

The VRM methodology identifies three "distance zones" (foreground, middleground, and background), each of which represents different levels of detail and clarity visible to an observer under clear atmospheric conditions. For the Project, we defined the distance zones as described below.

- **Foreground-middleground**: The area 3 to 5 miles from the observer. The outer boundary of this distance zone is defined as the point where the texture and form of individual plants are no longer apparent in the landscape (BLM, 1986a).

- **Background**: The area from the most distant edge of the foreground-middleground zone, up to 15 miles from the observer. This distance includes portions of the landscape visible beyond the foreground-middleground zone.

- **Seldom-seen**: The areas not visible within the foreground-middleground and background zones (i.e., parts of the landscape that are behind a ridge or other geographic or manmade structure), or that are beyond the 15-mile edge of the background zone.

The 15-mile distance was selected for the analysis area because this distance corresponds to the maximum extent of the background distance zone, and represents the distance within which Project features could potentially contrast with their surroundings and be noticeable to viewers. Although this distance zone is generally the farthest extent recommended for use with the VRM methodology, it was selected for the analysis area due to the expansive nature of the landscape in Alaska.

TABLE 4.10.1-1

Management Plans with Visual Resource Guidelines Relevant to the Project

Plan	Agency	Relevant Project Facilities
Revised Comprehensive Conservation Plan for ANWR	USFWS	Gas Treatment Facilities, Mainline Facilities
North Slope Management Plan	ADNR	Gas Treatment Facilities, Liquefaction Facilities
Utility Corridor RMP	BLM	Mainline Facilities
Central Yukon RMP	BLM	Mainline Facilities
East Alaska RMP	BLM	Mainline Facilities
INHT Comprehensive Management Plan	BLM	Mainline Facilities
Consolidated General Management Plan for DNPP	NPS	Mainline Facilities
Gates of the Arctic NPP General Management Plan Amendment	NPS	Mainline Facilities
Revised Comprehensive Conservation Plan for the Kanuti NWR	USFWS	Mainline Facilities
Comprehensive Conservation Plan for the Yukon Flats NWR	USFWS	Mainline Facilities
Dalton Highway Scenic Byway Corridor Partnership Plan	ADNR/ADOT&PF	Mainline Facilities
George Parks Highway Scenic Byway Corridor Partnership Plan	ADNR/ADOT&PF	Mainline Facilities
Denali State Park Management Plan	ADNR	Mainline Facilities
Tanana Valley State Forest Management Plan	ADNR	Mainline Facilities
Petersville Recreational Mining Area Management Plan	ADNR	Mainline Facilities
Nancy Lake State Recreation Management Area Management Plan	ADNR	Mainline Facilities
Master Plan for Willow Creek State Recreation Area	ADNR	Mainline Facilities
Susitna Matanuska Area Plan	ADNR	Mainline Facilities
Yukon Tanana Area Plan	ADNR	Mainline Facilities
Minto Flats SGR Management Plan	ADF&G	Mainline Facilities
Susitna Flats SGR Management Plan	ADF&G	Mainline Facilities
Revised Comprehensive Conservation Plan for the Kenai NWR	USFWS	Mainline Facilities, Liquefaction Facilities
Kenai Area Management Plan	ADNR	Mainline Facilities, Liquefaction Facilities
Trading Bay SGR and Redoubt Bay Critical Habitat Area Management Plan	ADF&G	Mainline Facilities, Liquefaction Facilities
Kenai River Comprehensive Management Plan	ADNR	Liquefaction Facilities

Sources: ADF&G, 1988, 1992, 1994; ADNR, 1990, 1998, 2001a, 2001c, 2006a, 2008a, 2008b, 2010b, 2011, 2014e, 2015f, 2016b, 2017b; BLM, 1986c, 1989, 2007; USFWS, 1987, 2008c, 2010a, 2015b; NPS, 2011, 2016b

Landscape Character and Scenic Quality

Scenic quality was evaluated based on the VRM scenic quality rating system. The scenic quality evaluation is a measure of the visual appeal of a tract of land. Consistent with *BLM Manual H-8410-1–Visual Resource Inventory* (*BLM Manual H-8410-1*), public lands are assigned a scenic quality rating of A, B, or C based on the apparent scenic quality determined by scoring seven visual characteristics: landform, vegetation, water, color, influence of adjacent scenery, scarcity (common versus rare), and cultural modifications (BLM, 1986a). The scoring basis is described in table 4.10.1-2.

Areas with the largest variety and most harmonious composition have the highest scenic value scores. Scores given to each visual quality reflect the evaluator's overall impression of the area. An "A" rating corresponds to a total score greater than 19; a "B" rating corresponds to a score from 12 to 19; and a "C" rating indicates a total score below 12 (BLM, 1986a).

Due to the geographic scope of the Project, AGDC did not inventory the entire analysis area. Instead, AGDC evaluated scenic quality at specific viewpoints within the study area, selected in coordination with BLM and other agencies, to establish a baseline for current scenic quality. The process used to select viewpoints for evaluating scenic quality is described in section 4.10.2.1.

TABLE 4.10.1-2

Visual Resource Management Rating System Scoring

Rating System Component	Scoring Minimum	Scoring Maximum	Scoring Basis
Landform	1	5	Contribution to scenic quality
Vegetation	1	5	Contribution to scenic quality
Water	0	5	Contribution to scenic quality (1-5 points). If no water is present or visible, score is 0
Color	1	5	Locations with unique, strong, or varied colors: 5 points. Locations with little color and variation in color: 1 point.
Adjacent scenery	0	5	Contribution to scenic quality (1-5 points). Adjacent views substantially affected by development or not considered scenic: 0 points.
Scarcity	1	5	Higher scores for rare or unique features; lower scores for features that are common in the region.
Cultural modification	-4	2	Based on ability to harmonize or detract from natural landscape. Cultural modifications that greatly detract from or block views are scored -4. Cultural modifications that greatly enhance views (e.g., bridges or pathways) are scored 2.

Source: BLM, 1986a

The character of each component varies considerably throughout the analysis area due to the Project's extent and the diversity of visual conditions in the analysis area. As a result, the descriptions are necessarily generalized. Landscapes at individual KOPs could differ substantially from these general descriptions, and could have distinctly different foregrounds, middlegrounds, and/or backgrounds. The following discussion summarizes the general scenic quality within the analysis area for each of the seven criteria in BLM's scenic quality rating system.

- **Landform**: Landform is typically flat to rolling in the areas immediately adjacent to the KOPs and the proposed Project features. In the areas near Galbraith, Coldfoot, and DNPP, the KOPs often have a flat foreground with more rugged, jagged landforms in the middle to background. At Atigun Pass, the landforms in both the foreground and background are rugged and jagged.

- **Vegetation**: Vegetation is typically characterized by low grasses, shrubs, and deciduous trees, with evergreens in the lowland areas. The lower slopes of the distant peaks are often blanketed with the rougher textures and dark greens of dense stands of evergreens. Trees are generally not present north of Chandalar Shelf.

- **Water**: Several large rivers cross the analysis area, including the Yukon, Nenana, Talkeetna, Susitna, and Kenai, as do more than 600 other smaller rivers and streams. The rivers contribute to scenic quality of the area with their undulating, ribbon-like forms. Several lakes are also visible in the analysis area, including Colleen Lake, Galbraith Lake, and Otto Lake. The general smoothness of these waterbodies contrasts with the rougher textures found in the vegetation. Cook Inlet's choppy oceanic waters provide a rougher texture and are a foreground for the mountainous terrain.

- **Color**: Color is primarily introduced by the vegetation (typically light to dark greens) and landform (typically gray to brown), and varies with the season, level of lighting, and weather. Seasonal red, yellow, and gold are present in the fall, while more vivid purples and blues are found seasonally in areas with wildflowers. Locations with water have additional white, browns, blues, and greens. Many of the colors in the landscape, particularly those associated with water, shift with the sky color and the angle of the sun.

- **Adjacent Scenery**: In many portions of the analysis area, the scenic quality is greatly enhanced by the influence of adjacent scenery. The mountain peaks of the Coastal, Brooks, and Alaska Ranges contrast with the flat to rolling topography adjacent to the proposed Mainline Pipeline route. In many areas, the peaks are covered with snow or darker vegetation, adding variety to the colors and textures in the viewshed.

- **Scarcity**: Many of the viewsheds in the analysis area have a high level of scenic quality, but because most of these viewsheds are characteristic of the surrounding region, scarcity (compared to landscapes available in other parts of Alaska) is a less influential factor in the overall scenic quality rating.

- **Cultural Modifications**: Cultural modifications in the analysis area consist primarily of transportation corridors, transmission lines, and oil and gas infrastructure. Oil and gas infrastructure is concentrated near Deadhorse and Nikiski, and present throughout the analysis area. Near Healy, Cantwell, Talkeetna, and Kenai, there are a greater number of residences and commercial buildings. Most residential and commercial buildings are small in scale and do not significantly detract from the scenic quality.

Visual Sensitivity Within the Analysis Area

The BLM uses sensitivity levels to evaluate public concern for scenic quality in an area. Impacts on visual quality are typically greater in an area with a higher sensitivity level, even if the scenic quality rating is the same as other areas.

The VRM system defines visual sensitivity as a measure of viewer concern for the scenic resource (scenic quality) and potential changes to the resource. Visual sensitivity is determined based on a combination of viewer sensitivity and viewer exposure. Viewer sensitivity is based on the identification of general viewer groups and their anticipated awareness and concerns for visual resources and aesthetics. Viewer sensitivity reflects the types of viewers, activities they could be engaged in, and the expressed or anticipated level of public interest and concern. Viewer exposure considers the numbers of viewers and the frequency and duration of their views.

BLM Manual H-8410-1 describes five components of visual sensitivity: the type of user, amount of use, public interest, adjacent land use, and special areas, along with other relevant factors or research. The VRM system weighs these five factors, described below, to establish a high, medium, or low sensitivity level (BLM, 1986a). High viewer sensitivity is typically assigned to viewer groups engaged in recreational or leisure activities; traveling on scenic routes for pleasure or to or from recreational or scenic areas; experiencing or traveling to or from protected, natural, cultural, or historic areas; or experiencing views from resort areas or their residences. Low viewer sensitivity is typically assigned to viewer groups engaged in work activities or commuting. General visual sensitivity in the analysis area is described below.

Types of Users

Five predominant user types use public land in the analysis area: tourists, travelers, workers, subsistence communities, and residents (including both rural and non-rural residents). Of these, tourists who participate in camping, hunting, fishing, or observing wildlife at formal and informal recreation sites are the most sensitive group. Because much of the Mainline Facilities parallel transportation corridors, travelers (particularly motorists), are the predominant user. These groups are not mutually exclusive. For example, tourists and residents moving to and from recreation areas could be considered travelers, as could workers (particularly long-distance truck drivers) moving to and from work sites.

Recreational travelers are highly sensitive to changes in the visual environment, while worker travelers such as truck drivers and workers at facilities near Deadhorse and Nikiski are less sensitive to visual changes since their primary focus is on reaching their destination or completing work tasks rather than observing the landscape along the route. The residents of small communities such as Wiseman, Coldfoot, Cantwell, Healy, and Nikiski would be sensitive to visual changes, but industrial structures associated with oil and gas development are present in these areas and therefore are a familiar part of the landscape for residents.

Amount of Use

Areas in the Kenai River Special Management Area and DNPP draw significant numbers of tourists. As discussed in section 4.11.7, the most popular tourism destinations in Alaska are in the southern and central parts of the state. The most popular tourist destinations in the analysis area include DNPP, Fairbanks, and Talkeetna, but recreation areas from Kenai River to north of the Arctic Circle also welcome visitors.

The Kenai River is a world-famous destination for fishing (Balmer, 2014) and has experienced increased tourism in recent years; more than 560,000 out-of-state tourists visited the Kenai River in 2016 (Earl, 2018). The DNPP, which consists of about 6 million acres of land, had about 600,000 visitors in 2016. The park has two visitor centers, six campgrounds, and 35.5 miles of constructed trails.

The Dalton Highway stretches about 415 miles from north of Fairbanks to Deadhorse. Although primarily a truck route serving TAPS and North Slope oil and gas industries, the Dalton Highway is also an increasingly popular tourist destination (see the discussion of the Dalton Highway Scenic Byway in section 4.9.4).

Public Interest

Portions of the analysis area that have been legislatively designated as important for scenic characteristics include the DNPP, Denali State Park, Tanana Valley State Forest, the Alexander Creek and Deshka River State Recreation Rivers, and the Minto Flats and Susitna SGRs. In other portions of the analysis area, the industrial features of the Project are expected elements of the landscape. Table 4.10.1-1 summarizes public management plans relevant to visual resources in the analysis area.

Adjacent Land Uses

The sensitivity level of the KOPs is affected by the current use of nearby land. For example, land along the Parks Highway south of Denali State Park is not under a special designation, but its proximity to and use by tourists traveling to Denali State Park and the DNPP increases the sensitivity of that area. Conversely, while Deadhorse is a destination for tourism, the nearby industrial features are an expected element in the area and reduce visual sensitivity.

Special Areas

Special areas, or SVRAs, are defined as areas with designations that require special consideration for the protection of visual values. These areas include Natural Areas, Wilderness or Wilderness Study Areas, Wild and Scenic Rivers, Scenic Areas, Scenic Roads or Trails, and ACECs. In addition to these federal designations, many state and local land management agencies have designations relating to the protection of scenic areas. Many of these areas have management plans to protect the resources and viewsheds that qualified them for designation. Table 4.10.1-1 lists relevant management plans for special areas in the analysis area, and section 4.9.5 discusses special interest areas in detail.

The inventory of SVRAs focused on areas identified in state and federal plans such as SGRs, recreation rivers, forests, parks, and scenic byways; National Forests; units of the National Park System; National Scenic Byways; National Historic Trails; towns; and cities. Each of these resources, either informally or by formal state or national legislation, exhibits a greater level of visual sensitivity than adjacent areas with no national, state, or local visual management objectives. SVRAs with management objectives include the DNPP, INHT, Parks Highway Scenic Byway, Dalton Highway Scenic Byway, Minto Flats SGR, Susitna State Recreational River, Tanana Valley State Forest, and Denali State Park. Section 4.9.4 describes these areas in detail. Towns and cities in the analysis area include Healy, Nenana, Cantwell, Nikiski, and Kenai.

SVRAs were identified or confirmed through agency and stakeholder consultation and desktop analysis within the analysis area. Appendix S-1 lists the 82 identified SVRAs in the analysis area, along with relevant information, such as the primary Project facility or facilities that could be visible, the potential visibility of the Project, the approximate pipeline milepost where it is located, the approximate distance between the Project and the SVRA, and relevant KOPs. Appendix S-3 includes a series of maps showing the locations of SVRAs in the analysis area. These maps also show locations of Project elements, KOPs, and other relevant information. Potential visibility of the Project from SVRAs was initially determined using available Digital Elevation Model (DEM) data line-of-sight analyses, which took into account topography and distance to the Project features.

Identification of Key Observation Points in the Analysis Area

Because visual conditions cannot be evaluated from every possible viewpoint within an analysis area (including the Analysis Area for the Project), the VRM system requires projects to identify and evaluate visual conditions and impacts at KOPs, which could include:

- "the most critical viewpoints, e.g., views from communities, road crossings;
- "typical views encountered in representative landscapes, if not covered by critical viewpoints; [or]
- "any special project or landscape features such as skyline crossings, river crossings, substations, etc." (BLM, 1986b).

The analysis area includes a variety of landscapes, land cover, and vegetation types, ranging from tundra to boreal forest and inland mountains and river valleys to coastal areas. Potential SVRAs were initially identified within the analysis area through agency and stakeholder consultation and desktop analysis of publicly available information, research, and reports. Data were compiled from a variety of GIS databases, including federal, state, and municipal governments, and non-governmental organizations.

As mentioned above, AGDC identified 82 SVRAs, including parks, wildlife refuges, trails, historic sites, communities, and other places within the analysis area. AGDC assessed the visibility of Project features from SVRAs through line-of-sight analyses, which took into account topography and distance to the Project features, using DEM information (see above). The DEM analysis determined that the Project could potentially be visible from 79 of the 82 SVRAs.

Field investigations were conducted during August 2015 and July 2016 to identify potential KOPs within or near SVRAs from which Project visibility and visual impacts (including impacts on SVRAs) would be assessed. KOPs were selected based on the presence of more visually intrusive Project features in sensitive areas, as identified throughout the background research process and through agency and stakeholder consultation. The KOPs were selected to represent important views of the analysis area from SVRAs and are generally located along major roads and highways and publicly accessible pull-outs, campgrounds, parks, trails, interpretive areas, and other areas with potential views of Project facilities.

Contributing agencies reviewed and provided recommendations regarding KOP selection prior to and during the KOP identification and evaluation process. The KOPs were used to illustrate the characteristic landscape types found at significant viewpoints of the analysis area. The VRM process of scenic quality evaluation was used to describe the visual attributes of the areas and assign a visual resource class to lands potentially visible from KOPs. After review by regulatory agencies in August 2015 and July and August 2016, as well as input from local communities during public meetings and open houses conducted during fall 2015, AGDC identified 83 KOPs.

In July 2018, AGDC prepared simulations of the Healy and Ray River Compressor Stations, as well as five crossings of the Parks Highway between Mainline Pipeline MPs 513 and 641. These KOPs are labeled as numbers 2018-1 through 2018-7 in table 4.10.1-3. Following coordination with NPS, AGDC submitted descriptions and analysis of seven additional KOPs in and near DNPP on August 15, 2018. These KOPs are labeled as numbers 2018-8 through 2018-14 in table 4.10.1-3. For these KOPs, the scenic quality and sensitivity evaluations were conducted according to NPS methodology and the results translated into VRM levels to allow for consistency in determining contrast ratings and impact assessments.

Table 4.10.1-3 describes the locations and key attributes of the KOPs analyzed for the Project. The sections below summarize the general nature of views from KOPs associated with each Project facility. Appendix S-2a provides a detailed description of the view from, and VRM characteristics of, each KOP including scenic quality, visual sensitivity,[93] and VRI class, along with the components of each of these characteristics, such as form, line, color, and texture. Appendix S-2b provides existing-conditions imagery and simulated views of future conditions from 30 KOPs. Appendix S-3 shows the locations of the KOPs and their surroundings, including Project elements, displayed on aerial photographs.

[93] Scenic quality and viewer sensitivity ratings are from AGDC, modified to reflect the existing visual resource designation or goal. These reports were included as part of AGDC's response to information request No. 156 dated April 27, 2018 (Accession No. 20180427-5181), available on the FERC website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter 20180427-5181 in the "Numbers: Accession Number" field.

TABLE 4.10.1-3

Existing Visual Environment and Key Observation Points

Key Observation Point Number	Key Observation Point Name	Closest Mainline Pipeline Milepost	Location	Description of View	Scenic Quality [a]	Viewer Sensitivity [a]	Existing Visual Resource Designation or Goal [b]	Subregion
KOP 1	Colleen Lake	10	Dalton Highway Terminus (MP 414.9) in Deadhorse	View of GTP and Prudhoe Camp about 7.5 miles to the northwest	C	L	VRM III [c]	Beaufort Coastal Plain
KOP 2	Dalton Highway Wayside	65	Dalton Highway MP 355.1	View of the Mainline Pipeline about 0.7 mile to the east	C	M	VRM III [c]	Brooks Foothills
KOP 3	Galbraith Lake Campground (view north)	144	Dalton Highway MP 274.7	View of Galbraith Lake Camp and Pipe Storage Yard 0.4 mile to the north; Galbraith Lake Compressor Station 5.0 miles southeast	A	H	VRM III [c]	Brooks Range
KOP 4	Galbraith Lake Campground (view southeast)	144	Dalton Highway MP 274.7	View of Mainline Pipeline / Galbraith Lake compressor station about 3.0 to 3.5 miles to the southeast	A	H	VRM III [c]	Brooks Range
KOP 5	Atigun Pass	170	Dalton Highway MP 244.7	View of adjacent Mainline Pipeline	A	H	None [c]	Brooks Range
KOP 6	Base of Atigun Pass	169	Dalton Highway MP 245.8	View of adjacent Mainline Pipeline	A	H	None [c]	Brooks Range
KOP 7	Atigun Pass Pullout	179	Dalton Highway MP 235.3	View from the pullout looking southwest to the Mainline Pipeline and pipe storage yard 0.2 mile to the southwest	A	M	None [c]	Brooks Range
KOP 8	Wiseman-Chandalar Trail	219	Dalton Highway MP 197.3	View toward pipe storage yard 0.3 mile southeast and Mainline Pipeline 0.1 mile east	B	M	None [c]	Brooks Range
KOP 9	Marion Creek Campground	237	Dalton Highway MP 179.7	View of adjacent Mainline Pipeline	A	M	VRM III [c]	Brooks Range
KOP 10	Arctic Interagency Visitor Center (view southeast)	242	Dalton Highway MP 175	View of Coldfoot Camp and Pipe Storage Yard about 0.4 mile to the east	B	H	VRM III [c]	Brooks Range
KOP 11	Arctic Interagency Visitor Center (view northeast)	242	Dalton Highway MP 175	View of Mainline Pipeline and Coldfoot Compressor Station about 0.8 mile to the northeast	A	H	VRM III [c]	Brooks Range
KOP A	Coldfoot Camp	242	Dalton Highway MP 175	View of proposed Coldfoot Camp about 0.1 mile away	C	M	VRM III [c]	Brooks Range
KOP B	Gobblers Knob Rest Area	283	Dalton Highway MP 132.1	View from the rest area looking north to the Mainline Pipeline 0.7 mile away	B	M	VRM III [c]	Ray Mountains

TABLE 4.10.1-3 (cont'd)

Existing Visual Environment and Key Observation Points

Key Observation Point Number	Key Observation Point Name	Closest Mainline Pipeline Milepost	Location	Description of View	Scenic Quality [a]	Viewer Sensitivity [a]	Existing Visual Resource Designation or Goal [b]	Subregion
KOP C	Arctic Circle Campground	298	Dalton Highway MP 115.6	View from the campground looking east to the Mainline Pipeline 1.5 miles away	C	M	VRM III [c]	Ray Mountains
KOP D	Finger Mountain Wayside (view northwest)	315	Dalton Highway MP 98.1	View from the wayside looking northwest to the Mainline Pipeline 0.1 mile away	A	H	VRM III [c]	Ray Mountains
KOP E	Finger Mountain Wayside (view southeast)	315	Dalton Highway MP 98.1	View from the wayside looking southeast to the Mainline Pipeline 0.1 mile away	B	H	VRM III [c]	Ray Mountains
KOP F [d]	86 Mile Overlook	327	Dalton Highway MP 86.6	View of Mainline Pipeline about 0.6 mile east	N/A	N/A	VRM III [c]	Ray Mountains
KOP 12	Yukon River Camp	357	Dalton Highway MP 56	View toward pipe storage yard about 3.0 miles north	B	M	VRM III [c] L-3 [e]	Ray Mountains
KOP 13	Yukon River	357	Dalton Highway MP 56	View of Mainline Pipeline crossing at the river 0.5 mile to the west	A	H	VRM III [c] L-3 [e]	Ray Mountains
KOP 14	Five Mile Camp	355	Dalton Highway MP 60	View of Five Mile Camp and pipe storage yard 0.1 mile to the northwest	B	M	VRM III [c] L-3 [e]	Ray Mountains
KOP G	Hess Creek Bridge	382	Dalton Highway MP 23.7	View from the Hess Creek Bridge about 0.2 mile from the east materials site	A	M	None	Ray Mountains
KOP H	Hess Creek Pullout	384	Dalton Highway MP 21.3	View of Mainline Pipeline about 0.1 mile east	C	L	None	Ray Mountains
KOP I	Hess Creek Overlook	385	Dalton Highway MP 20.6	View of Mainline Pipeline about 0.8 mile north	B	M	None	Ray Mountains
KOP 15	Elliott Highway	401	Elliott Highway MP 75	View from Elliott Highway of Livengood Camp and pipe storage yard about 0.3 mile to the north	B	L	VRM III	Ray Mountains
KOP 16	George Parks Highway Pullout	461	Parks Highway MP 318.8	View of Mainline Pipeline about 3.0 miles to the northwest in Minto Flats SGR	A	H	High scenic area	Tanana-Kuskokwim Lowlands
KOP 17	George Parks Highway (view north)	460	Parks Highway MP 320.5	View of Mainline Pipeline to the northwest in Minto Flats SGR / View of Pipe Storage Yard, Dunbar Camp, Railroad Work Pad about 3.6 miles to the north	B	H	High scenic area	Tanana-Kuskokwim Lowlands
KOP 18	George Parks Highway (view east)	472	Parks Highway MP 306.7	View of Mainline Pipeline and Nenana Railroad Spur about 0.3 mile to the southeast	B	H	Low scenic area	Tanana-Kuskokwim Lowlands

TABLE 4.10.1-3 (cont'd)

Existing Visual Environment and Key Observation Points

Key Observation Point Number	Key Observation Point Name	Closest Mainline Pipeline Milepost	Location	Description of View	Scenic Quality [a]	Viewer Sensitivity [a]	Existing Visual Resource Designation or Goal [b]	Subregion
KOP 19	Tanana River (south)	473	Parks Highway MP 305.8	View of Nenana Pipe Storage Yard about 0.9 mile to the southwest	A	H	Low scenic area	Tanana-Kuskokwim Lowlands
KOP 20	Tanana River (north)	473	Parks Highway MP 305.9	View at Nenana River adjacent to belowground Mainline Pipeline crossing	A	H	Low scenic area	Tanana-Kuskokwim Lowlands
KOP 21	Nenana City School (view northwest)	474	Nenana	View of the Mainline Pipeline about 0.9 mile to the northwest of the school	C	M	High scenic area	Tanana-Kuskokwim Lowlands
KOP 22	Nenana City School (view southwest)	474	Nenana	View of the Nenana Pipe Storage Yard about 0.5 mile to the southwest of the school	C	M	High scenic area	Tanana-Kuskokwim Lowlands
KOP 23 [d]	Dry Creek Site	525	Parks Highway MP 249.2	View of the Mainline Pipeline about 0.9 mile to the west	N/A	N/A	Low scenic area	Alaska Range
KOP 24	Tri-Valley School (view southwest)	525	Healy	View of the Mainline Pipeline about 2.0 miles to the west of the school	C	M	Low scenic area	Alaska Range
KOP 25	Tri-Valley School (view south)	525	Healy	View of the Healy Pipe Storage Yard about 1.4 miles to the south of the school	C	M	Low scenic area	Alaska Range
KOP 26	Otto Lake	528	North shore of Otto Lake	View of Mainline Pipeline about 1.2 mile to the south	A	M	High scenic area	Alaska Range
KOP 27	Otto Lake Road	528	North shore of Otto Lake	View of pipe storage yard about 0.7 mile to the east	B	M	High scenic area	Alaska Range
KOP J	Denali RV Park and Motel	530	Parks Highway MP 245.1	View of material site, less than 0.1 mile east, and Mainline Pipeline 0.2 mile east.	B	M	None	Alaska Range
KOP 28	Nenana River Bridge	532	Parks Highway MP 242.8	View of Nenana River pipeline aerial crossing about 0.1 mile from the Mainline Pipeline	A	H	None	Alaska Range
KOP 29	Fox Creek Crossing	534	Parks Highway MP 241.0	View of Fox Creek Bridge crossing about 0.1 mile to east	A	H	None	Alaska Range
KOP K	McKinley Chalet Resort	536	Parks Highway MP 238.9	View of Mainline Pipeline less than 0.1 mile northeast	B	H	None	Alaska Range
KOP L	Denali Princess Wilderness Lodge	536	Parks Highway MP 238.6	View of Mainline Pipeline about 0.2 mile east	B	H	None	Alaska Range

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TABLE 4.10.1-3 (cont'd)

Existing Visual Environment and Key Observation Points

Key Observation Point Number	Key Observation Point Name	Closest Mainline Pipeline Milepost	Location	Description of View	Scenic Quality [a]	Viewer Sensitivity [a]	Existing Visual Resource Designation or Goal [b]	Subregion
KOP M	Grande Denali Lodge	537	Parks Highway MP 238.1	View of Mainline Pipeline about 0.2 mile north	B	H	None	Alaska Range
KOP 30	DNPP Wilderness Access Center	538	Parks Highway MP 237.9	View of Mainline Pipeline about 0.7 mile to the east	B	H	Moderate scenic value	Alaska Range
KOP 31	George Parks Highway-Carlo Creek	553	Parks Highway MP 224.0	View of Mainline Pipeline and pipe storage yard about 0.5 mile to the north	B	H	Moderate scenic value	Alaska Range
KOP 32	Nenana River (view east)	560	Parks Highway MP 215.7	View of Nenana River toward pipeline crossing about 1.0 mile south	A	H	High scenic value	Alaska Range
KOP 33	Nenana River (view south)	560	Parks Highway MP 215.7	View at Nenana River second view added to the southwest to show more of the river	A	H	High scenic value	Alaska Range
KOP 34	Cantwell School (east)	568	Parks Highway MP 210.1	View of the Mainline Pipeline about 0.5 mile to the east of the school	B	M	High scenic value	Alaska Range
KOP 35	Cantwell School (south)	568	Parks Highway MP 210.1	View of the camp/pipe storage yard about 1.7 miles to the southwest of the school	B	M	High scenic value	Alaska Range
KOP 36	Windy Creek Trail	569	Cantwell	View of the camp/pipe storage yard about 0.1 mile to the south of the trail	B	M	High scenic area	Alaska Range
KOP N	George Parks Highway-MP 170.8	607	Parks Highway MP 170.8	View of material sites less than 0.1 mile west, northwest, and east	C	M	None	Alaska Range
KOP O	Upper Troublesome Creek Trailhead	640	Parks Highway MP 137.7	View of Mainline Pipeline about 0.1 mile north	C	M	None	Cook Inlet
KOP P	Lower Troublesome Creek Trailhead	641	Parks Highway MP 137.2	View of access road, adjacent to the west, and the Mainline Pipeline about 0.1 mile west	B	H	None	Cook Inlet Basin
KOP 37	Mt. McKinley Princess Wilderness Lodge (view southwest)	645	Parks Highway MP 133	About 1.4 miles from the construction corridor and 3.1 miles from the Chulitna Camp and pipe storage yard	B	H	Exceptional high scenic value	Cook Inlet Basin
KOP 38	Denali State Park Viewpoint	644	Parks Highway MP 134.8	View of Mainline Pipeline about 1.7 miles away	A	H	None	Cook Inlet Basin
KOP Q	Denali State Park Viewpoint South	644	Parks Highway MP 134.8	View of Mainline Pipeline about 1.7 miles north	A	H	None	Cook Inlet Basin
KOP R [d]	Denali State Park Visitor Center	648	Parks Highway MP 135.4	View of Mainline Pipeline about 2.8 miles northwest	N/A	N/A	None	Cook Inlet Basin

TABLE 4.10.1-3 (cont'd)

Existing Visual Environment and Key Observation Points

Key Observation Point Number	Key Observation Point Name	Closest Mainline Pipeline Milepost	Location	Description of View	Scenic Quality [a]	Viewer Sensitivity [a]	Existing Visual Resource Designation or Goal [b]	Subregion
KOP S	Mt. McKinley Princess Wilderness Lodge (view northwest)	647	Parks Highway MP 133	View of the Mainline Pipeline about 4.3 miles to the north	A	H	Exceptional high scenic value	Cook Inlet Basin
KOP 39	George Parks Highway-MP 131.2	648	Parks Highway MP 131.2	View of Mainline Pipeline, Chulitna Camp, and pipe storage yard about 0.3 mile to the north	B	H	Exceptional high scenic value	Cook Inlet Basin
KOP 40	George Parks Highway-MP 131	648	Parks Highway MP 131	View of Mainline Pipeline, Chulitna Camp, and pipe storage yard	B	M	None	Cook Inlet Basin
KOP T	George Parks Highway-MP 130.6	649	Parks Highway MP 130.6	View of adjacent Mainline Pipeline	C	M	None	Cook Inlet Basin
KOP U	George Parks Highway-MP 121.7	658	Parks Highway MP 121.7	View of adjacent Mainline Pipeline	C	M	None	Cook Inlet Basin
KOP V	Petersville Road	665	Trapper Creek	View of adjacent Mainline Pipeline	C	M	None	Cook Inlet Basin
KOP 41	Talkeetna Railroad Depot	665	Talkeetna	View of Mainline Pipeline about 5.3 miles to the west from Talkeetna Depot	C	M	None	Cook Inlet Basin
KOP 42	Susitna and Talkeetna Rivers	665	Talkeetna	View of Mainline Pipeline about 4.8 miles to the west	A	H	None	Cook Inlet
KOP 43	Alaska Railroad	665	Talkeetna	View of Mainline Pipeline about 4.8 miles to the west (near intersection of railroad with Woodpecker Avenue south of Talkeetna)	C	H	None	Cook Inlet
KOP 44	Susitna Valley High School (view north)	677	Talkeetna	View of the Sunshine Railroad Spur and work pad about 2.1 miles to the north of the school	C	M	High scenic value	Cook Inlet Basin
KOP 45	Susitna Valley High School (view west)	677	Talkeetna	View of Mainline Pipeline about 5.5 miles to the west of the school	C	M	High scenic value	Cook Inlet Basin
KOP 46 [d]	Susitna-Rainy Pass Trail	723	Alaska Range	View of pipe storage yard about 2.0 miles north of the trail. The Mainline Pipeline would be immediately adjacent to the Mainline to the north.	N/A	N/A	None	Cook Inlet Basin
KOP 47 [d]	INHT	724	Susitna Valley	View of Mainline Pipeline immediately adjacent to the trail to the southeast	N/A	N/A	None	Cook Inlet Basin
KOP 48 [d]	Trading Bay Beach	N/A	Trading Bay Scenic Game Refuge	View of the Liquefaction Facilities (view from the west about 13.6 miles across Cook Inlet)	N/A	N/A	None	Cook Inlet Basin

TABLE 4.10.1-3 (cont'd)

Existing Visual Environment and Key Observation Points

Key Observation Point Number	Key Observation Point Name	Closest Mainline Pipeline Milepost	Location	Description of View	Scenic Quality [a]	Viewer Sensitivity [a]	Existing Visual Resource Designation or Goal [b]	Subregion
KOP 49	Nikiski North Star Elementary School (view north)	N/A	Nikiski	View of Mainline Pipeline about 5.5 miles to the north of the school	C	M	None	Cook Inlet Basin
KOP 50	Nikiski North Star Elementary School (view west)	N/A	Nikiski	View of the Liquefaction Facilities about 1.5 miles to the west of the school	C	M	None	Cook Inlet Basin
KOP 51	Escape Route Road	N/A	Nikiski	View of the Liquefaction Facilities about 3.8 miles to the west of the Kenai NWR	C	M	None	Cook Inlet Basin
KOP 52	Kaleidoscope Charter School	N/A	Kenai	View of the Liquefaction Facilities about 6.1 miles to the north of the school	C	M	None	Cook Inlet Basin
KOP 53	Pillars Boat Launch	N/A	Kenai Rivers Special Management Area	View of the Liquefaction Facilities about 10.0 miles northwest of the Pillars Boat Launch	A	H	None	Cook Inlet Basin
KOP 54	Mt. Redoubt Church	N/A	Nikiski	View of the adjacent Liquefaction Facilities to the north	C	M	None	Cook Inlet Basin
KOP 2018-1	Healy Compressor Station	518	Parks Highway MP 256.2	View of the compressor station adjacent to the Parks Highway	A	H	None	Alaska Range
KOP 2018-2	Ray River Compressor Station	333	Dalton Highway MP 80.4	View of the compressor station adjacent to the Dalton Highway	B	M	VRM III	Ray Mountains
KOP 2018-3	Parks Highway Crossing 1 (Parks Highway MP 165.4)	613	Denali State Park	View of belowground Mainline Pipeline crossing of Parks Highway	C	M	VRM III	Alaska Range
KOP 2018-4	Parks Highway Crossing 2 (Parks Highway MP 152.8)	625	Denali State Park	View of belowground Mainline Pipeline crossing of Parks Highway	C	M	VRM III	Cook Inlet Basin
KOP 2018-5	Parks Highway Crossing 3 (Parks Highway MP 147.7)	630	Denali State Park	View of belowground Mainline Pipeline crossing of Parks Highway	C	M	VRM III	Cook Inlet Basin
KOP 2018-6	Parks Highway Crossing 4 (Parks Highway MP 146.4)	632	Denali State Park	View of belowground Mainline Pipeline crossing of Parks Highway	C	M	VRM III	Cook Inlet Basin
KOP 2018-7	Parks Highway Crossing 5 (Parks Highway MP 137.6)	641	Denali State Park	View of belowground Mainline Pipeline crossing of Parks Highway	C	M	VRM III	Cook Inlet Basin
KOP 2018-8	Denali Park Road	538	DNPP	View of the Mainline Pipeline about 0.8 mile northeast	C	M	VRM III	Alaska Range

TABLE 4.10.1-3 (cont'd)

Existing Visual Environment and Key Observation Points

Key Observation Point Number	Key Observation Point Name	Closest Mainline Pipeline Milepost	Location	Description of View	Scenic Quality [a]	Viewer Sensitivity [a]	Existing Visual Resource Designation or Goal [b]	Subregion
KOP 2018-9	Government Hill	539	DNPP	View of the Mainline Pipeline about 2.5 miles to the east	A	H	Very high scenic value	Alaska Range
KOP 2018-10	Alaska Railroad Above Horseshoe Lake	537	DNPP	View of the Mainline Pipeline about 0.7 mile to the northeast	B	M	Moderate scenic value	Alaska Range
KOP 2018-11	Mt. Healy Overlook Trail Summit	536	DNPP	View of the Mainline Pipeline about 1.7 miles to the east	B	H	Very high scenic value	Alaska Range
KOP 2018-12	Triple Lakes Trail	544	DNPP	View of the Mainline Pipeline about 2.8 miles to the northeast	B	H	High scenic value	Alaska Range
KOP 2018-13	Nenana River Pedestrian Bridge	537	DNPP	View of the Mainline Pipeline about 0.5 mile to the northeast	C	M	Low scenic value	Alaska Range
KOP 2018-14	South of Parks Highway MP 236	539	DNPP	View of the Mainline Pipeline about 1.5 miles to the northeast	B	M	Moderate scenic value	Alaska Range

N/A = Not applicable; KOP is not associated with the Mainline Pipeline. A = scenic quality score >19; B = 12 to 19; and C = <12.

[a] M = Medium; H = High (see section 4.10.1.2).

[b] As defined in the relevant federal or state agency management plan.

[c] Would be subject to the North Slope Management Plan (ADNR, 2017b) upon completion.

[d] KOP was not surveyed during AGDC field investigations due to limited accessibility.

[e] L-3 in the Yukon-Tanana Area Plan indicates "land to be managed consistent with Dalton Highway Master Plan" (ADNR, 2014e).

AGDC states that KOPs 23, F, R, and 46 through 48 were not surveyed due to lack of accessibility or weather conditions. KOP F, the 86-Mile Overlook on the Dalton Highway, is a publicly accessible scenic vista, while KOP 47 would provide a view of the INHT where it crosses the Mainline Facilities. In response to an information request from FERC staff, AGDC stated that the crossing of Fox Creek, which would be visible from KOP 29, would be belowground rather than aerial, as indicated in AGDC's application. We require information and imagery for all three of these KOPs to ensure we have sufficient information to analyze the visual impacts of the Project. In addition, we require a KOP at the crossing of the INHT branch that follows the Yentna River near Mainline Pipeline MP 720.9. To ensure we have sufficient information to analyze the visual impacts of the Project, **we recommend that:**

- **<u>Prior to the end of the draft EIS comment period</u>, AGDC should file with the Secretary updated information and photo simulations for KOPs F, 47, and 29 along with a new KOP near Mainline Pipeline MP 720.9. Specifically, AGDC should provide the information identified below for these KOPs.**

  a. Provide existing condition and simulation photos in panorama format (i.e., approximately 13 inches wide by 4.5 inches high, a ratio of approximately 2.9:1).

  b. For each KOP, produce one 11x17-inch page (with two panoramic images per page) showing:

  i daytime existing conditions;
  ii proposed daytime post-construction conditions;
  iii proposed daytime post-reclamation conditions;
  iv proposed daytime winter post-reclamation conditions; and
  v proposed nighttime post-reclamation conditions.

  c. Provide summary information about visual conditions at each KOP and the Project's impacts, comparable to the information provided in Resource Report 8, appendix L.

  d. Describe proposed mitigation for visual impacts during construction and operation, comparable to the information provided in table 2 of Resource Report 8, appendix M.

While KOPs 23, R, 46, and 48 were previously identified for analysis, we find that the other KOPs analyzed here and listed in the condition above provide sufficient information to analyze the Project's visual impacts.

4.10.1.3 Existing Visual Conditions at Project Facility Locations

This section describes the existing views from KOPs associated with the Gas Treatment Facilities, Mainline Facilities, and Liquefaction Facilities.

Gas Treatment Facilities

The GTP would be about 7.5 miles northwest of the terminus of the Dalton Highway in Deadhorse, the closest point in the area accessible to the general public where Project facilities could be viewed. From this point, the PBTL is about 8.3 miles away, in the same direction as the GTP, while the PTTL is about 4.4 miles northeast at its closest point. Access to the Project occurs through the PBU, which is secured as an area designated for oil and gas development. Visitors or individuals seeking recreational opportunities typically would not be permitted beyond this location.

As viewed from Deadhorse at the northern terminus of the Dalton Highway, the closest publicly accessible point to the GTP, PTTL, and PBTL, the landform is generally horizontal and flat, with small rectangular buildings and existing oil and gas infrastructure visible above the horizon about 1.5 miles away. Vegetation within this landscape consists of low plants in rough clumps. The vegetation, which ranges from green and brown with seasonal yellows and reds, and nearby structures, which consist primarily of white, gray, and tan metal buildings, provide the dominant colors in the area. There are no trees visible.

Mainline Facilities

Mainline Facilities would be constructed in a wide variety of landscapes. This section provides generalized summaries of existing visual conditions near the Mainline Facilities organized according to the subregions listed in the introduction to section 4.0. The subregions used in this EIS differ from those defined by the BLM in its VRI for the Central Yukon RMP (BLM, 2018c).

Beaufort Coastal Plain, Brooks Foothills, and Brooks Range Subregions

The northern portion of the Mainline Pipeline route is characterized by rolling terrain with short, continuous vegetation, and brown, tan, and gray colors. As the route approaches the Brooks Range, the terrain becomes more rugged. Near Galbraith Lake and in and near Atigun Pass, the flat to gently sloping foreground (i.e., up to 1 mile away), is surrounded by jagged, sparsely vegetated mountains of the Brooks Range in the middleground and foreground. The mountains are generally brown and gray colors, with light green and brown vegetation, that turns yellow seasonally.

In the portion of the Brooks Range south of Atigun Pass and the Chandalar Shelf (between MPs 180.0 and 265.0), the landscape retains the same flat river-valley foreground, surrounded by mountainous middleground and background. Vegetation density increases and becomes dominated by evergreen trees (characterized by rough texture and vertical lines) in the foreground, with smooth texture grasses and medium texture gravel in the middleground. The landscape is primarily dark green (reflecting the presence of evergreens), with seasonal yellows and reds in unforested areas. The colors of the Dalton Highway are mostly brown, gray, and black.

Ray Mountains Subregion

The Mainline Pipeline would cross the Ray Mountains generally between the South Fork Koyukuk and Chatanika Rivers (between MPs 257.1 and 430.3). This area is characterized by broad river and wetland complexes, separated by rounded mountainous terrain, dense forest and grassland vegetation, and large rivers (including the Yukon River) and lakes. The area is characterized by a mixed color and texture palette, with rough, dark green trees; smooth, light-green grasses; and dark blue and green rivers and lakes. Select vegetation turns red and yellow seasonally. Higher peaks, particularly those visible from Finger Mountain, have barren gray areas. The Dalton Highway and occasional development (such as the BLM Yukon Crossing Contact Station) add flat landforms in brown and tan colors.

Tanana-Kuskokwim Lowlands Subregion

South of Nenana, the Tanana-Kuskokwim Lowlands (between MPs 430.3 to 516.5) are generally flat and vegetated with a combination of evergreen and deciduous forest stands, interspersed with large areas of grassland and wetlands, as well as waterbodies. Foreground vegetation provides vertical elements, while the background consists of either flat horizon or distant, low, rounded hills. Colors include light and dark green trees, black evergreen trunks and white birch trunks, and smooth, green grasses that include yellow and red during the autumn.

Alaska Range Subregion

The area adjacent to the DNPP corresponds with the Alaska Range (MPs 516.5 to 616.5). Within this area, the landscape of the Mainline Pipeline route again becomes more mountainous. Within the Nenana River Gorge (between MPs 531.9 and 542.8), the landscape is steep and rugged with irregularly-shaped ridgelines in the foreground (i.e., within about 1 mile). In most other parts of the Alaska Range, the Mainline Pipeline would be situated within river valleys, many of which are U-shaped glacial valleys. Slopes leading to irregular to rugged ridgelines would be visible within the middleground (up to 5 miles away) or background, while the foreground would include rolling terrain and occasional views of the rocky, rough channels of the Nenana, Jack, or Chulitna Rivers, or their tributaries. Vegetation is highly varied, and includes evergreen and deciduous forest, grass, and shrub areas, with bare rock visible on mountain peaks and steeper slopes. Colors range from dark and light green trees (with deciduous trees turning yellow and gold in autumn) to green, gold, and brown grasses and wetlands, with increasing yellow and red in autumn. Bare rock is gray to silver (depending on the angle of sunlight), while roads are either gray asphalt or tan unpaved surface. Rivers are typically dark gray to pale blue due to the presence of sediments, while lakes and other waterbodies are typically dark.

