4.26 VEGETATION

This section provides a description of the potential environmental consequences of the project on vegetation, and rare and sensitive species, including impacts from invasive species.

4.26.1 EIS Analysis Area

The Environmental Impact Statement (EIS) analysis area for vegetation for each project component is defined below. The analysis area includes the area affected by potential direct and indirect impacts from construction and operations. The analysis area collectively includes areas for all four components (mine site, transportation corridor, ports, and natural gas pipeline) and the variants under each component, in each action alternative.

Mine Site—The mine site analysis area includes the direct disturbance footprint extended by a 330-foot buffer to account for the indirect impacts of fugitive dust deposition.

Transportation Corridor and Ports—The transportation corridor and ports analysis area includes the direct disturbance footprint extended by a 330-foot buffer to account for the indirect impacts of fugitive dust deposition. Although the direct disturbance footprints are included for the pile-supported and caisson dock designs (both of which have concrete decking), lightering areas, and mooring buoys, these features are not buffered, because they are not expected to be sources of fugitive dust (note open water is not considered part of the affected environment for vegetation).

Natural Gas Pipeline—The natural gas pipeline corridor analysis area includes the pipeline-only sections where the pipeline is not co-located with the transportation corridor. These sections of the natural gas pipeline have a maximum impact width of 91 feet through Iliamna Lake, 102 to 183 feet through Cook Inlet, and 150 feet through overland areas. The overland analysis area includes the direct disturbance footprints for access roads and material sites buffered by a 330-foot zone to account for dust impacts (note open water is not considered part of the affected environment for vegetation).

4.26.2 Analysis Methodology

Potential direct and indirect effects to vegetation and the risk of invasive species introductions were assessed according to four factors: the magnitude (intensity) of the impacts; the duration (how long the impact would last); the extent (the area of the impact); and the likelihood of the effect (the certainty that the impact would occur, should the project be permitted).

Magnitude—the magnitude of impacts is quantified by the number of acres impacted by the project.

Duration—duration considers how long an impact is expected to last, and is qualified as permanent, temporary, or long-term. The duration of direct impacts to vegetation is considered permanent where removal of—or disturbance to—vegetation would occur during construction and remain free of vegetation through closure. The duration of impacts would be considered temporary where vegetation functions would be reduced during construction, and the area would be reclaimed (meaning that vegetative functions would be restored) after the construction phase. Restoration measures would reduce the duration of temporary impacts (Chapter 5, Mitigation). The duration of indirect impacts due to the deposition of fugitive dust is considered long-term.

Extent—extent considers the geographic location of impacts in the analysis area. The extent of impacts would be limited to the watersheds where vegetation would be lost or disturbed as a result of project-related impacts or where the project would affect vegetation outside of the project

area, for example, by the introduction and spread of invasive species (see Figure 4.22-4 for an overview of the Hydrologic Unit Code [HUC] 10 watersheds impacted by the project).

Likelihood—likelihood evaluates the probability of impacts. The likelihood of vegetation loss and indirect impact to vegetation due to dust deposition would be certain if the project is permitted and constructed. The likelihood of the removal of rare or sensitive plant species or rare or sensitive plant species habitat is considered low if the project was to be permitted and constructed, because there are no confirmed occurrences of rare plants in the analysis area for vegetation. Assuming implementation of the invasive species management plan (ISMP) (Owl Ridge 2019d) developed by the Applicant, the likelihood of invasive species introductions is also considered low. This analysis factor is not further discussed, because there is no difference in likelihood among the alternatives.

Scoping comments requested that the EIS analyze impacts to rare and sensitive species, the effects of fugitive dust on vegetation in the project area, and the risk for introduction of invasive species (rare or sensitive plant and invasive species are defined in Section 3.26, Vegetation).

The following sections present the impacts to vegetation (including rare and sensitive species) under each alternative for all project components and associated variants. Direct effects from vegetation removal and fugitive dust are summarized by type of vegetation affected. Project vegetation types were developed as described in Section 3.26, Vegetation. Also described in Section 3.26, the “open water” type is not considered part of the affected environment for vegetation. Therefore, the open water type was not included in vegetation impact calculations. Values are rounded to the nearest whole acre, or nearest whole percent; apparent inconsistencies in sums are the result of rounding.