Yukon-Tanana Uplands and Cook Inlet Basin Subregions

Approaching Anchorage, the Mainline Pipeline route follows the Susitna River through the Cook Inlet Basin Subregion (between MPs 616.5 to 806.6). Terrain here is generally flat to rolling. The peaks of the Alaska Range are visible in the background south of the DNPP. In other parts of the subregion, the horizon is frequently blocked by the vertical forms and irregular tops of deciduous and evergreen vegetation. Dense vegetation, including trees, grasses, and shrubs, is primarily green with a variety of textures, heights, and shades of color (including yellows and reds in autumn). The Susitna and other rivers are wide, flat, and often brown to pale blue due to the presence of sediment loads. Cook Inlet is a large body of water, with either shore visible only in the distance. The inlet's appearance is highly variable based on weather and lighting conditions, and can range from relatively smooth and dark to rough and white-capped.

Much of the Mainline Pipeline route on the Kenai Peninsula is through evergreen forest. Vertical tree trunks and rough foliage dominate the foreground and largely obscure the background, except for occasional views across open fields. The landscape is largely dark green (trees) or light green (grasses).

Liquefaction Facilities

The landscape near the LNG Plant is similar to the Mainline Pipeline route on the Kenai Peninsula; generally flat and dominated by foreground evergreen and deciduous forest. Open vegetated areas near the LNG Plant are flat, smooth, with brown and gray colors, as well as light green and seasonal pink color from the vertical vegetation in the area. The western part of the LNG Plant site is cleared of vegetation (due to its former industrial status), and is adjacent to large industrial uses. Cleared industrial lands are typically smooth gray or brown, while industrial facilities (including transmission lines) have geometric vertical and horizontal elements that are black, tan, gray, and bright white, on top of flat, paved areas. The Marine Terminal would be along Cook Inlet (described above under Mainline Facilities), on a beach consisting primarily of round, gray cobbles. Other marine terminals and shoreline industrial facilities are visible. These facilities provide strong horizontal and vertical lines in gray and black.

4.10.2 Impacts and Mitigation

4.10.2.1 Visual Resources Management Methodology

The process of assessing visual impacts under the VRM system includes defining the management directives for each landscape (as expressed through Visual Resource Classes and Objectives), conducting simulations of future visual conditions at KOPs, describing the contrast that the Project would create, and then describing visual impacts based on the degree to which contrast affects the ability to achieve visual resource objectives.

Visual Resource Classes and Objectives

Visual Resource Classes and Objectives, as defined in *BLM Manual H-8410-1*, express BLM's regulatory intent for visual resources for a given landscape (BLM, 1986a). Landscape units are assigned one of four VRI classes. Class I is assigned to special areas where the current management situation requires maintaining a natural environment essentially unaltered by humans. Classes II, III, and IV are assigned based on a combination of factors that include distance zones, scenic quality, and sensitivity level (see section 4.10.1.2). These classes and their associated BLM management objectives are described below (BLM, 1986a).

- **Class I**: The objective of this class is to preserve the existing character of the landscape. This class provides for natural ecological changes, but it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and must not attract attention.

- **Class II**: The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities could be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

- **Class III**: The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities could attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

- **Class IV**: The objective of this class is to provide for management activities that require major modifications of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities could dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repetition of basic elements.

Where already defined, existing VRM classifications were used for this EIS, but the majority of the lands in the analysis area do not have an established VRM class rating. In these cases, including BLM lands and other lands not managed by BLM, AGDC developed visual resource class ratings based on the methodology in *BLM Manual H-8410*-1 as applied to the current scenic quality/sensitivity level (BLM, 1986a). In 2015 and 2016, AGDC conducted field surveys of lands within the analysis area to make these determinations.[94] These field studies noted landforms, vegetation, or structures in the area, and used a ranking system, based on the BLM methodology, to generate a scenic quality classification on a ranking scale of A to C, with a ranking of "A" being the highest and a ranking of "C" being the lowest. AGDC shared these candidate ratings with the BLM and other participating agencies.

Visual Simulations

AGDC conducted an analysis of the potential impacts on aesthetic resources both in the field and using desktop techniques, including review of engineering plans for construction and typical construction features for resources such as camps, pipe storage yards, and compressor stations. During the field visits, AGDC determined that additional analysis of 54 KOPs was not warranted based on the expected extent of visibility of the Project facilities, the anticipated scope of visual impacts, and the availability of other KOPs with more representative views to the Project area. AGDC prepared daytime (summer and winter) simulations for 30 KOPs (see section 4.10.2.2). Figure 4.10.2-1 provides an example of existing conditions photography and a simulation of future conditions at KOP 7 in Atigun Pass. Appendix S-2b includes all other existing conditions and simulation images.

For the visual simulations, AGDC used the most current available information on Project facility dimensions, materials, and colors in computer aided design and drafting (CADD), Autodesk 3ds Max® Design, or Google SketchUp formats, and used those files to create three-dimensional (3D) models in CADD and 3ds Max® Design for each location. AGDC then prepared visual simulations using the 3D model and Adobe Photoshop to show the existing and proposed conditions. Visual simulations were prepared to help determine whether the Project would meet the management objectives established for the area and whether other design techniques could be applied to help achieve these objectives.

Contrast Rating

The VRM system uses the concept of contrast, defined as "opposition or unlikeness of different forms, lines, colors, or textures in a landscape," as a primary element for identifying visual impacts (BLM, 1984). Contrast can result from activities and features such as removing vegetation or introducing elements that produce strong vertical lines in an area dominated by horizontal lines. The permissible level of contrast is established by the VRM classification or comparable management objective assigned for an area.

Assessment of the Project's visual impacts is specifically based on "contrast rating" as defined for the VRM system in BLM *Manual H-8431–Visual Resources Contrast Rating* (*BLM Manual H-8431*) (BLM, 1986b). Visual contrast rating entails comparing the Project's construction and operational features against the predominant features in the existing landscape using the following basic design elements (BLM, 1986b):

- **form**: the shape and mass of landforms or structures;
- **line**: landform edge types, bands, and silhouettes;
- **color**; and
- **texture**: grain, density, and internal contrast.

[94] AGDC's VRM class rankings field studies were included as part of AGDC's Resource Report No. 8, appendix M (Accession No. 20170417-5345). They can be viewed on the FERC website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter 20170417-5345 in the "Numbers: Accession Number" field.

Figure 4.10.2-1. Existing Conditions (top) and Post-reclamation Simulation of Key Observation Point 7

AGDC developed contrast ratings for the view from each KOP using criteria in *BLM Manual H-8431* (BLM, 1986b). These criteria specifically consider how the Project would change the following factors: distance, angle of observation, length of time the Project would be in view, relativity to size or scale, season of use, light conditions, recovery time, spatial relationship, and atmospheric conditions. Contrast ratings are noted as being strong, moderate, weak, and none depending on the degree of change, as described below:

- **strong**: the contrast demands attention, would not be overlooked by the average observer, and is dominant in the landscape;
- **moderate**: the contrast begins to attract attention and dominate the characteristic landscape;
- **weak**: the contrast can be seen but does not attract attention; and
- **none**: the contrast is not visible or not perceived.

Visual Impact Assessment

Visual impacts can result from construction or operational activities and features associated with a Project. Visual resource impacts are measured by the amount of contrast from the baseline condition created by these activities. For instance, the presence of construction equipment or materials in a location could cause changes by introducing elements of varied forms and lines or bright colors in a landscape typified by green forest, but these changes would only last for a limited period (i.e., during construction). Longer-term changes could include introduction of new geometric forms, such as a compressor station or cleared pipeline right-of-way, into an area characterized by diverse vegetation types and natural landscape features; introduction of elements with strong vertical forms and lines in an area dominated by sweeping horizontal or rounded forms and lines; or removal of vegetation that takes many years to return to pre-construction conditions.

As described in the introduction to section 4.0, temporary construction impacts generally would occur during the 8-year construction period, with the resource returning to pre-construction condition immediately after restoration or within a few months to a year following the installation of permanent erosion control measures. Impacts occurring for a period of less than 5 years after the installation of permanent erosion control measures would be considered short term; impacts occurring for more than 5 years but less than the Project’s nominal 30-year lifetime would be considered long term; and impacts lasting 30 years or more (whether associated with construction or operation) would be considered permanent.

Contrast was analyzed at KOPs for both the construction and operational phases of the Project. Levels of visual impact are based on *BLM Manual H-8431* (BLM, 1986b) and are defined as high, moderate, or low based on the degree of contrast of the Project compared to the acceptable level of contrast for that visual resource class, as defined below.

- **High Impacts**: Contrast from the Project is substantially greater than acceptable. High impacts typically occur where the Project components (including the cleared right-of-way, access roads, structures, and ancillary facilities) would be dominant or readily apparent from viewing locations frequented by causal observers. High impacts could also occur in high-quality, diverse, rare or unique, and natural landscapes.

- **Moderate Impacts**: Contrast is somewhat greater than acceptable for the visual resource class. Moderate impacts typically occur where the Project would be co-dominant with existing landscape features and moderately apparent from viewing locations frequented by casual observers. An example of a moderate impact would be one in which existing linear features exhibit form, line, color, and texture similar to the Project.

- **Low Impacts**: Contrast is acceptable for the visual resource class. Low impacts typically occur where the Project would be subordinate in the landscape, not readily apparent from viewing locations frequented by the casual observer, or in landscapes where higher levels of contrast are expected (as defined by management objectives). Low impacts on scenery would typically result in minimal change to the landscape character.

- **No Effect**: Visual contrast is imperceptible or the Project is not visible. No effect on scenery would typically result in no visible change to the landscape character.

BLM Manual H-8431 states that "mitigating measures should be prepared for all adverse contrasts that can be reduced" (BLM, 1986b). Such measures consider location, minimization of disturbance, and repetition of existing basic elements (form, line, color, and texture).

Modifications to the Visual Resource Management Methodology

This visual impact assessment was prepared using background research, desktop analysis, and field study as described in *BLM Manual H-8400, Visual Resource Management*, as well as *BLM Manuals H-8410-1* and *H-8431*, as described above (BLM, 1984, 1986a, and 1986b, respectively). The BLM methodology has been modified to adapt it to private and other lands that are not under BLM jurisdiction, and that have not been previously inventoried for visual quality and character. These modifications to BLM methodology consist of the following:

- definition of Landscape Character Units, based on the FHWA's visual impact assessment methodology in place of the BLM's Scenic Quality Rating Units, and evaluation of the changes to scenic character and quality in place of rating existing landscape units;

- modifications to adjust for the absence of visual management objectives on non-BLM lands in the analysis area; and

- modifications to account for the geographic scope of the Project and provide representative information on visual quality rather than a milepost-by-milepost inventory.

4.10.2.2 Visual Impacts of the Project

Table 4.10.2-1 summarizes the expected visual impacts at each KOP (except for the six KOPs that were not evaluated and one KOP where the pipeline installation would change from aboveground to belowground). Table 4.10.2-2 summarizes the mitigation measures that AGDC would implement at select KOPs.[95] Appendix S-2a provides a detailed description of the impacts at each KOP as well as applicable mitigation measures. The figures in appendix S-2b show photography of existing conditions and simulations of post-construction conditions. The sections below summarize visual impacts associated with each Project facility, based on the information in tables 4.10.2-1 and 4.10.2-2 and appendix S.

[95] Table 4.10.2-2 does not include KOPs where the only mitigation proposed is implementation of the Project Revegetation Plan, which is applicable to the entire Project, or KOPs where mitigation is not proposed because no impacts are anticipated.

TABLE 4.10.2-1

Summary of Visual Impact Analysis by Key Observation Point

Key Observation Point	Visual Resource Inventory Class [a]	Contrast: Construction/Operation [b]	Simulation Prepared?	Visual Impacts	
				Construction	Operation
KOP 1	III	Weak / Weak	Yes	Low	Low
KOP 2	III	Weak / Weak	Yes	Moderate	Moderate
KOP 3	III	Strong / Moderate	Yes	High	Moderate
KOP 4	III	Weak / Weak	No	Low	Low
KOP 5	III	Strong / Weak-Moderate	No	Low	Low-Moderate
KOP 6	III	Strong / Weak	No	Low	Low
KOP 7	III	Strong / Strong	Yes	High	High
KOP 8	III	Strong / Strong	No	Low	High
KOP 9	III	Moderate-Strong / Moderate	Yes	High	High
KOP 10	III	None / None	No	Moderate	Moderate
KOP 11	III	None / None	No	Moderate	Moderate
KOP A	III	Strong / Strong	Yes	High	High
KOP B	II	Weak / Weak	No	Low	Low
KOP C	II	None / None	No	None	None
KOP D	II	Strong / Weak	No	Low	Low
KOP E	II	Strong / Weak	No	Low	Low
KOP F [c, d]	NA	NA	No	NA	NA
KOP 12	III	None / None	No	None	None
KOP 13	III	None / None	No	None	None
KOP 14	III	Strong / Strong	Yes	High	High
KOP G	II	None / None	No	None	None
KOP H	IV	None / None	No	None	None
KOP I	III	None / None	No	None	None
KOP 15	III	None / None	No	Low	None
KOP 16	II	Strong / Strong	No	Moderate	Moderate
KOP 17	II	None / None	No	Low	None
KOP 18	IV	Moderate-Strong / Moderate	No	Low	Moderate
KOP 19	IV	Moderate / Weak	No	Low	Low
KOP 20	IV	Weak / Weak	No	Low	Low
KOP 21	IV	None / None	No	None	None
KOP 22	IV	None / None	No	None	None
KOP 23 [c]	II	NA	No	NA	NA
KOP 24	III	None / None	No	None	None
KOP 25	III	None / None	No	None	None
KOP 26	II	Strong / Strong	Yes	Moderate	Moderate
KOP 27	II	None / None	No	None	None
KOP J	II	Strong / Strong	Yes	High	High
KOP 28	I	Strong / Strong	Yes	Moderate	High
KOP 29 [d]	I	NA	Yes	NA	NA
KOP K	II	Strong / Moderate	Yes	High	Moderate
KOP L	II	None / None	No	None	None

TABLE 4.10.2-1 (cont'd)

Summary of Visual Impact Analysis by Key Observation Point

Key Observation Point	Visual Resource Inventory Class [a]	Contrast: Construction/Operation [b]	Simulation Prepared?	Visual Impacts	
KOP M	III	None / None	No	None	None
KOP 30	I	Strong / Strong	No	Low	High
KOP 31	II	Strong / Strong	Yes	High	High
KOP 32	I	None / None	No	None	None
KOP 33	I	None / None	No	None	None
KOP 34	II	None / None	No	None	None
KOP 35	II	None / None	No	None	None
KOP 36	III	Weak / Weak	No	Low	Low
KOP N	II	Moderate-Strong / Moderate-Strong	No	Moderate-High	Moderate-High
KOP O	II	None / None	No	None	None
KOP P	II	Strong / Strong	Yes	Low	High
KOP 37	I	None / None	No	None	None
KOP 38	I	None / None	No	None	None
KOP Q	II	None / None	No	None	None
KOP R [c]	NA	NA	No	NA	NA
KOP S	II	None / None	No	None	None
KOP 39	III	None / None	No	None	None
KOP 40	III	Strong / Strong	Yes	High	Moderate
KOP T	II	Moderate-Strong / Moderate-Strong	No	Low	Low
KOP U	II	Moderate-Strong / Moderate-Strong	Yes	Moderate	Moderate
KOP V	III	Moderate-Strong / Moderate-Strong	No	Moderate	Moderate
KOP 41	III	None / None	No	None	None
KOP 42	I	None / None	No	None	None
KOP 43	III	None / None	No	None	None
KOP 44	III	None / None	No	None	None
KOP 45	III	None / None	No	None	None
KOP 46 [c]	NA	NA	No	NA	NA
KOP 47 [c,d]	NA	NA	No	NA	NA
KOP 48 [c]	NA	NA	No	NA	NA
KOP 49	III	None / None	No	None	None
KOP 50	III	Moderate / Moderate	No	Moderate	Moderate
KOP 51	III	Moderate / Moderate	No	Moderate	Moderate
KOP 52	III	None / None	No	Moderate	Moderate
KOP 53	I	None / None	No	None	None
KOP 54	IV	Strong / Strong	No	Moderate	Moderate
KOP 2018-1	III	Moderate / Moderate-Strong	Yes	Moderate	Moderate
KOP 2018-2	III	Moderate / Moderate-Strong	Yes	Moderate	Moderate
KOP 2018-3	III	Moderate / Moderate	Yes	Moderate	Moderate

TABLE 4.10.2-1 (cont'd)					
Summary of Visual Impact Analysis by Key Observation Point					
Key Observation Point	Visual Resource Inventory Class [a]	Contrast: Construction/Operation [b]	Simulation Prepared?	Visual Impacts	
KOP 2018-4	III	Moderate / Moderate	Yes	Moderate	Moderate
KOP 2018-5	III	Moderate / Moderate	Yes	Moderate	Moderate
KOP 2018-6	III	Moderate / Moderate	Yes	Moderate	Moderate
KOP 2018-7	III	Moderate / Moderate	Yes	Moderate	Moderate
KOP 2018-8	NA	Moderate / Moderate	Yes	Low	Low
KOP 2018-9	NA	Strong / Moderate	Yes	High	Moderate
KOP 2018-10	NA	Strong / Weak	Yes	Moderate	Low
KOP 2018-11	NA	Strong / Moderate	Yes	High	Moderate
KOP 2018-12	NA	Weak / Weak	Yes	Low	Low
KOP 2018-13	NA	Weak / Weak	Yes	Low	Low
KOP 2018-14	NA	Moderate / Weak	Yes	Low	Low

NA = Not available

[a] Visual Resource Inventory class is derived using a combination of visual sensitivity levels, scenic quality, and distance zones (BLM, 1986c).

[b] See section 4.10.2.1

[c] KOP not surveyed during field investigations due to limited accessibility; therefore, visual impacts could not be evaluated.

[d] We have recommended that AGDC file updated information and photo simulations for these KOPs (see section 4.10.1.2).

Gas Treatment Facilities

The GTP would introduce horizontal and vertical lines and rectilinear forms on the distant horizon, including 29 vertical structures that exceed 200 feet in height. AGDC states that the colors introduced by the GTP would be tans and grays, and that the textures of the GTP would be smooth. These colors and textures would be similar to the colors and textures of other existing oil and gas infrastructure, but somewhat different from the more uneven textures of the surrounding natural landscape. Within the footprint of the GTP, vegetation would be replaced by industrial facilities. No changes in vegetation would occur outside of the Facility's footprint.

The GTP would include new sources of artificial nighttime light. The existing industrial area visible to observers looking at the GTP includes extensive existing lighting. To reduce the impact of added artificial lighting and to help minimize impacts on dark skies, lighting for the GTP would follow the Project Lighting Plan. Specifically, lighting would be the minimum intensity required for safety and security. Permanent lighting would be oriented downward and shielded to eliminate off-site light spill. Additionally, lighting would either be motion-activated or use timers to minimize unnecessary use of lighting. Because views of the GTP would be in the same direction as views of other industrial facilities, an observer at the northern terminus of the Dalton Highway would perceive GTP lighting amidst other existing light sources, rather than as a separate lighting source.

Although Deadhorse receives tourism, views of the GTP area are primarily experienced by oil and gas industry workers. Based on the methodology described in section 4.10.2.1, these viewers have low sensitivity to visual change and are unlikely to perceive the GTP as a contrast in the visual environment.

TABLE 4.10.2-2

AGDC's Proposed Mitigation for Selected Key Observation Points

Key Observation Point	Construction Contrast Summary	Operation Contrast Summary	Proposed Construction Mitigation	Proposed Operational Mitigation
KOP 1	View of GTP and Prudhoe Camp about 7.5 miles to the northwest. Weak contrast from construction activities.	Weak contrast created by GTP facility operation.	For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	Minimize the use of smooth, reflective surfaces and use non-contrasting colors. For all lights employed during operation, adhere to Project Lighting Plan (see discussion below).
KOP 2	View of the Mainline Pipeline about 0.7 mile to the east. Weak contrast from clearing for cut and fill.	Weak contrast created by clearing and change in vegetation.	Use previously disturbed areas during construction to minimize visual impacts. Winter construction to avoid visual conflicts with tourism.	Restore the construction footprint consistent with the Project Revegetation Plan.
KOP 3	View of Galbraith Lake Camp and Pipe Storage Yard 0.4 mile to the north. Short-term strong contrast due to smooth textures, dark colors, and geometric forms of stored materials and camp structures.	Moderate contrast except for granular pad areas.	Use fencing to screen the workspace from the campground. For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	Remove the camp and pipe storage yard. Restore the construction footprint consistent with the Project Revegetation Plan.
KOP 4	View of the Galbraith Compressor Station 3.5 miles to the southeast; weak contrast due to the presence of TAPs in the view.	Weak contrast due to the presence of TAPs in the view.	For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	Restore the Project site consistent with the Project Revegetation Plan. For all lights employed during operation, adhere to the Project Lighting Plan (see discussion below).
KOP 7	View from the Atigun Pass pullout looking southwest to the Mainline Pipeline and pipe storage yard 0.3 mile to southwest. Strong contrast to landform, vegetation, and structure by construction machinery and equipment.	Strong long-term to permanent contrast in landform and vegetation due to grading and clearing.	Limit vegetation clearing to areas within the approved construction footprint. For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below). Winter construction to avoid visual conflicts with tourism.	Remove the camp and pipe storage yard. Restore the Project site consistent with the Project Revegetation Plan.
KOP 8	View of the Mainline Pipeline 0.1 mile to the east. Strong contrast to lines, color, textures, and vegetation.	Strong contrast with vegetation, due to long regrowth period and the permanent presence of a granular pad.	For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below). Winter construction to minimize visual impacts on recreationists and tourists.	Restore the Project site (consistent with the Project Revegetation Plan.
KOP 9	View of Mainline Pipeline about 0.1 mile to the west. Moderate to strong contrast would be introduced to vegetation and structure from clearing and equipment, and weak contrast to landform.	Moderate contrast to landform and vegetation due to clearing. No short-term or long-term contrast in structure.	Limit cutting of vegetation to the construction footprint. For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below). Winter construction in this area to minimize impacts on tourists and recreationists.	Restore the Project site consistent with the Project Revegetation Plan.
KOP 10	No visual contrast, but potential view of lighting from construction of the Coldfoot Compressor Station.	No visual contrast, but potential view of lighting from the Coldfoot Compressor Station.	For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	For all lights employed during operation, adhere to the Project Lighting Plan (see discussion below).

TABLE 4.10.2-2 (cont'd)

AGDC's Proposed Mitigation for Selected Key Observation Points

Key Observation Point	Construction Contrast Summary	Operation Contrast Summary	Proposed Construction Mitigation	Proposed Operational Mitigation
KOP 11	No visual contrast, but potential view of lighting from construction of the Coldfoot Compressor Station.	No visual contrast, but potential view of lighting from the Coldfoot Compressor Station.	For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	For all lights employed during operation, adhere to the Project Lighting Plan (see discussion below).
KOP A	View of camp and pipe storage yard about 0.1 mile east. Strong short-term contrast, including weak contrast in landform and structure, and moderate to strong contrast in vegetation. Potential view of lighting from construction of the Coldfoot Compressor Station.	The duration and magnitude of contrast depends on whether the camp is used after construction. If so, strong short-term or long-term contrasts (similar to construction). If not, weak contrast for landform and structure, weak to strong for vegetation, and moderate overall. Potential view of lighting from the Coldfoot Compressor Station.	Use similar colors—grays, tans—for materials. Minimize vegetation clearing.	Restore the construction footprint consistent with the Project Revegetation Plan. For all lights employed during operation, adhere to the Project Lighting Plan (see discussion below).
KOP D	View of the Mainline Pipeline about 0.1 mile to the southwest. Strong contrast for structures, due to construction equipment, materials, and vehicles.	Weak contrast to color, line, and texture.	Winter construction to minimize impacts on tourists and recreationists.	Restore the construction footprint consistent with the Project Revegetation Plan.
KOP E	View of the Mainline Pipeline about 0.1 mile to the southwest. Strong contrast for structures, due to construction equipment, materials, and vehicles.	Weak contrast to color, line, and texture.	Winter construction to minimize impacts on tourists and recreationists.	Restore the construction footprint consistent with the Project Revegetation Plan.
KOP 13	No contrast expected.	No contrast expected.	AGDC would locate the DMT entry and exit points out of view from this KOP and minimize vegetation removal.	None
KOP 14	View of Five Mile Camp and pipe storage yard 0.1 mile to the northwest. Strong short-term contrast in vegetation and structure due to machinery and equipment. Weak contrast to landform.	Strong to moderate contrast during vegetation regrowth at camp and pipe storage yard site.	Minimize vegetation removal. Locate entry to the storage yard at an angle to the road after accommodating ADOT&PF driveway/access requirements. For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	Remove the pipe storage yard and camp. Restore the construction footprint consistent with the Project Revegetation Plan.

TABLE 4.10.2-2 (cont'd)

AGDC's Proposed Mitigation for Selected Key Observation Points

Key Observation Point	Construction Contrast Summary	Operation Contrast Summary	Proposed Construction Mitigation	Proposed Operational Mitigation
KOP 15	No contrast expected, but potential view of lighting from the Livengood camp and pipe storage yard.	No contrast expected.	Locate the camp away from the highway and maintain vegetation screening between the highway and facilities. Use dark colors such as dark browns and greens, and minimize vegetation clearing. For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	Restore the construction footprint consistent with the Project Revegetation Plan.
KOP 17	No contrast expected, but potential view of lighting from the Dunbar camp and pipe storage yard.	No contrast expected.	Locate the camp, storage yard, and railroad work pad away from the highway and maintain vegetation screening between the highway and facilities. Use dark colors such as dark browns and greens, and minimize vegetation clearing. For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	Remove the camp and pipe storage yard. Restore the construction footprint consistent with the Project Revegetation Plan.
KOP 26	View of Mainline Pipeline about 1.2 miles to the south. Strong contrast to vegetation and landform color.	Strong contrast to vegetation and landform color. No contrast in landform form, line, texture, or structure.	Winter construction to avoid visual conflicts with tourism.	Restore the construction footprint consistent with the Project Revegetation Plan.
KOP J	View of material site, less than 0.1 mile east, and Mainline Pipeline, 0.2 mile east. Strong short-term contrast in vegetation and structure, due to machinery and equipment.	Strong long-term contrast for landform and vegetation due to presence of the material site.	Locate material site entry at an angle to the road, maintain screening vegetation between the highway and site, limit vegetation clearing to the approved footprint, and screen equipment and vehicles from view from the highway. For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	Restore the construction footprint consistent with the Project Revegetation Plan. Minimize the use of smooth, reflective surfaces and use non-contrasting colors. For all lights employed during operation, adhere to the Project Lighting Plan (see discussion below).
KOP 28	View of Nenana River pipeline aerial crossing adjacent to the KOP. Strong short-term contrast to landform, water, vegetation, and structure.	Strong long-term contrast to landform, water, vegetation, and structure. The strongest contrast would be to structure, created by the bridge.	Minimize vegetation clearing. Locate new bridge adjacent to the existing bridge using similar materials and colors. For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	Minimize the use of smooth, reflective surfaces and use non-contrasting colors. Restore the construction footprint consistent with the Project Revegetation Plan. Construct a pedestrian walkway across the pipe bridge to conceal the pipe and tie in to existing use associated with vehicle pullout.

TABLE 4.10.2-2 (cont'd)

AGDC's Proposed Mitigation for Selected Key Observation Points

Key Observation Point	Construction Contrast Summary	Operation Contrast Summary	Proposed Construction Mitigation	Proposed Operational Mitigation
KOP 30	View of the Mainline Pipeline about 0.7 mile to the east. Strong contrast due to noticeable changes in vegetation, color, line, and landform.	Strong contrast due to noticeable changes in vegetation, color, line, and landform.	Minimize vegetation clearing, grading, and the use of cut and fill slopes. Winter construction to minimize impacts on tourists and recreationists.	Restore the construction footprint consistent with the Project Revegetation Plan.
KOP 31	View of Mainline Pipeline and pipe storage yard about 0.5 mile to the north. Strong overall short-term contrast, including moderate contrast to structure and vegetation, and weak contrast to landform.	Strong to moderate short-term to long-term contrast due to vegetation clearing; weak contrast to landform.	Minimize vegetation clearing. For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	Restore the construction footprint consistent with the Project Revegetation Plan.
KOP 36	View of the Cantwell pipe storage yard about 0.1 mile to the south. Weak contrast due to changes in landform, structure, and vegetation.	Weak contrast due to changes in landform, structure, and vegetation.	Minimize vegetation clearing. For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	Restore the construction footprint consistent with the Project Revegetation Plan.
KOP N	View of three material sites, each about 0.1 mile away in various directions. Moderate to strong overall contrast line, structure, color, and texture due to vegetation removal and the presence of machinery, materials, equipment, and vehicles.	Moderate to strong contrast, similar to construction, due to ongoing activity at the material site.	Set the disturbed areas away from the highway and maintain screening vegetation between the highway and sites. Minimize vegetation clearing and screen equipment and vehicles from view from the highway.	Restore the construction footprint consistent with the Project Revegetation Plan.
KOP P	View of access road through the Lower Troublesome Creek campground and of the Mainline Pipeline about 0.1 mile to the west. Strong contrast in form, line, color, and texture due to road construction, vegetation clearing, and the presence of construction equipment.	Strong contrast in vegetation, form, line, color, and texture, due to the permanent presence of the access road,	Maintain screening vegetation between the access road and site, and minimize vegetation clearing for the access road.	Restore the edges of the access road consistent with the Project Revegetation Plan.
KOP 40	View of the adjacent Mainline Pipeline, camp, pipe storage yard, and materials site. Strong short-term contrast, including weak to moderate contrast in structure, moderate to strong contrast in vegetation, and weak to strong contrast in landform.	The duration and magnitude of contrast depends on whether the camp is used after construction. If so, strong short-term or long-term contrast (similar to construction) in vegetation. If not, moderate to strong contrasts in landform and vegetation.	Minimize vegetation cutting and maintain a vegetation screen at the intersection with the Parks Highway to the extent practicable. Locate structures at an angle to road opening after accommodating ADOT&PF requirements for access from the highway. Minimize the use of smooth, reflective surfaces and use non-contrasting colors. For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	Restore the construction footprint consistent with the Project Revegetation Plan.

TABLE 4.10.2-2 (cont'd)

AGDC's Proposed Mitigation for Selected Key Observation Points

Key Observation Point	Construction Contrast Summary	Operation Contrast Summary	Proposed Construction Mitigation	Proposed Operational Mitigation
KOP 50	View toward the Liquefaction Facilities about 1.5 miles to the west. Moderate contrast due to construction lighting.	Moderate contrast due to views of operational lighting and condensation plumes.	For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	For all lights employed during operation, adhere to the Project Lighting Plan (see discussion below).
KOP 51	View toward the Liquefaction Facilities, about 3.8 miles to the west. Moderate contrast, due to construction lighting.	Moderate contrast due to views of operational lighting and condensation plumes.	For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	For all lights employed during operation, adhere to the Project Lighting Plan (see discussion below).
KOP 52	View toward the Liquefaction Facilities, about 6.1 miles to the northwest. No contrast, due to intervening vegetation, but possible view of construction lighting.	No contrast, due to intervening vegetation, but possible view of operational lighting and condensation plumes.	For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	For all lights employed during operation, adhere to the Project Lighting Plan (see discussion below).
KOP 54	View toward the Liquefaction Facilities, about 0.1 mile to the north. Strong contrast due construction lighting.	Strong contrast due to operational lighting and condensation plumes.	For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	For all lights employed during operation, adhere to the Project Lighting Plan (see discussion below).
KOP 2018-1	View of adjacent construction of the Mainline, Healy Compressor Station, and access road. Moderate to strong contrast in vegetation and structure due to machinery and equipment. Weak contrast to landform. Overall contrast would be moderate.	Overall contrast would be moderate to strong, due to changes in structure and vegetation.	Maintain existing vegetation. For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	Minimize the use of smooth, reflective surfaces and use non-contrasting colors. Maintain natural vegetation where practicable. For all lights employed during operation, adhere to the Project Lighting Plan (see discussion below). We recommend that AGDC design the facility lighting to conform to International Dark-Sky Association Guidelines if feasible (see additional discussion below).
KOP 2018-2	View of construction of Ray River Compressor Station and access road adjacent to and west of the Dalton Highway. Moderate to strong contrast in vegetation and structure due to machinery and equipment. Weak contrast to landform. Overall contrast would be moderate.	Overall contrast would be moderate to strong due to changes in structure and vegetation.	For all lights employed during construction, adhere to the Project Lighting Plan (see discussion below).	Minimize the use of smooth, reflective surfaces and use non-contrasting colors. Maintain natural vegetation where practicable. For all lights employed during operation, adhere to the Project Lighting Plan (see discussion below).
KOP 2018-3	View of construction of the Mainline Pipeline. Moderate short-term contrast to structure and vegetation from the presence of machinery and equipment.	Moderate short-term to long-term contrast in vegetation, including the vegetation regrowth period following construction. Overall contrast would be moderate.	Limit vegetation clearing to the construction footprint only. Maintain vegetation screen at the intersection with the Parks Highway to the extent practicable.	Maintain vegetation screen at the intersection with the George Parks Highway to the extent practicable. Restore the construction footprint consistent with the Project Revegetation Plan.

TABLE 4.10.2-2 (cont'd)

AGDC's Proposed Mitigation for Selected Key Observation Points

Key Observation Point	Construction Contrast Summary	Operation Contrast Summary	Proposed Construction Mitigation	Proposed Operational Mitigation
KOP 2018-4	View of construction of the Mainline Pipeline right-of-way on both sides of the Parks Highway. Moderate short term contrast to structure and vegetation from the presence of machinery and equipment.	Overall moderate contrast due to changes in in vegetation, including the vegetation regrowth period following construction.	Limit vegetation clearing to the construction footprint only. Maintain vegetation screen at the intersection with the Parks Highway to the extent practicable.	Maintain vegetation screen at the intersection with the Parks Highway to the extent practicable. Restore the construction footprint consistent with the Project Revegetation Plan.
KOP 2018-5	View of construction of the Mainline Pipeline. Moderate short-term contrast to structure and vegetation from the presence of machinery and equipment.	Overall moderate contrast due to changes in in vegetation, including the vegetation regrowth period following construction.	Limit vegetation clearing to the construction footprint only. Maintain vegetation screen at the intersection with the Parks Highway to the extent practicable.	Maintain vegetation screen at the intersection with the Parks Highway to the extent practicable. Restore the construction footprint consistent with the Project Revegetation Plan.
KOP 2018-6	View of construction of the Mainline Pipeline. Moderate short-term contrast to structure and vegetation from the presence of machinery and equipment.	Overall moderate contrast due to changes in vegetation, including the vegetation regrowth period following construction.	Limit vegetation clearing to the construction footprint only. Maintain vegetation screen at the intersection with the Parks Highway to the extent practicable.	Maintain vegetation screen at the intersection with the Parks Highway to the extent practicable. Restore the construction footprint consistent with the Project Revegetation Plan.
KOP 2018-7	View of construction of the Mainline Pipeline. Moderate short-term contrast to structure and vegetation from the presence of machinery and equipment.	Overall moderate contrast due to changes in in vegetation, including the vegetation regrowth period following construction.	Limit vegetation clearing to the construction footprint only. Maintain vegetation screen at the intersection with the Parks Highway to the extent practicable.	Maintain vegetation screen at the intersection with the Parks Highway to the extent practicable. Restore the construction footprint consistent with the Project Revegetation Plan.
KOP 2018-8	View of Mainline Pipeline from Denali Park Road. Moderate overall contrast due to strong lines and contrast between vegetation and soil color created by clearing the right-of-way, but limited extent and duration of typical views.	Moderate overall contrast due to strong lines, limited extent, and duration of typical views.	Limit vegetation clearing to the construction footprint only.	Restore the construction footprint consistent with the Project Revegetation Plan.
KOP 2018-9	View of Mainline Pipeline from Government Hill on Denali Park Road. Strong overall contrast due to strong lines and contrast between vegetation and soil color in cleared right-of-way.	Moderate contrast after reclamation in a highly scenic area, primarily due to distance and topography. Vegetation would act as a natural buffer.	Limit vegetation clearing to the construction footprint only. Consider construction schedule and traffic control planning that would reduce the size of crews and reduce contrasts over time.	Restore the construction footprint consistent with the Project Revegetation Plan.
KOP 2018-10	View of Mainline Pipeline from the Alaska Railroad above Horseshoe Lake. Strong overall contrast, with strong contrast in line, vegetation, and color. Limited viewer access and dwell time.	Weak contrast after reclamation.	Limit vegetation clearing to the construction footprint only. Consider construction schedule and traffic control planning that would reduce the size of crews and reduce contrasts over time.	Restore the construction footprint consistent with the Project Revegetation Plan.

TABLE 4.10.2-2 (cont'd)

AGDC's Proposed Mitigation for Selected Key Observation Points

Key Observation Point	Construction Contrast Summary	Operation Contrast Summary	Proposed Construction Mitigation	Proposed Operational Mitigation
KOP 2018-11	Extensive view of the Mainline Pipeline from the summit of Mt. Healy. Strong contrast for line, vegetation, and color due to right-of-way clearing.	Moderate visual contrast for line, vegetation, and color after revegetation.	Limit vegetation clearing to the construction footprint only. Consider construction schedule and traffic control planning that would reduce the size of crews and reduce contrasts over time.	Restore the construction footprint consistent with the Project Revegetation Plan.
KOP 2018-12	View of the Mainline Pipeline from the Triple Lakes Trail. Weak visual contrast for vegetation and color due to limited visibility of the right-of-way.	Weak visual contrast for vegetation and color after revegetation.	Limit vegetation clearing to the construction footprint only. Consider construction schedule and traffic control planning that would reduce the size of crews and reduce contrasts over time.	Restore the construction footprint consistent with the Project Revegetation Plan.
KOP 2018-13	Partial view of Mainline Pipeline on the ridge above this location. Weak visual contrast for vegetation and color due to right-of-way clearing.	Weak visual contrast for vegetation and color after revegetation.	Limit vegetation clearing to the construction footprint only. Consider construction schedule and traffic control planning that would reduce the size of crews and reduce contrasts over time.	Restore the construction footprint consistent with the Project Revegetation Plan.
KOP 2018-14	Partial view of the Mainline Pipeline from the south of Parks Highway MP 236. Moderate overall contrast, with strong contrast in line, vegetation, and color in a limited area of the view. This location typically has limited viewer dwell time.	Weak visual contrast after revegetation.	Limit vegetation clearing to the construction footprint only. Consider construction schedule and traffic control planning that would reduce the size of crews and reduce contrasts over time.	Restore the construction footprint consistent with the Project Revegetation Plan.

From KOP 1 at the northern terminus of the Dalton Highway in Deadhorse (see appendix S-2a), the GTPs vertical and rectilinear forms would be visible but difficult to perceive during the daytime. Differences in color and texture would also be difficult to perceive, while changes in vegetation would not be visible. For these reasons, the visual impact of the GTP would be low, as viewed from Deadhorse and more distant observation points.

No simulations have been prepared for the PTTL, which is about 4.4 miles away from KOP 1 at its closest point. To the degree that it is visible, the PTTL would add low horizontal (pipeline) and vertical (VSM) forms with smooth white and gray textures. These new visual elements would be similar to existing oil and gas infrastructure visible throughout the region. Based on the distance from the viewer, the absence of tall vertical structures or large rectilinear structures, and the presence of similar infrastructure in the region, any visual contrast resulting from the PTTL would be weak. From KOP 1, the PBTL would be behind the GTP and thus would not be visible.

From KOP 1, stockpiled overburden from the water reservoir and gravel mine would be visible as mounds on the horizon from a distance of about 6 miles. These stockpiles would likely be similar in color (i.e., tans and grays) to the existing landscape. The silhouettes of the stockpiles would contrast with the otherwise flat horizon. As stated in section 2.2.1.3, stockpiles would be temporary features, and would be removed as the overburden is used to fill nearby material sites or moved to another facility. Based on the distance from the viewer and the temporary nature of the stockpiles, construction and operation of the gravel mine and water reservoir would have low visual impacts.

Granular fill for Gas Treatment Facilities construction would initially be extracted from the existing Put-23 Mine, about 2 miles south of the Gas Treatment Facilities. Extraction and transport of this granular fill would not meaningfully change the appearance of the Put-23 mine, and would therefore have no visual impacts.

Participants in the traditional knowledge workshops on the North Slope described the importance of the landscape and views in the region as landmarks for travel and navigation (Braund, 2016). In particular, hills and distant mountain ranges provide orientation over long distances, while lakes, ponds, and springs serve as smaller-scale destinations or waypoints. The Gas Treatment Facilities would be constructed in an area already characterized by industrial development and artificial lighting, and would be similar in nature and location to this existing infrastructure and lighting. As a result, while the Gas Treatment Facilities could incrementally contribute to existing disruptions to traditionally important views (i.e., disruptions caused by existing industrial development), they would be unlikely to create new obstructions.

Considering the low to moderate viewer sensitivity described above, the Gas Treatment Facilities would have low visual impacts on existing residents and employees, and moderate visual impacts on recreational visitors.

Mainline Facilities

The Mainline Facilities would be constructed in a wide variety of landscapes, as described in section 4.10.1.3. This section provides generalized summaries of visual impacts of the Mainline Facilities. Detailed descriptions of potential impacts and proposed mitigation at each KOP are provided in appendix S-2a, and existing conditions photography and photo simulations of post-construction conditions at 30 KOPs are provided in appendix S-2b.

Mainline Facilities construction would add colors, textures, and geometric elements to the landscape that differ from existing conditions. Construction equipment would add smooth-textured, angular, yellow (or other colors) elements and movement (i.e., moving vehicles). Temporary and permanent aboveground facilities, such as compressor stations and construction camps, would add new rectilinear and triangular geometric shapes and vertical structures. Stockpiled pipe would add linear features. Exposed earth along the Mainline Pipeline and at material yards would typically add lighter colors to the landscape.

The Project would add compressor stations, MLVs, and other permanent aboveground facilities, along with the Mainline Pipeline right-of-way, to viewsheds. Compressor stations and, to a lesser degree, other aboveground facilities, would add rectilinear and vertical features to the landscape, with smooth textures and tan and gray colors. Clearing would introduce horizontal forms and lines in vegetation, but AGDC would implement the Project Revegetation Plan to minimize these impacts.

Aboveground facilities, construction camps, pipe storage yards, and other work areas for the Mainline Facilities would introduce new sources of artificial light along the pipeline route, many of which would be in areas where no similar light sources exist. To reduce the impact of added artificial lighting and help minimize impacts on dark skies, lighting for work camps, pipe storage yards, and other Project facilities and workspaces would follow the Project Lighting Plan. Specifically, lighting would be the minimum required for safety and security for nighttime activities. In addition, lighting would be oriented downward and shielded to eliminate off-site light spill, and lighting would (where appropriate) use timers or motion-activated sensors.

In its comments on the Project, the NPS indicated that outdoor lighting associated with the compressor stations should follow International Dark-Sky Association guidelines and have a color temperature of 3,000 Kelvins or less. In subsequent discussions with FERC staff, NPS clarified that this recommendation applied only to compressor stations potentially visible from NPS lands, specifically the DNPP. The Healy Compressor Station is the only such facility potentially visible from the DNPP. Based on these comments and clarifications, **we recommend that:**

- **<u>Prior to construction of the Healy Compressor Station</u>, AGDC should file with the Secretary, for the review and written approval of the Director of the OEP, a site-specific lighting plan for the station that conforms to International Dark-Sky Association Guidelines, including having a color temperature of 3,000 Kelvins or less; or provide site-specific justification for why the facility cannot conform to these lighting guidelines.**

The right-of-way would be bare earth immediately after construction and have relatively smooth, earth-colored (tan, gray, and brown) characteristics. The reestablishment of vegetation over the entire right-of-way would add slightly less smooth textures with lighter green colors. AGDC would restore vegetation using BMPs as provided in the Project Revegetation Plan. These BMPs range from fertilization to applying various plant cultivation treatments, as appropriate, with consideration for restoration goals and site conditions. Treatments include seeding with native grasses, sedges, and forbs; transplanting dormant shrub cuttings; or transplanting wetland graminoid sprigs.

As discussed in sections 4.5.3 and 4.5.2, tree regrowth in temporary workspaces would take 25 or more years along the southern portion of the right-of-way and up to 100 years along the northern portion of the right-of-way. During tree regrowth, vegetation in the former temporary workspaces would be shorter and typically a lighter shade than adjacent mature trees (e.g., see figure S.2-7 in appendix S-2b). The permanent right-of-way would remain free of trees. In forested areas, the permanent right-of-way would thus be a distinct linear feature. In open lands, new grasses and shrubs would typically be lighter in color than surrounding vegetation. Once this vegetation reaches maturity in about 3 to 30 years (see section 4.5.3), it would be similar to the surrounding vegetation.

The Mainline MOF at Beluga would be a new facility visible along the shoreline. This facility would be similar in character and location to the existing Beluga Landing facility. As a result, visual contrast and impacts associated with the Mainline MOF would be low.

Much of the Mainline Pipeline route follows the Dalton and Parks Highways. As a result, the Mainline Facilities would be visible from substantial portions of the analysis area. Axial views of the Mainline Pipeline right-of-way would exist where it crosses the Dalton or Parks Highways, while oblique or perpendicular views would be available along the road or at waysides, particularly in subregions with hilly or mountainous terrain (generally from the northern extent of the Brooks Range to the southern extent of the Alaska Range) that allows for elevated views.

The visual contrast created by the Mainline Facilities would vary depending on the facility viewed, existing vegetative cover, topography, and the angle of view. For example, within the Brooks Foothills Subregion (see the figures for KOP 3 in appendix S-2b), the Mainline Pipeline right-of-way would be visible from the Dalton Highway as a thin line of lighter tan or green vegetation parallel to the horizon or to other linear features such as the Dalton Highway or TAPS. While the right-of-way would be clearly visible in select areas, it would not be a dominant feature, particularly in areas where TAPS and the Dalton Highway are also visible. As a result, visual contrast from the right-of-way would be low.

In forested areas, the Mainline Pipeline would be a prominent cleared corridor through existing trees (see the figures for KOP U in appendix S-2b) and would thus result in moderate to high levels of contrast, although views would be rarer due to the presence of forest along the Dalton and Parks Highways. Compressor stations would begin to dominate the nearby landscape and have a moderate contrast for foreground-middleground viewers (those within about 3 to 5 miles), but would create no contrast for other areas (see the figures for KOP 2018-2 in appendix S-2b).

As listed in table 4.10.2-2 and discussed in appendix S-2a, AGDC would maintain or create vegetative screens between construction locations and public roads, primarily at highway crossings where there is alternative access to the Mainline Pipeline right-of-way. This also includes access in areas of construction camps, pipe storage yards, and material sites near the Parks Highway and near portions of the Dalton Highway where existing vegetation is sufficient to provide a natural buffer and reduce visual contrast.

In a study of plumes associated with compressor and heater stations, AGDC concluded that condensation plumes would be visible during 2 to 26 percent of daylight hours, with a maximum plume height of 130 to 430 feet (41 to 132 meters) and a maximum plume length of 130 to 1,540 feet (39 to 470 meters).[96] Based on this information, we conclude that condensation plumes from the Liquefaction Facilities would potentially be visible from KOPs 1, 4, 10, A, 2018-1, and 2018-2.

The Parks Highway provides access to major recreation sites such as the DNPP and Denali State Park. Recreational activity along the Dalton Highway is more limited due to its remote nature and rugged characteristics (see section 4.9.4). Recreational visitors throughout the analysis area typically expect a high level of visual quality and thus have a high sensitivity to visual impacts. Other users, such as residents and truck drivers on the Dalton and Parks Highways, likely have low sensitivity due to their familiarity with the region and with TAPS and other oil and gas infrastructure (particularly for drivers along the Dalton Highway).

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[96] Information can be found in AGDC's *Project Note: Analysis of Visible Condensation Plumes from Compressor and Heater Stations* (Accession No. 20170616-5204) on FERC's website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter the 20170616-5204 in the "Numbers: Accession Number" field.

As indicated in table 4.10.2-1, substantial segments of the Mainline Facilities would not be consistently visible or would have low contrast and low visual impacts. Areas with high visual impact include:

- the southern Brooks Range (KOPs 7 through 9 and A, as shown on figures S.2-4 through S.2-6 in appendix S-2b [note there is no simulation for KOP 8]);
- near DNPP (KOPs J, 28, K, , 31, 2018-9, and 2018-11, as shown on figures S.2-9 through S.2-12, S.2-24, and S.2-26 in appendix S-2b);
- Denali State Park (KOP P, as shown on figure S.2-13 in appendix S-2b); and
- coastal parts of the Kenai Peninsula.

Depending on viewer sensitivity, the visual impacts of the Mainline Pipeline would vary from low north of the Brooks Range (between Nenana and Clear) and in the Susitna River valley (south of Talkeetna) to high in the Brooks Range (from Galbraith Lake to south of Coldfoot) and Alaska Range (from Clear to Talkeetna), including the DNPP and Denali State Park. Due to their higher visual sensitivity, recreational visitors would generally perceive higher visual impacts, particularly in more heavily visited recreational areas, such as near Denali State Park and DNPP. Existing residents and employees would generally perceive lower visual impacts than visitors, but residents and employees would still perceive high visual impacts near popular recreation areas such as DNPP.

Liquefaction Facilities

The LNG Plant would introduce large, smooth-textured rectilinear buildings; cylindrical LNG tanks; vertical elements, including six structures that would be at least 200 feet tall and nine other structures that would be at least 140 feet tall; and horizontal linear structures and transmission lines atop flat and paved or graveled surfaces. Colors would generally include grays and whites. The Marine Terminal would introduce horizontal geometric structures at the shoreline, along with the presence of LNG carriers. We expect that these facilities would be similar in shape, color, texture, and overall appearance to the existing Kenai LNG plant, about 1 mile north.

There are no federal or state recreation areas within or adjacent to the Liquefaction Facilities. The closest recreation facility is Captain Cook State Park, about 15 miles northeast by road. As discussed above, recreational visitors throughout the analysis area typically expect a high level of visual quality and thus have a high sensitivity to visual impacts. Other users, such as residents and employees of businesses on the Kenai Peninsula, likely have low sensitivity due to the presence of the existing Kenai LNG, ASRC, and Agrium facilities adjacent to the Kenai Spur Highway. Overall, viewer sensitivity along the northwest coast of the Kenai Peninsula would be low to moderate.

The southern boundary of the Liquefaction Facilities would be about 0.2 mile from Mt. Redoubt Church (KOP 54). Other public viewing locations would include the publicly accessible beach north of the Liquefaction Facilities boundary and public roads near the Liquefaction Facilities boundary, such as Autumn Road and Miller Loop Road. Due to dense vegetation, much of which is evergreen or mixed forest, views of the LNG Plant from public roads would likely be sporadic. Where visible, the LNG Plant would attract a viewer's attention and begin to dominate the landscape when viewed close up, such as from publicly accessible roads adjacent to the Liquefaction Facilities boundary. As a result, the Liquefaction Facilities would have a moderate contrast.

Visitors to the publicly accessible beach along Cook Inlet would have clear views of the Marine Terminal and LNG Plant. From this location, the Liquefaction Facilities would be distinct and dominant in the landscape, although they would be similar to the existing Kenai LNG facility. Beachgoers would pass the Kenai LNG facility between the beach access point at Salamatof Road and the Liquefaction Facilities. As a result, the Marine Facilities would have a moderate contrast.

The Liquefaction Facilities would introduce new sources of artificial nighttime lighting. To reduce the impact of added artificial lighting and help minimize nighttime visual impacts, lighting for the Liquefaction Facilities would follow the Project Lighting Plan. Specifically, lighting would be the minimum required for safety and security for nighttime activities during construction and operation, and lighting would be oriented downward and shielded to eliminate off-site light spill. Additionally, lighting would be motion-activated or would use timers. Lighting for the Liquefaction Facilities would be adjacent to the lighting from the ASRC, Kenai LNG, and Agrium facilities. The nighttime visual impact of the Liquefaction Facilities would thus be an expansion of existing industrial lighting rather than an entirely new source of lighting. The Liquefaction Facilities would therefore have a moderate nighttime visual contrast.

AGDC did not evaluate the potential size and frequency of visible condensation plumes from the Liquefaction Facilities. As indicated above, plumes associated with compressor stations and heater stations would be visible during 2 to 26 percent of daylight hours, with a maximum plume height of 130 to 430 feet (41 to 132 meters) and a maximum plume length of 130 to 1,540 feet (39 to 470 meters).[97] Based on this information, we conclude that condensation plumes from the Liquefaction Facilities would potentially be visible from KOPs 50 and 54 (KOP 49 is in the same location as KOP 50, but is directed away from the Liquefaction Facilities). These plumes would be similar in appearance to condensation plumes associated with other industrial facilities, including those already present in Nikiski.

Considering the low to moderate viewer sensitivity described above, the Liquefaction Facilities would have low visual impacts on existing residents and employees and moderate visual impacts on recreational visitors.

4.10.3 Conclusion

Project construction would have both temporary and permanent impacts on visual resources, including high impacts on 11 KOPs evaluated in this section. Project operation would have permanent impacts on visual resources, including high impacts on 11 KOPs. With implementation of the mitigation measures listed in table 4.10.2-2, as well as our additional recommendations, Project construction and operation overall would not significantly affect visual resources.

4.11 SOCIOECONOMICS

This section discusses population demographics, housing occupancy data, property values, economic and employment characteristics, tax revenues, and public services. The existing socioeconomic conditions, and the potential socioeconomic impacts that could result from the Project, are discussed by subject. This section was prepared based on publicly available data published by a variety of federal and state agencies, including the U.S. Census Bureau; U.S. Bureau of Labor Statistics; Alaska Department of Labor and Workforce Development (ADOLWD); and Alaska Department of Commerce, Community and Economic Development (ADCCED).

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[97] Information can be found in AGDC's "Project Note: Analysis of Visible Condensation Plumes from Compressor and Heater Stations" (Accession No. 20170616-5204) on FERC's website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter the 20170616-5204 in the "Numbers: Accession Number" field.

The socioeconomic analysis for the Project encompasses the North Slope Borough; Yukon-Koyukuk Census Area (one of the 11 census areas in the unorganized borough); Fairbanks North Star Borough; Denali Borough; MSB; Kenai Peninsula Borough; and Anchorage (see figure 4.11-1).

In general, any city or census-designated place (CDP) within 10 miles as measured in a straight line from the Mainline Facilities, or within 50 miles of the Gas Treatment or Liquefaction Facilities, is considered a potentially affected community (PAC). Table 4.11-1 identifies the PACs by borough/census area. These distances were selected based on the extent and magnitude of socioeconomic impacts expected during Project construction and operation. Mainline Facilities construction and operation would have a smaller, shorter-term social and economic impact on the surrounding communities than the Gas Treatment or Liquefaction Facilities. Once the Mainline Facilities are completed, a minor amount of economic activity associated with pipeline operation and maintenance would occur. In contrast, significant employment and procurement activities would continue throughout Gas Treatment and Liquefaction Facilities operation. Additionally, Liquefaction Facilities operational employees would reside in the local community, thereby permanently affecting communities within commuting distance. In addition to the communities near the Project, major logistical and supply centers, such as the Fairbanks North Star Borough and Anchorage, have also been included in the analysis because large economic impacts would be expected to occur nearby.

For purposes of this section, the socioeconomic data are analyzed based on the existing conditions in and potential impacts on three different regions in the Project area: the Gas Treatment Facilities region, Mainline Facilities region, and Liquefaction Facilities region, as described below.

- The Gas Treatment Facilities region incorporates facilities in the North Slope Borough, specifically the GTP, PBTL, PTTL, and 182 miles of the Mainline Facilities. Prudhoe Bay CDP is the only PAC in this region. The GTP, PBTL, PTTL, and northern portion of the Mainline Pipeline would be within or traverse the Prudhoe Bay CDP.

- The Mainline Facilities region incorporates about 573 miles of the Mainline Pipeline and associated facilities in the Yukon-Koyukuk Census Area (304 miles of pipeline), the Fairbanks North Star Borough (2 miles of pipeline), the Denali Borough (87 miles of pipeline), and the MSB (180 miles of pipeline). The Mainline Pipeline would cross 8 of the 12 PACs in this region: Wiseman, Livengood, Anderson, Healy, Denali Park CDP, Cantwell, and Trapper Creek. Fairbanks, about 25 miles from this region, has also been included in the analysis due to its importance as a regional logistical and supply center.

- The Liquefaction Facilities region incorporates facilities in the Kenai Peninsula Borough, specifically the LNG Plant, Marine Terminal Facilities, and 51 miles of the Mainline Pipeline. There are 14 PACs in this region, including Anchorage. The Liquefaction Facilities are in Nikiski, while the Mainline Pipeline traverses Beluga. Anchorage (a logistical and supply center) is about 53 miles from the Liquefaction Facilities and 27 miles from the Mainline Pipeline.

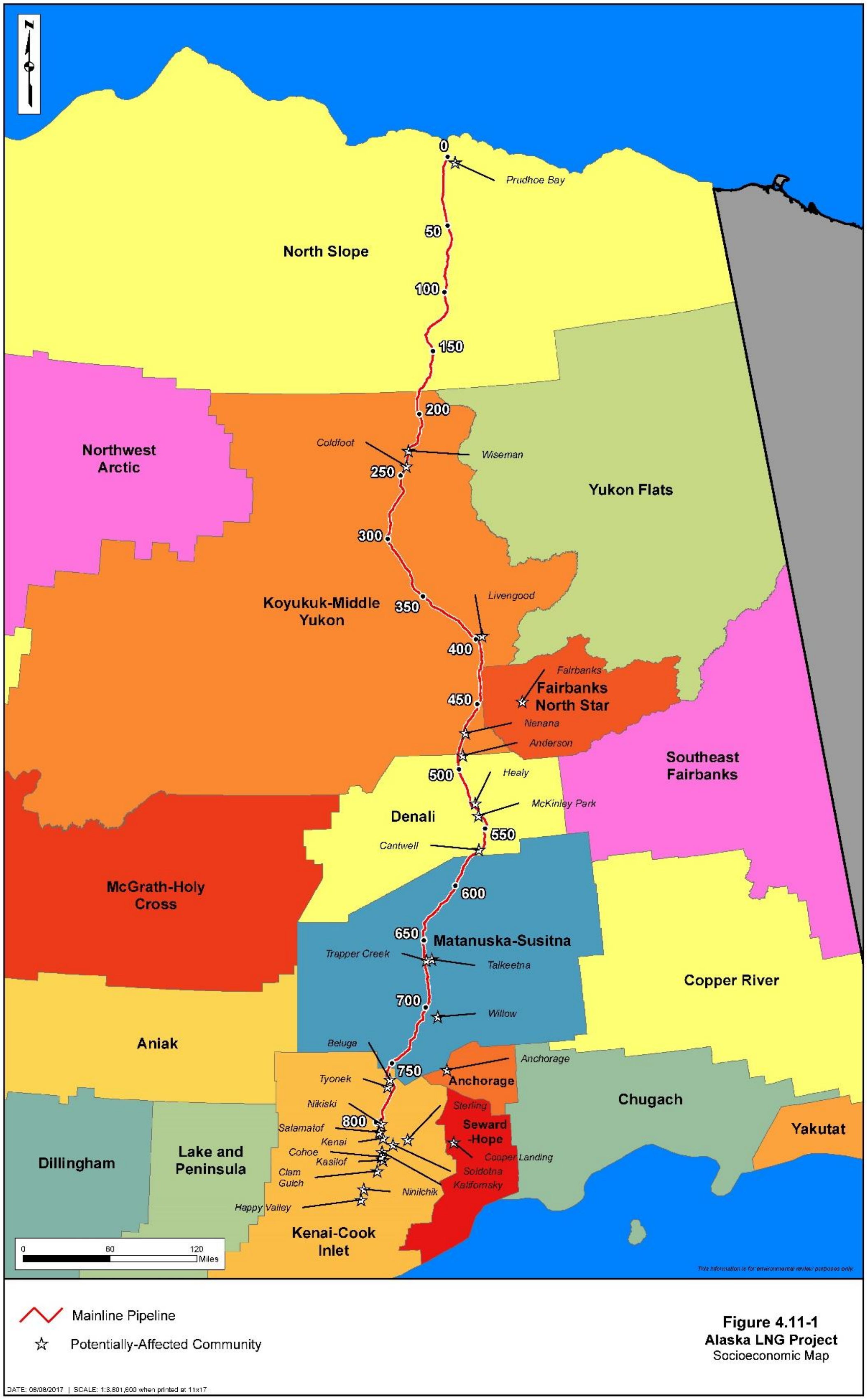


Figure 4.11-1
Alaska LNG Project
Socioeconomic Map

TABLE 4.11-1

Alaska Boroughs, Census Areas, and Potentially Affected Communities in the Area of Interest for the Socioeconomic Impact Analysis

	Project Facility in the Area	Distance to Nearest Project Facility (miles)	Logistical and Supply Center
North Slope Borough			
Prudhoe Bay CDP	GTP, PTTL, PBTL, Mainline Facilities	0	Yes
Yukon-Koyukuk Census Area			
Coldfoot CDP	Mainline Facilities	0	No
Livengood CDP	Mainline Facilities	0	No
Nenana	Mainline Facilities	1	No
Wiseman CDP	Mainline Facilities	0	No
Fairbanks North Star Borough			
Fairbanks	Mainline Facilities	25	Yes
Denali Borough			
Anderson	Mainline Facilities	0	No
Cantwell CDP	Mainline Facilities	0	No
Healy CDP	Mainline Facilities	0	No
Denali Park CDP	Mainline Facilities	0	No
Matanuska-Susitna Borough			
Talkeetna CDP	Mainline Facilities	3	No
Trapper Creek CDP	Mainline Facilities	0	No
Willow CDP	Mainline Facilities	2	No
Kenai Peninsula Borough			
Beluga CDP	Mainline Facilities	0	No
Clam Gulch CDP	Liquefaction Facilities	27	No
Cohoe CDP	Liquefaction Facilities	18	No
Cooper Landing CDP	Liquefaction Facilities	45	No
Happy Valley CDP	Liquefaction Facilities	43	No
Kalifornsky CDP	Liquefaction Facilities	8	No
Kasilof CDP	Liquefaction Facilities	20	No
Kenai	Liquefaction Facilities	4	No
Nikiski CDP	Liquefaction Facilities	0	Yes
Ninilchik CDP	Liquefaction Facilities	31	No
Salamatof CDP	Liquefaction Facilities	0	No
Soldotna	Liquefaction Facilities	13	No
Sterling CDP	Liquefaction Facilities	13	No
Tyonek CDP	Mainline Pipeline	3	No
Municipality of Anchorage	Major Supply Center	27	Yes

4.11.1 Population

4.11.1.1 Existing Population

According to the U.S. Census Bureau American Community Survey's (ACS) 5-year estimates for 2013 through 2017, the estimated population of Alaska in 2017 was 738,565, with an average population density of 1.3 persons per square mile (see table 4.11.1-1). The area of interest (AOI) of the Project is predominantly rural and, therefore, sparsely populated, with the exception of the areas in and around Anchorage and Fairbanks. The total population of all communities in the AOI was about 651,121 residents in 2017, representing over 88 percent of Alaska's population. Anchorage is the largest city in Alaska, with a population of 298,225 residents in 2017, which accounts for almost half of the AOI's population. Fairbanks, with a population of 31,853 residents in 2017, is the second largest city in Alaska. The population of the AOI, minus Anchorage and Fairbanks, was 321,043 residents in 2017. Table 4.11.1-1 provides population statistics for Alaska and additional communities in the AOI. By 2020, Alaska's population is projected to reach 746,582 (ADOLWD, 2018b).

4.11.1.2 Impacts and Mitigation

Constructing the Project would require a temporary but substantial influx of workers into Alaska. Construction of the various Project components is anticipated to take about 8 years to complete. Local and regional population in parts of the Project area would increase for all or a portion of this period. Employment would vary throughout a given year, with peak employment typically occurring in summer or winter months. Table 4.11.1-2 provides information on the estimated number of people required for construction, listed by the borough in which the jobs would be located. Project management and support activities would be headquartered in Anchorage. Employment would vary annually and seasonally, with peak employment typically occurring between Years 3 and 6.

AGDC would use local labor to the extent practicable; however, given the highly specialized skills needed to construct the Project, an estimated 22 to 68 percent of the construction jobs would likely be filled by non-residents, depending on the construction year. The remaining construction jobs would be filled by Alaska residents, ranging from 32 to 78 percent depending on the year. Table 4.11.1-3 provides a breakdown by year of the expected number of Alaska resident and non-resident workers. The increase in the construction workforce at its peak in Year 4 of 5,733 non-Alaskan workers would account for an increase of less than 0.8 percent of the total 2017 Alaskan population.

With exceptions, AGDC would rotate construction staff as identified in table 4.11.1-4. AGDC would transport workers to and from designated pickup locations at the beginning and conclusion of their spreads or work rotations. Pickup locations would be at in-state locations such as Anchorage and Fairbanks for resident workers and out-of-state locations such as Seattle for non-resident workers. When not on duty, construction workers could take up residence in these population centers or return to their homes elsewhere in Alaska or in the continental United States. Project workers, including local and non-local Alaska residents, would be required to live in construction camps and would not be allowed to leave the construction camp when off duty until their rotation is complete. AGDC would allow current Anchorage and Kenai Peninsula Borough residents involved in construction of the Liquefaction Facilities to commute from their homes. Due to the requirement to live in construction camps, workers would not be expected to bring families to the construction areas. A portion of these workers could choose to relocate their families to the pickup locations. However, based on the number of workers relative to the size of the pickup location cities, the increase in population from transient workers and families would be negligible.

TABLE 4.11.1-1

Population and Population Density in the Socioeconomic Area of Interest

Community	Population (2017) [a]	Population Density (persons/mi^2) (2017) [a]
Alaska	738,565	1.3
Gas Treatment Facilities		
North Slope Borough	9,757	0.1
Prudhoe Bay CDP	2,094	5.5
Mainline Facilities		
Yukon-Koyukuk Census Area	5,453	0.0
Coldfoot CDP	84	2.3
Livengood CDP	0	0.0
Nenana	368	62.4
Wiseman CDP	9	0.1
Fairbanks North Star Borough	100,031	13.6
Fairbanks	31,853	1,005.1
Denali Borough	2,303	0.2
Anderson	143	22.4
Cantwell CDP	201	1.7
Healy CDP	1,098	1.6
Denali Park CDP	834	4.7
Matanuska-Susitna Borough	101,135	4.1
Talkeetna CDP	946	35.3
Trapper Creek CDP	389	1.2
Willow CDP	2,121	3.1
Liquefaction Facilities		
Kenai Peninsula Borough	57,961	3.6
Beluga CDP	2	0.0
Clam Gulch CDP	176	13.2
Cohoe CDP	1,288	18.4
Cooper Landing CDP	568	8.6
Happy Valley CDP	624	7.1
Kalifornsky CDP	8,588	124.7
Kasilof CDP	483	46.3
Kenai	7,634	267.0
Nikiski CDP	4,728	68.1
Ninilchik CDP	741	3.6
Salamatof	1,055	130.4
Soldotna	4,516	654.5
Sterling CDP	5,387	69.3
Tyonek CDP	326	4.8
Municipality of Anchorage	298,225	174.9

Sources: U.S. Census Bureau, n.d.[d], 2012, 2016c
NA = Not available
[a] Population and population density data for 2017 is based on the ACS 5-year estimates for 2013 to 2017.

TABLE 4.11.1-2

Estimated Average Construction Workforce (Number of People) by Project Component

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Gas Treatment Facilities								
North Slope Borough	344	620	521	520	1,220	1,470	1,214	640
Matanuska-Susitna Borough	54	20	2	0	0	0	0	0
Municipality of Anchorage	22	20	21	20	30	40	36	20
Total Gas Treatment Facilities	**420**	**660**	**544**	**540**	**1,250**	**1,510**	**1,250**	**660**
Mainline Facilities								
North Slope Borough	53	206	290	800	460	254	74	0
Yukon-Koyukuk Census Area	226	386	620	970	700	203	53	0
Denali Borough	45	112	390	470	30	0	0	0
Matanuska-Susitna Borough	75	180	650	460	70	120	32	0
Kenai Peninsula Borough	0	9	60	70	0	0	0	0
Municipality of Anchorage	15	17	70	70	70	50	10	0
Total Mainline Facilities	**414**	**910**	**2,080**	**2,840**	**1,330**	**627**	**169**	**0**
Liquefaction Facilities								
Kenai Peninsula Borough	1,258	2,150	2,750	4,040	2,390	1,140	230	0
Municipality of Anchorage	55	60	60	60	50	40	20	0
Total Liquefaction Facilities	**1,313**	**2,210**	**2,810**	**4,100**	**2,440**	**1,180**	**250**	**0**
Overall Project Management Staff								
North Slope Borough	40	63	72	123	202	245	342	187
Yukon-Koyukuk Census Area	40	52	82	113	121	41	21	0
Denali Borough	10	10	51	51	10	0	0	0
Matanuska-Susitna Borough	20	21	92	51	10	20	10	0
Kenai Peninsula Borough	210	274	390	513	475	317	114	0
Municipality of Anchorage	80	80	90	100	100	100	78	47
Total Overall Project Management Staff	**400**	**498**	**777**	**951**	**918**	**723**	**565**	**234**
Total Direct Employment During Construction	**2,547**	**4,280**	**6,211**	**8,431**	**5,938**	**4,040**	**2,234**	**894**

TABLE 4.11.1-3

Total Direct Construction Workforce by Place of Residence During Construction [a]

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Total Number of Persons	**2,547**	**4,280**	**6,211**	**8,431**	**5,938**	**4,040**	**2,234**	**894**
Number Expected Alaska Residents	1,987	2,440	2,609	2,698	2,375	2,020	1,474	617
Number Expected Non-residents	560	1,840	3,602	5,733	3,563	2,020	760	277
Percent Alaska Residents	78%	57%	42%	32%	40%	50%	66%	69%
Percent Non-residents	22%	43%	58%	68%	60%	50%	34%	31%

[a] Totals may not add up due to rounding.

TABLE 4.11.1-4 **Work Schedules During Project Construction by Facility**	
Project Management Team (headquarters)	Standard work week; no rotation
Liquefaction Facilities	6 days per week; no rotation
Pipelines (Mainline/PBTL/PTTL)	On site for about 4 months for the duration of a construction spread.
Pipelines (aboveground facilities)	Construction crews on a 4-week on / 2-week off rotation; construction and on-site Project management staff on a 3-week on / 3-week off rotation
Gas Treatment Facilities	Construction crews on a 2-week on / 2-week off rotation; construction and on-site Project management staff on a 3-week on / 3-week off rotation
Gas Treatment Facilities (construction camp fabrication)	6 days per week; no rotation

Project management and support activities for construction would be headquartered in Anchorage. Anchorage office-based workers would live in the local community and could relocate with their families. Construction year 4 is anticipated to have the largest employment, with a total of 250 workers located in the municipality of Anchorage that year (see table 4.11.1-2). Even if all 250 workers were to relocate with their families to Anchorage, the increase in population would be minor relative to the current municipal population.

In addition to the Project's direct effects on population, the population of Alaska could be further affected by (indirect and induced) economic migration. A number of people could temporarily move to Alaska seeking jobs created by the increased economic activity that would occur once construction begins. Additionally, Alaska residents could move to other areas of the state with construction job opportunities, for direct employment with the Project or increased job opportunities in the regional economy.

Economic migration is not uncommon for construction projects in remote areas that do not have a pool of unemployed or underemployed labor. Economic migration has been well documented for several similar construction projects, including TAPS between 1974 and 1977 and the recent expansion of oil drilling in North Dakota (Information Insights, 2004; North Dakota Census Office, 2014). During the height of the Bakken shale gas boom, North Dakota became the fastest growing state in the country. Between 2012 and 2013, the total population in the United States increased by 0.7 percent, but during the same year, the total population in North Dakota increased by 3.1 percent. Migrating workers could bring their families to Alaska with them. Table 4.11.1-5 shows the potential change in the resident population size during Project construction as estimated by AGDC, accounting for migrants filling indirect jobs and families that travel with these workers.[98] As described previously, construction workers directly employed by the Project would not be expected to permanently move into the boroughs due to the use of worker camps and, therefore, have not been included in the population figures in table 4.11.1-5.

As shown in the table, populations in Anchorage, Fairbanks, MSB, and Kenai Peninsula Borough would experience the largest actual and relative growth due to the Project. By the year of peak population impact, an additional 9,820 residents would have relocated to Anchorage; 5,330 residents would have relocated to the MSB, which includes much of suburban Anchorage; and 1,530 additional residents would have moved to the Fairbanks North Star Borough. This increase in population is expected to amount to a 3-percent increase over 2017 population levels in Anchorage, as well as a 2-percent increase in Fairbanks North Star Borough and a 5-percent increase in the MSB. The Kenai Peninsula Borough would also experience substantial population growth from the Project, with an additional 1,760 residents expected to

98 Data regarding estimated increase in resident populations during Project construction was provided in AGDC's response to information request No. 160, dated May 11, 2018 (Accession No. 20180511-5130), available on the FERC website at http://www.ferc.gov. Using the "eLibrary" link, select "Advanced Search" from the eLibrary menu and enter 20180511-5130 in the "Numbers: Accession Number" field.

move to the borough by Year 7 of construction, representing a 3-percent increase in population over 2017 levels.

TABLE 4.11.1-5

Estimated Increase in Resident Populations During Project Construction

Persons	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Alaska	**4,000**	**8,200**	**11,400**	**14,800**	**16,900**	**18,700**	**19,200**	**18,700**
North Slope Borough	10	50	90	120	150	160	170	160
Yukon-Koyukuk Census Area	<10	<10	20	20	20	20	20	10
Fairbanks North Star Borough	20	260	620	940	1,270	1,430	1,530	1,530
Denali Borough	<10	<10	<10	10	10	10	10	10
Matanuska-Susitna Borough	270	1,030	2,100	3,030	3,970	4,660	5,330	5,760
Kenai Peninsula Borough	320	680	880	1,160	1,390	1,600	1,760	1,850
Municipality of Anchorage	2,260	4,520	6,200	7,990	8,940	9,810	9,820	9,260

Project operation would require about 980 permanent personnel per year. Nearly all permanent operation and maintenance personnel would become local residents who would either be hired locally or permanently relocate to the region if hired from outside the area. The resulting increase in population would be relatively small and would have a minor effect on overall population size.

The economic activity generated by the Project would expand employment opportunities in Alaska, thereby attracting non-residents to the state and increasing Alaska's population. Most of this population growth would occur in the Kenai Peninsula Borough, MSB, and Anchorage, while population growth in other areas of the AOI would be minor.

About 170 personnel would be in the North Slope Borough on rotation for operation and maintenance of the Gas Treatment Facilities. About 110 personnel (55 workers per shift) would be at the Gas Treatment Facilities at any one time, with the remaining 60 personnel on leave waiting their rotation. It is assumed that 70 percent of all operational workers (about 120 employees) working at the Gas Treatment Facilities would be Alaska residents. The remaining 30 percent of operational on-site workers would likely reside in the lower 48 states while not on rotation. Only 1 percent of the workers who are Alaska residents would be from the North Slope Borough. Therefore, while the effects of Project operation on the North Slope Borough population would be permanent, the population increase would be minor.

AGDC would employ about 225 field personnel during the operational phase of the Mainline Pipeline. These personnel would be stationed at the regional field office in Fairbanks but would work on site at the Mainline Facilities (i.e., pipeline, meter stations, compressor stations, and the heater station), as necessary. It is assumed that the field staff would be residents of the Fairbanks North Star Borough where the regional field office would be located. All other personnel (about 105 workers) responsible for the Mainline Pipeline would be stationed in Anchorage. This would be a minor addition to the populations of the Fairbanks North Star Borough, Yukon-Koyukuk Census Area, or Denali Borough during operation.

About 240 personnel would be in the Kenai Peninsula Borough for Liquefaction Facilities operation and maintenance. AGDC estimates that local development associated with the Project would induce 2,020 additional people to move to the area. In 2030, the estimated change in resident population as predicted by AGDC from the employees and their families and the additional development is a 3.5-percent increase from the 2017 population.

About 345 personnel would be based in Anchorage for operation and maintenance, including 170 Gas Treatment Facilities support staff, 105 Mainline Facilities support staff, and 70 Liquefaction Facilities support staff. AGDC estimates that local development associated with the Project would induce 7,200 additional people to move to the area. In 2030, the estimated change in resident population as predicted by AGDC from the employees and their families and the additional development is a 2.4-percent increase from the 2017 population.

4.11.2 Economy and Employment

4.11.2.1 Existing Economy and Employment

The Alaskan economy is driven by federal government spending, petroleum, new and traditional resources, and personal assets. A 2010 study by Scott Goldsmith ranked the economic drivers upon which Alaska depends by estimating each of their contributions to Alaska's total employment at the time (377,300 jobs) and total resident personal income ($24.9 billion). It included how much money each economic driver brings into the economy and how that money makes its way through the economy by generating new revenue, wages, jobs, and other income (including direct, indirect, and induced employment and income impacts). The top economic drivers between 2004 and 2007 are described below, listed in order of impact on the Alaska economy (Goldsmith, 2010).

- **Federal**: The federal government, including national defense and non-defense spending, accounts for the largest share of total economic activity in Alaska, contributing $9.9 billion in resident personal income (39.8 percent of total resident personal income) and 133,300 jobs (35.3 percent of the total employment).

- **Petroleum**: Petroleum, which includes production, state/local revenues, and the Permanent Fund/Constitutional Budget Reserve, was the second largest economic driver, contributing $7.4 billion in resident personal income (29.8 percent of total resident personal income) and 117,600 jobs (31.2 percent of the total employment) between 2004 and 2007. Of the three economic drivers grouped under this category, state/local revenues generated the most employment, while production generated the greatest resident personal income.

    - The Alaska Permanent Fund was created in 1976 to save and invest a portion of the state's mineral revenues for the future. While the Alaska Permanent Fund is managed as a single investment pool, it is divided into two parts: the principal, which cannot be spent and must be reinvested; and the earnings reserve, which can be spent by the state legislature for any public purpose, including Permanent Fund Dividend distribution. Permanent Fund dividends are sent to qualified Alaska residents each year.

- **New Resources**: Tourism, air cargo, and other manufacturing and services contributed $2.4 billion in resident personal income (9.4 percent) and 50,000 jobs (13.3 percent) total. Tourism was by far the largest of these, contributing $1.8 billion in resident personal income (7.3 percent of Alaska's total) and 41,500 jobs (11 percent of the total).

- **Traditional Resources**: Seafood, mining, timber, and agriculture, was the fourth largest economic driver, contributing $2.4 billion in resident personal income (9.7 percent of in resident personal income) and 49,300 jobs (13.1 percent of Alaska's total jobs). Seafood was by far the largest contributor to traditional resources, accounting for $1.8 billion in resident personal income and 38,700 jobs.

- **Personal Assets**: Personal assets includes cash flow from retirees (retirement income, health-care spending, etc.) and non-earned income (stock dividends, investments, etc.), which together contributed $2.8 billion in resident personal income (11.2 percent) and 27,000 jobs (7.2 percent) between 2004 and 2007.

The Alaska cost of living is high relative to other states due to many factors, including its remoteness and small population (Goldsmith, 2010). During the first quarter of 2018, Alaska had the seventh highest cost of living in the United States, with an index value of 123.6 compared to an index value of 100 for the nationwide average (ADOLWD, 2018a). The Alaska cost of living varies significantly by community, with some communities experiencing very high costs of living. Limited suppliers, high transportation costs, and high-energy costs are some of the primary reasons why the cost of the living is greater in small, remote communities. Typically, the more remote the community, the higher its cost of living. Table 4.11.2-1 provides an estimate of cost of living for selected communities in the AOI. These data were collected by the U.S. Department of Defense for military installations outside the contiguous United States. As shown on the table, North Slope Borough communities had cost of living indices of 150 in 2018, while communities near Fairbanks had indices of 122 to 128 (ADOLWD, 2018a).

TABLE 4.11.2-1

Cost of Living Index for Selected Communities in the Area of Interest (April 2018)

Community	Index Value
Gas Treatment Facilities	
North Slope Borough	
Barrow	150
Wainwright	150
Mainline Facilities	
Fairbanks North Star Borough	
Fairbanks (Ft. Wainwright)	122
Fairbanks (Elelson Air Force Base)	128
Matanuska-Susitna Borough	
Wasilla	122
Municipality of Anchorage	128
Liquefaction Facilities	
Kenai Peninsula Borough	
Kenai (includes Soldotna)	130
Seward	132

Source: ADOLWD, 2018a
Note: The ADOLWD data does not cover all communities in the AOI.

The annual average unemployment rates for Alaska were 7.0 and 6.6 percent in 2017 and 2018, respectively (ADOLWD, 2019). Employment varies seasonally, with the highest employment rates in Alaska occurring throughout the summer months, and the highest unemployment rates occurring in the winter months for the trade, transportation, utilities, and leisure and hospitality industries. Due to its restricted labor supply, Alaska's median hourly wage was $23.09, the highest in the United States in 2018 (U.S. Department of Labor, 2019). The state had an average per capita income of $35,065 in 2017, the eighth highest in the United States, and a median household income of $76,114, the third highest in the United States (see table 4.11.2-2) (U.S. Census Bureau, n.d.[b]). In 2017, the percent of Alaskans living below the national poverty line was 10.2 percent, which was lower than the national average of 14.6 percent (U.S. Census Bureau, n.d.[b]).

In 2018, the total number of jobs in the AOI was about 248,000, representing about 76 percent of the jobs statewide. Anchorage and Fairbanks North Star Borough account for the highest percentage of those jobs (ADOLWD, 2019c). Table 4.11.2-2 shows labor force statistics, per capita income, median household income, and poverty rates for the AOI.

About one-third of workers in Alaska are not residents where they work. Out of the 407,255 total workers in Alaska in 2017, 12 percent were non-local residents, while 21 percent were non-residents of Alaska. Similarly, about one-third of workers in the AOI are not residents where they work. Out of the 290,590 total workers in the AOI in 2017, 11 percent were non-local Alaska residents, while 13 percent resided outside the state (ADOLWD, 2019b). Table 4.11.2-3 shows worker residency for the AOI. The Denali Borough has the highest percentage of non-resident workers (69 percent) while the MSB has the lowest (12 percent). The North Slope Borough has the highest percentage of non-local resident workers (47 percent) (ADOLWD, 2019b).

4.11.2.2 General Impacts and Mitigation

In total, AGDC expects to make about $7.1 billion of materials and services purchases in the state throughout the entire construction period. Table 4.11.2-4 shows the value of construction materials and services purchased for each Project component and each geographical location. Given the rural nature of most of the AOI, AGDC would likely source the majority of the Alaska-based supplies from Anchorage or Fairbanks. Although local purchases would vary, each borough or census area crossed by the Mainline Pipeline would benefit because smaller-valued, bulky purchases of materials such as gravel or petroleum products would be supplied from the local area.[99]

The funds spent into the state and regional economies from expenditures on construction payroll would generate additional positive indirect and induced economic benefits. Tables 4.11.2-5 and 4.11.2-6 show the direct average annual construction workforce and estimated average payroll for that workforce by Project component, respectively. While some worker spending and material purchases would occur locally or in state, AGDC would source a majority of the materials needed to construct the Project from outside the state, and a substantial portion of the workers would be out-of-state residents. In addition, restricting non-resident and resident construction workers to construction camps would reduce the amount of induced economic activity generated during Project construction. Workers living in the construction camps would have little opportunity to make purchases within the local economy; therefore, most of the non-resident worker earnings would be spent outside the state. Table 4.11.2-7 provides an estimate made by AGDC of the total indirect and induced effects on employment that would result from construction activity. The change in total resident indirect and induced employment in the state would range from 6,250 to 15,910 jobs during the construction period.

[99] Estimated Demand by the Project for Housing Units During Project Construction was included as table 5.4.2-32 in Resource Report 5 (Accession No. 20170417-5338), accessible on the FERC website at http://www.ferc.gov. Using the “eLibrary” link, select “Advanced Search” from the eLibrary menu and enter 20170417-5338 in the “Numbers: Accession Number” field.

TABLE 4.11.2-2

Labor Force and Income Statistics for the Socioeconomic Area of Interest (2017)

	Total Labor Force [a, b]	Average Unemployment Rate (percent) [a]	Average Per Capita Income ($) [c]	Median Household Income ($) [c]	Population with Incomes Below the Poverty Level (percent) [c]
Alaska	**360,759**	**7.0**	**35,065**	**76,114**	**10.2**
Gas Treatment Facilities					
North Slope Borough	3,600	7.4	48,777	77,266	10.2
Prudhoe Bay CDP	NA	NA	109,128	NA	0.8
Mainline Facilities					
Yukon-Koyukuk Census Area	2,477	17.6	21,057	37,819	25.5
Coldfoot CDP	NA	NA	36,868	NA	29.8
Livengood CDP	NA	NA	NA	NA	NA
Nenana	NA	NA	24,588	38,750	16.0
Wiseman CDP	NA	NA	NA	NA	NA
Fairbanks North Star Borough	46,420	6.1	35,328	76,250	7.7
Fairbanks	NA	NA	29,375	60,658	11.9
Denali Borough	1,130	9.4	33,084	83,295	15.5
Anderson	NA	NA	48,629	97,500	2.7
Cantwell CDP	NA	NA	34,580	58,438	7.5
Healy CDP	NA	NA	36,001	90,750	7.8
Denali Park CDP	NA	NA	26,397	51,250	30.0
Matanuska-Susitna Borough	48,323	8.2	30,409	74,887	9.8
Talkeetna CDP	NA	NA	30,233	59,394	3.6
Trapper Creek CDP	NA	NA	27,036	33,438	19.1
Willow CDP	NA	NA	25,737	54,620	16.4
Liquefaction Facilities					
Kenai Peninsula Borough	26,859	8.3	33,336	65,279	11.0
Beluga CDP	NA	NA	NA	NA	NA
Clam Gulch CDP	NA	NA	34,230	41,336	11.9
Cohoe CDP	NA	NA	30,974	63,984	15.6
Cooper Landing CDP	NA	NA	33,643	66,801	9.0
Happy Valley CDP	NA	NA	25,875	39,926	14.6
Kalifornsky CDP	NA	NA	33,979	83,654	8.9
Kasilof CDP	NA	NA	18,524	56,359	NA
Kenai	NA	NA	36,510	58,125	11.5
Nikiski CDP	NA	NA	29,514	56,722	13.1
Ninilchik CDP	NA	NA	33,746	50,972	9.9
Salamatof CDP	NA	NA	19,055	60,000	18.3
Soldotna	NA	NA	36,987	68,662	6.5
Sterling CDP	NA	NA	37,770	77,098	9.3
Tyonek CDP	NA	NA	17,167	37,917	22.1
Municipality of Anchorage	153,725	5.8	38,977	82,271	8.1

TABLE 4.11.2-2 (cont'd)

Labor Force and Income Statistics for the Socioeconomic Area of Interest (2017)

	Total Labor Force [a, b]	Average Unemployment Rate (percent) [a]	Average Per Capita Income ($) [c]	Median Household Income ($) [c]	Population with Incomes Below the Poverty Level (percent) [c]

Sources: ADOLWD, 2019a; U.S. Census Bureau, n.d.(b)

NA = Not available

[a] Data for labor force and unemployment are from 2017 (ADOLWD, 2019).

[b] The labor force includes all people classified in the civilian labor force, plus active duty members of the military. The civilian labor force consists of people classified as employed or unemployed. Excluded are people 16 years old and over who are not actively looking for work, such as students, homemakers, retired workers, seasonal workers who are not looking for work, institutionalized people, and people doing only incidental unpaid family work. Also excluded are working-age individuals who have stopped looking for work because they believe work is unavailable.

[c] Data for average per capita income, median household income, and percent poverty are from the ACS 5-year estimates for 2013 to 2017 (U.S. Census Bureau, n.d.[b]).

TABLE 4.11.2-3

Worker Residency in the Area of Interest (2017)

	Total Workers [a]	Percent Local Residents	Percent Non-local Residents	Percent Non-residents
Alaska	**407,255**	**67**	**12**	**21**
Gas Treatment Facilities				
North Slope Borough	17,409	20	47	33
Mainline Facilities				
Yukon-Koyukuk Census Area	3,493	67	19	14
Fairbanks North Star Borough	47,190	71	12	17
Denali Borough	4,182	15	16	69
Matanuska-Susitna Borough	30,813	79	9	12
Liquefaction Facilities				
Kenai Peninsula Borough	27,304	73	6	21
Municipality of Anchorage	160,199	76	11	13

Source: ADOLWD, 2019b

[a] "Total workers" is the cumulative number of people who worked in an occupation over the course of a year. A single position can be filled by more than one person over a period due to turnover. Excludes self-employed and federal workers who are covered by federal unemployment insurance.

[b] Non-local workers are those who did not live in the borough or census area where they worked.

[c] Non-resident workers are those who did not apply for an Alaska Permanent Fund Dividend in 2017 or 2018.

The direct, indirect, and induced employment generated during the construction phase would increase employment opportunities in most industries, with particular growth expected in the following sectors: oil and gas; mining support services; construction; transportation; professional, scientific, and technical services; and tourism industries. Unemployed and underemployed workers with the requisite skills would find additional job opportunities available. Wage inflation would be expected, particularly in the most heavily affected aforementioned industries, as other employers would compete for workers. This wage growth would be temporary, lasting during peak construction years, and would be limited to workers with skills that would be in high demand.

While construction activity associated with the Project would generate a significant economic boon throughout the state, this injection of funds is a one-time expenditure. However, expenditures on personnel and materials needed for operation and maintenance of Project facilities would continue for the life of the Project.

During operation, workers would be employed permanently in Alaska. While AGDC could recruit workers from outside the state, they would be expected to locate permanently to the area. The total operational workforce would be about 980 employees. An estimated 240 employees would work at the Liquefaction Facilities; 170 employees would work at the Gas Treatment Facilities; and an estimated 225 full-time employees would work along the pipeline route. An additional 345 management and support staff would be in Anchorage. Table 4.11.2-8 provides the estimated annual payroll for the operational workforce by Project component and geographic area. In Year 9, an estimated $395 million in total wages and salaries would be paid to employees to maintain and operate the Project. AGDC estimates that these payroll costs would increase by 2.5 percent per year.

TABLE 4.11.2-4

Estimated Construction Materials and Services (Excluding Payments to Direct Labor) Purchased Locally by Project Component by Geographical Location

Facility/Geographical Area	Amount (millions of 2015 $) [a]
Gas Treatment Facilities	
Municipality of Anchorage	$1,290.3
Fairbanks North Star Borough	$118.9
Kenai Peninsula Borough	$35.6
Matanuska-Susitna Borough	$91.4
North Slope Borough	$92.2
Valdez-Cordova Census Area	$35.6
Total Gas Treatment Facilities [a]	**$1,664.0**
Mainline Facilities [b]	
Municipality of Anchorage	$1,595.7
Fairbanks North Star Borough	$150.2
Kenai Peninsula Borough	$84.6
Matanuska-Susitna Borough	$217.0
Valdez-Cordova Census Area	$8.4
Total Mainline Facilities [a]	**$2,055.9**
Liquefaction Facilities	
Municipality of Anchorage	$2,892.6
Fairbanks North Star Borough	$3.7
Kenai Peninsula Borough	$501.5
Southwest Alaska Region	$5.3
Total Liquefaction Facilities [a]	**$3,403.1**
Total Construction Materials and Services [a]	**$7,123.0**

[a] Totals may not add up due to rounding.
[b] Construction materials and services purchased for the Mainline Facilities in the North Slope Borough have been combined with construction materials and services purchased in the borough for the Gas Treatment Facilities.