4.26.3 Direct and Indirect Impacts

The project has the potential to cause the following direct and indirect impacts on vegetation:

- Direct impacts from:
  - Vegetation removal
  - Elimination of rare or sensitive plant species and habitat
- Indirect impacts from:
  - Invasive species introduction or spread
  - Fugitive dust

Project-related direct impacts to vegetation are the removal of vegetation, and the removal of rare or sensitive plant species, or rare or sensitive plant species habitat. Vegetation removal would require the clearing of existing vegetation and grading of the soil surface. Most direct impacts to vegetation would be initiated during the construction phase, and would result in the temporary or permanent loss of vegetation cover, and the functions that cover provides. Where the disturbance of vegetation does not result in the direct loss of habitat, alterations to plant community composition, structure, and functions such as soil stabilization and the attenuation of surface water flow may result. Because the mine site is designed to divert water to settling and water management ponds prior to leaving the site, the potential for increased erosion and sedimentation due to the removal of vegetation would be limited to the project components of the transportation and natural gas pipeline corridor. It is expected that best management and industry practices would minimize erosion and sedimentation along these corridors. Direct impacts related to erosion and sedimentation are evaluated in Section 4.14, Soils; and Section 4.18, Water and Sediment Quality. See Section 4.23, Wildlife Values, and Section 4.24, Fish Values, for discussion of the consequences of habitat loss and degradation for wildlife.

Temporary habitat loss areas include construction workspace associated with road and other infrastructure construction, and the natural gas pipeline corridor where it is not associated with the access road. Restoration of temporarily impacted vegetation would aim to stabilize soils through practices including terrain recontouring, spreading stockpiled topsoil, placing erosion control devices, and/or establishing temporary vegetation cover. Such practices would commence post-construction, or concurrent with construction activities, once the desired grading has been achieved; the workspace is no longer needed; or the pipeline has been installed. Restoration aims to establish a permanent vegetation cover with species densities and compositions similar to adjacent lands undisturbed by the project, with efforts being deemed complete by the successful establishment of the perennial plant cover (Owl Ridge 2019a; PLP 2019-RFI 123).

Permanent habitat loss area is the direct footprint of disturbance, including mine facilities, access and mine roads, ferry terminals, and ports. Where reclamation of permanently impacted areas would entail revegetation, growth medium would be placed, amended, seeded, and watered as necessary. Reclamation would begin concurrent with operations for project facilities as soon as practical and safe; otherwise, reclamation would be phased over 50 years post-closure. Reclamation aims to achieve 30 percent vegetative cover within 3 years, with efforts considered complete when 70 percent vegetation cover is achieved (SRK 2019d; PLP 2019-RFI 115).

Both restoration and reclamation would promote the processes of natural succession that would be expected to occur in the absence of human intervention. Succession proceeds at rates dependant on the severity and extent of disturbance, the type of vegetation disturbed, and proximity of seed sources (Fastie 1995). Typically, large-scale disturbance where the removal of vegetation and overburden leaves bare mineral soil (i.e., primary succession) would take longer to recover to pre-disturbance condition, compared to small-scale disturbance where the organic layer remains intact (i.e., secondary succession). In a scenario of primary succession, plants are often nitrogen-limited; therefore, bare mineral soil is pioneered by species capable of nitrogen fixation such as lichens, lupine (*Lupinus* spp.), mountain avens (*Dryas* spp.), and alders (*Alnus* spp.) (Tilman 1985). Under a scenario of secondary succession where plants are typically light-limited, seral[1] stages transition from those dominated by species with high growth rates and prolific seed production to slow-growing species that are better able to compete for limited resources (MacArthur and Wilson 1967). Typically, sheltered, temperate sites with nearby seed sources would recover more quickly than exposed, alpine sites where reproduction is predominantly vegetative, and topography often presents a barrier to the delivery of seed from nearby, intact communities. Restoration and reclamation are further discussed in Chapter 5, Mitigation. Pebble Limited Partnership's (PLP's) draft Restoration Plan for Temporary Impacts (Owl Ridge 2019a; PLP 2019-RFI 123) and draft Reclamation and Closure Plan (SRK 2019d; PLP 2019-RFI 115) are included in Appendix M3.0 and Appendix M4.0, respectively.

Project-related indirect impacts to vegetation would include invasive species risk and fugitive dust. The areas of these indirect impacts may overlap. Indirect impacts may occur during any phase of the project, and result in temporary or permanent loss of vegetation, or the ecological functions their communities provide.

Invasive species may be introduced to the project area during construction, operations, and closure as contaminants on materials, vehicles, vessels, and/or people. The potential impacts of invasive species are assessed qualitatively based on known or potential occurrence, invasiveness, location of infestation, and implementation of an invasive species management plan. The Invasive Species subsection discusses the known and potential occurrences of all taxa of non-native species in the analysis area.

[1] Seral refers to a plant community that is demonstrably susceptible to replacement by another community.