TABLE 4.11.2-5

Construction Workforce (Number of Positions)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Gas Treatment Facilities								
North Slope Borough	170	280	240	230	560	670	560	290
Matanuska-Susitna Borough	50	20	0	0	0	0	0	0
Municipality of Anchorage	20	20	20	20	30	40	30	20
Total Gas Treatment Facilities [a]	**240**	**320**	**260**	**250**	**590**	**710**	**590**	**310**
Mainline Facilities								
North Slope Borough	50	190	280	720	380	170	50	0
Yukon-Koyukuk Census Area	210	360	580	880	570	140	30	0
Denali Borough	40	100	370	420	30	0	0	0
Matanuska-Susitna Borough	70	170	610	410	60	80	20	0
Kenai Peninsula Borough	0	10	60	70	0	0	0	0
Municipality of Anchorage	10	20	70	70	60	30	10	0
Total Mainline Facilities [a]	**390**	**850**	**1,960**	**2,580**	**1,090**	**420**	**110**	**0**
Liquefaction Facilities								
Kenai Peninsula Borough	1,190	2,020	2,580	3,800	2,240	1,070	210	0
Municipality of Anchorage	50	60	60	60	50	40	20	0
Total Liquefaction Facilities [a]	**1,240**	**2,080**	**2,640**	**3,860**	**2,290**	**1,110**	**230**	**0**
Overall Project Management Staff								
North Slope Borough	40	60	70	120	200	240	330	190
Yukon-Koyukuk Census Area	40	50	80	110	120	40	20	0
Denali Borough	10	10	50	50	10	0	0	0
Matanuska-Susitna Borough	20	20	90	50	10	20	10	0
Kenai Peninsula Borough	210	260	380	500	470	310	110	0
Municipality of Anchorage	80	80	90	100	100	100	80	50
Total Overall Project Management Staff [a]	**400**	**480**	**760**	**930**	**910**	**710**	**550**	**240**
Total Direct Employment During Construction [a]	**2,270**	**3,730**	**5,620**	**7,620**	**4,880**	**2,950**	**1,480**	**550**

[a] Totals and subtotals may not add up due to rounding.

[b] Totals presented here differ from those in table 4.11.1-2 as these are the number of positions needed, and in some instances, more than one worker would be needed for each position.

TABLE 4.11.2-6

Estimated Average Annual Payroll ($ Millions) for Construction Workforce by Project Component and Geographical Location

Project Facility	Description	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Gas Treatment Facilities									
North Slope Borough	Closed Camp	58	135	123	114	220	246	200	88
Matanuska-Susitna Borough	Module Fabrication Site	18	10	1	0	0	0	0	0
Municipality of Anchorage	Anchorage Office	8	10	10	10	12	13	13	8
Total Gas Treatment Facilities [a]		**84**	**155**	**134**	**124**	**233**	**259**	**212**	96
Mainline Facilities									
North Slope Borough	Closed Camp	14	93	73	201	99	39	8	0
Yukon-Koyukuk Census Area	Closed Camp	60	174	155	244	150	31	6	0
Denali Borough	Closed Camp	12	50	97	117	8	0	0	0
Matanuska-Susitna Borough	Closed Camp	20	81	161	115	16	19	4	0
Kenai Peninsula Borough	Closed Camp	0	4	15	19	0	0	0	0
Municipality of Anchorage	Anchorage Office	4	8	18	19	16	8	1	0
Total Mainline Facilities [a]		**111**	**410**	**519**	**716**	**288**	**97**	**19**	**0**
Liquefaction Facilities									
Kenai Peninsula Borough	Closed Camp with limited commuting	210	366	584	851	543	284	65	0
Municipality of Anchorage	Anchorage Office	10	10	13	14	13	12	8	0
Total Liquefaction Facilities [a]		**220**	**377**	**598**	**865**	**556**	**296**	**73**	**0**
Overall Project Management/ Construction Management Staff									
North Slope Borough	Closed Camp	10	17	19	33	52	57	74	37
Yukon-Koyukuk Census Area	Closed Camp	10	14	22	30	31	10	5	0
Denali Borough	Closed Camp	3	3	14	14	3	0	0	0
Matanuska-Susitna Borough	Closed Camp with limited commuting	5	6	25	14	3	5	2	0
Kenai Peninsula Borough	Closed Camp	55	75	106	136	123	74	25	0
Municipality of Anchorage	Anchorage Office	13	13	15	16	16	16	13	8
Total Overall Project Management/ Construction Management Staff [a]		**97**	**128**	**202**	**242**	**228**	**162**	**119**	**45**
Total Direct Wages and Salaries during Construction Phase [a]		**511**	**1,070**	**1,452**	**1,948**	**1,305**	**814**	**424**	**141**

[a] Totals may not add up due to rounding.

TABLE 4.11.2-7

Estimated Indirect and Induced Employment by Project Component and Place of Residence

Facility/Geographical Area	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Gas Treatment Facilities								
North Slope Borough	<10	20	<10	<10	<10	80	140	190
Yukon-Koyukuk Census Area	<10	<10	0	0	0	<10	<10	<10
Fairbanks North Star Borough	220	410	270	140	160	220	260	170
Denali Borough	0	0	0	0	0	0	0	0
Matanuska-Susitna Borough	370	360	260	190	170	250	330	340
Kenai Peninsula Borough	30	50	50	40	30	60	70	90
Municipality of Anchorage	1,360	2,260	1,650	1,010	980	1,460	1,790	1,570
Other Regions (outside the AOI)	20	30	40	30	30	20	40	30
Total Gas Treatment Facilities [a]	**2,030**	**3,140**	**2,280**	**1,410**	**1,370**	**2,100**	**2,630**	**2,390**
Mainline Facilities								
North Slope Borough	20	20	30	30	20	<10	0	0
Yukon-Koyukuk Census Area	20	60	30	10	10	<10	0	0
Fairbanks North Star Borough	230	420	480	630	420	310	220	180
Denali Borough	0	<10	<10	<10	<10	<10	0	0
Matanuska-Susitna Borough	630	960	850	760	620	570	500	440
Kenai Peninsula Borough	90	150	100	140	110	90	70	40
Municipality of Anchorage	1,270	2,230	3,110	4,250	3,070	2,470	1,660	1,270
Other Regions (outside the AOI)	40	60	60	70	50	60	50	50
Total Mainline Facilities [a]	**2,310**	**3,910**	**4,670**	**5,900**	**4,310**	**3,520**	**2,490**	**1,980**
Liquefaction Facilities								
North Slope Borough	20	30	20	10	10	<10	0	0
Yukon-Koyukuk Census Area	<10	20	<10	<10	<10	<10	0	0
Fairbanks North Star Borough	270	340	280	250	260	220	100	40
Denali Borough	<10	<10	<10	<10	<10	<10	<10	0
Matanuska-Susitna Borough	470	680	580	520	620	780	580	390
Kenai Peninsula Borough	1,100	1,970	1,220	870	960	1,020	890	750
Municipality of Anchorage	4,100	5,710	4,170	3,510	4,030	5,230	2,690	670
Other Regions (outside the AOI)	70	100	100	70	70	90	80	30
Total Liquefaction Facilities [a]	**6,040**	**8,860**	**6,380**	**5,240**	**5,970**	**7,360**	**4,340**	**1,880**
Total Indirect and Induced Employment [a]	**10,380**	**15,910**	**13,330**	**12,550**	**11,650**	**12,980**	**9,460**	**6,250**

[a] Totals may not add up due to rounding.

TABLE 4.11.2-8

Estimated Average Annual Wage and Salary Costs for Operational Workforce by Project Component and Geographical Location in Year 9

Facility/Geographical Area	Annual Wage and Salary Costs [a]
Gas Treatment Facilities	
North Slope Borough	$62,000,000
Municipality of Anchorage	$78,000,000
Total Gas Treatment Facilities [a]	**$140,000,000**
Mainline Facilities	
North Slope Borough	$16,000,000
Yukon Koyukuk Census Area	$28,000,000
Fairbanks North Star Borough	$16,000,000
Denali Borough	$8,000,000
Matanuska-Susitna Borough	$16,000,000
Kenai Peninsula Borough	$5,000,000
Municipality of Anchorage	$49,000,000
Total Mainline Facilities [a]	**$139,000,000**
Liquefaction Facilities	
Kenai Peninsula Borough	$84,000,000
Municipality of Anchorage	$32,000,000
Total Liquefaction Facilities [a]	**$116,000,000**
Total Annual Wage and Salary Costs during Operation [a]	**$395,000,000**

[a] Totals may not add up due to rounding.

As noted in table 4.11.2-8, annual employee earnings in the Denali Borough and the Yukon Koyukuk Census Area would increase by about $8.0 million and $28 million, respectively, during Project operation. This would represent an 8-percent increase in the total wages and salaries in Denali Borough and a 36-percent increase in the total wages and salaries in the Yukon Koyukuk Census Area compared to 2017 total earnings. Therefore, the economic impact of the operational payroll in these areas would be significant. In contrast, impacts on Anchorage and the Kenai Peninsula Borough from the operational payroll, while greater in absolute terms, would have a minor impact on the local economy relative to existing conditions.

According to information collected during the traditional knowledge workshops, construction and operation of previous oil and gas development projects in the region resulted in large cost of living increases in some of the more remote communities. Price levels increased as non-local workers with higher incomes purchased scarce supplies in the local communities, making some basic essentials no longer affordable to local residents. Impacts on general price levels and the cost of living would be anticipated to have a smaller effect under this Project than previous oil and gas developments. The use of closed, self-contained construction camps and the Gas Treatment Plant operations camps would limit the number of people purchasing supplies in the local communities. In addition, AGDC would supply camps and purchase construction materials from major supply centers such as Fairbanks or Anchorage. Few local purchases would be made, thereby reducing competition with local residents for scarce supplies in remote communities.

Another issue raised during the traditional knowledge workshops was the concern that many of the construction jobs created during previous oil and gas development projects went to non-Alaskans, with few

Native Alaskans employed on these projects. While a large percentage of the Project workforce would likely come from outside Alaska, ADOLWD is developing statewide programs to prepare and train the Alaska workforce for employment in Project construction and operation to maximize the number of Alaskans employed by the Project. ADOLWD's *Alaska LNG Project Gasline Workforce Plan* released in April 2018 identifies anticipated workforce needs to construct and operate the Project and provides recommendations for training programs throughout the state, policy recommendations, and suggestions to maximize "Alaskans First" hiring practices on the Project. The plan also includes goals to increase workforce diversity through outreach and training programs (ADOLWD, 2018c).

An MOU was executed on October 13, 2018 between AGDC, the South Central Alaska Building and Trades Council, the Fairbanks Building and Trades Council, and the Alaska Petroleum Joint Craft Council regarding construction of the Project. The MOU states that the parties agree to align critical labor acquisition as stated in ADOLWD's *Alaska LNG Project Gasline Workforce Plan* and acknowledges that the first and primary sources of labor for the Project would be from Alaskan-based labor. The hierarchy for labor sourcing, as stated in the MOU, is 1) Alaska resident qualified craft hire, 2) Alaska training graduate, and 3) Lower 48 craft hire.

While neither the *Alaska LNG Project Gasline Workforce Plan* nor the MOU provide for preferential hiring of Native Alaskans, Alaska Native-owned corporations and contractors would likely be engaged in constructing the Project. Each Alaska Native Corporation has instituted Alaska Native employment goals to ensure preferential hiring of Alaska Natives.

4.11.2.3 Facility-Specific Impacts and Mitigation

Gas Treatment Facilities

Construction of the Gas Treatment Facilities would include an estimated $1,664 million in construction materials and services purchased in Alaska. Of this, only $92 million would be purchased in the North Slope Borough (see table 4.11.2-4). Due to the remote location of the North Slope Borough and the fact that construction activities, including procurement, employment, and lodging, would be self-contained at the facilities and brought in from outside areas, very little indirect or induced economic impacts would occur to the local economy. As shown in table 4.11.2-7, the total estimated indirect and induced employment from construction of the Gas Treatment Facilities is 3,140 jobs at its peak, according to economic modeling completed by ADGC. Of these, however, the vast majority would be in Anchorage (2,260 jobs), while only 20 indirect and induced jobs would be created in the North Slope Borough.

The operation workers in the North Slope Borough would receive an annual payroll of $62 million. Similar to the impacts under construction, only very limited indirect and induced impacts would occur in the North Slope Borough during operation. Nearly all operational workers at the Gas Treatment Facilities would work on a rotational basis and be housed in self-contained work camps while on site. Therefore, only a very small amount of these employee earnings would be spent in the local economy, and induced economic impacts in the borough would be minor. In addition, AGDC would source only limited materials from the North Slope Borough due to its remote nature. Therefore, the majority of the indirect and induced economic impacts from GTP and PBTL operation would accrue in areas outside of the North Slope.

Additional support staff personnel in Anchorage would also be required for GTP and PBTL operation and maintenance, with an annual payroll of $78 million. In addition to these direct economic impacts, Anchorage would also receive the majority of indirect and induced economic impacts associated with operation of the Gas Treatment Facilities. The majority of Alaskan-based materials would be sourced out of Anchorage, and a substantial portion of the staff working on rotation in the North Slope would reside in Anchorage or the surrounding communities.

Mainline Facilities

As shown in tables 4.11.2-3 and 4.11.2-5, construction of the Mainline Facilities at its peak in Year 4 would create about 2,580 positions and generate about $716 million in annual wages and salaries. The additional wages and salaries in the region, as well as the purchases of materials and construction supplies in the local region, would have a positive economic impact on communities in the AOI. Mainline Facilities construction alone would include an estimated $2,056 million in materials and services purchased in Alaska (see table 4.11.2-4). However, the more remote communities crossed by the Mainline Facilities would experience limited economic impacts from construction given the use of closed worker camps and the fact that the majority of construction materials purchased in Alaska for this component would be sourced from the Anchorage and Fairbanks areas. According to modeling completed by AGDC, Project development would generate a total of 5,900 indirect and induced jobs in Alaska during peak construction of the Mainline Facilities in Year 4, with the majority of these jobs in the Municipality of Anchorage, MSB, and Fairbanks North Star Borough (see table 4.11.2-7).

Mainline Facilities operation would require 225 on-site personnel and an additional 105 management and support staff in Fairbanks. The majority of on-site personnel would be based in Fairbanks and rotate on-site. However, some operational and maintenance staff would be distributed along the Mainline Pipeline route and at compressor/meter stations throughout the Yukon-Koyukuk Census Area and Denali Borough. These personnel would consist of trade technicians, technical specialists, safety personnel, support staff, and management. While only a limited amount of direct local employment would be expected during operation in the Yukon-Koyukuk Census Area and the Denali Borough, any increase in employment and employee earnings in these areas could have a substantial impact on local income levels given the relatively small size of the local economies. The majority of the indirect and induced economic impacts associated with operating the Mainline Facilities would occur in the Fairbanks area because the majority employees of operational employees would reside there and the majority materials needed for operation would be sourced out of Fairbanks.

Liquefaction Facilities

Construction of the Liquefaction Facilities would create about 3,860 positions at its peak in Year 4, with nearly all these positions in the Kenai Peninsula Borough. However, the majority of these construction workers would reside in closed camps. Only current residents would be allowed to reside in the community and commute to work. Therefore, much of the induced impacts associated with construction employment would go to communities where the non-local workers permanently reside. The total estimated materials and services to be purchased in Alaska for the Liquefaction Facilities construction is $3,403 million. Of this, an estimated $502 million would be spent locally in the Kenai Peninsula Borough and an estimated $2.9 billion would be spent in Anchorage (see table 4.11.2-4). The sourcing of more than $500 million from the borough and $2.9 billion in Anchorage would have a substantial indirect economic impact on these communities.

As shown in table 4.11.2-7, at its peak in Year 2, AGDC estimates that development associated with the Liquefaction Facilities construction would generate 8,860 indirect and induced jobs in Alaska, with the majority of these jobs in Anchorage and the Kenai Peninsula Borough. In Year 2, about 5,710 indirect and induced jobs would be supported in Anchorage and about 1,970 jobs would be supported by this construction in the Kenai Peninsula Borough. The remaining 1,180 would be in the MSB, Fairbanks North Star Borough, North Slope Borough, Yukon-Koyukuk Census Area, Denali Borough, and other regions outside the AOI.

Anchorage and the Kenai Peninsula Borough would also receive the majority of the economic impacts associated with operation of the Liquefaction Facilities. Liquefaction Facilities operation would require about 240 on-site staff with an additional 70 support staff in Anchorage. In addition, every 4 years, extra personnel would be required to perform turnaround maintenance at the Liquefaction Facilities. Total annual direct payroll would be about $84 million in the Kenai Peninsula Borough and $32 million in Anchorage during Liquefaction Facilities operation.

4.11.3 Commercial Fisheries

4.11.3.1 Existing Fishery Resources

The commercial fishing industry is an important traditional resource in coastal Alaska. Alaska is the highest-ranking state for both weight and value of commercial fisheries landings. In 2016, Alaska's commercial landings totaled 5.6 billion pounds (2.5 million metric tons) valued at $1.6 billion (NMFS, n.d.). In 2012, 55,390 people were employed in the commercial fishing and seafood industry in the state (NMFS, 2012), and the industry accounts for about 9 percent of Alaska's total employment when indirect and induced effects are included (McDowell Group, 2015a). The salmon fishery accounts for the majority of Alaska's commercial fishing and seafood industry, creating 38,100 positions (direct and indirect) and generating $5.1 billion of total economic output on average for 2013 and 2014 (McDowell Group, 2015a). Other commercially important species of fish include groundfish, shellfish, and herring (ADF&G, n.d.[a])

Fisheries occur in the proposed Mainline and Liquefaction Facilities Project areas. Prince William Sound fisheries were not included in the analysis because Project facilities would not be in this region. While there are multiple secondary ports in Prince William Sound that have the potential to be used as support for Project construction, their level of use is unknown at this time; however, it is unlikely that any significant impact on these fisheries would occur as any use of these ports by AGDC would be similar to existing uses of the ports. Fisheries resources are discussed in detail in section 4.7.

Mainline Facilities

The main fishery in the Mainline Facilities area is the Upper Yukon River Fishery, which is a commercial salmon fishery. The Upper Yukon River Fishery Area extends along the Yukon River from near the Municipality of Fairbanks and Beaver CDP to southeast of Kaltag. The fishery is small due to the isolated nature of the villages and limited sales opportunities; just two PACs are on the Upper Yukon River: Nenana and Fairbanks.

In 2016, there were nine commercial fishers in the fishery. In this year, about 50,220 salmon, mostly fall chum and coho salmon, were harvested from the Upper Yukon River Area, including 4,020 summer chum salmon, 25,595 fall chum salmon, and 20,605 coho salmon (The United States and Canada Yukon River Joint Technical Committee, 2017). The value of total Upper Yukon ex-vessel[100] salmon averaged about $119,539 per year between 2010 and 2015, with summer chum salmon averaging an estimated $96,154, fall chum salmon averaging an estimated $17,731, and coho salmon averaging an estimated $5,655 per year between 2010 and 2015 (Estensen et al., 2017). Subsistence fishing is discussed in section 4.14.

Liquefaction Facilities

South-central Alaska, which encompasses Cook Inlet, includes the Municipality of Anchorage, MSB, Kenai Peninsula Borough, and Valdez-Cordova Census Area. During the 2013 to 2014 season,

[100] "Ex-vessel value" is defined by the ADF&G as "The post-season adjusted price per pound for the first purchase of commercial harvest. The ex-vessel value is usually established by determining the average price for an individual species, harvested by a specific gear, in a specific area. The delivery condition of the product is usually taken into consideration when the average price is established." (ADF&G, n.d.[b]).

south-central Alaska accounted for 9 percent of Alaska's total commercial fisheries harvest volume. About one-third of Alaska commercial fishers live in this region (McDowell Group, 2015a). Major fisheries in Cook Inlet include salmon, razor clams, smelt, Pacific halibut, herring, and groundfish (ADF&G, 2017b). All five species of Pacific salmon (Chinook, sockeye, coho, pink, and chum) are commercially fished in Cook Inlet. The salmon fishery accounts for 86 percent of the wholesale value of fish caught in south-central Alaska. The value of the regional salmon harvest was $177 million in 2014.

Cook Inlet has been divided into seven salmon districts: the Northern District, Central District, Southern District, Kamishak Bay District, Barren Islands District, Outer District, and Eastern District (see figure 4.11.3-1). Table 4.11.3-1 shows Cook Inlet salmon harvest and value by gear and district. In 2016, about 18.7 million pounds of salmon were harvested in Cook Inlet, representing $23.8 million in ex-vessel value, and $24.5 million in wholesale value. As shown in the table, the 2016 harvest was slightly less than the 2015 harvest due to the decline in purse seine harvest. The Central District is Cook Inlet's most profitable salmon district, landing 16.7 million pounds of salmon in 2016 at a wholesale value of $22.9 million. Set gillnet makes up about 45 percent of total salmon value in the Central District, or $10.2 million (Shriver, 2017; Northern Economics, 2017).

TABLE 4.11.3-1

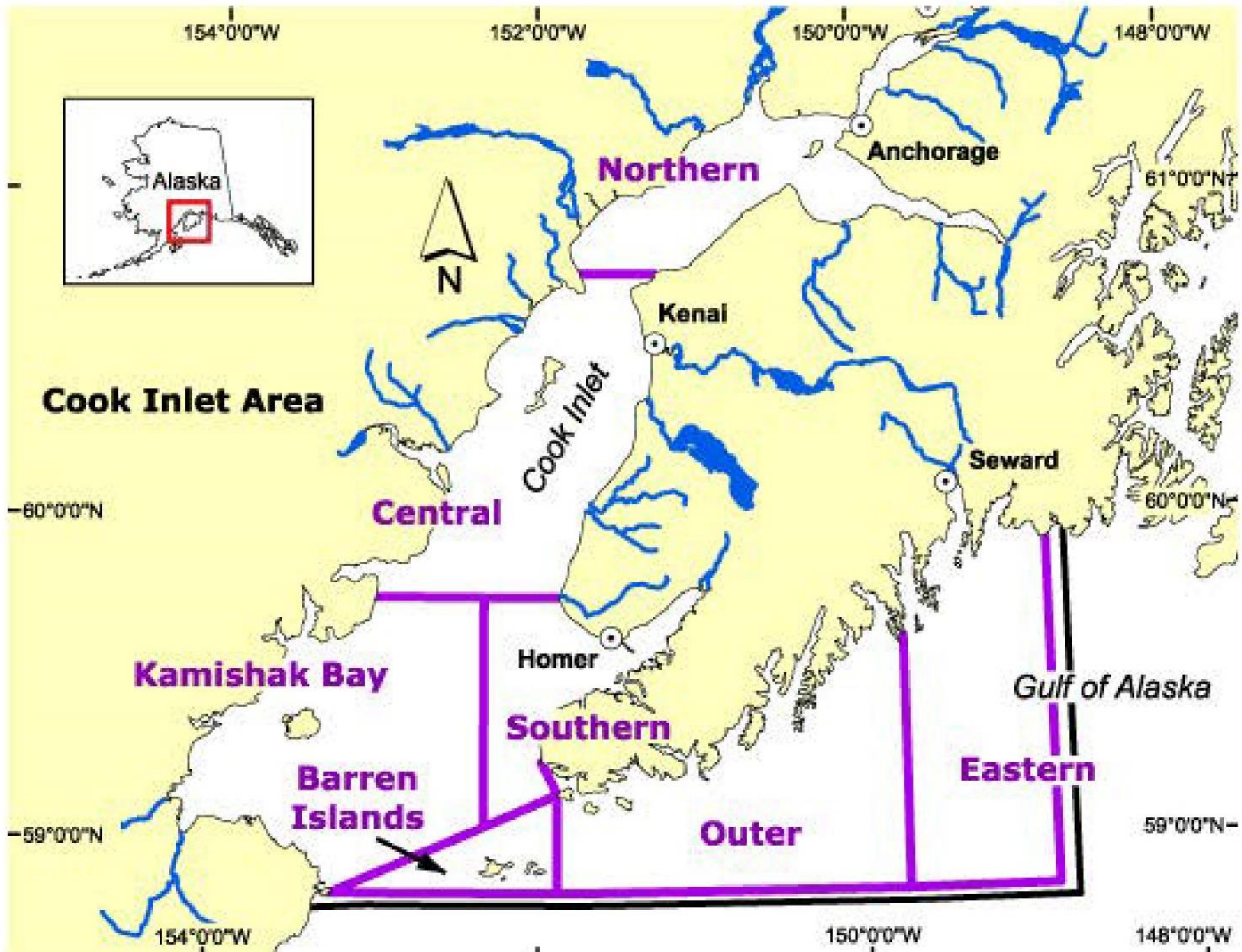
Cook Inlet Salmon Harvest, Ex-vessel Value, and Wholesale Value by Gear and District [a]

		Harvest (pounds)		Ex-vessel Value ($)		Wholesale Value ($)	
Cook Inlet Salmon District	Gear	2015	2016	2015	2016	2015	2016
Northern District	Set gillnet	529,879	473,611	620,053	527,645	579,862	586,949
	Total	**529,879**	**473,611**	**620,053**	**527,645**	**579,862**	**586,949**
Central District	Drift gillnet	8,128,669	9,878,434	10,090,130	12,279,641	9,620,983	12,606,315
	Set gillnet	8,577,036	7,022,839	12,909,152	9,980,120	12,496,823	10,247,785
	Total [b]	**16,705,705**	**16,901,273**	**22,999,282**	**22,259,761**	**22,117,806**	**22,854,099**
Southern District	Set gillnet	395,086	231,566	377,631	212,284	380,494	224,080
	Purse seine	734,327	443,770	501,089	406,449	517,091	416,247
	Total [b]	**1,129,413**	**675,336**	**878,719**	**618,733**	**897,585**	**640,327**
Eastern/Outer/ Kamishak Bay/ Barren Islands Districts	Purse seine	14,203,479	606,761	3,066,979	347,671	3,598,836	414,936
	Total	**14,203,479**	**606,761**	**3,066,979**	**347,671**	**3,598,836**	**414,936**
Overall Total	**Set gillnet**	**9,502,001**	**7,728,016**	**13,906,836**	**10,720,049**	**13,457,179**	**11,058,814**
	Drift gillnet	**8,128,669**	**9,878,434**	**10,090,130**	**12,279,641**	**9,620,983**	**12,606,315**
	Purse seine	**14,937,806**	**1,050,531**	**3,568,068**	**754,120**	**4,115,927**	**831,183**
	Total [b]	**32,568,476**	**18,656,981**	**27,565,033**	**23,753,810**	**27,194,089**	**24,496,311**

Sources: Shriver, 2017; Northern Economics, 2017

[a] Numbers are based on reported data and should be considered lower estimates since confidential data could not be included in totals.

[b] Totals may not add up due to rounding.



This information is for environmental review purposes only.

Salmon District Boundaries

Figure 4.11.3-1
Alaska LNG Project
Cook Inlet Salmon Districts

Source: (Alaska Department of Fish and Game, n.d.[a])

Table 4.11.3-2 shows salmon permits fished, harvest, and gross earnings by borough of residence for commercial salmon fishing in Cook Inlet. In 2016, 783 Cook Inlet salmon permits were fished, employing about 2,918 people on fishing crews. Of these total permits, 433 were set gillnet permits that employed 2,019 people. About 831 people were employed in drift gillnet salmon commercial fishing, and 68 people were employed in purse seine salmon commercial fishing in Cook Inlet. Gross earnings from salmon fishing in Cook Inlet were about $17.9 million in 2016. Of the four boroughs / census areas surrounding Cook Inlet, Kenai Peninsula Borough is the borough of residence for the majority of commercial fishers, representing 78 percent of permits fished and 83 percent of the total harvest and gross earnings in 2016 (Northern Economics, 2017).

TABLE 4.11.3-2

Permits Fished, Harvest, and Gross Earnings by Borough of Residence for Salmon in Cook Inlet

		Permits Fished (number)		Harvest (pounds)		Gross Earnings ($)	
Borough	Gear	2015	2016	2015	2016	2015	2016
Municipality of Anchorage	Purse Seine	4	2	1,616,695	110,629	423,878	79,381
	Drift Gillnet	29	26	402,293	495,826	486,389	615,031
	Set Gillnet	87	89	1,204,408	936,344	1,765,875	1,286,849
	Total	**120**	**117**	**3,223,396**	**1,542,799**	**2,676,142**	**1,981,261**
Kenai Peninsula Borough	Purse Seine	14	15	11,392,371	829,719	2,719,288	595,359
	Drift Gillnet	295	287	5,367,451	6,341,213	6,595,649	7,807,254
	Set Gillnet	316	307	5,947,658	4,623,978	8,655,571	6,381,409
	Total	**625**	**609**	**22,707,480**	**11,794,910**	**17,970,508**	**14,784,022**
Matanuska-Susitna Borough	Drift Gillnet	18	18	358,980	363,235	454,473	452,015
	Set Gillnet	39	36	526,778	428,815	726,958	579,134
	Total	**57**	**54**	**885,758**	**792,050**	**1,181,431**	**1,031,149**
Valdez-Cordova Census Area	Drift Gillnet	2	2	35,707	35,277	43,565	44,227
	Set Gillnet	2	1	34,537	13,773	50,129	18,964
	Total	**4**	**3**	**70,244**	**49,050**	**93,694**	**63,191**
Overall Total [a]	**Set Gillnet**	**444**	**433**	**7,713,381**	**6,002,910**	**11,198,533**	**8,266,356**
	Drift Gillnet	**344**	**333**	**6,164,431**	**7,235,551**	**7,580,076**	**8,918,527**
	Purse Seine	**18**	**17**	**13,009,066**	**940,348**	**3,143,166**	**674,740**
	Total	**806**	**783**	**26,886,878**	**14,178,809**	**21,921,775**	**17,859,623**

Sources: Northern Economics, 2017; Alaska Commercial Fisheries Entry Commission, 2017

[a] Overall total represents the sum of the four boroughs/census areas and does not represent the overall total for Cook Inlet.

Table 4.11.3-3 shows Cook Inlet fisheries harvest and values for razor clam, smelt, herring, Pacific cod, Pacific halibut, octopus, pollock, rockfish, and other groundfish. Commercial shellfish harvest (with the exception of razor clams) has been closed since at least 2013 to allow stocks to recover. There are no plans to reopen these fisheries (ADF&G, 2016). Historically, Cook Inlet included commercial crab, littleneck clam, shrimp, and scallop fisheries (Rumble et al., 2016). Octopuses are harvested in Cook Inlet as bycatch. In 2015, about 11,260 pounds of octopus were harvested, with an ex-vessel value of $6,053 (Shriver, 2017).

Groundfish is defined by the ADF&G as “any marine finfish except halibut, osmerids, herring, and salmonids” (ADF&G, n.d.[c]). Commercial groundfish fisheries in Cook Inlet include Pacific cod, pollock, multiple rockfish species (primarily black rockfish), and other groundfish. Groundfish are harvested in Cook Inlet using longline, jig, and pot gear. Other species of fish harvested in Cook Inlet include smelt, which are harvested using dip nets; herring, which are harvested using gillnets; and Pacific halibut, which are harvested using longline. With the exception of salmon, Pacific cod were the most abundant harvest in 2015 and 2016 in Cook Inlet, but Pacific halibut were the most profitable species caught, bringing in more than $2 million in wholesale value in 2015 (Northern Economics, 2017; ADF&G, 2017b; Shriver, 2017).

TABLE 4.11.3-3

Cook Inlet Fisheries Razor Clam, Spelt, Herring, Pacific Cod, Pacific Halibut, Octopus, Pollock, Rockfish, and Other Groundfish Harvest and Ex-vessel Value by Species

	Harvest (pounds)		Ex-Vessel Value ($)	
Species	2015	2016	2015	2016
Razor clam	318,538	284,800	236,563	211,507
Smelt	213,934	191,536	120,743	108,101
Herring	52,448	45,823	53,311	45,800
Pacific cod	2,596,461	3,283,397	933,516	1,080,034
Pacific halibut	395,419	286,919	2,012,362	1,541,121
Octopus	11,260	NA	6,063	NA
Pollock	29,407	NA	4,364	NA
Rockfish	308	670	233	510
Other groundfish [a]	326,013	289,164	300,230	69,990

Sources: Alaska Commercial Fisheries Entry Commission, 2017; Northern Economics, 2017; Shields and Dupuis, 2017; Shriver, 2017

NA = Not available due to business confidentiality reasons.

[a] North Gulf District was excluded from groundfish totals.

4.11.3.2 Impacts and Mitigation

As discussed in section 4.7, Project construction could affect commercial fishing in the AOI and, by extension, the seafood industry, by either reducing the abundance of commercially harvested fish communities or interfering with fishers' access to commercial fishing grounds. Commercially important fish species would be affected in the Project area; however, impacts on the fish and shellfish industry during construction would be temporary or short term.

Coordination with federal and state agencies as well as the ADF&G would further define and mitigate impacts, as necessary. AGDC would develop a Recreational and Commercial Fishing Construction and Mitigation Plan in coordination with the ADF&G. AGDC has also indicated it would engage commercial fishing representatives and other marine resource users with early and substantive communication regarding construction activities that could affect commercial fishing operations.

Impacts on fisheries during Project operation would primarily be due to increased vessel traffic in Cook Inlet from the LNG carriers transiting to and from the Marine Terminal Facilities and the pilot station in Homer. Operation of the LNG facility would increase the number of vessel calls at Nikiski and Homer for the life of the Project. Vessel traffic increases from Project operation are discussed further in section 4.12.

The Mainline Pipeline would cross under the Yukon River and Tanana River using the DMT construction method. This method is not anticipated to affect the Yukon River or Tanana River fisheries, fishers, or fish processing industries. Normal operational and maintenance activities of the Mainline

Pipeline are also not expected to affect the Yukon River or the Tanana River fisheries, fishers, or fish processing facilities.

Construction of the Mainline Pipeline across Cook Inlet would temporarily limit commercial fishers' access to fishing grounds. Commercial fishing vessels would be restricted in active workspaces, but fishers would have undeterred access to the inactive portions of the construction right-of-way. Moreover, prior to construction in bottom-gear fishery areas, AGDC would coordinate with the ADF&G regarding timing such that commercial fishers would have the opportunity to harvest those areas before construction begins. Specifically, AGDC would provide public advertising (e.g., a local notice to mariners) and/or direct notice (e.g., mailed letters) before beginning construction to allow commercial fishers the opportunity to harvest and/or remove any fixed fishing gear from the construction area.

Construction of the Marine Terminal Facilities and Marine Terminal MOF in the Port of Nikiski and the Mainline MOF near Beluga Landing would displace set gillnet fishers. Set gillnet fishing in and near these areas would be affected for the construction duration (i.e., two seasons during the Marine Terminal MOF dredging and pile driving and one season during Mainline MOF pile driving near Beluga Landing). Construction of the Mainline Pipeline crossing of Cook Inlet could also affect set gillnet fishing in the construction area. As noted above, the Project Recreational and Commercial Fishing Construction and Mitigation Plan would help mitigate the negative impacts on set gillnet fishers.

Commercial set gillnet fishers in Cook Inlet are required to have a permit from the Alaska Commercial Fisheries Entry Commission to catch salmon. In addition, commercial set gillnet fishers may obtain 10-year shore fishery leases from the ADNR in Cook Inlet. These leases give the leaseholders priority in setting gillnets in the leased area. As of October 30, 2012, several shore fishery leases were in the construction area. These leaseholders would be particularly affected by the construction and access restrictions. According to a study prepared for the Alaska Commercial Fisheries Entry Commission, fishing with an ADNR shore fishery lease typically results in a 25-percent increase in earnings compared to fishing without an ADNR shore fishery lease (Gho et al., 2012). Therefore, while these leaseholders would be allowed to fish for salmon elsewhere in Cook Inlet with their permits, it is unlikely they would achieve similar earnings.

A temporary increase in vessel traffic would affect the set salmon gillnet fishery in the purse seine salmon, commercial smelt, and groundfish fisheries by potentially limiting fishers' access to these fisheries in Cook Inlet. The increase in vessel traffic and construction access restrictions and fuel and labor costs could increase for all set salmon gillnet fishers in the area, but this would be a temporary impact on set gillnet fishing in Cook Inlet. There would be a temporary impact on the purse seine salmon fishery from increased vessel traffic during Project construction; however, the purse seine salmon fishery typically operates close to shore in the lower inlet south of Anchor Point and along the Gulf Coast. The smelt fishery uses dip nets on the west side of Cook Inlet between the Chuitna and Little Susitna Rivers during May and June that could be temporarily affected by an increase in vessel traffic during Mainline MOF construction. Coordination with the ADF&G and smelt fishers would further define and mitigate impacts. Furthermore, these fisheries are accustomed to sharing Cook Inlet with shipping vessels. Therefore, impacts on the groundfish fishery from increased vessel traffic during Project construction would be negligible. Impacts on commercial razor clam fishing and herring fishery would not be expected from construction vessels since fishing occurs away from Project facilities.

While fishing effort and harvest rates in areas directly affected by Project construction would be negatively affected, overall fishery harvest rates in Cook Inlet would not be expected to change substantially. In addition, impacts on the fish-processing sector from Project construction would also be expected to be minor. See section 4.7 for additional information on Project construction impacts on Cook Inlet fishery resources and proposed mitigation measures.

As is the case for construction impacts, operational impacts would not be expected to have substantial impacts on the herring fishery, commercial razor clam fishery, and/or other shellfish fisheries. The salmon, smelt, and groundfish fisheries could be affected by the increase in vessel traffic in Cook Inlet during Project operation. As noted above, however, these fisheries are accustomed to sharing Cook Inlet marine traffic, so impacts on the groundfish fishery from increased vessel traffic would be negligible. Impacts on the processing sector from Project operation and impacts on overall Cook Inlet harvests would be anticipated to be minor.

Throughout Project operation, there would be an operational easement along the pipeline right-of-way; however, fishing restrictions would not be associated with the easement, and fishing could resume once construction is complete. Thus, the marine easement would have a negligible effect on commercial fishers' access to fishing grounds traversed by the Mainline Pipeline, which would be buried at the Cook Inlet shore crossing to avoid potential impacts from shallow water hazards. Additionally, where the Mainline Pipeline is not buried in Cook Inlet, AGDC would coat the offshore pipe with 3.5 inches of concrete coating for on-bottom stability as well as protection from physical damage. This concrete would minimize impacts from anchors and reduce the chances of entanglement of fishing gear under the pipeline. As discussed in sections 4.9.1 and 4.12.2, LNG carriers in transit and docked at the Marine Terminal would have a 1,000-yard security zone (about 650 acres), within which other vessels would be prohibited without prior authorization by the Coast Guard. Commercial fishing vessel owners operating in Cook Inlet routinely receive approval to fish within the security zone of LNG carriers calling on the existing Kenai LNG dock. The security zone would occupy a small area of Cook Inlet, so impacts on fishing and fishing vessels in this area would be minor.

4.11.4 State and Local Taxes and Government Revenues

4.11.4.1 Existing State and Local Taxes and Government Revenue

The following section provides information on state taxes, revenues, and expenditures for Alaska and the three regions within the AOI. During fiscal year (FY) 2017, the State of Alaska collected $12.7 billion in revenue, with the majority of this revenue coming from oil taxes and royalties (see table 4.11.4-1). Other revenue sources for the state included funding from the federal government and investment earnings, primarily from Alaska's Permanent Fund. In 2017, state revenue per capita was $17,187, one of the highest in the United States. The State of Alaska does not collect personal income or sales taxes (Tax Foundation, 2015).

Revenue from oil and gas is included in table 4.11.4-1 under taxes and rents and royalties. Unlike other states in the country, Alaska receives nearly a third of its total revenues from the oil and gas industry. In FY2014, Alaska received $5.4 billion in unrestricted oil and gas revenues, which accounted for 32 percent of total revenues (Bradner and Bradner, 2015). In comparison, Texas received $2.3 billion in oil and natural gas production tax receipts in FY2016 (Texas Comptroller of Public Accounts, 2016). Alaska received nearly $3.2 billion in federal grants aid, which accounted for 25 percent of total revenues. The majority of funding went to Medicaid, while education received the second largest amount. More than 18 percent of the state's total expenditures went for capital outlay and equipment (Alaska Department of Administration, 2014).

The oil and gas production contribution to the Alaska Permanent Fund is an important revenue source for Alaska residents. Since 1982, eligible Alaska residents have received annual Permanent Fund dividends ranging from $845.76 in 2005 to a high of $2,072.00 in 2015. The Alaska Permanent Fund dividend in 2016 was $1,022.00 (Alaska Department of Revenue, 2016). For many Alaska residents, the Alaska Permanent Fund dividend payments they receive from the state actually exceed the local taxes they pay. On a per capita basis, local governments in Alaska collected about $2,304.45 in taxes per resident in 2013. In many cases, individual local tax bills would be less because funds raised from businesses or other entities are included in this figure (U.S Census Bureau, n.d.[f]).

TABLE 4.11.4-1

State of Alaska Government Funds – Revenues by Source

	Fiscal Year 2017 ($ million)
Taxes [a]	679.6
Licenses and Permits	148.7
Charges for Services	214.3
Fines and Forfeitures	40.4
Rents and Royalties [b]	1,162.9
Premiums and Contributions	36.1
Interest and Investment Income (Loss)	7,109.8
Federal Grants in Aid	3,198.1
Payments in from Component Units	31.2
Other Revenues	72.9
Total Revenues	**$12,694.0**

Sources: Alaska Department of Administration, 2017

[a] Taxes include corporate income taxes, oil and gas production and property taxes, mining license taxes, sales and use taxes, estate taxes, employment security taxes, alcoholic beverage taxes, tobacco taxes, marijuana taxes, commercial passenger vessel excise taxes, electric cooperative taxes, fisheries-related taxes, passenger vessel gambling taxes, motor fuel taxes, tire fees, telephone cooperative taxes, vehicle rental taxes, and withholding taxes (Alaska Department of Revenue, 2017).

[b] Permanent Fund revenues are included in Rents and Royalties and Interest and Investment Income.

Table 4.11.4-2 shows the State of Alaska's general fund expenditures for FY2017. In FY2017, the state spent $9.5 billion. The largest percentage of expenditures was on health and human services (32 percent), education (19 percent), and transportation (14 percent) (Alaska Department of Administration, 2017). During FY2013, Alaska government expenditures were about $16,345 per resident, compared to the average for all states in the United States of about $6,345 per resident. While accounting differences may account for some of the disparity in per capita expenditures, the majority of the differences were caused by the small, dispersed population in Alaska and the costs associated with providing public services and facilities to these communities (National Conference of State Legislatures, 2016).

Table 4.11.4-3 shows local government revenues in the AOI for FY2015. The Municipality of Anchorage, North Slope Borough, and MSB have the highest government revenues. A portion of local government revenues comes from the state and federal government, through intergovernmental transfers, particularly in the form of education funding. Six PACs within the AOI, including the Municipality of Anchorage, have city governments that collected taxes in FY2015, most often in the form of property taxes, sales taxes, and other taxes, such as hotel/motel "bed" taxes or alcohol and tobacco taxes (see table 4.11.4-3). As shown in table 4.11.4-3, the majority of boroughs/census areas in the AOI including the North Slope Borough, the Fairbanks North Star Borough, the MSB, the Kenai Peninsula Borough, and Anchorage receive revenue from oil and gas property taxes. In addition, Fairbanks and Kenai collect oil and gas property taxes.

Table 4.11.4-4 shows local government operating expenditures in the AOI for FY2015. Operating expenditures account for the majority of spending for most boroughs and cities in the AOI.

TABLE 4.11.4-2

State of Alaska Government Funds – Expenditures by Use

Category	Fiscal Year 2017 ($ million)
General Government	524.2
Alaska Permanent Fund Dividend	652.7
Education	1,823.2
University	379.2
Health and Human Services	3,076.0
Law and Justice	237.8
Public Protection	714.9
Natural Resources	332.9
Development	184.6
Transportation	1,289.7
Intergovernmental Revenue Sharing	97.5
Debt Service	
Principal	93.8
Interest and Other Charges	67.6
Total State General Fund Expenditures	**9,474.0**

Sources: Alaska Department of Administration, 2017.

4.11.4.2 Impacts and Mitigation

Project construction and operation would permanently affect taxes collected and revenue generated by state and local governments and likely result in an increase in government expenditures. During construction, state and local government revenues generated from taxes would increase due to materials purchases, payroll expenditures, and property and other taxes. Revenues from other location-specific special use taxes such as bed taxes and rental car, motor fuel, and utility taxes would also be expected to increase as construction workers and others move into the region.

Anchorage, MSB, Fairbanks, and the Kenai Peninsula Borough would likely be affected by the Project-related expenditures: however, local governments would not be expected to experience a significant increase in expenditures. Because the majority of non-resident construction workers would be required to live in Project construction camps that supply electric utilities, solid waste disposal, water and wastewater services, medical care, and emergency services, local governments would not incur expenditures for these workers.

Additional in-migration could occur during the construction phase in the AOI as individuals are drawn to the region due to the additional economic activity that would occur. These additional residents could create an added burden on local governments because they would increase the demand for local community services and facilities. The additional government revenues generated during the construction period in most cases would offset the increase in expenditures. A lag time could exist at the beginning of the construction phase when the amount of government expenditures incurred would increase rapidly before government revenues generated by the Project would expand. This impact would be temporary to short term. In the following years, revenues would be larger than total expenditures.

TABLE 4.11.4-3

Local Government Revenues by Source in the Area of Interest (FY2015)

	Property Tax	Oil and Gas Property Tax [a]	Other Taxes [c]	Other Fees and Charges	Inter-governmental Transfers	Other Non-tax Revenues	Total
	$ Thousands						
Gas Treatment Facilities							
North Slope Borough	354,900	329,064	13,979	8,537	57,515	38,201	473,132
Mainline Facilities							
Yukon-Koyukuk Census Area	NA	NA	NA	NA	NA	NA	NA
Nenana	250	NA	148	92	137	162	789
Fairbanks North Star Borough	122,216 [b]	8,370	NA [b]	4,490	29,049	2,902	158,657
Fairbanks	14,911	107	5,875	4,741	3,627	3,448	32,602
Denali Borough	NA	NA	3,414	NA	NA	1,139	4,553
Anderson	NA	NA	22	175	153	53	403
Matanuska-Susitna Borough	125,664 [b]	54	NA [b]	9,055	117,685	2,424	254,828
Liquefaction Facilities							
Kenai Peninsula Borough	54,663	7,253	30,138	NA	25,379	8,726	118,906
Kenai	10,914 [b]	98	NA [b]	5,636	7,240	3,217	27,007
Soldotna	7,922 [b]	NA	NA [b]	2,673	10,404	263	21,262
Municipality of Anchorage	577,857 [b]	5,342	NA [b]	49,576	169,459	20,374	817,266

Sources: City of Anderson, 2015; City of Fairbanks, 2014; City of Kenai, 2014; City of Soldotna, 2014; Denali Borough, 2014; Fairbanks North Star Borough, 2016; Kenai Peninsula Borough, 2016; MSB, 2016; Municipality of Anchorage, 2016; Municipality of Nenana, 2014; and North Slope Borough, 2016a

NA = Not available

[a] Oil and gas property tax estimated by ADGC based on information in ADCCED (2014a). Included in total property tax figures.

[b] Property tax figures for Fairbanks North Star Borough, Matanuska-Susitna Borough, City of Kenai, the City of Soldotna, and the Municipality of Anchorage includes revenues from all taxes, not just property taxes.

[c] Other taxes could include local taxes such as sales and use taxes, bed taxes, occupancy taxes, etc.

TABLE 4.11.4-4

Local Government Operating Expenditures by Category in the Area of Interest (FY2015)

	General Government	Public Safety	Public Works	Health and Human Services	Education	Parks and Recreation	Other	Total
	$ Thousands							
Gas Treatment Facilities								
North Slope Borough [a]	79,796	34,825	77,982	31,953	48,420	NA	334,610	607,586
Mainline Facilities								
Yukon-Koyukuk Census Area	NA	NA	NA	NA	NA	NA	NA	NA
Nenana	244	161	43	NA	75	200	33	756
Fairbanks North Star Borough	22,048	13,662	13,263	NA	56,874	16,859	41,249	163,955
Fairbanks	10,846	15,804	7,578	NA	NA	NA	1,358	35,586
Denali Borough	182	NA	NA	NA	2,667	NA	1,204	4,053
Anderson	117	58	86	NA	NA	12	85	358
Matanuska-Susitna Borough	26,340	22,542	7,024	28,220	52,764	NA	196,664	333,554
Liquefaction Facilities								
Kenai Peninsula Borough	21,437	20,831	17,226	NA	53,912	2,343	6,452	122,201
Kenai	5,178	7,000	4,934	952	NA	2,251	6,285	26,600
Soldotna	1,556	2,280	2,396	NA	NA	2,264	13,618	22,114
Municipality of Anchorage	28,141	241,935	59,175	56,613	240,240	NA	248,661	874,765

Sources: City of Anderson, 2015; City of Fairbanks, 2014; City of Kenai, 2014; City of Soldotna, 2014; Denali Borough, 2014; Fairbanks North Star Borough, 2016; Kenai Peninsula Borough, 2016; MSB, 2016; Municipality of Anchorage, 2016; Municipality of Nenana, 2014; and North Slope Borough, 2016a

NA = Not available

[a] The "Other" category includes $153.0 million in expenditures for capital projects and $173.1 million in expenditures for debt service.

As described previously in section 4.11.2, the majority of the increased economic activity, and thus the majority of the expected in-migration in excess of the construction workforce, would occur in the urban centers of Anchorage, Fairbanks, and the Kenai Peninsula. Therefore, the larger communities, which would be more capable of accommodating an additional increase in demand for community services and facilities, would be expected to incur the majority of these population change induced impacts. According to fiscal impact modeling completed by AGDC, the North Slope and Denali Boroughs are the only communities in the AOI expected to experience a negative impact on public services during construction. This is largely due to the difficulty of providing public services in such a remote area coupled with a cold climate. AGDC's population-based expenditure and revenue modeling predict that the fiscal position of the North Slope Borough would experience a 1-percent decline in overall fiscal position during construction, while the Denali Borough would experience a less than 1-percent decline in overall fiscal position during construction.

Impacts on local government revenues and expenditures during operation would be similar to those described for the construction phase. Municipalities that have a portion of the Project within its boundaries would experience the largest positive revenue impacts, though most communities in the state would benefit and would receive increased tax revenues.

As described in section 4.11.1.2, the operational workforce would locate to various communities throughout the AOI, the majority of whom would live in Fairbanks, Anchorage, the MSB, and the Kenai Peninsula Borough. The workers who relocate to the AOI because of job opportunities would presumably relocate their entire household. Because of this population increase and the in-migration generated by the increase in economic activity in the region, the demand for community services and facilities would expand as the local population rises. The increase in local government revenues, however, would more than offset any expected increases in expenditures.

4.11.5 Housing

4.11.5.1 Existing Housing Resources

The U.S. Census Bureau defines a housing unit as a house, apartment, group of rooms, or single room occupied or intended for occupancy as separate living quarters. Table 4.11.5-1 summarizes housing characteristics in the AOI. Table 4.11.5-2 provides data on the types of vacant units available in the AOI, including the number of vacant units for sale, rent, or seasonal, recreational, or occasional use. In 2016, an estimated 236,603 housing units were within the AOI, which is more than three quarters of the total 309,171 housing units in Alaska. Anchorage accounts for 48 percent (114,443 units) of the 236,603 total housing units in the AOI, while Fairbanks accounts for another 5 percent (12,550 units). In contrast, Denali Borough contains only 1,711 total housing units, and the North Slope Borough contains 2,550 total housing units (U.S. Census Bureau, n.d.[c,e]). Of the total housing units in the AOI, 83 percent were occupied compared to the state average occupancy rate of 81 percent (U.S. Census Bureau, n.d.[c,e]).

Of the 39,305 vacant housing units in the boroughs and census areas of the AOI in 2016, 4,611 were available for rent. Per the U.S. Census Bureau definition, a housing unit is vacant if no one is living in it at the time of the census interview, a definition which captures units for sale or rent, seasonal use units, and any other unoccupied units. The majority of the vacant units are seasonal, recreational, or occasional use such as hunting lodges/cabins. A small percentage (6 percent) of the vacant housing units are available for sale. Additional vacant units include those that are rented or sold but not occupied, units designated for migratory workers, and other types of vacant units. The majority of vacant housing units in the AOI are in the MSB (27 percent), the Kenai Peninsula Borough (24 percent), Anchorage (24 percent), and Fairbanks North Star Borough (16 percent). The majority of the housing units available for rent in the AOI are in Anchorage (46 percent), Fairbanks North Star Borough (29 percent), and Kenai Peninsula Borough (13 percent). Another 9 percent of the vacant housing units available for rent in the AOI are in the MSB, while about 1 percent are in the North Slope Borough, Yukon-Koyukuk Census Area, or Denali Borough. Temporary housing is available in the form of daily, weekly, and monthly rentals in motels, hotels, campgrounds, and RV parks, as shown in table 4.11.5-1 (U.S. Census Bureau, n.d.[c,e]; ADCCED, 2015).

In addition to traditional housing units, modular work camps are common housing solutions for oil and gas workers in Alaska since they are usually able to accommodate a variable number of employees and typically include both lodging and meals. About 14 companies offer modular work camps in Alaska. About 60 workforce camps exist in the AOI, providing a total estimated bed capacity of 3,400. Work camps range in size from 20 to 400 beds and generally include dormitories, a cafeteria, recreation rooms, and other amenities.

TABLE 4.11.5-1

General Housing Characteristics in the Socioeconomic Area of Interest

	Total Units (2016)	Number of Vacant Units (2016)	Percent of Vacant Units for Rent (2016)	Median Value of Owner Occupied Units ($) (2016)	Median Monthly Gross Rent ($) (2016)	Hotels/ Motels (2015)	RV Parks/ Campgrounds (2015)
Alaska	**309,171**	**58,936**	**10**	**257,100**	**1,173**	**NA**	**NA**
Gas Treatment Facilities							
North Slope Borough	2,550	532	12	154,100	1,057	NA	NA
Prudhoe Bay CDP	0	0	0	NA	NA	1	0
Mainline Facilities							
Yukon-Koyukuk Census Area	4,060	2,079	3	90,800	631	NA	NA
Coldfoot CDP	3	3	0	NA	NA	0	0
Livengood CDP	30	30	20	NA	NA	1	0
Nenana	215	71	6	93,800	608	2	1
Wiseman CDP	40	36	0	NA	NA	0	0
Fairbanks North Star Borough	41,670	6,367	21	224,000	1,240	NA	NA
Fairbanks	12,550	1,585	36	200,200	1,277	87	7
Denali Borough	1,711	1,004	1	228,600	933	NA	NA
Anderson	150	86	5	121,600	933	0	0
Cantwell CDP	206	111	2	156,300	850	9	1
Healy CDP	796	368	1	248,100	950	17	3
Denali Park CDP	324	219	0	330,000	1,104	0	0
Matanuska-Susitna Borough	41,417	10,578	4	230,100	1,079	NA	NA
Talkeetna CDP	669	325	12	152,100	1,016	32	4
Trapper Creek CDP	617	437	0	127,100	1,055	4	1
Willow CDP	1,908	1,193	1	150,300	1,178	5	5
Liquefaction Facilities							
Kenai Peninsula Borough	30,752	9,271	6	229,200	970	NA	NA
Beluga CDP	42	37	0	36,300	NA	0	0
Clam Gulch CDP	153	64	0	131,300	NA	3	0
Cohoe CDP	927	359	2	212,500	681	0	0
Cooper Landing CDP	393	211	0	375,500	NA	19	3
Happy Valley CDP	537	268	1	166,800	955	0	0
Kalifornsky CDP	3,651	756	10	235,100	1,205	0	0
Kasilof CDP	238	105	0	275,000	NA	3	4
Kenai	3,508	423	22	209,400	899	23	4
Nikiski CDP	2,111	341	13	200,300	1,210	7	0
Ninilchik CDP	940	581	1	175,000	904	19	5
Salamatof CDP	312	71	8	208,900	786	0	0
Soldotna	1,892	196	29	223,000	1,019	54	14

TABLE 4.11.5-1 (cont'd)							
General Housing Characteristics in the Socioeconomic Area of Interest							
	Total Units (2016)	Number of Vacant Units (2016)	Percent of Vacant Units for Rent (2016)	Median Value of Owner Occupied Units ($) (2016)	Median Monthly Gross Rent ($) (2016)	Hotels/ Motels (2015)	RV Parks/ Campgrounds (2015)
Sterling CDP	3,273	1,222	0	285,000	998	9	6
Tyonek CDP	150	71	7	26,700	767	1	0
Municipality of Anchorage	114,443	9,474	23	298,000	1,231	140	11

Sources: U.S. Census Bureau, n.d.[c,e]; ADCCED, 2015
NA = Not available; 0 = No visitor accommodations were identified.

4.11.5.2 General Impacts and Mitigation

As described in section 4.11.2, the majority of construction workers would be required to live in work camps while on-duty (see section 2.1 for a description of work camps). Construction workers in the Kenai Peninsula Borough would be exempted from living in work camps, but this exemption would largely apply to local workers already living in existing housing within commuting distance of the Liquefaction Facilities. Workers relocating to the area would not be allowed to purchase or rent housing in the local community. Workers assigned to offices in the Anchorage area would live in the local community, not work camps. Those workers recruited from outside the area would require short-term housing in Anchorage or the MSB. However, the increased demand for housing would be minor and temporary and would not substantially affect the overall housing availability in Anchorage or the MSB since the increased demand would be small relative to the housing availability in these areas.

Workers migrating to Alaska could increase the demand for temporary housing such as rental properties, hotel/motel rooms, and RV campsites. The majority of these workers would seek housing in or near the municipalities of Anchorage or Fairbanks. In addition to being the largest population centers, Anchorage and Fairbanks are home to the state's construction union hiring halls. Based on an estimate made by ADGC, up to 19,200 people would migrate to Alaska for job opportunities created by the Project. Of these, a projected 9,820 people would migrate to Anchorage and a projected 1,530 people to the Fairbanks North Star Borough at its peak (see table 4.11.1-5).

AGDC states that Project personnel responsible for transporting construction materials and equipment to Project worksites could elect to temporarily stay in hotels or motels if not in their trucks or in the Project work camps. At peak employment in Year 4, 1,080 workers would be required to transport construction materials and equipment throughout the AOI. Since not all logistic personnel would require temporary housing in overnight accommodations in the same area at the same time, the availability of overnight accommodations in the AOI would not be significantly affected.

Table 4.11.5-3 shows the potential increased demand for housing units by indirect and/or induced workers during construction as estimated by AGDC. The increase in demand for housing could temporarily reduce vacancy rates in the AOI. In the affected boroughs, the maximum number of additional housing units demanded could range from 10 units in the Denali Borough and the Yukon-Koyukuk Census Area to 3,570 units in Anchorage, according to AGDC's modeling. In instances where construction occurs in rural areas, such as Denali Borough and the Yukon-Koyukuk Census Area, AGDC would house nearly all Project-related personnel in construction camps, and there would be little indirect or induced population growth. Therefore, the existing supply of housing would likely be sufficient to meet the expected increase in demand in most of these areas.

TABLE 4.11.5-2

Vacant Housing in the Socioeconomic Area of Interest (2016)

	Number of Vacant Units	Number of Vacant Units for Sale	Number of Vacant Units for Rent	Number of Vacant Units for Seasonal, Recreational, or Occasional Use	Number of Additional Vacant Units [a]
Alaska	**58,936**	**3,037**	**6,067**	**30,711**	**19,121**
Gas Treatment Facilities					
North Slope Borough	532	0	66	179	287
Prudhoe Bay CDP	0	0	0	0	0
Mainline Facilities					
Yukon-Koyukuk Census Area	2,079	27	55	1,235	762
Coldfoot CDP	3	0	0	3	0
Livengood CDP	30	3	6	15	6
Nenana	71	5	4	35	27
Wiseman CDP	36	0	0	21	15
Fairbanks North Star Borough	6,367	362	1,325	2,382	2,298
Fairbanks	1,585	86	578	177	744
Denali Borough	1,004	45	11	691	257
Anderson	86	3	4	28	51
Cantwell CDP	111	13	2	62	34
Healy CDP	368	24	5	239	100
Denali Park CDP	219	0	0	197	22
Matanuska-Susitna Borough	10,578	584	433	7,264	2,297
Talkeetna CDP	325	7	39	191	88
Trapper Creek CDP	437	3	0	413	21
Willow CDP	1,193	57	15	976	145
Liquefaction Facilities					
Kenai Peninsula Borough	9,271	463	585	5,927	2,296
Beluga CDP	37	0	0	26	11
Clam Gulch CDP	64	3	0	46	15
Cohoe CDP	359	8	6	253	92
Cooper Landing CDP	211	8	0	182	21
Happy Valley CDP	268	5	3	214	46
Kalifornsky CDP	756	47	76	383	250
Kasilof CDP	105	0	0	20	85
Kenai	423	64	95	122	142
Nikiski CDP	341	52	44	137	108
Ninilchik CDP	581	21	6	472	82
Salamatof CDP	71	9	6	22	34
Soldotna	196	0	56	87	53
Sterling CDP	1,222	96	0	936	190
Tyonek CDP	71	5	5	30	31
Municipality of Anchorage	9,474	996	2,136	1,986	4,356

Source: U.S. Census Bureau, n.d.[e]

[a] The number of additional vacant units includes the sum of vacant housing units categorized by the U.S. Census Bureau as rented, not occupied; sold, not occupied; for migratory workers; and other vacant.

TABLE 4.11.5-3

Estimated Increase in Demand for Housing Units for Indirect/Induced Workers During Construction

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
	Number of Units							
Gas Treatment Facilities								
North Slope Borough	20	30	50	60	60	60	60	60
Mainline Facilities								
Yukon-Koyukuk Census Area	0	10	10	10	10	10	0	0
Fairbanks North Star Borough	100	230	340	460	520	560	550	520
Denali Borough	0	0	0	0	10	10	0	0
Matanuska-Susitna Borough	380	760	1,100	1,440	1,690	1,940	2,060	2,100
Liquefaction Facilities								
Kenai Peninsula Borough	120	250	320	420	500	580	640	670
Municipality of Anchorage	820	1,640	2,260	2,900	3,250	3,570	3,570	3,370

In more urban areas that would be expected to receive the majority of the additional residents as a result of indirect and/or induced activities, such as Fairbanks and MSB, there is the possibility that Project-related population growth could lead to competition for vacant housing units. AGDC's modeling predicts the influx of new residents to the area could affect housing availability and affordability in the region, with the largest effect occurring in the MSB. The excess demand could create a substantial increase in rental rates and homeowner property prices during construction. Some low-income residents could become priced out of the market. However, should the Project construction start date become certain, we expect the housing providers in the area would expand capacity in anticipation of the opportunity, thus alleviating the pressure. As construction is completed, the economic stimulus generated by the Project would decline and the demand for housing would stabilize or decline.

As described previously, Project operation would require about 980 additional permanent, full-time staff. Of these 980 workers, a large portion would likely relocate to the region, along with their households, as a direct result of the Project. Additionally, as discussed in section 4.11.1.2, the results of AGDC's modeling indicate that additional people would likely relocate to the region, along with their households, as an indirect result of the Project through induced/indirect jobs and increased government spending. Total population in the AOI would increase by about 14,930 people from indirect and induced employment opportunities that would be generated during Project operation. Most of these people would move to existing population centers, such as Anchorage, the MSB, Fairbanks North Star Borough, and the Kenai Peninsula Borough. The additional population, when compared to the overall size of the regional housing market, would be small and not affect housing demand or supply in the region. Therefore, there would not be a significant change in the housing demand or supply in the region because of Project operation.

4.11.5.3 Facility-Specific Impacts and Mitigation

Gas Treatment Facilities

Construction crews in the North Slope Borough would be housed in the Project camps. During the short duration before the construction camp is set up, a small temporary Pioneer Camp would be opened that would house the staff involved in setting up the larger, more permanent construction camp. Additional staff could be housed in other work camps in the Prudhoe Bay CDP as well. Therefore, Gas Treatment

Facilities construction would not have an impact on the demand or supply of housing in the North Slope Borough or elsewhere in the region.

Non-local Project management staff and suppliers on temporary visits could choose not to stay in the construction camp. These and additional staffing for Project subcontractors and suppliers could result in additional demand for temporary housing, such as hotels, in the North Slope Borough. As shown on table 4.11.5-3, an estimated 60 additional housing units could be required in the borough at peak construction levels. This increase in demand would be concentrated in communities near the Gas Treatment Facilities, such as Deadhorse, whose housing stock is almost entirely dedicated to the oil and gas industry. Given the vast distances between communities in the North Slope Borough and the difficulties associated with commuting, it is unlikely that an increase in the demand for housing near the Gas Treatment Facilities would have a substantial impact on the supply and price of housing paid by residents in the region. Hotel availability and affordability could be affected in the areas near the Gas Treatment Facilities, but these impacts would almost entirely affect oil and gas companies and their suppliers, not local residents. In addition, this impact would be temporary. Once construction is complete, housing demand would be expected to return to pre-construction levels.

As described previously in section 4.11.1.2, about 110 operational and maintenance workers would be employed at the Gas Treatment Facilities and reside at the operations camp at any one time. Since housing would be provided, impacts on the local housing market in the North Slope Borough would not be expected.

Mainline Facilities

As described previously, temporary work camps would house Alaska residents and non-resident construction workers employed to build the Mainline Facilities. The camps would be fully self-sustaining and would be throughout the construction area. Therefore, additional demands would not be placed on temporary housing in the local area.

The non-local Project management staff and individuals attracted to the region for economic reasons would create an increase in demand for housing in the region. For the more remote areas, such as the Yukon-Koyukuk Census Area and Denali Borough, this increase would be minor. The impact on the Fairbanks North Star and the MSBs would be greater as the additional residents would likely gravitate to populous areas.

Table 4.11.5-3 shows the expected increase in demand for housing units by borough and year during construction, as predicted by AGDC. At its peak, according to the modeling, 560 additional housing units would be required in the Fairbanks North Star Borough, and 2,100 additional housing units would be required in the MSB. These increases in demand would represent a significant proportion of all vacant units available for rent or sale in the Fairbanks North Star Borough and MSB. This additional demand could place pressure on prices and availability. However, as supply increases and more housing units are built to accommodate the population influx, pressure on prices and availability would decline.

As described in detail in section 4.11.1.2, operation and maintenance of the Mainline Facilities would employ about 225 on-site workers with an additional 105 support staff based in Anchorage. Due to the nature of the work, the majority of the on-site workers would reside on site near the Mainline Facilities or around the regional field office in Fairbanks. Local labor would be used to the maximum extent practicable; however, non-local workers would relocate to fill these jobs. Given the small number of on-site operational jobs created and the small number of personnel likely to relocate to fill these jobs, the total impact on the regional housing market would be minor during operation. The existing housing stock would be sufficient to handle the expected increased demand for housing created by this influx of operational personnel.

Liquefaction Facilities

Liquefaction Facilities construction in the Kenai Peninsula Borough would create a short-term increase in the demand for temporary housing throughout the region, but this increase in demand would be temporary until a construction camp is built and available at the site. The construction camp would house up to 5,000 workers.

Until construction of the camp and associated facilities is completed, fewer than 300 workers would need housing in the local community. These workers would increase the demand for temporary housing, including hotel/motel rooms and rental properties in the area, until the camp is operational. Rental property owners and hotel/motel owners would benefit as vacancy rates would decrease. However, visitors would experience additional competition for existing hotel/motel rooms and rental properties.

The indirect or induced population influx associated with the Project would increase the demand for housing in the region and reduce the vacancy rates throughout the area. At peak, an estimated 670 additional housing units would be required in the Kenai Peninsula Borough during construction (see table 4.11.5-3). This increased demand for housing represents more than two-thirds of the total vacant units available for rent or sale in 2016. As described above, this increase in demand would lead to a decrease in housing availability and affordability that should be alleviated as supply increases and more housing units are built to accommodate the population influx.

Liquefaction Facilities operation would have a minor impact on the housing market in the Kenai Peninsula Borough. An estimated 240 staff at the Liquefaction Facilities would reside off-site in the local community (see section 4.11.1.2). About half or 120 of these staff would reside in the Kenai Peninsula Borough, while the remaining 120 workers would reside elsewhere in other south-central Alaska communities. An additional 70 support workers would reside in Anchorage. Because the operational jobs would be permanent, it is likely that the staff would find permanent owner-occupied or rental housing. As described above, the Kenai Peninsula Borough has an estimated 30,752 housing units. The increase of 120 workers would represent 0.4 percent of the total housing stock. Therefore, the impact on the housing market would not be significant during operation.

4.11.5.4 Property Values

We evaluated potential property value effects from construction and operation of the Liquefaction and Mainline Facilities. We concluded that the Gas Treatment Facilities would not affect property values because of the absence of nearby residential properties other than structures associated with existing oil and gas-related developments.

Mainline Facilities

For purposes of the property value assessment, the primary contributing components of the Mainline Facilities are the nine compressor stations and the Mainline Pipeline. As presented in section 4.16.4, only the Healy and Coldfoot Compressor Stations are within 1 mile of a residence, and in both instances, only one residence would be within 1 mile of the station.

Property value studies regarding industrial facilities are relevant to the evaluation of effects from the aboveground compressor stations on residential properties, though they are comparatively small-scale. The main criteria derived from these studies are equally relevant to compressor stations; compressor station proximity, noise, appearance, context, and health and safety attributes would all factor into the likelihood of construction and operation resulting in property value effects.

Potential visual impacts from the Healy and Coldfoot Compressor Stations on the nearby residences could include changes to the viewshed and artificial lighting (see section 4.10.2). To minimize impacts, AGDC would follow a Project Lighting Plan. Additionally, an increase in ambient noise from operation of the compressor stations would be perceptible to the nearby residences. While the residence near the Coldfoot Compressor Station would not likely experience a noticeable increase in existing noise levels at the nearby residence, noise levels at the residence near the Healy Compressor Station could experience a greater effect (see section 4.16.4). We have made a recommendation in section 4.16.4 that AGDC file a noise survey for the Healy Compressor Station soon after the in-service date and install any additional noise controls, if needed, to confirm compliance.

AGDC's design for compressor station construction and operation meet state and federal air emissions standards (see section 4.15). Construction emissions are typically evaluated up to 0.25 mile from the construction site, beyond which emissions dissipate to negligible. The nearest residences to each compressor station are at least 0.5 mile away; therefore, potential health effects on residents from the air emissions would be negligible.

While it is possible that the construction and operation of the Healy and Coldfoot Compressor Stations could affect the property values of the two nearby residences based primarily on visual or noise impacts, we would not expect a significant reduction in their property values given the mitigation incorporated into AGDC's compressor station design, adherence to the Project Lighting Plan, the distance of the residences from the compressor stations, and our own recommended mitigation measures.

The Mainline Pipeline route is proposed in primarily unpopulated, rural regions of the state, but it does pass within 200 feet of approximately six residences, as shown in section 4.9.1. The potential for property value effects from pipelines would be much more limited than the components evaluated thus far. Pipelines, themselves, do not generate noise or emissions, and in most regions, pipelines are buried underground, minimizing any permanent visual impact. Segments of the Mainline Pipeline that would remain aboveground would be limited to the region of tundra terrain, where residences and other non-industrial properties would not be located.

We have conducted independent research and acknowledge that it would be reasonable to expect that property values could be affected differently based on the setting and inherent characteristics of each property. Based on the research we have reviewed, however, we find no conclusive evidence indicating that natural gas pipeline easements or compressor stations would have a significant negative impact on residential property values, although this is not to say that any one property may or may not experience an impact on property value for either the short or long term.

Liquefaction Facilities

The site of the Liquefaction Facilities in the community of Nikiski is adjacent to existing industrial facilities, including the former ConocoPhillips Kenai LNG Plant that began operation in 1969. According to the Kenai Peninsula Borough Comprehensive Plan, the Nikiski industrial area is one of the largest industrial complexes in the state, with developments largely concentrated in the petrochemical industry (Kenai Peninsula Borough, 2005). Due south of the Liquefaction Facilities is the community of Salamatof. The majority of the site is wedged among and alongside properties that have been developed as industrial or accessory uses; much of the site, itself, is currently undeveloped.

The economic, fiscal, and environmental conditions in a community, as well as mitigation measures associated with a project, lead to varying effects, including no effect, on neighboring property values (Gabe et al., 2005). To investigate potential effects from the terminal on the values of nearby properties, we identified studies that assessed similar kinds of industrial development. In the case of Cove Point LNG, commissioned in 1978 in Maryland, 323 of 377 homes within 1 mile of the facility were built after commissioning (Maryland Department of Natural Resources, 2014). This indicates that land in proximity to the Cove Point LNG terminal has maintained value sufficient to encourage new development. In the case of Cove Point LNG, the terminal was partially screened from residential properties by forest cover and topography.

In a study of fossil fuel power plants constructed in the 1990s in neighborhoods across the United States, housing units within 2 miles of newly commissioned power plants were found to experience a minor decrease (3 to 5 percent) in rents and mortgages compared with housing 2 to 5 miles away (Davis, 2010). The transferability of this finding to the Alaska LNG Project is limited because power plants may be perceived as more undesirable local land uses than LNG storage facilities and terminals (Gabe et al., 2005).

One peer-reviewed study found that housing values were higher near LNG facilities than elsewhere, all other variables being equal (Clark and Nieves, 1994). In yet another study prepared for residents in the town of Harpswell, Maine, a consulting group interviewed local realtors and concluded that proximity to an LNG terminal would depress residential property values up to 2 miles away from the Project boundary (Yellow Wood Associates, Inc., 2004). Finally, a composite study that examined peer-reviewed studies of different types of industrial developments such as landfills, Superfund sites, nuclear power plants, and large manufacturing facilities did not find a consistent trend characterizing how these industrial uses affected property values (Regional Economic Studies Institute of Towson University, 2004).

Although studies to date are sometimes contradictory or inconclusive, the consensus seems to be that proximity is a chief factor influencing whether a facility could affect property values, and that properties beyond 2 miles are too far away to experience measurable property value impacts (e.g., Maryland Department of Natural Resources, 2014; Davis, 2010; Gabe et al., 2005; Yellow Wood Associates, 2004). The closest residences to the Liquefaction Facilities are 10 residences within the LNG Plant footprint (including property and workspaces) (see section 4.9.1). AGDC would purchase these residential land holdings and remove the residences prior to construction. Several other residences in the communities of Nikiski and Salamatof are within 2 miles of the LNG Plant footprint. The closest residences outside the footprint are in the community of Salamatof, which begins approximately 0.4 mile south of the Liquefaction Facilities workspace.

Perception is another key factor that indicates whether a new development would affect property values, and so we considered the context of the Liquefaction Facilities and their aesthetic and health impacts. The oil and gas industry in the Kenai Peninsula Borough is mature, and related developments are prevalent. The Nikiski industrial area is one of the largest in the state, and the proposed site of the Liquefaction Facilities is in a designated industrial land use area, according to the Kenai Peninsula Borough Comprehensive Plan (Kenai Peninsula Borough, 2005). Thus, local perception of the Liquefaction Facilities would be influenced by community members' familiarity with other oil and gas-related infrastructure and by the siting of the facility near other industrial facilities. Appearance and noise also influence perception of an industrial facility, and these factors were evaluated in sections 4.10 and 4.16.

Our visual impact assessment in section 4.10.2 concluded that the Liquefaction Facilities would have low to moderate visual impacts on existing residences and business establishments, similar to impacts that would be expected from any new development in this industrial land use area. As discussed in section 4.16.3, construction noise would likely be audible in nearby residential areas. We are recommending that AGDC file a construction noise mitigation plan for the Liquefaction Facilities (see section 4.16.3). During operation, noise attributable to Liquefaction Facilities would be lower than FERC's sound level thresholds at the nearest noise sensitive areas (typically residences), particularly because of the noise mitigation measures AGDC incorporated into the design, including acoustic walls around on-site turbines and compressors (see 4.16.4). Perceived health risks could also factor into property values of nearby residences. However, we evaluated the air emissions and safety procedures and found that construction and operation of the Liquefaction Facilities would meet state and federal air quality and safety standards (see sections 4.15 and 4.18). Based on the evidence described above, we conclude that the Liquefaction Facilities would not likely have a significant adverse effect on residential property values.

4.11.6 Public Services

The following section describes public services and facilities in the AOI, including schools, law enforcement, fire protection, and utilities such as electricity and heating, solid waste disposal, sewage treatment, and drinking water. Due to the nature of these resources, the affected areas vary by the type of community service assessed and do not correspond exactly to the AOI used for the broader socioeconomic analysis. A wide range of public services and facilities are provided across the AOI, with a higher concentration of services in the larger cities such as Anchorage and Fairbanks.

4.11.6.1 Schools

Existing Educational Resources

Eight school districts are in the AOI, with 247 total schools and a total average daily membership (attendance) of 92,980 students in 2015 (see table 4.11.6-1). According to the Alaska Department of Education and Early Development (Alaska DEED) (2015), average daily membership is the average number of enrolled students during a 20-school-day count period in October.

In addition to traditional public schools, a number of students in Alaska, particularly those who live in remote areas without convenient access to school facilities, attend correspondence schools or other forms of distance learning for all or a portion of the time. The total average daily membership for correspondence schools was estimated to be about 11,120 students in 2016, or 10 percent of total average daily membership in Alaska (Alaska DEED, 2015).

Impacts and Mitigation

As described previously, the use of closed construction camps would significantly reduce the potential influx of dependents to the construction areas. With the exception of a few workers in Anchorage and the Kenai Peninsula, all construction workers would be required to reside in construction camps until their rotation is complete, thus reducing the incentive for families to relocate near construction sites. In addition, as shown in table 4.11.1-5, indirect and induced population growth during construction would be limited primarily to Anchorage, Fairbanks, and the Kenai Peninsula and the MSBs. Therefore, Project construction would not create a substantial increase in-migration of school-aged children to the majority of the AOI. Anchorage, Fairbanks, and the Kenai Peninsula and MSBs could experience some increase in the number of students. However, this impact would not be significant.

According to the AGDC modeling, indirect and induced population growth from associated activities would temporarily increase the population of Anchorage by 3 percent, the MSB by 5 percent, the Fairbanks North Star Borough by 2 percent, and the Kenai Peninsula Borough by up to 3 percent compared to 2017 levels (see table 4.11.1-5). A small percentage of the construction workforce and economic in-migrants would move their families to the area. Use of public schools from the estimated changes in population during construction would be temporary and negligible to minor, since students would be enrolled over many schools throughout the Anchorage, MSB, and Fairbanks North Star Borough School Districts. The impact from additional students to the Kenai Peninsula School District during Project construction would be minor. Additional funding by state and local governments could be required, but the increase in funding would be minor.

TABLE 4.11.6-1

Characteristics of School Districts in the Area of Interest (2015)

	Total Number of Schools	Average Daily Membership [a]	Student to Teacher Ratio	Percentage of School Facility Capacity Used
Gas Treatment Facilities				
North Slope Borough School District	11	1,739	11:1	33
Mainline Facilities				
Yukon-Koyukuk Census Area				
Yukon-Koyukuk School District	10	1,456	28:1	29
Fairbanks North Star Borough				
Fairbanks North Star Borough School District	35	13,770	17:1	75
Denali Borough				
Denali Borough School District	4	890	34:1	27
Nenana City School District	2	978	46:1	49
Matanuska-Susitna Borough				
Matanuska-Susitna Borough School District	45	17,757	20:1	84
Liquefaction Facilities				
Kenai Peninsula Borough				
Kenai Peninsula Borough School District	43	8,828	15:1	62
Municipality of Anchorage				
Anchorage School District	98	47,562	17:1	84

Sources: Alaska DEED, n.d.(a,b,c)

[a] Average daily membership is the average number of enrolled students during the 20-school-day count period, which ends on the fourth Friday of October.

[b] Revenue per average daily membership excludes State of Alaska Public Employees' Retirement System and Teachers' Retirement System payments.

Project operation would have a negligible impact on the North Slope Borough School District. Because only 170 workers are required to operate facilities in the North Slope Borough, and these workers would reside in the operations camps without their dependents, no increase in the population of school-age children would occur. Maintenance and operational workers migrating from outside the Project area could permanently increase the population of Anchorage and the MSB by about 345 workers and the Fairbanks North Star Borough by about 225 workers. A percentage of the operational workforce and economic in-migrants would move their families to the area. Due to the existing school districts in these areas, use of public schools from the estimated changes in population during operation would be minor, since students would enroll in many schools and grades throughout the Anchorage, MSB, and Fairbanks North Star Borough School Districts.

Operational and maintenance workers at the Liquefaction Facilities would increase the population of the Kenai Peninsula Borough by an estimated 240 workers. The majority of the maintenance and operational workforce would move their families to the area. In addition, the population in the borough would also experience an increase as a result of the indirect and induced effects of the Project. If all of the additional households are assumed to have school-age children, the increase in the student population during operation could be significant. Though these increases would not be expected to result in the need for more schools, classroom sizes could increase, which could result in higher student-to-teacher ratios. This could result in the need for additional teachers and the addition of portable classrooms.

4.11.6.2 Police and Fire Protection Services

Existing Police and Fire Protection Services

As shown in table 4.11.6-2, a wide range of police and fire protection services are available in the AOI. However, law enforcement in most rural areas of Alaska is primarily the responsibility of the Division of Alaska State Troopers under the Alaska Department of Public Safety. (Alaska Department of Public Safety, 2014a). In many communities around the state, and particularly in rural areas, Village Public Safety Officers (VPSO) assist law enforcement with fire protection, search and rescue, emergency medical assistance, crime prevention, and basic law enforcement. VPSOs are employed by non-profit organizations associated with the Alaska State Troopers. Much of the AOI is covered by either Alaska State Troopers or VPSOs. Alaska State Troopers respond to emergencies and criminal activity as quickly as they can; however, their response time is sometimes hampered by weather, long distances, or other delays. In the Mainline Facilities region, Nenana, Fairbanks, Anchorage, and Tanacross have VPSOs. The remainder of the Mainline Facilities region is covered by Alaska State Trooper posts in Coldfoot, Fairbanks, Nenana, Healy, and Wasilla. Additionally, the Project area is covered by emergency 911 service, but dispatch centers may be insufficiently staffed.

While a few communities and boroughs in the Project area have fire departments staffed with career firefighters, volunteer firefighters provide these services in most Alaska communities. Because of the amount of federal land in Alaska, wildland fire management in the state is an interagency effort operating at the Interagency Coordination Center at Fort Wainwright near Fairbanks. The interagency effort involves the BLM Alaska Fire Service, ADNR Division of Forestry, and the USFS. Additionally, the Alaska Interagency Coordination Center provides coordination and support for all-hazard emergency response activities for federal landholding agencies in Alaska (Alaska Interagency Coordination Center, 2014).

Impacts and Mitigation

Comments from Alaska Natives expressed concern that the increase in population from construction could result in a temporary increase in anti-social behavior, including crimes against persons and property. During construction, work camps would be self contained and AGDC would employ private camp security. Camp security staff would be responsible for tracking, sorting, and implementing daily transits to and from the camps during rotations, demobilizations, and mobilizations; and for securing the camp perimeter from unauthorized entry or exit. In addition, hiring procedures, training, screening, and camp rules would be implemented to reduce issues of workplace and community illegal activities. Since construction camps would use private security and have no direct impact on the population size of local communities, the direct impact on local police and fire services would be minor.

TABLE 4.11.6-2 **Police and Fire Protection Services in the Area of Interest**					
	Local or Borough Police Department	Village Public Safety Officer	Alaska State Trooper Post	Nearest Law Enforcement Facility	Local or Borough Fire Department
Gas Treatment Facilities					
North Slope Borough					
Prudhoe Bay CDP	Yes	No	No	North Slope Borough Police Department	Yes
Mainline Facilities					
Yukon-Koyukuk Census Area					
Coldfoot	No	No	Yes	Coldfoot State Troopers Post	No
Livengood	No	No	No	Fairbanks State Troopers Post	No
Nenana	No	Yes	Yes	Nenana State Troopers Post	Yes
Wiseman	No	No	No	Fairbanks State Troopers Post	No
Fairbanks North Star Borough					
Fairbanks	Yes	Yes	Yes	Fairbanks State Troopers Post	Yes
Denali Borough					No
Anderson	No	No	No	Nenana State Troopers Post	Yes
Cantwell	No	No	Yes	Cantwell State Troopers Post	Yes
Healy	No	No	Yes	Healy State Troopers Post	Yes
Denali Park	No	No	No	Healy State Troopers Post	Yes
Matanuska-Sustain Borough					No
Talkeetna	No	No	Yes	Palmer/Mat-Su West Alaska State Troopers Post	Yes
Trapper Creek	No	No	No	Wasilla State Troopers Post	Yes
Willow	No	No	No	Wasilla State Troopers Post	Yes
Liquefaction Facilities					
Kenai Peninsula Borough					No
Beluga	No	No	No	Soldotna State Troopers Post	No
Clam Gulch	No	No	No	Soldotna State Troopers Post	No
Cohoe	No	No	No	Soldotna State Troopers Post	No
Cooper Landing	No	No	Yes	Cooper Landing State Troopers Post	Yes
Happy Valley	No	No	No	Ninilchik State Troopers Post	No
Kasilof	No	No	No	Soldotna State Troopers Post	No
Kenai	Yes	No	No	Soldotna State Troopers Post	Yes
Nikiski	No	No	No	Soldotna State Troopers Post	Yes
Ninilchik	No	No	Yes	Ninilchik State Troopers Post	Yes
Ninilchik ANVSA	No	No	No	Ninilchik State Troopers Post	Yes
Salamatof	No	No	No	Soldotna State Troopers Post	Yes
Seward	Yes	No	Yes	Seward State Troopers Post	Yes
Soldotna	Yes	No	Yes	Soldotna State Troopers Post	Yes
Sterling	No	No	No	Soldotna State Troopers Post	Yes

TABLE 4.11.6-2 (cont'd) **Police and Fire Protection Services in the Area of Interest**					
	Local or Borough Police Department	Village Public Safety Officer	Alaska State Trooper Post	Nearest Law Enforcement Facility	Local or Borough Fire Department
Tyonek	No	No	No	Soldotna State Troopers Post	Yes
Anchorage	No	No	No	Anchorage Police Department and State Troopers Regional Post	Yes
Sources: Alaska Department of Public Safety, 2014b, 2014c; Collins, 2014 ANVSA = Alaska Native Village Statistical Area					

According to AGDC's Health Impact Assessment (HIA), the presence of work camps and outside workers have the potential to exacerbate social problems or impact mental health of local communities (see appendix V). These camps and outside workers could result in increased anxiety and stress related to real and perceived safety issues, which in turn can be associated with higher rates of substance abuse and domestic violence. The potential impact on households would be minor and could be alleviated with support from community, regionally-based, and existing federal support of native health and public health programs. According to demographic modeling completed by AGDC, the Project could lead to indirect and induced workers migrating from outside the Project area who would increase the populations of Anchorage, the MSB, the Fairbanks North Star Borough, and the Kenai Peninsula Borough during operation from between 2 to 5 percent over 2017 populations (see table 4.11.1 5). A percentage of the maintenance and operational workforce and economic in-migrants would move their families to the area. An increase in crime proportionate to the increase in population would be expected.

Impacts on police and fire services from migrating workers during construction and operation would be minor in communities with high levels of law enforcement, such as Anchorage. However, communities such as Kenai have limited resources, such as police officers and patrol cars, and may struggle to handle an increase in crime.

4.11.6.3 Construction Materials

The following section describes availability of construction materials expected to be sourced within the State of Alaska within the AOI.

Existing Construction Material Resources

<u>Gravel / Granular Material</u>

The State of Alaska has an abundant supply of sand and gravel, or granular material, and has produced over 1.3 billion tons over the last 125 years. Once one of the largest providers of sand and gravel behind only California, Alaska produced over 67 million metric tons of sand and gravel at its peak in 1976 (USGS, 2018a). In 2015, just 8.9 million metric tons of sand and gravel for construction was produced in Alaska, valued at $77.5 million (USGS, 2018a). Production of sand and gravel in Alaska has generally been a reflection of economic conditions and construction demand (McDowell Group, 2018). In 2016, Alaska had 120 active gravel operations (McDowell Group, 2018). The U.S. Census indicated Alaska had 29 construction sand and gravel mining businesses that employed 190 workers in 2016 (U.S. Census, 2016b).

Wood/Timber

Alaska has over 12 million acres of forested land, over 73 percent of which are on federal lands (USDA, 2019a). Commercial logging has historically taken place in the Tongass National Forest. However, the amount of land managed for timber production has been reduced gradually by the USFS from 5 million acres in 1976 to approximately 300,000 acres in 2016 (Resource Development Council, n.d.). The U.S. Census indicated Alaska had 30 forestry and logging businesses that employed 215 workers in 2016 (U.S. Census, 2016b).

Diesel Fuel

Diesel fuel is used for both transportation and electricity generation in Alaska. Many of the isolated rural communities in Alaska are not connected to the electrical grid and rely on diesel-fueled generators for some or all of their electricity (U.S. Energy Information Administration, 2018a). Approximately 277,000 gallons per day of ultra-low sulfur diesel was sold in Alaska in 2018 (US Energy Information Administration, 2018b). Petro Star Refinery in Valdez and Tesoro Refinery in Kenai have a combined excess idle ultra-low sulfur diesel capacity of 11 million gallons per month.

Waste Management

Solid waste management in Alaska is regulated by the EPA, ADEC, and local jurisdictions. The Alaska SWP regulates municipal solid waste landfills and other solid waste disposal facilities associated with oil and gas development, mining, timber, construction, fishing, and tourism industries (see section 4.9.6). There are four existing, regulated, non-hazardous waste disposal facilities in the Project area: Oxbow Landfill (Prudhoe Bay), Fairbanks Landfill, Anchorage Regional Landfill, and the Central Peninsula Landfill (Soldotna). Within the AOI, solid waste is also hauled to a local landfill in the closest community (Colt et al., 2003).

Impacts and Mitigation

Granular fill would be required during construction of Project components, including for base material for aboveground facility pads, temporary construction facilities (e.g., work pads), access roads, and other uses. The Project would require a total of approximately 32 million cubic yards (45 million metric tons) of granular fill during the 8 years of construction, including 4.7 million cubic yards for the Liquefaction Facilities, 8.8 million cubic yards for the Mainline Pipeline work pad, and 6.9 million cubic yards for the GTP.