Drawdown of groundwater is expected at the mine site as a result of operations. Depression of the groundwater table is expected to impact area wetlands, surface waters, and vegetation. Because the severity of impact from dewatering is expected to be greater for wetlands relative to non-wetland vegetation, impacts to vegetation resources are discussed collectively in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites. Impacts to surface water are presented in Section 4.16, Surface Water Hydrology; impacts to groundwater are discussed in Section 4.17, Groundwater Hydrology.

Fugitive dust—Fugitive dust is expected to be produced from ground-disturbing actions during construction, operation, and closure of the mine, as well as from the wind or vehicle dispersion of exposed soil in the post-closure period. Fugitive dust has the potential to injure or collect on vegetation, with consequences for plant physiology, community composition, and function (Farmer et al. 1993). The potential for dust-related impacts is considered long-term.

The type of impacts experienced from mineral dust deposition on vegetation largely depends on the characteristics of the dust, the plant species affected, and the environmental conditions surrounding deposition (Doley 2006). Because particle size is strongly correlated to dispersal distance, larger, gravity-deposited particles may cause smothering adjacent to a road surface; whereas smaller, wind-blown particles may cause abrasion of plant tissue and loading of plant surfaces at greater distances (Walker and Everett 1987). For vascular plants, the physical shading of photosynthetic surfaces and blockage of stomata from dust loading cause subsequent reductions in photosynthesis, respiration, and transpiration (Spatt and Miller 1981; Thompson et al. 1984).

Research on fugitive dust in Alaska shows that the deposition rate and particle size decrease logarithmically with distance from the ground-disturbing activity (Auerbach et al. 1997; Ford and Hasselbach 2001). Because the physical and chemical effects of dust deposition have been shown to be difficult to document beyond 330 feet from the disturbing action (Walker and Everett 1987), an indirect impact area was calculated by buffering the area of direct disturbance by 330 feet, then subtracting the direct disturbance footprint to exclude vegetation directly impacted by permanent mine facilities. This area of analysis is the same applied to wetlands and other waters to evaluate indirect impacts of dust (see Figure 4.22-2), and follows methods used by recent EISs in Alaska (Ambler Road DEIS [BLM 2019b]; Donlin Gold 2018 [USACE 2018d]; Point Thompson 2012 [USACE 2012a]).

Addition of dust with a pH higher than the resident soil can initiate shifts in plant community composition from acidic to more alkaline vegetation types (Auerbauch et al. 1997). Increase in soil nutrients due to higher pH has been shown to promote the recruitment and growth of mineotrophic species such as the shrub, *Alnus viridis* (Gill et al. 2014), graminoids (Meyers-Smith et al. 2006), and ruderal mosses (*Ceratodon purpureus, Bryum* spp. and *Polytrichum juniperinum*) (Walker and Everett 1987). This increase in mineotrophic species typically occurs at the expense of acrocarpous mosses (*Hylocomium splendens*) (Hasselbach et al. 2005; Neitlich et al. 2017), lichens (DiMeglio 2019), peat mosses (*Sphagnum lenense*) (Spatt and Miller 1981), forbs and dwarf shrubs (e.g., *Empetrum nigrum, Rhododendron subarcticum*, *Cassiope tetragona, Ledum palustre,* and *Vaccinium vitis-idaea, V. uliginosum*) (Gill et al. 2014; Walker and Everett 1987).

Where dust deposition facilitates the dominance of tall shrubs (e.g., alder), several ecological feedbacks are strengthened: higher-stature vegetation acts to entrap dust and further increase soil nutrient availability, thereby further reducing the presence of acidophilous mosses and vascular plants as soil pH and shading increase. Tall shrubs acting as a windbreak may also increase the depth and lateral extent of snow accumulation, insulating the ground and potentially leading to higher ground temperatures beyond areas immediately adjacent to the road (Gill et al. 2014).

The deposition of dust with color different from the natural leaf or soil surfaces can cause an albedo-induced change in temperature, affecting the rates of cellular and pedogenic processes. This is generally the case with dust deposition on snow, which has been shown to accelerate melt, thereby encouraging the early green-up of the underlying vegetation (Auerbach et al. 1997; Walker and Everett 1987). Although analysis area soils are acidic, road materials would be locally sourced, which reduces the potential for pH to differ drastically from that of native soils. Exceptions would include the deposition of light-colored and potentially higher pH mineral road dust to darker and more acidic organic soils.

With respect to the influence of environmental conditions on dust deposition, dust impacts may be directed by plant architecture, precipitation, and wind (Auerbach et al. 1997; Doley 2006). Plant susceptibility to dust loading is increased by a mat or prostrate growth form; lack of a protective leaf cuticle; narrow leaves and intricate branching; and non-deciduous leaves, which, when not covered by snow, are able to intercept dust outside of the growing season (Walker and Everett 1987). Alternatively, wind and precipitation would decrease the amount of dust retained on plant surfaces. In the analysis area, dwarf shrub and evergreen shrub and forests would be expected to be more susceptible to the adverse effects of dust deposition.