The amount of granular material required for Project construction would represent a large portion of granular material produced in the State of Alaska in 2015 and could result in periodic shortages or an increase in prices until production is able to match demand. To reduce the likelihood of shortages, AGDC would obtain granular material from both existing sites and new sites developed specifically for the Project. The majority of granular fill for the Liquefaction Facilities would be obtained on site, while some additional fill to be used for concrete would be sourced from multiple quarries within 20 miles of the site. AGDC identified 149 new and existing locations in Alaska containing an estimated 90 million cubic yards of granular fill as potential sources for the Project. Additionally, AGDC would develop a new Project gravel mine southwest of the GTP site that would provide the majority of granular fill for the GTP. Table C-8 in appendix C lists the primary and alternate sites for granular material along with the estimated quantities available. Based on the estimated amount of granular material available at identified sites, sufficient granular material exists in Alaska for the Project.

During construction, timber construction mats would be used to cross inundated wetlands, and additional timber may be used for leveling and drainage of camp modules. Depending on the amount of timber required, some shortages or increases in timber prices could occur. Where feasible, AGDC would salvage timber cleared in the right-of-way for Project use. AGDC has determined that the majority of the trees within the right-of-way would not be appropriate for use as construction mats; however, trees within the right-of-way could be used for support under pre-fab mats or where heavy vehicle use is not required. If insufficient timber is available in Alaska for Project use, additional timber could be imported from the lower 48 states.

During construction, diesel fuel would be used for construction vehicles and equipment, as well as for power generation at construction camps. The Project would require about 7 million gallons of ultra-low sulfur diesel per month at peak demand across all facilities during construction. The amount of ultra-low sulfur diesel fuel required for Project construction would represent over 80 percent of the ultra-low sulfur fuel sold in Alaska in 2018. However, the Project demand for ultra-low sulfur diesel would be within the excess capacity at the Petro Star Refinery in Valdez and the Tesoro Refinery in Kenai. During summer months, when in-state demand for ultra-low sulfur diesel fuel peaks in Alaska, additional fuel could be shipped from other states as needed. Additional ultra-low sulfur diesel distribution resources and infrastructure, such as storage tanks, would be required in the Project area.

As described in detail above, Project construction would generate a major increase in the demand for granular material, timber, and diesel fuel in the AOI and throughout Alaska as a whole. The existing supply of these materials would not be sufficient to accommodate the Project and existing customers. Shortages, at least in the short term, would occur. Prices would increase as there would be more competition for limited resources. Existing users could be affected as raw materials would become more scarce and associated costs could increase. However, suppliers would likely respond to the increased demand by producing or sourcing more granular material, timber, and diesel fuel in the AOI, bringing supply back up and prices back down. The long planning time associated with the Project would also help reduce some of the supply issues associated with Project construction. Suppliers would receive a substantial amount of notice concerning the expected increase in demand for their commodities and would be able to increase production accordingly.

During operation, heating and power generation for the Gas Treatment, Mainline, and Liquefaction Facilities would principally be supplied by the natural gas processed and transported by the Project. However, diesel fuel would be used for transportation and emergency situations. The additional diesel and heating fuel needed to support the increased resident population would be minor relative to in-state refinery capacity and current demand.

Other construction materials, including pipe and modules, would be obtained from outside the Project area and would not be expected to create any local shortages or increases in prices to materials such as steel.

Most solid waste from constructing the Gas Treatment Facilities would be disposed of at the Oxbow Landfill. This landfill, with an estimated 30 to 40 years of capacity, would also be sufficient to receive construction-related solid waste from the construction camps (Olson, 2016). The landfill is expected to be sufficient to receive operational-related solid waste, including waste from the operations camp (Olson, 2016). Waste from PTTL construction and operation would be processed at existing facilities at Point Thomson. If these facilities do not have sufficient capacity, mobile incinerators would be temporarily used. Mainline Pipeline camps would incinerate burnable solid waste on site where permitted. All other waste associated with the Mainline Facilities would be temporarily stored on site and then trucked to a licensed solid waste disposal facility. The Central Peninsula Landfill, south of Soldotna, has about 18 years of remaining capacity and would be sufficient to receive the estimated volume of construction-related solid waste from construction of the Liquefaction Facilities (less than 8 percent of current landfill use) (Persily, 2015).

AGDC developed a Project Open Burning Plan, which would be used to manage open burning activities to ensure that emissions generated during open burning do not create a health hazard or public nuisance (see section 4.15.4). Any waste that could not be disposed of at a landfill, including non-exempt hazardous waste, would be transported to appropriate facilities in other areas of Alaska or in the Lower 48 by a combination of truck and rail. The Project Waste Management Plan includes procedures for disposal of hazardous and non-hazardous materials, including methods to reduce impacts on local solid waste utilities. Additional information on the Project Waste Management Plan is provided in section 4.9.6. Impacts on existing solid waste utilities would be permanent but minor relative to the amount disposed of in existing landfills.

4.11.6.4 Electric Utilities

The availability of electricity varies throughout the AOI. The Project would potentially affect 28 communities covered by a variety of one or sometimes a combination of electric utility providers. Providers include TDX North Slope Generating, Matanuska Electric Association, Homer Electric Association, Golden Valley Electric Association, Chugach Electric Association, Anchorage Municipal Light and Power, and Aurora Energy. Based on individual locations, households may or may not be serviced by an electric utility provider. Coldfoot CDP, Livengood CDP, and Wiseman CDP are not served by electric utility providers and rely on individual generators.

Electricity during construction and operation on the Mainline Facilities would come from independent power generation units and would not affect local electric utilities. Existing local electrical utilities in the MSB, Fairbanks North Star Borough, and elsewhere in the Mainline Facilities area would be sufficient to handle the increased residential electrical demand during operation since the increase in the resident population would be minor relative to existing capacities in these areas.

During construction of the Liquefaction Facilities, about 17 to 28 megawatts of electricity would be needed, including 7 to 10 megawatts for the Liquefaction Facilities and 10 to 17.5 megawatts for the work camp. The Liquefaction Facilities would use portable generators for electricity needs, although Homer Electric Association's generating facilities could also be used during construction. Given Homer Electric Association's capacity of more than 200 megawatts, the Project requirements represent about 8.5 to 14 percent of the utility's total electric capacity (Homer Electric Association, 2014). Additional utility needs from an increased population during construction would be minor relative to existing capacity.

Electricity during operation of the GTP and GTP camp would come from independent power generation units and would not use local electric utilities. These power generation units would include gas turbines for main power generation and diesel generators for essential and backup power generation. Similarly, PTTL and PBTL operation would not use local electric utilities. The increased resident population of the North Slope Borough during operation would be minor relative to the capacity of existing electric utilities, so no impacts would be anticipated.

During operation of the Liquefaction Facilities, about 150 megawatts of electricity would be needed. Homer Electric Association does not have sufficient capacity to provide this electricity, which would represent about 75 percent of the existing capacity (Homer Electric Association, 2014). Instead, natural gas would be used to generate the primary electricity needed for the Liquefaction Facilities. Electricity from Homer Electric Association would be used in emergencies. Therefore, impacts would be intermittent and minor.

Additional electric needs from the increased resident population in the Kenai Peninsula Borough during operation would be minor relative to Homer Electric Association's existing capacity. Similarly, additional electric needs from the increased resident population in Anchorage during Project operation would be minor relative to existing local electric utility capacity.

4.11.7 Tourism and Coastal Recreation

4.11.7.1 Existing Tourism and Coastal Recreation Resources

Over the last 50 years, tourism and tourism-related industries have evolved into an important economic sector in the Alaskan economy. The number of tourists visiting Alaska increased from 39,000 visitors in 1961 to about 1.1 million visitors in 1998, adding more jobs than any other basic industry in the 1990s (Leask et al., 2001). From May 2013 through April 2014, about 2.0 million people visited Alaska, spending an estimated $1.8 billion. The average visitor expenditure per person in 2016 was $1,057 (McDowell Group, 2017a).

Most visitors (about 86 percent) travel to Alaska in the summer, and most lodges advertised to visitors are open from May through September (McDowell Group, 2014). During the 2016 summer tourist season (May to September), about 1.9 million people visited Alaska. About half (55 percent) of these visitors arrived by cruise ship, 40 percent by air, and 5 percent by highway or ferry (McDowell Group, 2017a).

In a 2016 visitor survey, the most common activities cited by non-residents visiting Alaska included shopping (75 percent), wildlife viewing (45 percent), day cruises (39 percent), cultural activities (39 percent), hiking/nature walks (34 percent), train trips (32 percent) city/sightseeing tours (31 percent), fishing (19 percent), flightseeing (15 percent), and tramway/gondola (10 percent) (McDowell Group, 2017a). Approximately 64 percent of non-cruise visitors purchase multi-night packages, of which 50 percent are fishing packages, 10 percent are wilderness lodge packages, 10 percent are rail packages, and 9 percent are adventure tour packages (i.e., rafting, biking, kayaking, and hiking) (McDowell Group, 2017a).

Gas Treatment Facilities

Very little tourism occurs in the North Slope Borough due to its remote location.

Mainline Facilities

The DNPP, Fairbanks, Talkeetna, and Palmer/Wasilla are popular tourist destinations in the Mainline Facilities area. There are at least 33 recreation areas within 1 mile of the Mainline Pipeline in the Yukon-Koyukuk Census Area, Fairbanks North Star Borough, MSB, and Denali Borough. These recreation areas include the DNPP, Denali State Park, Minto Flats SGR, and the Tanana Basin Planning Area. In 2017, the BLM documented over 20,000 commercially-guided visitors in the Yukon-Koyukuk Census Area. An additional 10,000 non-commercially guided visitors are estimated to have travelled to the area, with the Arctic Circle Wayside and the Dalton Highway being the most visited sites (Egger, 2019). A number of tourists also visit the proposed Mainline Facilities Project area to see northern lights during the "aurora season" from August 21 to April 21. Northern lights' viewing is the main driver of winter tourism in the region. Wildlife viewing and birdwatching, along with visits to friends and relatives, are common reasons visitors travel to the MSB. The DNPP contains about 70 percent of Denali Borough's land area (Fried, 2009). A separate study by the McDowell Group (2017a) found that about 428,000 people visited the DNPP between May and September of 2016.

Liquefaction Facilities

Many tourists travel to the Kenai Peninsula Borough for wildlife viewing, birdwatching, and fishing. The peak visitor season in the Kenai Peninsula Borough is from May through September. About 127,000 tourists visited the Kenai/Soldotna area in 2016. Many coastal recreational activities are dependent on vessels in Cook Inlet (e.g., recreational fishing, boating, whale-watching, and commercial cruises). In 2016, 1.025 million cruise passengers visited Alaska. Large round-trip vessels, generally departing from Seattle or Vancouver, comprise the largest share of cruise passengers. Smaller ships (less than 250 passengers) represent 1 percent of the cruise vessel passengers, yet visit more of the ports along the coast (McDowell Group, 2017a). Recreational fishing is also a large activity, with approximately 300,862 non-resident fishing licenses issued in 2016 (McDowell Group, 2017a).

Data from the ADOLWD provides information on employment in the leisure and hospitality sector at the borough level. The tourism industry is mainly included in ADOLWD's leisure and hospitality industrial classification, which includes two sub-sectors: arts, entertainment, and recreation; and accommodation and food services. Table 4.11.7-1 shows average monthly employment, total earnings, and average monthly wages for the leisure and hospitality sector in 2013 in Alaska and in the boroughs affected by the Project. As shown in the table, the leisure and hospitality sector employed on average of 33,671 people in Alaska, which generated more than $700 million in employee earnings in 2013. Anchorage accounted for more than 50 percent of total employment in the sector and 51 percent of the total earnings in that year (see table 4.11.7-1). There are two recreation areas that could be affected by the Liquefaction Facilities, including a local beach to Cook Inlet (Cook Inlet Beach). See section 4.9.4 for a detailed discussion of recreational facilities in the Project area.

TABLE 4.11.7-1

Leisure and Hospitality Sector (2013)

Location	Average Monthly Employment	Total Earnings ($)	Average Monthly Wage ($)
Alaska	**33,671**	**715,707,106**	**1,771**
Gas Treatment Facilities			
North Slope Borough	534	22,330,230	3,485
Mainline Facilities			
Yukon-Koyukuk Census Area	24	549,032	1,906
Fairbanks North Star Borough	4,180	81,129,098	1,617
Denali Borough	1,102	30,649,042	2,318
Matanuska-Susitna Borough	2,520	41,152,930	1,361
Liquefaction Facilities			
Kenai Peninsula Borough	2,481	46,335,193	1,556
Municipality of Anchorage	16,986	370,586,952	1,818

Source: ADOLWD, 2014a

4.11.7.2 General Impacts and Mitigation

Construction impacts on tourism could include disturbances to recreation areas—such as certain trails, snow machine areas, and other off-road recreation areas—in the form of noise and aesthetics, restricted access, and temporary closures. Restricted access and temporary closures would be major temporary impacts, potentially affecting local businesses. Section 4.9.4 details the parks and other recreation areas crossed by or near the Project and discusses potential mitigation measures to ensure that the effects on these recreational resources are minimized to the maximum extent practicable. For affected recreation areas, the Project would develop site-specific crossing plans and coordinate planning and construction activities with the applicable agencies/organizations to minimize potential impacts. Through these minimization measures, the potential effects on the tourism industry in the affected areas would be minor and limited to certain periods during construction.

As discussed above for the Liquefaction Facilities, many coastal recreational activities are dependent on vessels in Cook Inlet (e.g., recreational fishing, boating, whale-watching, and commercial cruises). Any negative impacts on visitor experiences (e.g., reduction in catch, less frequent whale sightings, longer transit times, or re-routes) on vessel transits throughout Cook Inlet waters would be temporary and limited in frequency (see section 4.9.4).

The Project would have both beneficial and adverse impacts on the accommodation and food services subsector. Project construction could indirectly create additional jobs in these sector and increase profits as construction workers seek temporary accommodations and food services. As discussed in section 4.11.1.2, most construction workers would be housed in camps. Initial personnel arriving before the construction camps are available for use could temporarily stay in hotels or motels in supply or logistical centers or in communities along the Project transportation routes. Existing hotel and motel rooms are sufficient to accommodate the estimated number of personnel needing temporary accommodations; however, this could lead to low vacancy rates during the summer months. Similarly, economic in-migrants seeking employment created indirectly by Project construction could compete with tourists for temporary accommodations, such as hotel/motel rooms, campgrounds, and house/apartment rental units. This competition would most likely occur during the summer months in areas that would attract economic in-migrants, such as the MSB and Fairbanks North Star Borough. High occupancy rates could be beneficial for accommodation and food service businesses; however, if tourists should be prevented from visiting these areas due to a lack of accommodations, other parts of the tourism industry could be adversely affected.

Project construction would require transporting workers to Project sites, which would primarily be accomplished through air transportation, potentially increasing competition for plane tickets during the summer tourist season and restricting tourist travel to and throughout Alaska. Similarly, construction trucks transporting Project materials could contribute to congestion on popular highways and cause additional traffic, particularly during the summer tourist season. Increased vessel traffic in Cook Inlet could disrupt recreational fishing, boating, whale-watching, and commercial cruise vessel transit routes or schedules and reduce vessel speeds.

AGDC has agreed to work closely with the Alaska Tourism Industry Association, Explore Fairbanks, Alaska Cruise Association, local chambers of commerce, and others to discuss the Project construction timeline to minimize impacts and tourist displacement. The following measures are examples of actions AGDC could implement to mitigate against potential impacts on recreational and visitor activities during Project construction:

- reduce Mainline Facilities pre-construction and construction activity during high use recreational and tourism periods to the extent practicable;
- coordinate and consult early and regularly with the public along with tourism and recreation businesses;
- reduce off-road vehicle use in remote areas associated with Mainline Pipeline construction activities;

- reduce impacts on the existing natural landscape to the extent practicable;
- use vegetative screening to reduce visibility of the pipeline, compressor stations, and material sites;
- coordinate closely with the NPS, USFWS, BLM, and Alaska State Parks before and during construction to reduce potential effects on visitor and recreational activities; and,
- coordinate with local organizations, including Mat-Su Convention and Visitors Bureau, Explore Fairbanks, Friends of Denali, Iditarod, and others regarding timing of local activities to reduce conflicts between those activities and construction.

Both the beneficial and adverse impacts of Project construction would primarily be temporary and minor. Since the majority of construction workers would reside in construction camps where meals and accommodations would be provided, an increase in demand at accommodations and food service providers in the AOI would be limited. Workers employed in the larger urban areas, such as Anchorage or Fairbanks, or those workers who would complete tasks before work camps are available for use, would seek local community accommodations. Therefore, with the mitigation measures described above, minor, short-term impacts would occur during construction.

4.11.7.3 Facility-Specific Impacts and Mitigation

Gas Treatment Facilities

No construction or operational impacts on tourism or recreation would be anticipated in the Gas Treatment Facilities area.

Mainline Facilities

At least 27 recreation areas would be crossed by the Mainline Pipeline. Some of the popular recreation areas affected by Project construction include George Parks Highway, Nenana River Gorge, and the Tanana Basin Planning Area. The Mainline Pipeline would be within or visible from the Dalton Highway corridor between MPs 20 and 400, which has been designated by the BLM as a Special Recreation Management Area. There are 14 waysides, four campgrounds, and a visitor center all managed by the BLM that could potentially be affected during Mainline Pipeline construction and operation along the Dalton Highway. Impacts from Mainline Pipeline construction and operation would be the same as those described in section 4.11.7.2 (Egger, 2019). Section 4.9.4 includes a detailed discussion of recreation areas affected by the Mainline Facilities.

The Mainline Facilities would also occur in close proximity to the DNPP. In particular, the Healy Compressor Station could become a noticeable permanent visual change in the landscape from the DNPP, which could affect the visitor experience. Section 4.10.2 discusses these visual impacts and recommends mitigation measures, including a recommendation for a station lighting plan.

Other impacts on tourism during operation could include the establishment of a potential recreational corridor on the pipeline right-of-way. A new recreational corridor could provide tourists with increased opportunities for hiking, camping, hunting, and other outdoor activities. AGDC would allow access to the right-of-way at the landowner's / land management agency's discretion. Outright bans, some seasonal limits, or bans on motorized vehicles could occur depending on the sensitivity of the resources in the area. AGDC would develop individual land use plans during the permitting process.

Since the main route to the DNPP is the Parks Highway, construction trucks could cause additional traffic and contribute to congestion there and along other popular highways, particularly during the summer tourist season. Construction trucks on Glenn and Elliott Highways could also increase congestion. See section 4.12 for a more detailed discussion on potential traffic and transportation impacts and proposed mitigation.

Liquefaction Facilities

Portions of two recreation areas would be crossed by the 51 miles of Mainline Pipeline included in the Liquefaction Facilities AOI: Susitna Flats SGR and Revised Statute 2477 Trail 200. Potential impacts on these areas from Mainline Pipeline construction and operation are the same as those described above and in section 4.11.7.2.

As discussed in section 4.9.4, the Cook Inlet beach, which is not a formal recreation area but is used by local residents, is within the proposed Liquefaction Facilities Project area. The Mainline MOF and PLF components of the Liquefaction Facilities would be on the shoreline and block existing access to the Cook Inlet beach from Salamatof Road. To mitigate impacts, AGDC would develop a plan to construct an alternate public beach access point prior to construction. The alternate access point would be south of Miller Loop Road. The plan for public beach access would address pedestrian and vehicular access, traffic and parking, signage, and construction methods to maintain bluff integrity.

The presence of Project employees from outside the area could temporarily create competition with tourists for accommodation and food services in the Kenai Peninsula Borough. In addition, operational impacts on tourism could result from changes to the overall aesthetic character of the Liquefaction Facilities AOI, which could affect the visitor experience. However, there are no state or federal recreation areas (other than the GMU sub-unit) within about 15 miles of the Liquefaction Facilities (see section 4.10.2), so while the effect on the viewshed could be low to moderate in this area, effects on tourists would likely occur infrequently.

As discussed above, the establishment of a potential recreational corridor in the Mainline Pipeline right-of-way could affect tourism by creating additional recreational outdoor activities in the Liquefaction Facilities region, depending on landowner permission.

Increased vessel traffic in Cook Inlet from the LNG carriers transiting to and from the Liquefaction Facilities and the pilot station in Homer could potentially affect recreational fishing, boating, whale-watching, and commercial cruises by interrupting their typical vessel transit routes or schedules and reducing their vessel speeds. Operation would increase the number of vessel calls in Nikiski and Homer; however, the effect on overall visitor experiences and tourism levels would be minor or negligible.

4.11.8 Environmental Justice

EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, requires federal agencies to consider if impacts on human health or the environment (including social and economic aspects) would be disproportionately high and adverse for minority and low-income populations and appreciably exceed impacts on the general population or other comparison group.

To determine if the Project would result in disproportionately high and adverse impacts on minority or low-income populations (i.e., environmental justice populations), we evaluated potential environmental justice impacts related to the Project, taking into account the following:

- the racial and economic composition of affected communities;

- health-related issues that could amplify Project effects on minority or low-income individuals; and

- public participation strategies, including community or tribal participation in the NEPA process.

According to EPA guidance, a minority is defined as an individual who is a member of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. Low-income populations are those that fall within the annual statistical poverty thresholds from the U.S. Department of Commerce Bureau of the Census *Population Reports, Series P-60 on Income and Poverty*. For 2010, the annual low-income threshold ranges from $10,458 to $47,882 depending on family size.

A minority population exists when a community's population is over 50-percent minority or if its minority population is meaningfully greater than the percentage in the general population or other comparison group. The State of Alaska (33-percent minority) was used as the comparison group. For the purposes of this analysis, "meaningfully greater" is assumed to be equal to or greater than 1.2 times the State of Alaska minority population, which equates to a minority population of 40 percent or higher.

A low-income population exists when a community's population is over 50-percent low-income or when the low-income population percentage of the community exceeds that of the general population or other comparison group which, for the purposes of this analysis, is the State of Alaska. In the State of Alaska, 10.1 percent of the population is at or below the poverty level.

Accordingly, to determine if the Project could affect an environmental justice population, we identified:

- census block groups where the minority population is 40 percent or higher (equal to or greater than 1.2 times the State of Alaska minority population);

- census block groups that intersect Project facilities where minority and/or low-income individuals are equal to or exceed 50 percent of the population; and

- census block groups with a greater percentage of the population at or below the poverty level compared to the State of Alaska.

4.11.8.1 Existing Minority and Low-Income Populations

Data on race and ethnicity were acquired from *2010 Census Redistricting Data (Public Law 94-171) Summary File Table P1: Race*. Low-income populations were identified using data from the ACS. *Table S1701: Poverty Status in the Past 12 Months* provided 5-year estimates (2010 through 2014) from the ACS for census tracts and block groups.

As shown on figure 4.11.8-1, the Project would cross 35 block groups. Table 4.11.8-1 identifies the racial/ethnic characteristics of these block groups and the boroughs in which they are located. Alaska has a 33-percent minority population, with American Indian and Alaska Natives making up 14.8 percent of the total population in Alaska. As shown in table 4.11.8-1, three block groups within three boroughs have minority populations that are meaningfully greater (1.2 times greater) than the statewide reference population of 33 percent. Two of these block groups also exceed the 50-percent criterion.

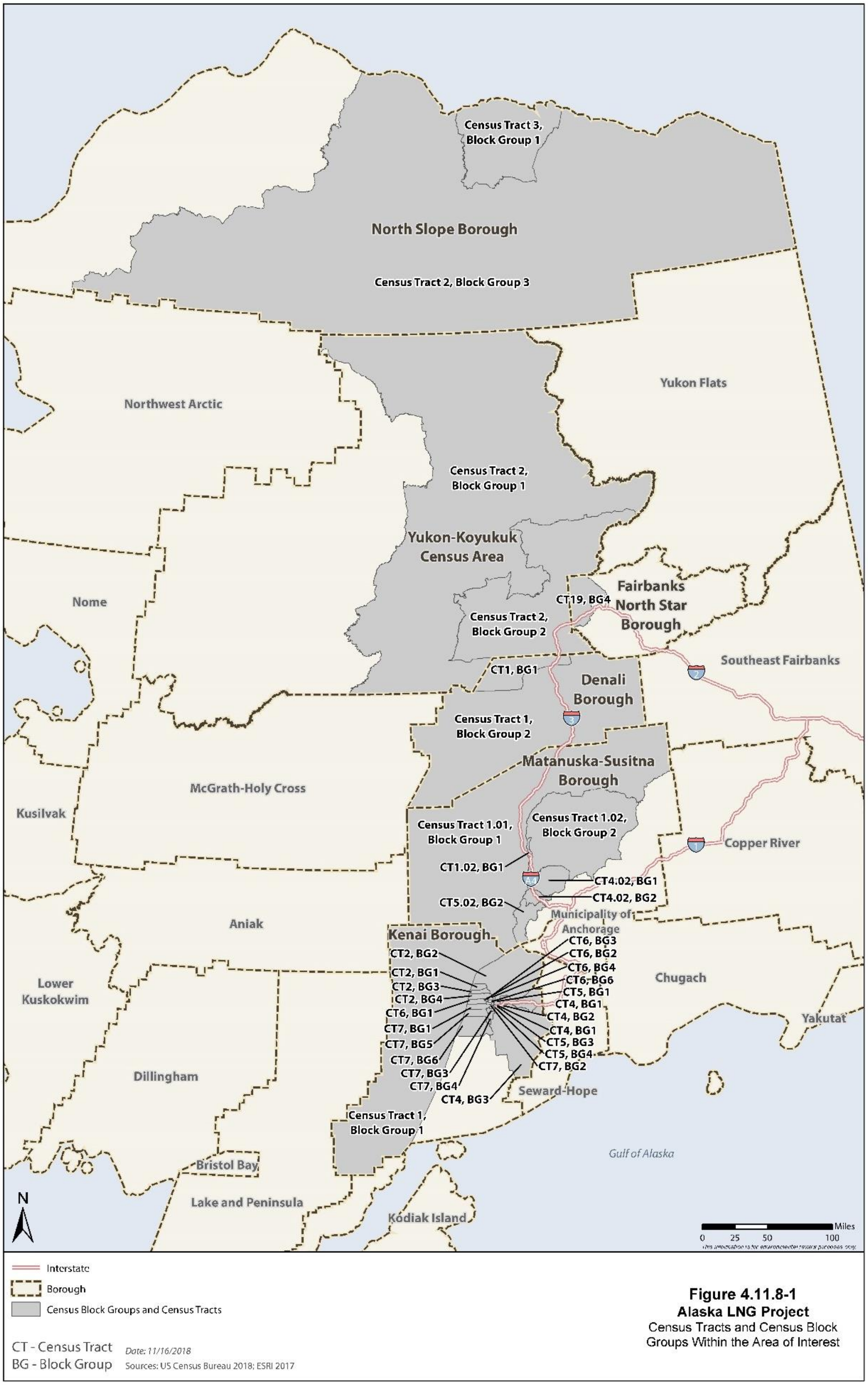


Figure 4.11.8-1
Alaska LNG Project
Census Tracts and Census Block Groups Within the Area of Interest

TABLE 4.11.8-1

Race and Ethnicity in the Environmental Justice Area of Interest

Geography	Total Population	Total Minority Population	Percent Minority Population (percent)	Alaska Native / American Indian Population (percent)	Hispanic/ Latino Population (percent)
Alaska	**710,235**	**236,659**	**33.3**	**14.8**	**5.5**
Gas Treatment Facilities					
North Slope Borough	9,430	6,283	66.6	58.5	2.6
Block Group 3, Census Tract 2	1,030	888	86.2	85.5	0.9
Block Group 1, Census Tract 3	2,527	359	14.2	8.5	3.7
Mainline Facilities					
Denali Borough	1,826	189	10.4	6.4	2.3
Block Group 1, Census Tract 1	308	38	12.3	7.8	3.9
Block Group 2, Census Tract 1	1,518	151	9.9	6.1	2.0
Fairbanks North Star Borough	97,581	2,406	23	10.9	5.8
Block Group 4, Census Tract 19	4,415	507	11.5	7.6	2.5
Matanuska-Susitna Borough	88,995	13,455	15.1	10.1	3.7
Block Group 1, Census Tract 1.01	620	70	11.3	9.0	.8
Block Group 1, Census Tract 1.02	940	97	10.3	7.8	2.4
Block Group 2, Census Tract 1.02	1,241	135	10.9	8.4	2.2
Block Group 1, Census Tract 4.02	910	103	11.3	9.7	1.9
Block Group 2, Census Tract 4.02	1,195	89	7.4	5.8	0.8
Block Group 2, Census Tract 5.02	1,054	121	11.5	9.7	2.1
Yukon-Koyukuk Census Area	5,588	4,345	77.8	76.4	1.2
Block Group 1, Census Tract 2	641	538	83.9	82.8	2.2
Block Group 2, Census Tract 2	820	283	34.5	31.8	1.6
Liquefaction Facilities					
Kenai Peninsula Borough	55,400	8,543	15.4	11.6	3.0
Block Group 1, Census Tract 1	373	182	48.8	46.1	3.5
Block Group 1, Census Tract 2	1,600	277	17.3	13.0	2.1
Block Group 2, Census Tract 2	916	133	14.5	12.1	2.5
Block Group 3, Census Tract 2	1,998	238	11.9	10.3	3.1
Block Group 4, Census Tract 2	1,109	339	30.6	26.0	2.9
Block Group 1, Census Tract 4	2,999	319	10.6	7.5	2.5
Block Group 2, Census Tract 4	2,618	254	9.7	6.9	2.9
Block Group 3, Census Tract 4	880	79	9.0	6.3	1.1
Block Group 1, Census Tract 5	1,263	130	10.3	7.3	2.2
Block Group 3, Census Tract 5	2,448	344	14.1	8.6	3.5
Block Group 4, Census Tract 5	1,793	252	14.1	8.6	4.4
Block Group 1, Census Tract 6	1,297	291	22.4	17.0	4.8
Block Group 2, Census Tract 6	1,225	282	23.0	16.8	4.9
Block Group 3, Census Tract 6	1,084	243	22.4	16.1	5.4

TABLE 4.11.8-1 (cont'd)

Race and Ethnicity in the Environmental Justice Area of Interest

Geography	Total Population	Total Minority Population	Percent Minority Population (percent)	Alaska Native / American Indian Population (percent)	Hispanic/ Latino Population (percent)
Block Group 4, Census Tract 6	732	153	20.9	17.2	3.0
Block Group 6, Census Tract 6	1,128	160	14.2	12.0	3.7
Block Group 1, Census Tract 7	2,794	410	14.7	9.3	3.4
Block Group 2, Census Tract 7	1,761	273	15.5	10.8	4.2
Block Group 3, Census Tract 7	1,613	147	9.1	7.1	4.0
Block Group 4, Census Tract 7	1,381	146	10.6	8.6	2.0
Block Group 5, Census Tract 7	850	99	11.6	8.8	2.9
Block Group 6, Census Tract 7	1,540	169	11.0	8.9	2.0

Sources: U.S. Census Bureau, 2010a,b

Table 4.11.8-2 shows the percentages of people living below the poverty level in the environmental justice AOI. Fourteen block groups within three boroughs have a greater percentage of persons living below the poverty level than the statewide reference comparison of 10.1 percent. None exceed the 50-percent criterion.

Table 4.11.8-3 summarizes which block groups we consider to be environmental justice populations based on the criteria described above and therefore have the potential to experience disproportionately high and adverse impacts. As shown in the table, we have identified 15 block groups as environmental justice communities.

EO 12898 also calls for consideration of populations that rely on subsistence consumption of fish and wildlife for a principal portion of their diet. Where an agency action may affect fish, vegetation, or wildlife, subsistence patterns of consumption, the analysis should address the potential for disproportionately high and adverse impacts on minority and low-income populations, which we have done below.

Subsistence activities were found to occur within 29 communities in the AOI, as described in section 4.14. Of these communities, the six block groups listed below also qualify as environmental justice populations (census tracts and block groups are identified on figure 4.11.8-1).

- **North Slope Borough Block Group 3, Census Tract 2**: Large land mammal, subsistence use areas are primarily found within 20 miles of the Project. Construction activities could affect the resource availability of caribou for Anaktuvuk Pass and Kaktovik. As noted in section 4.14, Anaktuvuk Pass has the greatest reliance on caribou (nearly 80 percent of the total harvest) to meet their subsistence needs. In addition, residents hunt caribou at high levels during both the summer and winter months when construction of the Mainline Pipeline through the foothills into the Brooks Range would occur.

- **Yukon-Koyukuk Census Area Block Group 1, Census Tract 2**: Resources within 20 miles of the Project include bird and egg, large land mammal, salmon and non-salmon fish, small land mammal, and vegetation subsistence use areas.

- **Yukon-Koyukuk Census Area Block Group 2, Census Tract 2**: Resources within 20 miles of the Project include bird and egg, large land mammal, salmon and non-salmon fish, small land mammal, and vegetation subsistence use areas.
- **Denali Borough Block Group 2, Census Tract 1**: Resources within 20 miles of the Project include bird and egg, large land mammal, non-salmon fish, small land mammal, and vegetation subsistence use areas.
- **Matanuska-Susitna Borough Block Group 1, Census Tract 1.01**: Resources within 20 miles of the Project include bird and egg, large land mammal, marine mammal, salmon and non-salmon fish, small land mammal, and vegetation subsistence use areas.
- **Kenai Peninsula Borough Block Group 1, Census Tract 1**: Resources within 20 miles of the Project include bird and egg, large land mammal, marine invertebrates, marine mammal, salmon and non-salmon fish, small land mammal, and vegetation subsistence use areas.

4.11.8.2 Impacts and Mitigation

Project construction and operational impacts on the natural and human environments are identified and discussed throughout the environmental analysis section of this document. Project-related impacts on environmental justice populations can be characterized as temporary, short term, and long term. As described in previous sections of this EIS, impacts would vary based on location, duration, and magnitude. Impacts on environmental justice populations would be similar to those experienced by the general community; however, low-income or minority populations could experience disproportionately high and adverse impacts.

Project impacts that could have the potential to disproportionately affect environmental justice populations include traffic delays and new traffic patterns; visual effects from nighttime lighting or changes to the existing viewshed; interference with subsistence activities or habitats; potential changes to residential property values; and health impacts. The subsections below summarize these impacts and identify if and where specific impacts on environmental justice populations would be anticipated.

Traffic Impacts

As noted in section 4.12, several potential impacts on vehicular and marine traffic could result from Project construction and operation. These impacts would generally be related to the movement of construction materials, personnel, and supplies by road, rail, and marine vessel, and would be mitigated by the development and implementation of traffic control plans. On the North Slope, marine traffic could temporarily interfere with subsistence activities such as whale hunting, which is further described in section 4.14. Section 4.12 concludes that the impacts from Project-related traffic would be temporary and not result in significant impacts. Therefore, we conclude that traffic impacts would not be disproportionately high and adverse on environmental justice communities.

TABLE 4.11.8-2

Low-Income Populations in the Environmental Justice Area of Interest

Geography	Total Population	Population at or below the Poverty Level (percent)
Alaska	**710,235**	**10.1**
Gas Treatment Facilities		
North Slope Borough	9,430	10.2
Block Group 3, Census Tract 2	1,030	9.7
Block Group 1, Census Tract 3	2,527	3.9
Mainline Facilities		
Denali Borough	1,826	12.8
Block Group 1, Census Tract 1	308	2.9
Block Group 2, Census Tract 1	1,518	13.9
Fairbanks North Star Borough	97,581	8.0
Block Group 4, Census Tract 19	4,415	4.2
Matanuska-Susitna Borough	88,995	10.2
Block Group 1, Census Tract 1.01	620	33.2
Block Group 1, Census Tract 1.02	940	7.3
Block Group 2, Census Tract 1.02	1,241	18.2
Block Group 1, Census Tract 4.02	910	14.4
Block Group 2, Census Tract 4.02	1,195	16.3
Block Group 2, Census Tract 5.02	1,054	6.9
Yukon-Koyukuk Census Area	5,588	24.1
Block Group 1, Census Tract 2	641	25.8
Block Group 2, Census Tract 2	820	22.7
Liquefaction Facilities		
Kenai Peninsula Borough	55,400	9.3
Block Group 1, Census Tract 1	373	12.8
Block Group 1, Census Tract 2	1,600	5.7
Block Group 2, Census Tract 2	916	3.0
Block Group 3, Census Tract 2	1,998	6.9
Block Group 4, Census Tract 2	1,109	11.7
Block Group 1, Census Tract 4	2,999	9.4
Block Group 2, Census Tract 4	2,618	6.0
Block Group 3, Census Tract 4	880	16.5
Block Group 1, Census Tract 5	1,263	5.2
Block Group 3, Census Tract 5	2,448	3.4
Block Group 4, Census Tract 5	1,793	3.5
Block Group 1, Census Tract 6	1,297	25.0
Block Group 2, Census Tract 6	1,225	11.3
Block Group 3, Census Tract 6	1,084	2.9
Block Group 4, Census Tract 6	732	0.0

TABLE 4.11.8-2 (cont'd)

Low-Income Populations in the Environmental Justice Area of Interest

Geography	Total Population	Population at or below the Poverty Level (percent)
Block Group 6, Census Tract 6	1,128	6.3
Block Group 1, Census Tract 7	2,794	1.8
Block Group 2, Census Tract 7	1,761	4.8
Block Group 3, Census Tract 7	1,613	0.0
Block Group 4, Census Tract 7	1,381	11.1
Block Group 5, Census Tract 7	850	6.1
Block Group 6, Census Tract 7	1,540	15.8

Source: U.S. Census Bureau, n.d.[a]

TABLE 4.11.8-3

Potential Environmental Justice Communities

Geography	Minority Population is Meaningfully Greater than State of Alaska	Minority Population Exceeds 50 Percent	Low-Income Population is Greater than State of Alaska (10.1%)
Gas Treatment Facilities			
North Slope Borough			
Block Group 3, Census Tract 2	X	X	–
Mainline Facilities			
Denali Borough	–	–	–
Block Group 2, Census Tract 1		–	X
Matanuska-Susitna Borough	–	–	–
Block Group 1, Census Tract 1.01	–	–	X
Block Group 2, Census Tract 1.02	–	–	X
Block Group 1, Census Tract 4.02	–	–	X
Block Group 2, Census Tract 4.02	–	–	X
Yukon-Koyukuk Census Area	–	–	–
Block Group 1, Census Tract 2	X	X	X
Block Group 2, Census Tract 2	–	–	X
Liquefaction Facilities			
Kenai Peninsula Borough		–	–
Block Group 1, Census Tract 1	X	–	X
Block Group 4, Census Tract 2	–	–	X
Block Group 3, Census Tract 4	–	–	X
Block Group 1, Census Tract 6	–	–	X
Block Group 2, Census Tract 6	–	–	X
Block Group 4, Census Tract 7	–	–	X
Block Group 6, Census Tract 7	–	–	X

X = Criterion met for this location.

Visual Impacts

As noted in section 4.10, the Project would result in both temporary and permanent impacts on visual resources and views associated with construction activities, artificial nighttime lighting, cleared rights-of-way, access roads, and aboveground facilities. Impacts would vary based on location and viewer sensitivity and would be mitigated by using vegetative cover in front of construction areas, as well as locating access roads away from public areas. The use of lights would be limited during nighttime hours as practicable. Vegetation clearing would be minimized and BMPs employed to restore vegetation as described in the Project Revegetation Plan. Section 4.10 concludes that visual impacts from construction and operation would not be significant. Therefore, we conclude that the visual impacts from the Project would not be disproportionately high and adverse on environmental justice communities.

Subsistence Impacts

As noted in section 4.14, subsistence in Alaska is characterized by a high level of consumption of wild foods; hunting and gathering activities organized by kinship groups, and the pursuit of these activities within traditional territories. Subsistence is an important part of the Alaska Native economic system, often referred to as a "mixed subsistence-market economy" wherein individuals and families or households trade wild foods and goods to supplement their income. Within each community's subsistence use area, hunting, fishing, and gathering follow a seasonal cycle that corresponds to animal migration patterns, weather, and the quality of resources in the area.

Section 4.14 finds that the subsistence use areas for the 29 communities would be directly affected by the Project, although these effects would vary depending on construction timing, wildlife presence and migration, and community harvest strategies. In general, the Project would cross numerous subsistence use areas; temporarily and permanently affect resource availability; temporarily affect access to subsistence resources; temporarily increase the effort (e.g., travel distances and cost of harvest time) associated with subsistence activities; and temporarily affect resource harvest rates. Additionally, a major concern of local residents who participated in traditional knowledge workshops is that the development of linear infrastructure would offer enhanced opportunities for non-locals to access subsistence use areas, which could reduce resource availability and increase competition for resources for the life of the Project.

To reduce impacts on subsistence activities, construction would be coordinated with state and local authorities and construction schedules would be communicated to local users. This communication could take place in the context of a subsistence advisory committee comprised of federal, state, local, and native subsistence users within the Project area. Additionally, subsistence impacts would be mitigated by the following measures, as discussed in section 4.14:

- avoid subsistence use areas and harvest times to the maximum extent possible;
- employ local subsistence representatives to provide an avenue for communication between local residents and the Project;
- restrict access along the right-of-way to prioritize local subsistence harvesters in previously undeveloped areas;
- prohibit Project employees from hunting, fishing, and gathering while stationed at work camps; and
- coordinate marine vessel traffic to avoid and minimize impacts on subsistence whaling and marine mammal hunting.

The subsistence evaluation presented in section 4.14 concludes that Project construction would not result in significant impacts on subsistence resources or users due to the temporary to short-term duration and limited nature of construction activities in a given area and the availability of adjacent suitable habitat. Therefore, the impacts of construction on subsistence would not be disproportionately high and adverse for minority and low-income populations.

Section 4.14 also concludes that operation of this linear infrastructure would have long-term or permanent effects on some communities by altering caribou migration patterns. This would result in a disproportionate impact on the minority and low-income populations in Utqiagvik, Nuiqsut, and Anaktuvuk Pass, but we do not expect those impacts would be high and adverse. Similarly, section 4.14 concludes the Project would have a long-term and permanent impact on subsistence users due to the access roads that would be constructed in undeveloped areas providing access to non-local hunters. This would have a disproportionate impact on the minority and low-income residents of Minto, Nenana, Four Mile Road, Alexander Creek/Susitna, and Beluga, but we do not expect those impacts to be high and adverse.

Residential Property Value Impacts

As noted in section 4.11.5.4, residential property values would not be expected to be negatively affected by the Project facilities. The Gas Treatment Plant would not be located near residential areas and the Liquefaction Facilities would be located in an industrial area of the Kenai Peninsula Borough. The Mainline facilities would primarily follow designated utility corridors to avoid residential communities. Project construction sites and aboveground permanent facilities would be in areas separated from residential homes to the maximum extent practicable to minimize impacts on housing values or the quality of life of adjacent residents. Additionally, adjacency or proximity of industrial facilities does not always translate into effects on property values (also see section 4.11.5.4). Therefore, we conclude that the impact on property values of environmental justice populations would not be disproportionately high and adverse.

Health Impacts

As described in section 4.17 and according to the Alaska Department of Health and Social Services (ADHSS) HIA, Project construction would be expected to have low to high adverse impacts on the health of residents in the AOI. Low adverse impacts would be expected in the following categories: accidents and injuries; exposure to potentially hazardous materials; food, nutrition, and subsistence activity; non-communicable chronic diseases; water and sanitation; and health service infrastructure and capacity. Project construction would be expected to have a medium adverse effect on the social determinates of health, which include the effects on depression and anxiety and the potential impacts on subsistence and subsistence lifestyles. The impacts from construction on infectious disease would be expected to be high and adverse. The social determinates of health affected by the change in employment and median household income would be high and positive.

Overall, operational activities according to the HIA would be expected to have a low to medium adverse impact on the health of residents in the AOI. Low adverse impacts would be expected in the following categories: accidents and injuries; exposure to potentially hazardous materials; food, nutrition, and subsistence activity; non-communicable chronic diseases; water and sanitation; and health service infrastructure and capacity. Medium adverse effects on social determinates of health would be expected due to perceptions that the Project would threaten a way of life, and to infectious disease during operation. Medium positive impacts on social determinates of health could occur during operation due to the potential increase in long-term employment and household income, as well as the reduced exposure to potentially hazardous materials and non-communicable chronic diseases that would result from positive changes in air quality in Fairbanks.

In conclusion, while the impacts from construction on infectious diseases would be temporarily high and adverse, these impacts would not disproportionately affect environmental justice populations. During construction, nearly all construction workers would be housed in closed worker camps and transported to and from the right-of-way. This would reduce many of the potential negative impacts associated with interaction with rural, isolated populations. Even so, the HIA concludes that construction would have a medium adverse effect on the social determinates of health, which could disproportionately affect environmental justice populations due to anxiety and depression associated with potential impacts on subsistence. Permanent health impacts would be unlikely to have disproportionately high and adverse impacts on environmental justice populations.

4.11.9 Conclusion

Project construction and operation would affect residents in the AOI and throughout the State of Alaska in different ways. Generally, facility construction would lead to a large one-time injection of funds into the local, regional, and state economies as workers are paid and materials are purchased. Communities with more developed economies such as Anchorage or Fairbanks would be expected to receive the majority of this additional spending. Smaller, more remote communities would experience fewer of these economic benefits. Also, a large influx of construction workers would move into the Project area as it is being built. Due to the remote nature of much of the Project Area, in nearly all instances, construction workers would be housed in closed worker camps. The use of these closed worker camps would be beneficial to the local communities because it would reduce many of the potential negative socioeconomic impacts associated with the Project, including impacts on cost of living; housing affordability and availability; demands for community services and facilities; and social cohesion. However, use of these workers camps would also limit many of the positive economic impacts in more remote communities because workers would not be spending their earnings in the local economy and fewer supplies would be sourced from the local area.

During construction, the Project would have minor and temporary impacts on the population, state and local economies, housing, schools, law enforcement, and utilities. Additionally, the construction of the Project would create temporary impacts on the commercial fishing industry in Cook Inlet and tourism in the DNPP. The set gillnet salmon fishery near the Liquefaction Facilities would experience disruption during the construction period, but impacts would be temporary. Construction activities could prevent DNPP establishments from being accessed or overwhelm these establishments with Project construction workers, which could prevent or deter tourists from using the facilities. Construction impacts would disproportionately affect environmental justice populations, but these impacts would not be high and adverse.

Project operation in the Gas Treatment and Liquefaction Facilities regions would create a permanent increase in the economic activity around the Kenai Peninsula, the North Slope Borough, and Anchorage and Fairbanks; more job opportunities would be created, higher income levels would be realized, and local government receipts would increase. A small but permanent increase in population, housing demands, and community services and facilities would also occur in these areas. To a lesser extent, areas affected by the Mainline Facilities would also experience an increase in economic activity. The long-term or permanent effects of Project operation would disproportionately affect some environmental justice communities by altering caribou migration patterns and by providing additional access in undeveloped areas to non-local hunters. However, we do not expect those impacts to be high and adverse.

4.12 TRANSPORTATION

The Gas Treatment Facilities, Mainline Facilities, and Liquefaction Facilities would use road, rail, marine, and air transport. This section describes existing transportation resources, the Project's potential impacts on these resources, and mitigation measures.

4.12.1 Existing Transportation Resources

4.12.1.1 Road Network

The ADOT&PF is responsible for operation and maintenance of 5,629 miles of highway, including 3,750 paved miles and 1,861 unpaved miles, as well as 836 road bridges in Alaska (ADOT&PF, 2018a). The highways include 2,229 road miles that are part of the National Highway System, which are the major roads that serve as the "backbone" of the national transportation system (FHWA, 1996). Major state highways link cities and urban areas in the south-central portion of the state, such as Anchorage, Fairbanks, Valdez, and the Kenai Peninsula.

The Project would use the existing highway network, as described below, to transport equipment, materials, and personnel to Project work areas. Table 4.12.1-1 provides a description of major highways in the Project area and existing annual average daily traffic (AADT) volumes on each highway. The highest AADT volumes were recorded on the Glenn Highway in Anchorage. Figure 4.12.1-1 shows the location of the highways listed in table 4.12.1-1. Except where noted, the major highways are two-lane paved roads, with paved shoulders, and occasional pull-off areas.

Dalton Highway

The Dalton Highway (State Route 11) extends from the Elliott Highway in Livengood, north of Fairbanks, to Deadhorse, near Prudhoe Bay, on the North Slope. Originally named the Haul Road, the Dalton Highway was built as an industrial road in conjunction with construction of the TAPS to serve the oil and gas production that followed the 1968 discovery of oil in Prudhoe Bay. Although opened to public travel in 1994, the Dalton Highway remains an industrial haul road (BLM, 2017c) intended for heavy truck traffic to and from the North Slope. The Dalton Highway is primarily a gravel road with sections of asphalt paving and chip seals. The paved segments have markings for two lanes, while the unpaved segments are not marked. The Dalton Highway is maintained year-round, although winter driving conditions are "extremely hazardous" (BLM, 2017c). Overlooks, waysides (i.e., pull-off areas), and limited service areas are available along the highway. Traffic volumes on the Dalton Highway are typically less than 300 vehicles per day, with trucks comprising more than 60 percent of total traffic (ADOT&PF, 2015; 2018b).

Steese, Elliott, and Richardson Highways

The Steese Highway begins in Fairbanks and ends at the Yukon River at Circle (the Steese Highway is signed as State Route 2 between Fairbanks and Fox and State Route 6 between Fox and Circle.). The Elliott Highway (State Route 2) begins in Fox at the Steese Highway and runs north to Livengood before turning southwest and ending in Manley Hot Springs on the Tanana River. The Richardson Highway begins in Fairbanks at the Steese Highway and ends in Valdez (the Richardson Highway is signed as State Route 2 between Fairbanks and Delta Junction and State Route 4 between Delta Junction and Valdez). These highways provide access from the Fairbanks Airport and Railyard toward the Dalton Highway corridor and also link Valdez to the Project area. All three roads are paved and are available year-round.

In the Fairbanks area, the roads are multi-lane highways with signalized intersections and grade-separated interchanges. Other segments are two-lane roads with paved shoulders and passing lanes where necessary due to terrain. Traffic on the Elliott Highway is generally low, at less than 1,200 vehicles per day. The Steese and Richardson Highways carry more traffic, at typically more than 20,000 vehicles per day in and around Fairbanks (ADOT&PF, 2018b).

TABLE 4.12.1-1

Major Roadway Use for Project Construction and Operation

Highway (State Road Number)	Highway Segment	Minimum and Maximum Annual Average Daily Traffic (2015) [a]	State Improvements Planned [b]
Dalton Highway (Route 11)	Lake Colleen Drive East to Elliott Highway	147–294	Reconstruction: MPs 0–9, 18-37, 109–144, 120−135, 209–235, 305–335, and 362–414 Rehabilitation: MPs 289–305 Roche Moutonnee Creek Bridge replacement
Steese Highway (Route 2 and 6)	Elliott Highway to Richardson Highway	3,178–24,234	None
Elliott Highway (Route 2)	Dalton Highway to Steese Highway	364–1,191	Rehabilitation: MPs 0–12 and 73–107. Globe Creek Bridge replacement
Richardson Highway (Route 2 and 4)	Gaffney Road to Parks Highway Ramps	20,683	None
Glenn Highway (Route 1)	Parks Highway Ramp to 6th Avenue	29,362–65,270	Reconstruction of MPs 34–42 and 53–56. Rehabilitation of MPs 67–92
Parks Highway (Route 3)	Richardson Highway to Glenn Highway	988–34,753	Reconstruction: MPs 44–52, 183–192, 239–263, and 305–325 Rehabilitation: MPs 90–99, 163–183, and Nenana, Tanana, and North Slough Tanana River bridges Install passing lanes: MPs 83–163
Kenai Spur Highway	Holt Lamplight Road to Sterling Highway	1,860–15,622	Rehabilitation between Soldotna and Kenai (create a five-lane highway)
Sterling Highway (Route 1)	Kalifornsky Beach Road to Seward Highway	3,183–22,846	Reconstruction: MPs 45–60, Rehabilitation: MPs 60–79, 157–169 Install passing lanes: MPs 60–79
Seward Highway (Route 1 and 9)	Seward to East Fireweed Lane	1,611–57,076	Reconstruction: Diamond Blvd to O'Malley Rd (Seward) Rehabilitation: MPs 17–23, 25–36, 75–90 Install passing lanes: MPs 37–52

Sources: ADOT&PF, 2017, 2018b

[a] Traffic volumes vary depending on the location along each highway. Highest traffic volumes tend to be within more heavily populated areas such as the Anchorage and Fairbanks metropolitan areas.

[b] Independent of the Project and as listed in the 2016–2019 Statewide Transportation Implementation Plan (ADOT&PF, 2017). MPs refer to highway mileposts. Definitions:

Reconstruction = Complete removal and replacement of pavement (could include widening or other upgrades).
Rehabilitation = Repaving or other pavement improvements that do not involve actual reconstruction.

Glenn and Parks Highways

The Glenn Highway (State Route 1) begins in Anchorage and ends in Glenallen (via the Wasilla area) at the Richardson Highway. The George Parks Highway (Parks Highway; State Route 3) begins at the Glenn Highway east of Wasilla and runs west and north before ending in Fairbanks. Together, the Glenn and Parks Highways are the major overland routes between Anchorage and Fairbanks. Both are paved roads that are used year-round. The highway corridors include multi-lane segments in the Wasilla/Anchorage and Fairbanks metropolitan areas with signalized intersections and grade-separated interchanges. Other segments of the Glenn and Parks Highways are two-lane roads with paved shoulders and passing lanes where necessary due to terrain. The Glenn Highway has the highest traffic volumes in the state, exceeding 65,000 vehicles per day in Anchorage. The Parks Highway also has high traffic volumes near Wasilla and Fairbanks (exceeding 30,000 vehicles per day), although it also experiences very low volumes in other locations (e.g., less than 1,000 vehicles per day in Denali State Park (ADOT&PF, 2018b).

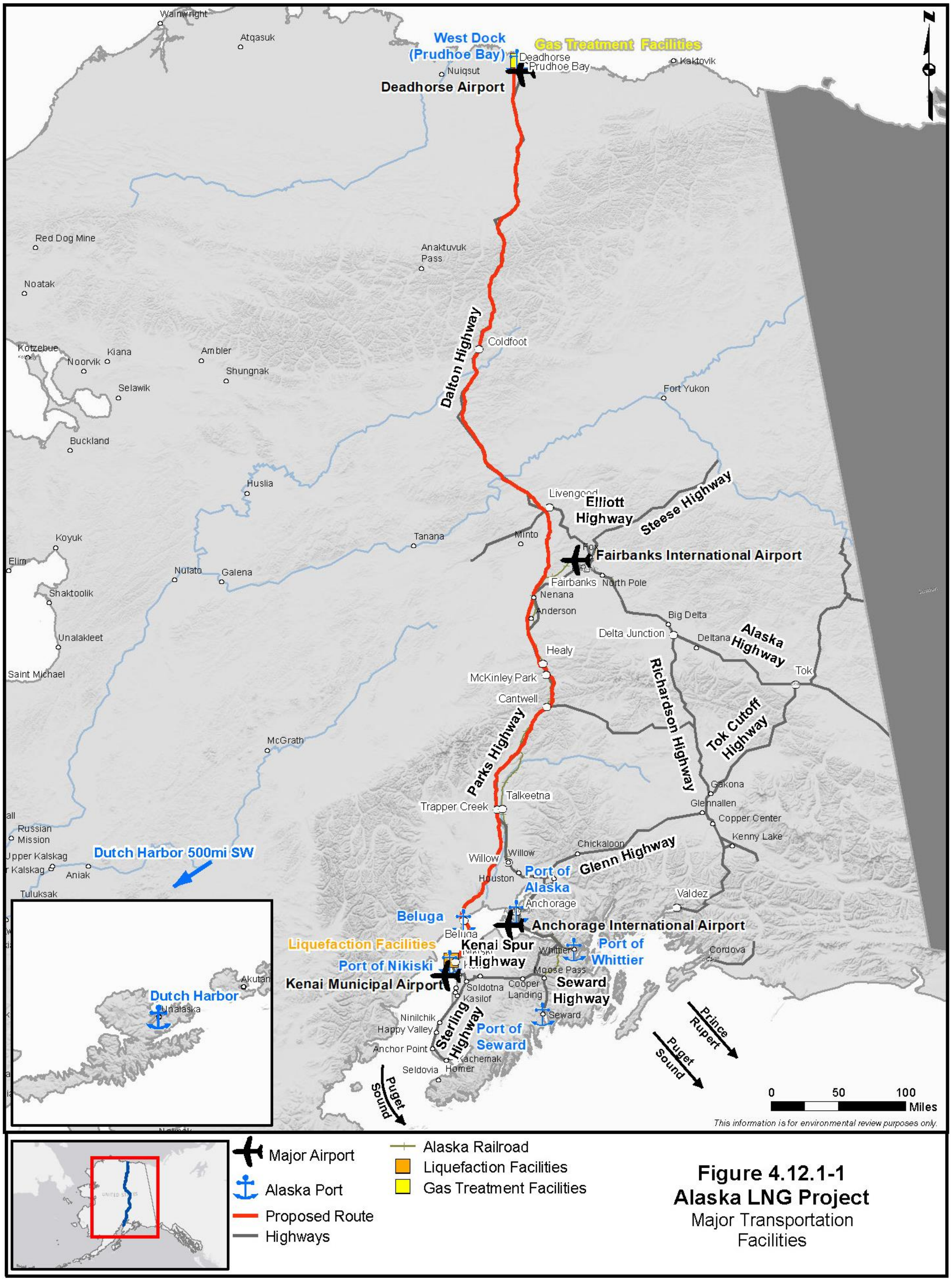


Figure 4.12.1-1
Alaska LNG Project
Major Transportation Facilities

Kenai Spur Highway

The Kenai Spur Highway runs along the shore of Cook Inlet from north of the Captain Cook Recreation Area to Soldotna, where it connects with the Sterling Highway. In Kenai and Nikiski, the Kenai Spur Highway is a multi-lane undivided highway with signalized intersections and turn lanes. Otherwise, the paved road has two lanes with minimal paved shoulders and at-grade intersections. Traffic volumes on the Kenai Spur Highway vary from less than 2,000 vehicles per day in Nikiski to more than 15,000 vehicles per day in Soldotna.

Sterling/Seward Highways

The Sterling Highway (State Route 1) runs along the shore of Cook Inlet from Homer to Soldotna and then east toward the interior of the Kenai Peninsula, where it ends at the Seward Highway at Tern Lake. The Seward Highway (State Route 1 from Anchorage to the Sterling Highway and State Route 9 from the Sterling Highway to Seward) runs from Seward to Anchorage. Together, these highways connect Kenai Peninsula Borough with Anchorage. In Anchorage, the Seward Highway is a multi-lane divided highway with signalized intersections and grade-separated interchanges. In other urban areas, such as Seward, Soldotna, and Homer, the two highways have turn lanes and wider shoulders along with signalized intersections. Otherwise, the two roads generally have two lanes with minimal paved shoulders and at-grade intersections.

Traffic volumes on the Sterling and Seward Highways vary. The Sterling Highway carries more than 22,000 vehicles per day in Soldotna, but generally carries less than 5,000 vehicles per day on other parts of the Kenai Peninsula. The Seward Highway's highest traffic volumes, at more than 57,000 vehicles per day, are in Anchorage.

4.12.1.2 Rail Network

The Alaska Railroad has provided passenger and freight rail service in south-central Alaska since its completion in 1923. The ARRC is an independent entity of the State of Alaska that operates the Alaska Railroad but receives no operating funds from the state. The Alaska Railroad system includes 656 miles of rails on its main rail line, branch lines, sidings, and rail yards. Figure 4.12.1-2 shows the ARRC's facilities. The Alaska Railroad's main rail line runs between Seward on the Kenai Peninsula and Fairbanks, generally paralleling the Glenn and Parks Highways north of Anchorage. Branch lines serve Palmer, Suntrana, Eielson Air Force Base, and Anchorage and Fairbanks International Airports (ADOT&PF, 2016).

The ARRC owns 51 locomotives, 44 passenger cars of various types, and 485 freight cars (of which 409 are uncovered or covered hopper cars designed to carry bulk materials). It also hauls privately owned rail cars, including about 300 freight cars (primarily owned by the Flint Hills Refinery) and 24 passenger cars owned by cruise ship companies that call on Seward (ADOT&PF, 2016).

The railroad is an important freight transportation mode during seasons when barges are unable to access the North Slope. Cargo from barges can be off-loaded at the ice-free ports of Seward, Whittier, or Anchorage, transported by rail to Fairbanks, and then off-loaded onto commercial trucks that travel the Dalton Highway for delivery to the North Slope.

Freight transportation on the Alaska Railroad declined from about 5.6 million tons in 2012 to 3.7 million tons in 2016 due in part to decreased North Slope oil and gas activities and decreased global demand for coal. As a result, ARRC reported a 16-percent drop in freight revenues between 2015 and 2016, resulting in a net loss of $4.4 million (ARRC, 2017b). Passenger ridership on the Alaska Railroad increased from about 415,000 in 2012 to 490,000 in 2016. According to the ADOT&PF (2016), rail passenger traffic in Alaska is linked to visitors to the state and heavily concentrated during the May to September peak tourism period (ARRC, 2017b).

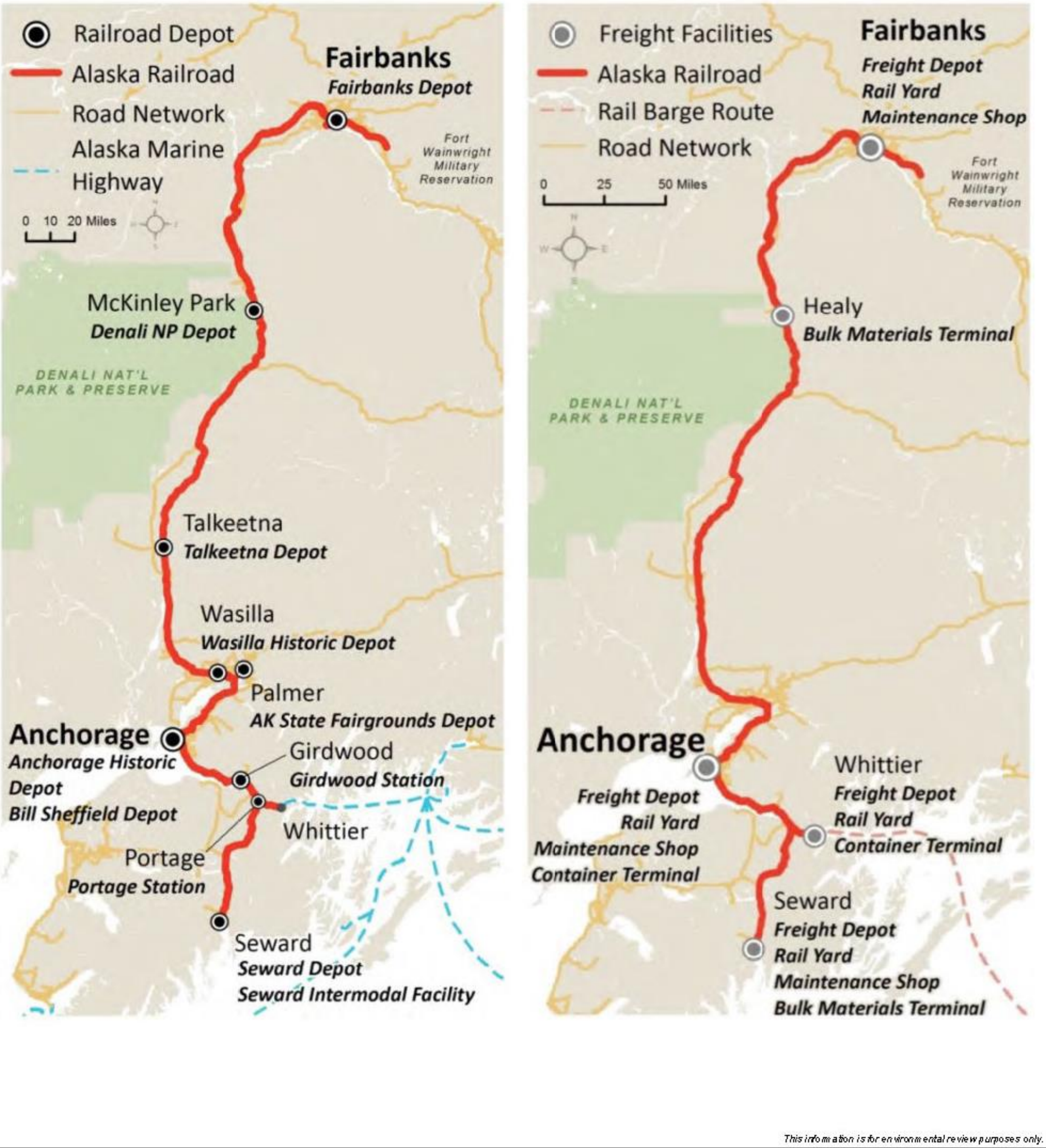


Figure 4.12.1-2
Alaska LNG Project
Alaska's Railroad Facilities:
Passenger (Left) and
Freight (Right) Facilities

4.12.1.3 Marine Transportation

Marine ports are a main point of entry for materials entering Alaska. AGDC would use six existing ports, harbors, or landings (referred to as "primary ports" in AGDC's application) during Project construction (see Figure 4.12.1-1). AGDC would construct a new Mainline MOF adjacent to the existing Beluga Landing facility, but would not use Beluga Landing itself (Beluga Landing is included in this section for reference). Although not a formal term, a "landing" typically refers to a marine cargo facility without dock or quay structures, generally used by light-draft vessels. Table 4.12.1-2 summarizes characteristics of the marine port facilities AGDC would use for the Project.

Table 4.12.1-2

Characteristics of Ports, Harbors, and Landings Used by the Project

Harbor, Port, or Landing	Primary Freight Type	2017 Freight (short tons) [a]
Port of Alaska [b]	Petroleum products, manufactured equipment, machinery, and products	3,297,897
Beluga Landing (existing) [c]	—	—
Port of Dutch Harbor	Seafood/petroleum products	1,816,7526
Port of Nikiski	Crude oil/other petroleum products	4,668,736
Point Thomson Marine Facilities	Construction materials, petroleum products	—
Prudhoe Bay West Dock	Construction materials, petroleum products	—
Port of Whittier	Petroleum products, food and farm products, manufactured equipment, machinery, and products/manufactured goods	487,148
Port of Seward	Coal/manufactured equipment, machinery, and products/manufactured goods	76,493

Source: COE, 2018d

[a] A "—" indicates that the measure is unavailable.

[b] The Port of Anchorage changed its name to the Port of Alaska on October 24, 2017.

[c] AGDC would construct a new Mainline MOF adjacent to the existing facilities at Beluga Landing, but would not use the Beluga Landing facility itself. Beluga Landing is included for comparison, and due to proximity to the Mainline MOF.

Ports, Harbors, and Landings

Table 4.12.1-3 provides vessel call data for the six ports, harbors, and landings that the Project would use during construction as well as data for Beluga Landing, to which the Mainline MOF would be adjacent. As referenced in the table, light-draft vessels have a draft of 6.6 feet or greater, but less than 26.2 feet, while deep draft vessels have a draft of 26.2 feet or greater. The cited vessel call data does not include fishing vessels less than 164 feet in length, other vessels less than 33 feet in length, or local vessels such as docking tugs, tour boats, and fishing charters. The Port of Alaska is the state's most diverse port and handled more than 3 million tons of cargo in 2016. The Port of Nikiski handles more than 4.7 million tons of cargo per year, the majority of which is crude oil and other petroleum products.

As shown in table 4.12.1-3, while ports such as Dutch Harbor, Nikiski, and Alaska host a variety of vessel types, most of the ports proposed for use by the Project focus on one or a small number of specialized marine activities. For example, Dutch Harbor is a focal point for fishing vessel activity. The Port of Alaska is the state's primary port for deep-draft cargo and tanker vessel calls, the Port of Seward has a concentration of passenger vessel activity, and the Port of Nikiski has a concentration of activity for supply vessels for offshore oil and gas rigs. The sections below describe existing facilities and activities as well as planned upgrades at each primary port (none of the planned upgrades are specifically intended to support the Project).

TABLE 4.12.1-3

Number of Vessel Calls in 2014 to Primary Ports, Harbors, and Landings [a]

Harbor/Port/ Landing	Draft	Tanker	Cargo	Offshore Supply Vessel	Passenger	Tug with Barge	Tug without Barge [a]	Government	Other	Fishing	Total
Port of Alaska	Light	0	3	0	0	118	17	3	1	0	142
	Deep	15	207	0	4	0	0	0	3	0	229
Beluga Landing [b]	Light	0	0	0	0	160	0	0	0	0	160
	Deep	0	0	0	0	0	0	0	0	0	0
Port of Dutch Harbor	Light	0	215	0	18	114	88	37	66	825	1,363
	Deep	14	167	0	1	0	0	4	0	45	231
Port of Nikiski [c]	Light	0	18	281	0	50	60	0	54	0	463
	Deep	86	0	0	0	0	0	0	0	0	86
Prudhoe Bay West Dock	Light	0	13	0	1	15	0	0	0	0	29
	Deep	0	0	0	0	0	0	0	0	0	0
Port of Whittier	Light	0	27	0	404	95	44	2	5	0	577
	Deep	0	0	0	35	0	0	0	2	0	37
Port of Seward	Light	0	7	4	28	91	38	4	33	0	205
	Deep	0	7	0	25	0	0	1	0	0	33

Source: COE, 2013c

[a] Number of vessel calls only includes vessels equipped with Automated Identification System transmitters. Fishing vessels less than 164 feet in length and other vessels less than 33 feet in length are excluded.

[b] AGDC would construct a new Mainline MOF adjacent to the existing facilities at Beluga Landing, but would not use the Beluga Landing facility itself. Beluga Landing is included for comparison and for its proximity to the Mainline MOF.

[c] Includes tugs for which it could not be determined whether a barge was present.

Port of Alaska

The Port of Alaska is a regional port at the head of Cook Inlet along the Knik Arm in Anchorage and the largest and highest-capacity deep-draft point of entry for Alaska. The Municipality of Anchorage owns and operates the port profitably; the port generates enough revenue to support its operation and pay its municipal annual fee (Port of Alaska, 2018). The port provides direct connections to the Ted Stevens Anchorage International Airport (Anchorage International Airport), Alaska's highway system, the Alaska Railroad, and adjacent (off-port) industrial parks and tank farms. Table 4.12.1-4 describes the existing facilities at the Port of Alaska. In addition to these facilities, the Port of Alaska has 84 acres of land that it could develop for future uses (Moffatt & Nichol, 2014).

The Port of Alaska handles 90 percent of the consumer goods serving about 87 percent of the State's population (Moffatt & Nichol, 2014). More than 3 million tons of cargo passed through the Port of Alaska in 2016. In the decade ending in 2014 (the most recent year for which detailed data are available), unitized shipments (i.e., vans, flats, and containers) accounted for 37 to 52 percent of total annual imports and exports by weight (Moffatt & Nichol, 2014). Between 2007 and 2016, container cargo ships delivered an annual average of 1.86 million tons of freight to the port, or about 140,000 40-foot equivalent units (FEU) (Port of Alaska, 2017b). Containerized and other cargo ships typically arrive twice weekly throughout the year. Cranes and RO/RO transfer bridges are used to offload containers. Two carriers (shipping companies) provide commercial ship transportation service between Anchorage and the Port of Tacoma: Matson, which provides container service, and Totem Ocean Trailer Express, Inc. (TOTE) Maritime, which provides RO/RO service.

TABLE 4.12.1-4 **Facilities at the Port of Alaska**					
Facility Name	Berthing Space (linear feet)	Depth (feet)	Facility and Storage Description	Purpose	Operator
Port of Alaska Terminal No. 1 Wharf	2,800 (combined, all facilities at Port of Alaska)	35 (minimum for all facilities at the Port of Alaska)	Silo storage (20,000 tons)	Receipt of bulk cement	Alaska Basic Industries
Port of Alaska Terminal No. 2 Wharf			Open storage (37 acres)	Receipt and shipment of containerized and non-containerized general cargo	CSX Lines of Alaska (Matson)
Port of Alaska Terminal No. 3 Wharf			Open storage (17 acres)	Receipt and shipment of RO/RO cargo and general cargo	TOTE
Port of Alaska, Petroleum, Oil, and Lubricants Terminals 1 and 2			Berthing and pipelines extending to tank storage (66 tanks)	Receipt and shipment of petroleum products	Municipality of Anchorage

Source: NOAA, 2017h

The Port of Alaska began modernization efforts in 2017. The modernization is scheduled to be completed in 2024, but funding limitations could delay the completion date (Port of Alaska, 2016). Planned projects include replacing cargo Terminals 2 and 3, improving the seismic resilience of the port, replacing existing infrastructure and incorporating modern technology, and adding three new ship-to-shore cranes that would allow the port to accommodate larger container vessels. As part of its modernization program, the Port of Alaska is planning to construct a new rail spur connecting the existing dry barge berth with the end of the Alaska Railroad's rail line and installing new gantry cranes to transfer containers or chassis to the rail (Port of Alaska, 2018).

Navigation into the Port of Alaska is difficult in the winter due to the combination of currents and ice floes (NOAA, 2017h). As a result, much of the Port of Alaska's winter vessel traffic is comprised of twice-weekly container ship calls. As Cook Inlet becomes ice-free in the spring, tugs and barges with freight and fuel also begin to call at the port along with tanker vessels. These additional vessel calls continue through the summer before dropping off with the onset of ice floes during the late fall.

Beluga Landing

Beluga Landing is a barge landing site in Beluga, near Tyonek, west of Anchorage. The landing, owned by the Kenai Peninsula Borough, provides an offloading point for equipment and supplies for the electric power plant and natural gas fields at Beluga, as well as the domestic needs for area residents. The Project would not use the existing Beluga Landing, but AGDC would construct the Mainline MOF adjacent to the existing facility. The information on the existing Beluga Landing facility provided below characterizes existing activity and conditions near the Beluga MOF location.

Beluga Landing is a manmade cut in the existing bluff with a single RO/RO facility, consisting of an 80-foot-wide landing area with no dock. Users maintain the landing before each vessel call. The landing is not available during the winter months due to ice. When in use, tides restrict the offloading time for barges to about 1 to 3 hours during high tide. The landing includes a 5-acre unpaved onshore laydown area that is fully occupied by current users during the normal barging season. Beluga Landing has road connections to Beluga Highway, the local road that provides service to the area around Beluga and Tyonek (this road system is isolated from the major roads described in section 4.12.1.1). A sharp and steep curve in the landing's access road restricts the equipment that can be loaded or offloaded to 65 feet or less in length.

Port of Dutch Harbor

The Port of Dutch Harbor is on the Island of Unalaska, the westernmost major island in the Aleutians West Borough. As shown in table 4.12.1-2, Dutch Harbor (including facilities owned by the City of Unalaska, as well as private facilities in and around Dutch Harbor) is the center of a major commercial fishing industry centered on various species harvested in the Bering Sea and adjacent waters, and is the top fishery export port of record for the United States. Aside from commercial fishing, Dutch Harbor hosts a wide variety of other marine activity. Tug and barge companies offer regularly scheduled barge service between the port, Tacoma, and Anchorage. American President Lines has a separate containership dock and provides service to Asian ports from the Port of Dutch Harbor. Two container shipping companies provide weekly service to the port.

The City of Unalaska's Department of Ports and Harbors operates several marine facilities at the Port, including two that AGDC would use for Project construction: the Unalaska Marine Center and the Light Cargo Dock (see table 4.12.1-5), which are accessible by the island's road network.

TABLE 4.12.1-5

Facilities at the Port of Dutch Harbor

Facility Name	Berthing Space (linear feet)	Depth (feet)	Facility and Storage Description	Purpose	Operator
Unalaska Marine Center	2,051	40	Covered storage (6,000 square feet); open storage (1,500 containers); 30- and 40-ton crane and rail system.	Receipt and shipment of containerized general cargo; landing for passenger and vehicular ferry.	Various
Light Cargo Dock	340	25	General storage, parking, and work area [a]	Handling supplies and equipment.	City of Unalaska

Source: City of Unalaska, 2018 (except where noted)
[a] Source: City of Unalaska, 2006

Port of Nikiski

Several oil refineries are located in the Port of Nikiski and they process oil from the North Slope. Port Nikiski's docks also support offshore drilling, which expanded following the discovery of oil in the Kenai Peninsula during the late 1950s.

The Port of Nikiski is not a single onshore facility, but rather the collective term applied to privately owned and operated wharves and piers on the Kenai Peninsula north of Kenai, each of which is generally associated with either an onshore or an offshore industrial use.[101] The port has direct access to Anchorage and the Alaska mainland via the Kenai Spur, Sterling, and Seward Highways. Table 4.12.1-6 describes the docks in the port.

[101] A wharf is "a structure built along or at an angle from the shore of navigable waters so that ships may lie alongside to receive and discharge cargo and passengers," while a pier is "a structure (such as a breakwater) extending into navigable water for use as a landing place or promenade or to protect or form a harbor" (Merriam-Webster, Inc., 2018b).

TABLE 4.12.1-6 **Facilities at the Port of Nikiski**					
Facility Name	Berthing Space (linear feet)	Depth (feet)	Facility and Storage Description	Purpose	Operator
Nikiski Wharf (Agrium)	1,135	45	T-head pier with bulk urea loading tower, anhydrous ammonia pipelines, hose-handling derricks, 2-ton utility hoist, 125,000 square feet of covered storage, and ammonia storage tanks (85,000-ton capacity).	Shipment of anhydrous ammonia and dry bulk urea	Agrium U.S., Inc.
Kenai LNG Dock	1,050	40	Berthing and LNG pipelines connected to three onshore storage tanks (capacity not available).	Shipment of LNG	Phillips Petroleum Co.
Nikiski Wharf (Kenai Pipe Line)	1,310	42	Berthing and LNG pipelines to 21 onshore storage tanks (3,516,000-barrel total capacity).	Receipt of crude oil and shipment of petroleum products	Kenai Pipe Line Co.
Rig Tenders Marine Terminal [a]	2,100	4.5 [b]	40-ton mobile crane; two 15-ton forklifts; landing craft loading ramps; 45,000 square feet of warehouse storage; 8 acres of unpaved dockside storage; 14 acres of unpaved upland storage.	Handling material and equipment for offshore oil wells	APC Natchiq

Sources: NOAA, 2017h and COE, 2005 (except where noted)
[a] Source: ASRC, 2018
[b] Reflects low-water depth, deeper during high tide.

Port of Whittier

The Port of Whittier is an ice-free, deep-draft port on Prince William Sound with depths of up to 45 feet (NOAA, 2017h). The port connects by highway to Anchorage and is served by ARRC freight and passenger trains. The freight dock serves RO/RO barges and has a side ramp for container offloading from barges.

Alaska Marine Lines and Canadian National Railway via Foss Maritime service Whittier. Alaska Marine Lines provides weekly container and rail barge service from Seattle. Barge capacity is 400 to 450 FEUs, while rail barges have the ability to carry up to 48 standard rail cars or 29, 90-foot flatcars, plus up to 132 FEUs on the racks. Canadian National services Whittier from Prince Rupert, British Columbia with “Aquatrain”/rail barge service. The Aquatrain sails about every 15 days with each sailing having the capacity to carry 40 to 46 standard rail cars or 29, 90-foot flatcars. The freight barge slip operated by the ARRC includes a 40-ton crane (NOAA, 2017h) and two 34-foot dock structures alongside the slip to facilitate unloading with forklifts (ARRC, 2011).

The rail yard is currently at capacity for freight and passenger train operations and also stores southbound freight cars prior to barge arrival and offloading. When barges arrive, freight cars are unloaded onto tracks in the rail yard, after which the waiting cars can be loaded for transport south. Additional land at the port serves as a staging area where flat cars are unloaded and containers are stacked prior to being loaded onto barges for transport out of Alaska (City of Whittier, 2012).

The port is connected to the Alaska Highway and rail systems by the Anton Anderson Memorial Tunnel and Portage Tunnels. These tunnels do not have adequate height to allow double-stack container railcars. The Anton Anderson Tunnel serves rail and road traffic on an alternating basis (rail and road vehicles traveling in opposite directions must take turns). Most ARRC freight trains operate during the evening hours when the tunnel is closed to vehicle traffic. Trains could also operate during the 15-minute period between vehicle traffic openings (ADOT&PF, 2017).

Port calls at Whittier occur through the year as tugs and barges offload freight for Anchorage and other locations in south-central Alaska. Increased summer activity is the result of more frequent activity by Alaska Marine Highway System ferries, cruise ships, and excursion vessels. As shown in table 4.12.1-3, freight activity comprises less than 5 percent of vessel calls at the Port of Whittier. Passenger vessels, primarily cruise ships, comprise more than 70 percent of the total light and deep-draft vessel calls at the port. Tugs with and without barges comprise nearly 23 percent of Whittier vessel traffic, while government and other vessel calls account for the remainder.

West Dock Causeway

The West Dock Causeway is a private dock facility owned and operated by the working interest owners of BP Exploration (Alaska), Inc., ExxonMobil, ConocoPhillips, and Chevron on the western shore of Prudhoe Bay. It was constructed following the 1968 discovery of oil in Prudhoe Bay to transport oilfield supplies and equipment to the Prudhoe Bay area. The West Dock Causeway is an about 2.2-mile-long, gravel causeway that extends into Prudhoe Bay and has the following two unloading facilities:

- Dock Head 2 is about 4,000 feet from shore and has a draft of 4 to 6 feet; and
- Dock Head 3 is about 9,000 feet from shore and has a draft of 8 to 10 feet.

In 1981, an extension elongated the causeway an additional 5,010 feet to its current length to accommodate the construction of a seawater treatment plant, but this extension does not include unloading facilities. Because the West Dock is not a deepwater port, cargo ships and oceangoing barges typically use shallow-draft or medium-draft barges to transport cargo, and people, to shore. Arrival and offloading occur during the ice-free window, which generally runs from about August through September. A 45-foot-wide haul road moves materials and equipment off the causeway to industrial facilities in the Prudhoe Bay area. The West Dock Causeway includes about 3 acres of land leased by ExxonMobil for materials staging (BLM, 2012).

Activity occurs at the West Dock Causeway during each summer (ice-free) sealift season, which involves movement of supplies and components by vessel. In addition to offloading, activities at the West Dock Causeway include dock and causeway maintenance and erosion control activities, and ADF&G and NMFS monitoring of the seawater treatment plant. A checkpoint at the onshore end of the West Dock Causeway recorded 20,000 vehicle trips from the start of July through mid-October in 2010 (an average of 210 vehicles daily), along with an average of 270 people per day.

Port of Seward

The Port of Seward is an ice-free, deepwater port about 125 miles south of Anchorage at the southern end of the Seward Highway. Built as the Alaska Railroad's original marine terminal between 1917 and 1922 (ARRC, 2014), the port serves cruise ships, exports bulk coal mined in Alaska, and connects with the Alaska Railroad, which owns the major industrial and cruise ship docks. The Alaska Railroad terminus on the waterfront enables intermodal connections to Anchorage and Fairbanks. Table 4.12.1-7 describes the Alaska Railroad port facilities in Seward. In addition to cargo and cruise ships, Seward is a popular base for commercial recreational and excursion vessel trips, such as whale watching (section 4.6.3 discusses marine mammals) and sightseeing.

TABLE 4.12.1-7 **Facilities at the Port of Seward**					
Facility Name	Berthing Space (linear feet)	Depth (feet)	Facility and Storage Description	Purpose	Operator
Alaska Railroad Freight Dock	570	35	Cargo mooring facilities; unpaved 3-acre on-dock storage area, with on-dock Alaska Railroad rail lines	Receipt and shipment of containerized and non-containerized general cargo; ferry landing; available for passenger ships, as needed	Alaska Railroad
Alaska Railroad Passenger Dock	1,470	35	Terminal for deep-draft passenger cruise liners; 3-acre paved dock surface; 24,000-square-foot terminal and intermodal connection facility for passengers (rail, bus, pedestrian [to downtown Seward], and automobile)	Mooring cruise ships	Alaska Railroad
Seward Loading Facility (Coal Dock)	1,763	52	Stationary ship loader with conveyor system; railcar dumping system	Coal export	Hyundai Merchant Marine America, Inc.
Sources: NOAA, 2017h; ARRC, 2014					

The Alaska Railroad dock facilities in Seward (including freight and passenger docks and the Seward loading facility, as well as contiguous onshore facilities) encompass about 75 acres with more than 130,000 people and more than 2 million tons of cargo transiting via the Alaska Railroad dock facilities annually (ARRC, 2014). The demand for berthing at the freight dock exceeds current availability (ARRC, 2014). Current plans call for creating additional laydown space near the dock area, widening and lengthening the freight dock, and extending tracks and utility service to the expanded freight dock. The Divide Tunnel, along the Alaska Railroad north of Seward, does not have adequate clearance for double-stack container railcars (ADOT&PF, 2016), a restriction that limits the amount of cargo that can be hauled in and out of Seward by rail.

Peak vessel activity in Seward occurs in the summer when cargo, cruise, and excursion vessel activities are at their highest. In addition, tug and barge traffic increases in the spring months as construction companies prepare for the summer construction season. Small (less than 164 feet in length) commercial fishing vessels operate from the port during the summer, harvesting salmon in Resurrection Bay.

Secondary Ports and Harbors

AGDC's application, and subsequent responses to our comments, identified ten "secondary" ports and harbors: the Ports of Adak, Homer, Nome, Skagway, Valdez, and Whittier, as well as Port MacKenzie, the Badami and Oliktok Landings, and the Point Thomson Marine Facilities. These secondary ports are not included in the Project's execution plans, and AGDC has subsequently stated that it does not intend to use secondary ports for Project construction except to address unforeseen events, such as extreme weather or equipment failures at one or more of the ports, harbors, or landings described in this section. Accordingly, we do not discuss secondary ports further in this EIS.

Marine Shipping Channels and Navigation Areas

Table 4.12.1-8 provides information on the shipping channels providing access to the ports that could be affected by Project-related transportation construction and operation. Figure 4.12.1-3 shows these shipping channels. Except for dockside areas, most of the channels listed in table 4.12.1-8 can accommodate deep-draft vessels, even at low tide. The vessel traffic volumes reflect the location of Alaska's major ports (i.e., higher volumes for Cook Inlet, which serves Anchorage and Nikiski, and the highest volumes near Dutch Harbor). Since 1995, the Coast Guard has typically activated "Phase I" measures for ice conditions (indicating the potential presence of sea ice or icing conditions that could affect vessel navigation and safety) in Upper Cook Inlet in late November or early December. The Coast Guard typically deactivates these measures in late March or early April (Coast Guard, 2017b; Cook Inlet Harbor Safety Committee, 2017).

TABLE 4.12.1-8

Characteristics of Navigation Channels and Fairways Affected by the Project

Navigation Channel/Fairway	Area	Controlling Depth (mean lower low water)	Primary Vessel Traffic	Monthly Vessel Traffic Volume	
				Average	Peak
Beaufort Sea/Prudhoe Bay	North Slope Borough	4 feet in best access route	Tugs/barges, launches	2.4	21.0
Bering Sea/Norton Sound	Nome Census Area	6–7 fathoms 1 mile off beach; 22 feet alongside City Dock	Fishing vessels, tugs / barges, landing craft	NA	NA
Upper Cook Inlet/Approach channel north of Fire Island	Matanuska-Susitna Borough	28.5 feet in approach channel	Bulk cargo ships	0.7	4.0
Upper Cook Inlet/Approach channel north of Fire Island	Municipality of Anchorage	28.5 feet in approach channel	Container ships, tugs/barges	30.9	42.0
Prince William Sound/ Valdez Arm	Valdez-Cordova Census Area	Valdez Marine Terminal Berth 5: 85 feet; ferry dock: 20 feet; City Dock: 50 feet: other berths: 90 feet	Fishing vessels, crude oil tankers, ferries	61.1	106.0
Prince William Sound/Passage Canal	Valdez-Cordova Census Area	Ocean Dock: 27-30 feet; DeLong Pier: 45 feet; ferry terminal: 18 feet;	Fishing vessels, tugs / barges, cruise ships	51.2	91.0
Upper Cook Inlet (Nikiski)	Kenai Peninsula Borough	Agrium Dock: 38 feet; Kenai LNG dock: 40 feet; Kenai Pipeline Company dock: 42 feet	Tankers, barges, LNG carriers, fishing vessels	45.8	78.0
Resurrection Bay	Kenai Peninsula Borough	Alaska Railroad dock: 35 feet; coal terminal: 58 feet	Fishing vessels, cruise ships, bulk cargo ships	19.8	46.0
Kennedy Entrance/Lower Cook Inlet/Kachemak Bay	Kenai Peninsula Borough	Homer Cargo Dock: 20-40 feet	Ferries, offshore supply vessels, tugs / barges, fishing vessels	27.5	112.0
Iliuliuk Bay/Iliuliuk Harbor/ Captains Bay	Aleutians West Census Area	25 feet in entrance channel	Fishing vessels, container ships	132.8	192.0

Sources: NOAA, 2017h; COE, 2013c; Nuka Research, 2015a
NA = Not available

Figure 4.12.1-3
Alaska LNG Project
Navigation Channels and Fairways

4.12.1.4 Air Transportation

Air transportation comprises an important component of Alaska's overall transportation system by linking communities with little or no other road or water access to the remainder of the state. Components of the state's air transportation system range from major international airports used by passenger and cargo jets to unpaved airstrips used by aircraft and waterbodies used by seaplanes. Table 4.12.1-9 provides an overview of the characteristics of airports and airstrips proposed to be used by the Project for fixed wing (airplane) and rotary wing (helicopter) air travel. These identified facilities are owned and maintained by the state or municipalities and are available for public use, except for Prospect Creek Airstrip, which is a private airstrip that supports TAPS operations; Cantwell Airstrip, which is a private airstrip but is available for public use; and Beluga Airstrip and Point Thomson Airstrip, which are private airstrips used by ConocoPhillips and ExxonMobil, respectively.

TABLE 4.12.1-9

Characteristics of Airports Affected by the Project

Airport, Airfields, and Heliports	Gravel/ Asphalt	Maximum Runway Length (feet)	2016 Total Operations (number of flights) [a]	Commercial Air Traffic Volume (2016) [b]	
				Passengers (no.)	Cargo (tons)
Anchorage International Airport	Asphalt	12,400	261,961	2,519,683	3,400,141
Beluga Airstrip	Gravel	5,002	NA	NA	NA
Cantwell Airstrip	Gravel	2,080	2,350	NA	NA
Chandalar Shelf Airstrip	Gravel	2,529	11,300	29	NA
Coldfoot Airstrip	Gravel	4,001	1,000	478	2,143
Deadhorse Airport	Asphalt	6,500	32,912	42,911	36,102
Fairbanks International Airport	Asphalt	11,800	119,898	516,796	112,843
Galbraith Lake Airport	Gravel	5,182	351	NA	174
Homer Airport	Asphalt	6,701	48,091	43,436	10,979
Kenai Municipal Airport	Asphalt	7,830	38,960	92,374	23,490
Livengood Camp Airstrip	Gravel	3,000	100	NA	NA
Nenana Municipal Airport	Asphalt	4,600	6,000	NA	53
Point Thomson Airstrip	Gravel	5,000	NA	NA	NA
Prospect Creek Airstrip	Gravel	4,968	498	NA	124
Seward Airport	Asphalt	4,533	10,510	NA	1
Summit Airstrip	Gravel	3,814	834	NA	NA
Talkeetna Airport	Asphalt	3,500	30,000	NA	<1
Willow Airport	Gravel	4,400	15,815	NA	NA

Sources: FAA, 2018; GCR, Inc., 2018; DOT, 2018
NA = Not available
[a] An operation is one flight, either inbound or outbound.

Anchorage International Airport is the state's largest hub for passenger and cargo air traffic and is among the world's busiest cargo airports. In 2015, Anchorage International Airport handled more than 3.4 million tons of cargo, the fourth highest in the world behind only Hong Kong, Memphis, and Shanghai (Airports Council International, 2016). Fairbanks International Airport is the air gateway to interior, northern Alaska, and is the second-busiest airport in the state for passengers and cargo. Deadhorse, Homer, and Kenai are regional airports that host service by commercial air carriers. The airports listed above are generally able to accommodate helicopters.

4.12.2 Impacts and Mitigation

Project construction and operation would potentially affect vehicular, rail, marine, and air traffic due to the movement of construction materials, personnel, and supplies by road, rail, air, and marine vessels. Construction impacts would include increased traffic volumes, and potential increases in congestion or traffic delays, along with corresponding increases in traffic safety risks. Impacts could also occur during construction across, or adjacent to, roads and rail lines. Operational impacts would be primarily related to LNG carrier activities at the Liquefaction Facilities.

4.12.2.1 Road Network

Table 4.12.2-1 summarizes the key Project-related use of the major highways described in section 4.12.1.1. Construction of the Mainline Facilities would require the use of 621 access roads to link work areas to the major highways. Of that total, 130 existing roads would be used as-is, 28 existing roads would require upgrades such as widening or addition of gravel, and 463 new access roads would be built. Of the new access roads, 15 would be used during Project operation; the remainder would remain in place after construction unless removal of a road is requested by the landowner. The Gas Treatment Facilities would include a permanent access road, emergency egress road, and service road connecting the GTP to the water reservoir and gravel mine. AGDC states that it would use existing roads for the GTP access road to the extent practicable. Access to the Liquefaction Facilities would be directly via the Kenai Spur Highway.

TABLE 4.12.2-1

Project-Related Traffic Increases on Major Roadways During Construction

Highway	Primary Project Activities Generating Vehicular Traffic
Gas Treatment Facilities and Mainline Facilities	
Dalton Highway Steese Highway Elliott Highway Richardson Highway	Truck delivery of materials and equipment from Fairbanks to the North Slope and Mainline Facilities north of Fairbanks. Daily bus transportation of construction workers between construction camps and work areas. Transportation of workers between construction camps and Deadhorse or Fairbanks airports at the beginning and end of each construction season.
Mainline Facilities	
Glen Highway Parks Highway	Truck delivery of materials and equipment from Anchorage and other southern ports to Mainline Facilities or to Fairbanks for delivery further north. Daily bus transportation of construction workers between construction camps and work areas. Transportation of workers between construction camps and Anchorage or Fairbanks airports at the beginning and end of each construction season.
Liquefaction Facilities	
Kenai Spur Highway Sterling Highway Seward Highway	Truck deliveries of materials and equipment from the Ports of Seward and Anchorage to the Liquefaction Facilities. Bus transportation of construction workers from Kenai Airport to the Kenai Construction Camp and daily commuting of construction workers that reside in the area to the Liquefaction Facilities. Relocation of a 1.3-mile-long segment of the Kenai Spur Highway to accommodate the Liquefaction Facilities (see section 4.19).

During the scoping process, we received comments expressing concern about the addition of Project-related traffic to public roads, specifically along the Kenai Spur Highway near the Liquefaction Facilities. Project-related traffic would include employee personal vehicles, employee transport buses, heavy trucks, and pickup trucks or other vehicles used for Project inspection and other activities. These Project-related trips would increase traffic volumes on area roadways.

AGDC would transport construction workers by bus from airports and airstrips to construction camps at the beginning and end of each construction season, a process that would take one or more days depending on the distance of the camp to the airport. The maximum numbers of round trips by bus for these mobilizations and demobilizations would be as follows: 8 for the Gas Treatment Facilities (to and from Deadhorse Airport); 175 for the Mainline Facilities (to and from Deadhorse, Fairbank International, Anchorage International, and Kenai Municipal Airports); and 18 for the Liquefaction Facilities (to and from Kenai Municipal Airport).

Once workers are at the construction camps, AGDC would use buses daily to shuttle workers to and from work areas. Workers would be transported from each of the 46 construction camps associated with the Mainline Facilities to work areas using public roads. Depending on the location of the construction camp and work area, public roads used for each construction spread (as defined in section 2.2.2) would include:

- Spread 1: Dalton Highway;
- Spread 2: Dalton and Elliott Highways;
- Spread 3: Elliott, Steese, and Parks Highways; and
- Spread 4: Parks, Glenn, Seward, Sterling, and Kenai Spur Highways.

A maximum of four buses for each construction camp would be used to transport workers each day to work areas during peak construction. Up to 175 bus round trips per day would be required during peak construction to transport workers to and from work areas for the Mainline Facilities, including 84 buses at the start and end of the daily work period. Because the GTP construction camp is contiguous with the GTP worksite, bus transportation on public roads would not be required during construction of this facility.

During construction of the Liquefaction Facilities, as many as 200 local workers who reside in Kenai Peninsula Borough could commute to the site in personal vehicles each day. This could result in up to 400 daily worker trips on the Kenai Spur, Sterling, and Seward Highways. Because some of the workers at the Liquefaction Facilities would be local residents who currently commute to other job locations using the Kenai Spur, Sterling, and Seward Highways, the Project would likely generate fewer than 400 new worker trips per day on these roads.

Highways and access roads would be used to transport construction equipment and materials from seaports (see section 4.12.2.3) and rail yards (see section 4.12.2.2) to the Project work areas. AGDC expects that peak construction for the overall Project would occur over a 12-month period, but the timing of peak construction activity on specific roads would vary. Table 4.12.2-2 summarizes the projected annual and average daily truck trips on each major highway system in each year of Project construction.

The peak increase in construction trips associated with Mainline Facilities construction on the Glen and Parks Highways, including the truck trips shown in table 4.12.2-2, bus trips, and other construction-related vehicle trips, would occur in Year 6 and would result in an average of 116 construction trips per day. On the Dalton, Steese, Elliott, and Richardson Highways, the peak increase would result in an average of 82 construction trips per day, including trips on the Dalton Highway associated with the Gas Treatment and Mainline Facilities. The Kenai Spur and Sterling Highways would experience an average of at least 123 construction vehicles accessing the Liquefaction and Mainline Facilities per day. Peak activity on the Seward Highway would increase an average of 82 trips per day.

Table 4.12.2-3 shows the increase in existing road traffic volumes based on the peak construction activity described above. Peak activity, the highest Project-related traffic activity, represents the conditions most likely to create traffic congestion and delays, and thus provides the best description of traffic impacts (and associated mitigation measures, if any), even though such conditions would exist for only a portion of the overall construction phase. On highway segments with higher traffic volumes (such as those in Fairbanks and Anchorage), Project-related traffic increases would represent no more than a 3-percent increase in traffic, a change that would not generally be noticeable on a daily basis. The same numerical increase in traffic on less-traveled road segments, such as the Dalton Highway, would be more noticeable due to lower existing use.

TABLE 4.12.2-2

Annual Truck Trips Generated by Project Construction

Highway	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Dalton/Steese/ Elliott							
Annual	9,100	12,500	15,000	15,000	15,000	14,400	3,400
Average Daily	25	34	41	41	41	39	9
Glenn/Parks							
Annual	15,200	22,200	22,500	22,900	22,900	26,300	5,400
Average Daily	42	61	62	63	63	72	15
Sterling/ Kenai Spur							
Annual	22,500	22,500	33,800	45,000	45,000	45,000	11,300
Average Daily	61	62	93	123	123	123	31
Seward							
Annual	15,500	17,300	24,000	29,000	29,000	30,100	7,200
Average Daily	42	47	66	79	79	82	20

TABLE 4.12.2-3

Project-Related Road Traffic Volume Increases

Highway	Annual Average Daily Traffic (2015) [a]		Project-Related Average Daily Traffic During Peak Years	Percent Increase	
	Minimum	Maximum		vs. Minimum Annual Average Daily Traffic	vs. Maximum Annual Average Daily Traffic
Dalton Highway	147	294	82	51	28
Steese Highway	3,178	24,234	82	3	< 1
Elliott Highway	364	1,191	82	23	7
Richardson Highway, Fairbanks	20,683	20,683	82	< 1	< 1
Glenn Highway	29,362	65,270	116	< 1	< 1
Parks Highway	988	34,753	116	12	< 1
Kenai Spur Highway	1,860	15,622	123	7	< 1
Sterling Highway	3,183	22,846	123	4	< 1
Seward Highway	1,611	57,076	82	5	< 1

Sources: ADOT&PF, 2017, 2018a

[a] Numbers indicate the lowest and highest AADT observed on each road.

Project-related traffic volume increases on major highways would occur year-round. Project-related traffic would generally comprise a small share of traffic. The daily traffic listed in table 4.12.2-3 would be distributed throughout a day; as a result, only a few Project-related vehicle trips would occur at any given time. The Project would add an average of about 3.4 trips per hour on the Dalton, Steese, Elliott, and Richardson Highways; about 5.1 trips per hour on the Kenai Spur, Sterling, and Seward Highways; and about 4.8 trips per hour on the Glenn and Parks Highways (assuming 24-hour construction activity). While Project-related traffic would represent a 28- to 51-percent increase on the Dalton Highway and 7- to 23-percent increase on portions of the Elliott Highway, these roads are generally uncongested, particularly in rural areas. For example, the Dalton Highway's current AADT volume of 294 vehicles is equivalent to

12 to 13 vehicles per hour (assuming 24-hour travel), or one vehicle every 5 minutes. The traffic on the Dalton Highway would increase from 12 to 13 vehicles per hour to about 15 to 16 vehicles per hour or one every 4 minutes. The incremental, Project-related change in traffic volumes on other highways listed in table 4.12.2-3 would be similarly minimal. Additionally, AGDC states that it does not anticipate and is not requesting Project-related road improvements to accommodate vehicles that exceed existing size or weight standards. Accordingly, we find that Project traffic would not contribute to traffic congestion or delays.

AGDC proposes to close lanes along the Dalton and Parks Highways where Mainline Pipeline construction would be in close proximity to these roads. These locations include MPs 244.3 to 244.9, 242.2 to 242.4, and 235.0 to 235.6 on the Dalton Highway, and MPs 532.1 to 532.2 and 536.2 to 538.6 on the Parks Highway near the Nenana River Gorge. As shown in table 4.12.1-1, existing traffic volumes in these areas are generally low. Closures on the Dalton Highway would occur as part of Mainline Facilities construction in Year 3. AGDC would develop detailed construction schedules as part of construction execution plans, but the lane closures on the Dalton Highway could last for all of Year 3. Lane closures would be scheduled for nighttime and advertised in advance. As discussed in section 4.9.4, construction of the Mainline Facilities along the Parks Highway would occur in the fall of Year 1 between MPs 532.1 and 536.2, and in the summer and fall of Year 1 between MPs 536.2 and 538.6. No alternate routes are available in these areas; therefore, the lane closures on the Parks Highway could lead to traffic delays. Assuming that the closures are advertised far enough in advance to allow road users to make alternate plans (i.e., delaying travel), traffic delays due to Project-related road closures would be short term and less than significant.

The Mainline Pipeline would cross 128 public and private roads. A detailed list of the road crossings and the crossing methods are provided in appendix T. The Dalton, Elliot, and Parks Highways would be crossed using the conventional horizontal bore method, which would avoid traffic interruption. Other roads would be crossed using the open-cut method and would require temporary road closures. Descriptions of the horizontal bore and open-cut construction techniques are provided in section 2.2.2. Where lane closures and open-cut crossing methods would be used, AGDC would establish detours, where possible, or keep one lane open for traffic. Steel plates would be kept on site and available to be placed across trenches, if necessary, to allow vehicle access in the event of an emergency. Following construction, roadways would be restored per agreements with state and municipal authorities and property owners.

Prior to issuance of a state Right-of-Way Grant for lands associated with the Project, AGDC would enter into a Highway Use Agreement with the ADOT&PF. AGDC has also developed a Traffic Mitigation Plan to reduce impacts from construction traffic, lane closures, and open-cut crossings. This plan would be reviewed and approved by the ADOT&PF prior to the issuance of road construction permits. The Traffic Mitigation Plan outlines general mitigation measures, including:

- scheduling deliveries during off-peak traffic hours;
- utilizing the Alaska Railroad to the extent possible;
- providing at least a 2-week notice of road crossings to affected residences and local authorities;
- establishing temporary detours prior to the start of construction, or keeping at least one lane of traffic open where no suitable detour can be identified;
- implementing temporary traffic control measures, including signage, barricades, and flaggers;
- keeping steel plates on site to temporarily cover road crossing trenches, if needed for emergency vehicle movements; and
- developing site specific traffic plans as required by the ADOT&PF or local authorities.

Implementation of the Project Traffic Mitigation Plan, once approved by the ADOT&PF, would adequately reduce traffic volume impacts. Accordingly, we find that the Project, with the mitigation measures listed above, would have minor and short-term impacts on road transportation. As discussed in section 4.19, a portion of the Kenai Spur Highway would be relocated near the Liquefaction Facilities. The impacts associated with this relocation are discussed in section 4.19.2.

4.12.2.2 Rail Network

The Project would use the Alaska Railroad to transport fuel, pipe, construction equipment, and other cargo from Anchorage, Seward, and Whittier to storage areas in Fairbanks; and use rail spurs near the Mainline Pipeline work areas. After materials arrive in Fairbanks, they would be delivered to Project work areas by truck. Peak rail usage for the Project would occur in Year 3. AGDC states that the Alaska Railroad has a net unused capacity of 34 rail cars, but Project demand would exceed that total for all but 1 year of construction. Table 4.12.2-4 shows the difference between Project rail car demand and available rail car supply by construction year. AGDC states that it would implement long-lead contracting, procurement, and cooperation with the ARRC to mitigate for its demand, and that a 2-year notice would be sufficient to allow the ARRC to procure the additional rail cars needed to support construction.

TABLE 4.12.2-4

Project Rail Car Demand

Year	Project Rail Car Demand	Net Surplus (Deficit) of Alaska Railroad Rail Cars
1	60	(25)
2	93	(58)
3	102	(67)
4	78	(43)
5	78	(43)
6	99	(64)
7	19	16

AGDC states that the Project would not require improvements to the Alaska Railroad mainline or existing rail yards, or construction of new rail yards, but would construct eight new rail spurs to facilitate delivery of materials to the Mainline Facilities' work areas. These spurs and the closest Mainline Pipeline mileposts are listed below.

- Dunbar Spur MP 456.1
- Nenana Spur MP 473.6
- Rex Spur MP 498.6
- Healy Spur MP 528.8
- Cantwell Spur MP 568.8
- Broad Pass Spur MP 583.2
- Hurricane Spur MP 606.9
- Sunshine Spur MP 676.1

Each spur would generally be about 0.5 mile long and would be parallel to and adjacent to the existing rail mainline. The exceptions are the Rex spur, which would be constructed along an existing rail spur near Clear, and the Sunshine Spur, which would curve away from the existing rail mainline. Construction of these spurs would not affect the use of existing railroads, but would instead provide space to store rail cars during unloading, thereby avoiding delays on the existing rail mainline while allowing more operational flexibility.

The Mainline Pipeline would cross the Alaska Railroad in four locations (MPs 532.1, 572.8, 588.1, and 609.0). AGDC would cross the railroad using the horizontal bore method to avoid impacts on rail traffic, and would obtain permission from the Alaska Railroad before boring beneath the rail line or connecting new rail spurs to the existing rail line.

Congestion along the rail line could occur during the summer season when passenger trains for tourists are present. To avoid impacts on passenger traffic (and specifically tourist traffic), AGDC would conduct some freight movements at night. Even with nighttime freight movements, the addition of a number of rail trips could still result in delays for passenger trains. Most of the Alaska Railroad mainline has a single track, allowing trains to pass each other only where sidings are present. Such delays could cause some travelers, particularly tourists, to avoid rail trips in favor of automobile trips. Section 4.11.7 discusses the Project's impacts on tourism. These impacts, if they occur, would last for the entire construction period, but would be less than significant.

4.12.2.3 Marine Transportation

The majority of construction equipment and materials for the Project would be shipped to Alaska using ships and oceangoing tugs pulling barges. No single primary port has the current capacity to receive the volume of cargo required for Project construction. AGDC would use multiple existing ports and construct a Marine Terminal MOF at Nikiski and a Mainline MOF near the existing Beluga Landing. Primary ports accessible through the GOA, such as those in Anchorage, Seward, and Nikiski, would be the points of entry for offloading equipment and materials. Improved docking facilities in Prudhoe Bay would be used to receive modules, equipment, and material during the ice-free shipping season. Each primary port receives specific cargo types, and the modes of transport off the dock and into the interior of Alaska varies. Table 4.12.2-5 summarizes the principal uses of the primary ports during construction.

TABLE 4.12.2-5

Project-Related Marine Vessel Use of Primary Ports During Construction

Primary Port	Role and Use During Project Construction
Port of Alaska	Receipt of food and other construction camp supplies, non-containerized materials, modules that can be transported via truck (up to 410,000 pounds, with an ADOT&PF oversize load permit), pipe, and fuel.
Mainline MOF	Receipt of pipe and other materials for the construction of the southernmost spreads of the Mainline Pipeline and for construction of the offshore portion of the Mainline Pipeline.
Port of Dutch Harbor	Used for Gas Treatment Facilities for customs importation of the major sealift modules.
Port of Nikiski (Pioneer MOF and Marine Terminal MOF)	Offloading facility for construction materials and equipment for the Liquefaction Facilities until the Marine Terminal MOF is built.
Prudhoe Bay West Dock Head 4	Used for delivery of materials for the Gas Treatment Facilities and staging for ocean-going tugs.
Port of Whittier	Used for pipe, consumable supplies, and materials that can be carried on rail flatcars.
Port of Seward	Used for pipe, truckable modules, and other construction materials.

AGDC proposes to use the Ports of Alaska and Seward as the primary ports to receive Project construction equipment and materials due to their existing rail and road connections, with some materials also arriving at the Port of Whittier. AGDC would use the Port of Dutch Harbor as a staging and customs clearance area for imported Project construction materials awaiting transport to the Gas Treatment Facilities by barge. AGDC would construct a new dock head (Dock Head 4) at the Prudhoe Bay West Dock Causeway to serve as the unloading facility for the marine sealifts bringing in modules and other Project supplies and equipment to the Gas Treatment Facilities.

Existing docks near the Port of Nikiski would serve as a Pioneer MOF to receive materials and equipment for construction until AGDC builds the Marine Terminal MOF (see section 2.1.5). AGDC would build a second MOF for the Mainline Pipeline near Beluga to support offloading of pipe and other materials and equipment for construction and operation of the southern portion of the Mainline Pipeline.

Ports and Harbors

Port of Alaska

The Port of Alaska would be the likely point of entry for breakbulk materials (materials not transported via container), materials of standard load size, and truckable modules, including oversize and overweight loads. As defined by the ADOT&PF, oversize loads are more than 14 feet tall, 8.5 feet wide, or with a trailer longer than 53 feet. Overweight loads are greater than 80,000 pounds (gross vehicular weight). Table 4.12.2-6 summarizes the estimated use of the Port of Alaska during Project construction. Peak year Project requirements at the Port of Alaska would represent about a 26-percent increase in the amount of containerized freight received by the port, compared to the annual average amount recorded at the port during the 2007 to 2016 period (see section 4.12.1.3).

TABLE 4.12.2-6

Project-Related Marine Vessel Use of the Port of Alaska During Construction

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Materials (short tons)	161,722	245,864	304,740	486,754	377,678	351,170	71,284
Number of foot equivalent units	12,226	18,587	23,038	36,798	28,552	26,548	5,389
Number of vessel calls [a]	208 [b]	208 [b]	230 [c]	217 [c]	214 [a]	208 [b]	208 [b]
Project-related days of dock time unloading ships [a]	17	26	32	51	40	37	7
Project-related dock and crane utilization (%) [a]	5	7	9	14	11	10	2

[a] Assumes no change in non-Project vessel calls, dock unloading time, or dock and crane utilization.
[b] Matson and TOTE each have 104 scheduled sailings to the Port of Alaska, making a combined total of 208 vessel calls each year.
[c] Includes additional sailings required to meet Project demands, using the assumption that the current utilization rate for TOTE and Matson stays the same.

Project-related marine traffic at the Port of Alaska would be provided via commercial service rather than chartered vessel. As described in section 4.12.1.3, only Matson (container service) and TOTE Maritime (RO/RO service) provide commercial ship transportation service between Anchorage and Seattle/Tacoma. These two providers have 208 scheduled commercial sailings per year along this route. The two marine service providers have a seasonally weighted annual utilization rate of about 83 percent, leaving additional capacity of only 18 percent on each commercial sailing. AGDC states that this is equivalent to 22,859 FEUs. If the current utilization of Matson and TOTE vessels remains constant, additional sailings would be required to meet the increased demands from the Project in Years 3, 4, and 5 of construction equating to a maximum of 13,939 additional FEUs. AGDC would be required to obtain this additional carrier capacity for the 3-year period.

AGDC estimates that the port utilizes 40 percent of its dock and crane capacity and that peak Project activities would increase port utilization by 14 percent. The Port of Alaska's modernization program (see section 4.12.1.3) could reduce the port's nominal capacity by temporarily occupying some port land or taking some port facilities out of service. As a result, the Port of Alaska might not have sufficient capacity to support Project demands (in combination with ongoing non-Project demands).

If capacity limitations emerge, AGDC states that it would shift up to 13,939 FEUs of containerized deliveries to the Port of Seward. The diverted deliveries would be those that exceed Matson and TOTE's existing 22,859 FEU capacity. Based on the data in table 4.12.2-6, diverted shipments could occur in Year 3 (179 FEUs), Year 4 (13,939 FEUs), Year 5 (5,693 FEUs), and Year 6 (3,689 FEUs). AGDC has not stated how it would shift cargo if the Port of Alaska modernization reduces Matson and TOTE's total capacity below existing levels, although, as discussed below, shipping companies serving the Port of Whittier could have the ability to add capacity.

Mainline Material Offloading Facility

AGDC would construct a new permanent Mainline MOF that would be independent of, but adjacent to, the existing Beluga Landing. It would be used in the ice free season to receive barges transporting onshore pipeline construction materials and equipment. AGDC would then truck these materials to the southernmost spreads (north of Cook Inlet) of the Mainline Pipeline. Table 4.12.2-7 shows the estimated use of the Mainline MOF. The peak of 147 Project-related vessel calls would occur in Year 2. This peak corresponds to nearly a 92-percent increase over the 160 annual vessel calls recorded at Beluga Landing in 2014 (see table 4.12.1-3), although all Project-related vessels would arrive at the Mainline MOF. As would be the case for the existing Beluga Landing, barge arrivals and departures at the Mainline MOF would be affected by tides; at low tides, barges would be grounded at the MOF.

TABLE 4.12.2-7

Project-Related Marine Vessel Use of the Mainline MOF During Construction

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Number of barge loads	88	147	41	41	50	36

Port of Dutch Harbor

Major sealift modules and pipe imported for the Project would go through the established customs entry process in the Port of Dutch Harbor, and the port would be used as a staging area for imported Project construction materials to be shipped to the Gas Treatment Facilities by oceangoing tugs pulling barges. Table 4.12.2-8 summarizes the outgoing Project-related barge traffic based on the number of barge loads estimated for the Port of Dutch Harbor.

TABLE 4.12.2-8

Project-Related Marine Vessel Use of the Port of Dutch Harbor During Construction

	Year 4	Year 5	Year 6	Year 7
Number of modules	51	32	17	17
Number of barges	23	18	10	10

The peak Project activity of 23 outbound barge trips in Year 4 is equivalent to less than 2 percent of total light-draft vessel activity recorded in Dutch Harbor in 2014. Although AGDC has not stated the number of corresponding inbound vessels, we anticipate that such vessels would comprise a similarly small share of existing traffic.

Due to the number of vessels in operation in and around the Port of Dutch Harbor, adequate anchorage could be limited. AGDC would prepare, in conjunction with U.S. Customs and Border Protection, a Project-specific Importation Guide that provides standardization of imports and increases customs clearance efficiencies. We conclude that additional efforts are needed to minimize disruption of existing marine vessel activity in Dutch Harbor, particularly the commercial fishing fleet. Prior to the use of the Port of Dutch Harbor as part of the Project, AGDC would file with the Secretary a Sealift Entry and Exit Strategy, prepared in conjunction with the Coast Guard, that specifies the anticipated schedule, as well as anchorage, offloading, and loading needs of Project-related vessels.

Port of Nikiski

To support Liquefaction Facilities construction, AGDC would construct the Marine Terminal MOF and on-site haul road at the Liquefaction Facilities. The Marine Terminal MOF and on-site haul road would allow AGDC to transfer major modules, construction materials, breakbulk materials, and construction equipment directly to the Liquefaction Facilities site. The Marine Terminal MOF would be designed for 10 years of use, including the construction time period and beyond, and would be removed or re-purposed following completion of construction.

Prior to the completion of the Marine Terminal MOF, existing dock facilities in the area, such as the Nikiski Fabrication Facility and Rig Tenders Marine Terminal, would be used as a Pioneer MOF to receive shipments during the early Liquefaction Facilities site development. The existing dock facilities and the Marine Terminal MOF would be used during peak construction periods to facilitate scheduling demands. The Pioneer MOF would receive about 50 barge shipments of steel products, about 100 barge shipments of bulk materials, and about 45 marine shipments of PLF modules over the Liquefaction Facilities construction period.

The Marine Terminal MOF would receive about 60 shipments of modules from fabrication yards during Liquefaction Facilities construction. These deliveries would be made by about 10 barges, circulating between Nikiski and Anchorage or Seward on a weekly basis for 3 years. Shipments of construction equipment and materials would primarily be made during the 8-month warmer-weather shipping season. Project construction would generate as many as three deep-draft vessel calls at the Marine Terminal MOF per week, equivalent to 117 total deep-draft vessel calls per year, which is about a 136-percent increase over the annual average of 86 deep-draft calls at the Port of Nikiski in 2014 (see table 4.12.1-3).

Construction of the Marine Terminal at the Liquefaction Facilities would occur from Year 3 through Year 5. In addition to the Marine Terminal MOF, the Marine Terminal would include an access trestle, loading platforms, and breasting and mooring dolphins. Whereas Marine Terminal MOF construction would be land-based, AGDC would carry out the trestle and heavy-lift module construction from barges in the waters adjacent to the LNG Plant. These activities would occur within 1 mile of the shoreline. Non-Project vessels would need to navigate around the Marine Terminal MOF and Marine Terminal during construction and operation.

Port of Whittier

The dimensions of the Anton Anderson and Portage tunnels prevent the shipping of Project modules and large construction equipment through Whittier (see section 4.12.1.3), but other equipment, commodities, and pipe that fit on standard Alaska Railroad freight cars could be accommodated. Table 4.12.2-9 summarizes the Project's planned use of the Port of Whittier. According to AGDC, Canadian National has stated that its summer sailings are typically 50- to 60-percent utilized, while its busier winter season is typically 80-percent utilized on average. If necessary, Canadian National could augment its shipping schedule to add up to 12 more sailings to accommodate demand. Alaska Marine Lines indicated a 70-percent utilization rate and has one rail barge in its fleet that could be added to its existing service to Whittier should it need to expand barge service. This barge could provide an additional 18 trips per year. Augmented service by Canadian National and Alaska Marine Lines could add 30 additional voyages per year, or one additional port call every 12 days. This change in cargo vessel activity would comprise about a 4.9-percent increase in total light and heavy draft vessel traffic at the Port of Whittier (see table 4.12.1-3). This incremental change would not meaningfully increase conflicts between cargo and non-cargo (i.e., passenger) vessels.

TABLE 4.12.2-9

Project-Related Marine Vessel Use of the Port of Whittier During Construction

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Materials (short tons)	29,127	29,127	29,127	29,127	29,127	29,127	29,127
Number of foot equivalent units	2,200	2,200	2,200	2,200	2,200	2,200	2,200
Number of vessel calls	105	105	105	105	105	105	105
Days of dock time unloading ships	53	53	53	53	53	53	53
Project-related dock utilization (%)	14	14	14	14	14	14	14

West Dock Causeway

It is anticipated that the GTP modules would be built outside Alaska and transported to the new West Dock Head 4 at Prudhoe Bay on barges pulled by oceangoing tugs during two summer sealift periods prior to Project construction and four summer sealift periods during Project construction. Table 4.12.2-10 shows the estimated use of West Dock Head 4 during construction of the Gas Treatment Facilities. Currently, the West Dock has three docks used to supply operators in the PBU.

TABLE 4.12.2-10

Project-Related Marine Vessel Use of West Dock Head 4 During Construction

	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Number of modules	8	57	17	15	10	9
Number of barges	9	9	12	12	10	9

Peak Project-related vessel calls in Year 4 of construction would correspond to a nearly 80-percent increase over the number of vessel calls at the existing West Dock Heads 1, 2, or 3 in 2014 (see table 4.12.1-3), but the overall level of vessel activity in the vicinity of the West Dock in Prudhoe Bay would remain low. During the open-water season, tugs and barges associated with Project sealifts would anchor in the PBOSA, about 5 miles northwest of West Dock and landward of Reindeer Island. Project construction would increase existing traffic on the West Dock causeway, resulting in congestion and potentially increasing the risk of accidents. AGDC would develop a Journey Management Plan (incorporating the activities of other West Dock users) to ensure a safe and functional traffic management and risk mitigation plan during Project construction.

Port of Seward

Due to the Port of Seward's rail-on-dock service and direct linkage to the Alaska Railroad, the Project would use it primarily for receiving line pipe; pipelining equipment; block valves, fittings, compressor, heater, and meter station components; supplies; and other materials required for constructing the Mainline Pipeline, PTTL, and PBTL. Barges would transport pipeline construction materials and equipment from the Port of Seward to the Mainline MOF near Beluga for the Mainline Pipeline segments on the north shore of Cook Inlet, an area not accessible by road or rail.

Table 4.12.2-11 shows the anticipated infrastructure demands placed on the Port of Seward during Project construction. AGDC states that peak Project-related utilization of dock space would be 13 percent, and that this utilization is less than the dock space available. AGDC assumes that Project-related vessels calling at the Port of Seward would be Project charters with an average vessel carrying capacity of about 18,000 short tons. Larger ships would take significantly longer to unload and consume more on-dock storage (i.e., until cargo can be transferred to the Alaska Railroad and moved away from the port) and would thus reduce the Port's availability for other (non-Project) shipping activities. Project-related vessel calls would comprise up to a 7.6-percent increase in total light and heavy draft vessel traffic at the Port of Seward (see table 4.12.1-3). This incremental change would not meaningfully increase conflicts between cargo and non-cargo (i.e., passenger) vessels.

TABLE 4.12.2-11

Project-Related Marine Vessel Use of the Port of Seward During Construction

	Year 1	Year 2	Year 3
Materials (short tons)	89,140	124,796	142,643
Number of foot equivalent units	8,198	11,476	13,116
Sticks of pipe	28,904	40,461	46,243
Number of vessel calls	11	16	18
Days of dock time unloading ships	30	42	48
Project-related dock utilization (%)	8	12	13

If modernization upgrade activities at the Port of Alaska necessitate rerouting of cargo (see section 4.12.1.3), AGDC states it would shift containerized cargo to the Port of Seward. Depending on the start of Project construction relative to the port upgrades, these diverted shipments would occur after planned Project deliveries end in Year 3 (except for a small amount of activity [179 FEUs] in Year 3). In Year 4, the peak year for such diverted deliveries, 13,939 FEUs would be delivered to Seward, slightly more than the amount of cargo delivered in Year 3 and accounting for a dock utilization of about 14 percent.

Marine Shipping Channels and Navigation Areas

Material Deliveries

Table 4.12.2-12 summarizes the marine vessel traffic generated by deliveries of Project materials and modules to the primary ports described above. Project-related marine vessel traffic increases in the Beaufort Sea and Bering Sea (serving the Prudhoe Bay West Dock Head 4) represent a 182-percent increase in traffic, but a comparatively small numerical increase. Project-related barge activity in Upper Cook Inlet and Lower Cook Inlet would represent a 9- to 19-percent increase in existing vessel traffic from Year 1 through Year 5. The peak Project-related vessel traffic volumes shown in table 4.12.2-12 for other waterways would typically last for 1 to 2 years. Overall, Project-related vessel traffic volumes would constitute a long-term, minor impact on traffic in navigation channels.

Other Construction Activities

In addition to vessel activity associated with deliveries, Project construction would generate vessel traffic and potential marine navigation impacts associated with construction of the Mainline Pipeline across Cook Inlet and dredge disposal near the Liquefaction Facilities. We received comments from the public during the scoping process that Project vessel traffic would increase the risk of vessel collisions. In addition, we received comments that Project-related vessel traffic (for construction and operation) could affect commercial fishing vessels by interfering with fishing and navigation and reducing the total allowable fishing area. Section 4.11.3 discusses the Project's socioeconomic effects on commercial fishing. The remainder of this section focuses on the Project's navigation impacts.

TABLE 4.12.2-12

Project-Related Marine Vessel Use of Navigation Channels During Construction

Navigation Channel/Fairway	Primary Ports Served [a]	Peak Project Vessel Traffic Year	Peak Project Vessel Traffic Volume (number of port calls)	Project-Related Vessel Traffic Increase (%) [b]
Beaufort Sea/Prudhoe Bay	Prudhoe Bay West Dock Head 4	Year 2	51	182
Bering Sea/Norton Sound	Prudhoe Bay West Dock Head 4	Year 2	51	182
Upper Cook Inlet North of Fire Island	Alaska	Year 3	22	6
Upper Cook Inlet/Nikiski	Alaska, Beluga, Nikiski [c]	Year 2	197	19
Resurrection Bay	Seward	Year 3	18	10
Kennedy Entrance/Lower Cook Inlet/Kachemak Bay	Alaska, Beluga, Nikiski	Year 2	197	19
Iliuliuk Bay/Iliuliuk Harbor/Dutch Harbor/Captains Bay	Dutch Harbor	Year 4	23	4

[a] Data in this table reflect assumed routes for Project vessels making calls on primary ports.

[b] Assumes no change in baseline (non-Project) traffic volumes. Reflects all existing vessel traffic in table 4.12.1-3 except for light-draft fishing, government, passenger, and other vessels, which are different in physical characteristics and navigation requirements from deep-draft vessels and light-draft cargo vessels such as barges.

[c] Includes deliveries to the Marine Terminal MOF and Pioneer MOF.

AGDC would lay the offshore portion of the Mainline Pipeline across Cook Inlet during the ice-free season. AGDC would coordinate with the Coast Guard and other waterway and nearshore users, including commercial fishing vessels, to reduce potential navigation impacts. Liquefaction Facilities construction would restrict nearshore navigation for commercial fisheries near the Liquefaction Facilities. These construction-related restrictions would be limited in a geographic area, comprising a portion of the Cook Inlet crossing and the area immediately adjacent to the Liquefaction Facilities. As a result, construction-related impacts on navigation in Cook Inlet and near the Liquefaction Facilities would be minor and temporary.

Project Operation

The Project would generate an average of 21 round trips per month by LNG carriers, each assisted by five assist tugs between Homer/Kachemak Bay (where LNG carriers would temporarily stage or anchor) and the Marine Terminal. These LNG carrier trips would constitute an increase in deep-draft vessel traffic volumes in Cook Inlet, based on the data for Anchorage, Nikiski, and Beluga Landing in table 4.12.1-3. Federal law (33 CFR 165.1709) establishes a 1,000-yard security zone around LNG carriers, including those docking at the Marine Terminal. This security zone protects LNG carriers from collisions or sabotage by prohibiting other vessels from entering the zone unless specifically authorized by the Coast Guard. For the Project, AGDC would obtain authorization from the Coast Guard Marine Safety Detachment in Homer. Commercial fishing vessel owners operating in Cook Inlet would need to seek approval from the Coast Guard to fish within the security zone of LNG carriers.

Fishing vessels and other small vessels (such as recreational boats) must give way to other vessels navigating within a narrow channel, fairway, or traffic lane (Coast Guard, 2015). Apart from these rules, there are no restrictions against fishing boats working in or traveling through shipping lanes. Indeed, this is a common occurrence throughout the salmon fishing season in Cook Inlet (Impact Assessment, Inc., 2004). To avoid conflicts with fishing vessels operating in Cook Inlet, most large, deep-draft cargo ships, including LNG carriers, announce their presence on VHF marine radio channels at specific waypoints in the Cook Inlet shipping lane (Weil, 2003; Maw, 2015).

As described in the discussion of impacts on ports and harbors, commercial fisheries in marine shipping channels are generally accustomed to the presence of large vessels. Additional Project-related large vessels would be an incremental increase of such vessels in Cook Inlet. The Coast Guard has reviewed the Project pursuant to its *Navigation and Vessel Inspection Circular 01-2011* (Coast Guard, 2011) and determined that Cook Inlet is suitable for accommodating Project LNG carrier activity (Coast Guard, 2017a). Accordingly, we find that the Project would have minor and permanent impacts on marine shipping channels and navigation areas.

4.12.2.4 Air Transportation

Air transportation would be used for the movement of workers, supplies, and equipment destined for remote areas of Alaska because of the long distances between cities and the limited highway and railroad infrastructure. Most Project-related air travel would be associated with worker movements during scheduled rotation periods. The Project would use Anchorage International, Fairbanks International, Kenai Municipal, and Deadhorse Airports as regional hub airports for the transportation of Project personnel. Table 4.12.2-13 describes these airport hubs, summarizes their anticipated principal uses for Project construction, and provides the estimated number and type of airplane trips required to transport the Project workforce.

TABLE 4.12.2-13

Use of Key Airport Hubs for Project Construction

Airport	Role	Facility	Maximum Flights per Day (aircraft type) [a]
Anchorage International Airport	Key interstate transportation hub for construction personnel rotating to and from out-of-state locations. Regional hub for access to other regional hubs within Alaska (Kenai Municipal Airport and Fairbanks International Airport) as well as for tactical airports supporting remote Mainline Facilities construction sites in southern Alaska.	Mainline Facilities	12 (Boeing 737-400)
Deadhorse Airport	Destination and departure point for Gas Treatment Facilities construction personnel. Destination and departure point for PTTL construction personnel (between Prudhoe Bay and the PTU).	Gas Treatment Facilities	2 (Boeing 737-400)
Fairbanks International Airport	Entry point for Mainline Facilities construction personnel originating from outside of Alaska. Regional hub for access to other regional hubs within Alaska (Deadhorse Airport) as well as for smaller airports supporting remote Mainline Facilities construction sites in northern Alaska.	Mainline Facilities [b]	12 (Boeing 737-400)
Kenai Municipal Airport	Destination and departure point for personnel supporting the construction of the Liquefaction Facilities as well as a smaller number of Mainline Facilities construction workers.	Mainline Facilities	2 (Dash 8-100)
		Liquefaction Facilities	18 (Dash 8-100)

[a] Includes only workers originating or terminating at each airport; does not include transfers.

[b] AGDC states that 50 percent of construction camps would be served via Fairbanks International Airport. For purposes of estimation, we assume that Anchorage and Deadhorse would each serve about 25 percent of the workforce and that Kenai would receive a nominal number of flights specifically associated with construction of the Mainline Facilities. The number of flights needed is calculated based on a 7,000-person peak workforce, and an aircraft capacity of 144, as provided by AGDC.

The peak in Project-related passenger traffic at the hub airports would occur in Year 4. Project-related passenger traffic at Anchorage International and Fairbanks International Airports would be small in comparison to recent passenger volumes shown in table 4.12.1-9.

The majority of Project construction personnel would be transported from the regional hub airports to the Project sites via bus, but the Project could use smaller airstrips, such as Point Thomson, Galbraith Lake, Chandalar, Coldfoot, Livengood Camp, Prospect Creek, Nenana, Cantwell, Summit, Talkeetna, Willow, and Beluga for specialized trips not associated with workforce rotations. Except for Beluga, all airstrips listed above are public or available for public use. The limited use of airstrips would be within the constraints of current design and conditions and would employ the same type of aircraft that serve these airstrips; therefore, no improvements would be needed at the airstrips. AGDC has not specified the number or frequency of construction worker travel to airstrips, but states that the increase in passengers and flights is not expected to adversely affect operations at Anchorage International and Fairbanks International Airports (where flights to tactical airstrips would originate) or at the airstrips themselves. If Project needs change to the point where improvements are needed at airstrips, AGDC would consult with airport management agencies or owners. AGDC will file with the Secretary an Air Transport plan that details the planned number of Project-related aircraft operations at each airport and airstrip used during Project construction.

During construction, AGDC would use helicopters to transport personnel from construction spreads. AGDC states that Project construction would generate an average of three and a maximum of six helicopter flights per day for each of the Project's 48 permanent and temporary helipads (including 19 permanent helipads at MLVs, 9 permanent helipads at compressor or heater stations, and 20 temporary helipads at construction camps). During operation, helicopter trips would transport personnel for planned maintenance, routine checks, calibration of equipment and instrumentation, inspection of critical components, and servicing and overhauls of equipment. Project operation would generate an average of one helicopter trip per month per helipad. Section 4.18.10 discusses Mainline Pipeline inspection activities, which would include aerial inspections of the Mainline Facilities.

Construction of the Liquefaction Facilities in Nikiski would require air transport of about 4,600 workers during workforce rotations every 2 weeks (the 4,400 cited in section 2.1.5 minus about 200 workers who reside within vehicular commuting distance as discussed in section 4.12.2.1). This would result in a major increase in passenger volumes at Kenai Municipal Airport. AGDC states that the airport is underutilized and that no airfield infrastructure improvements (such as runways, taxiways, or ramp space) are needed at Kenai Municipal Airport to support Project activities.

The increase in passenger traffic at Kenai Municipal Airport could have a temporary but significant adverse effect on the public's use of the airport by creating crowded conditions at the passenger terminal. This would lead to delays at ticket counters, security checkpoints, and baggage claims; and result in greater demand for airport services such as food and restrooms (Cohen and Coughlin, 2003). These conditions would likely occur only during scheduled rotation periods every 2 weeks. AGDC would consult with Kenai Municipal Airport representatives to identify potential solutions to handle the increased passenger demands.

Deadhorse Airstrip would also experience an increase in passenger traffic during peak construction, when about 2,000 workers would be transported during each workforce rotation. Because Deadhorse is primarily used by existing oil and gas industry employees working in the greater Prudhoe Bay area, the Project-related increase in passenger activity would not affect the general public. Workers who are already in the area and Project personnel would be affected by the increased congestion at the passenger terminal during Project construction.

As shown in table 4.12.2-13, the Project would use two different aircraft types for transportation to and from airport hubs. Flights to tactical airstrips would require smaller propeller aircraft.

Rotations, mobilizations, and demobilizations of Project construction personnel would cause sharp peaks in demand for aircraft. AGDC states that most trips between the Lower 48 and Alaska (either

Anchorage or Fairbanks) would be via chartered aircraft; therefore, Project construction would not compete with commercial (including) tourist demand for these routes.

For flights within Alaska, there is insufficient aircraft capacity to support the Project's peak intrastate personnel rotation requirements (e.g., transporting staff from Anchorage to Fairbanks, Kenai, and Deadhorse). During peak construction periods, Project workers could require as many as 700 to 800 aircraft seats per day for intrastate air service to support rotations, mobilizations, and demobilizations. With this level of demand, AGDC states that intrastate commercial air service providers would have excess capacity of 300 to 400 seats per day to accommodate other intrastate passengers during peak Project construction. Block seating purchases on commercial intrastate flights by the Project would result in fewer seats available for tourists, which could lead to increased costs for available seats. These peak demands would likely occur over one or a few days at a time (i.e., during rotations), rather than continuously during the Project's peak years of construction. As a result, we find that Project construction would not have a significant impact on intrastate air transportation.

4.12.3 Conclusion

Construction of the Project would result in additional truck traffic on Alaska's major roads, use of the Alaska Railroad, increased activity at primary ports, and increased air travel. Project-related road traffic would not contribute to congestion or delays. Temporary closures associated with crossings of public roads would not result in significant traffic delays. Added traffic on the Alaska Railroad could result in delays for passenger trains or non-Project freight activity during Project construction, including during the summer season when passenger trains for tourists are present.

Project construction would require delivery of modules, equipment, materials, and supplies at many of Alaska's largest and busiest ports as well as additional vessel traffic in marine shipping channels and navigation areas. The ports generally have available dock space and unused crane capacity. The Port of Alaska modernization project could limit the available capacity at this port, which would require AGDC or potentially other shippers to increase the use of Seward, Whittier, and other ports. AGDC would minimize impacts by coordinating with port facilities to plan arrivals.

Many of the ports used for Project deliveries are the homeports for commercial fishing activities and other maritime industry users. While commercial fisheries and other users in these locations may generally be accustomed to the presence of large vessels, increased vessel activity associated with delivery of Project modules, materials, and supplies would increase vessel traffic in port areas. However, Project activities during construction would not have a significant impact on traffic in navigation channels.

We find that the Project would have permanent but minor impacts on marine shipping channels and navigation areas in Cook Inlet during operation. Project operation would generate no regular vessel traffic and would have no effect on other ports and harbors during operation.

While airports and airfields have sufficient capacity to accommodate additional Project-related flights, Project-related demand for commercial airline seats on intrastate flights could displace some non-Project passengers for short periods during peak construction (i.e., during rotation shifts). Construction of the Project would therefore not have a significant impact on public air travel in Alaska.