Dust-induced changes in plant community composition would likely vary by vegetation type. Dry prostrate shrub and aquatic graminoid tundra show little effect beyond smothering adjacent to the roadside; however, moist and wet graminoid tundra show an increase in mineotrophic species at the expense of acidophilous species, with lichen- and *Sphagnum*-dominated communities being the most sensitive to dust deposition (Farmer 1993). Lichens are extremely slow-growing, and take decades to over a century to recover from disturbance (Joly et al. 2010). Following fire, lichen communities transition to graminoid dominance. These communities remain low in lichen cover for over 55 years, with full recovery estimated to take as long as 160 years (Black and Bliss 1978). The sensitivity of lichen-rich communities to dust deposition and disturbance in general is important for caribou (*Rangifer tarandus granti*), which have been shown to derive much of their winter diet from reindeer lichens in the *Cladonia* genus (e.g., *Cladonia rangiferina, C. arbuscula, C. mitis,* and *C. stellaris*) (Jolly et al. 2010). Impacts to caribou due to fugitive dust deposition are discussed in 4.23, Wildlife Values; the sensitivity of peatlands to dust deposition is discussed in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites.

PLP developed a conceptual Fugitive Dust Control Plan that identifies project design features and best management practices (BMPs) to minimize fugitive dust emissions (PLP 2019-RFI 134). Among other measures, the plan would enforce separation of mine site and access road traffic to minimize cross-contamination of vehicles, and would implement the use of sealed containers (i.e., containerized bulk-handling technology) for the transport of concentrate. Wet mill processes, the watering of haul roads, use of wetting material, washing of concentrate containers, and covering and/or revegetation of stockpiled soil would also be used as controls on fugitive dust generation and deposition. Although these measures would be expected to minimize fugitive dust emissions, the deposition of dust on vegetation would still be expected. Fugitive dust at the mine site is expected to be derived from both concentrate and road material, whereas dust deposition in the transportation corridor is expected to be road material dust only.

Specific to the Pebble Project, a dust dispersion model was developed to predict the worst-case scenario of air quality impacts of particulate matter at the mine site (PLP 2018-RFI 009a). Maximum annual modeled deposition of dust with an aerodynamic diameter less than or equal to 10 microns in diameter (PM_{10}) was 1.5 grams per square meter per year (grams/m^2/year) due to construction; maximum values as high as 30 grams/m^2/year were reported within the mine site ambient air quality boundary. The influence of prevailing northwest-southeast winds is clearly shown in the orientation of the deposition-rate isopleths (see Figure 4.22-3 and Figure 4.14-1).

Additional modeling evaluated concentrations of hazardous air pollutant (HAP) metals carried by fugitive dust for incremental increase over the 20-year operations period at the mine site. Only copper (6 percent) and antimony (3 percent) showed increases in concentration over 1 percent at the end of operations. Even with these increases, modeled concentrations of HAP metals are considered insufficient to produce adverse impacts on human health (Section 4.10, Health and Safety, and Section 4.14, Soils). Although the potential for adverse impacts to vegetation is presumed to be low, deposition of metal-contaminated dust at the mine site would largely affect dwarf shrub communities, which have low capacity to sequester metals; and due to a characteristically significant lichen component, would be more susceptible to the uptake of metals.

Although a few metals are essential to plant metabolism in trace amounts, including copper, manganese, cobalt, zinc, and chromium, most are toxic in bioavailable forms at high levels (Nagajyoti et al. 2010; Yurela 2005). Plants growing in metal-polluted sites exhibit altered metabolism, growth reduction, and lower production of biomass (Nagajyoti et al. 2010). Select vascular species are adapted to sequester or exclude heavy metals or avoid uptake from surface soils via a deep root system, and can survive longer in contaminated soils (Nagajyoti et al. 2010). However, mosses and lichens, which lack vascular transport mechanisms and therefore absorb water and nutrients through their thalli and leaf surfaces, are highly susceptible to airborne pollutants (DeMeglio 2019; Hasselbach et al. 2005; Neitlich et al. 2017). Metal concentrations in moss and lichen have been shown to exceed baseline levels up to 25 miles from a gravel mine access road in arctic Alaska (Red Dog haul road; Hasselbach et al. 2005; Neitlich et al. 2017). The dispersal and toxicity of metal-contaminated dust is expected to be considerably less than that documented along the Red Dog haul road due to PLP's proposed mitigation, which would reduce the generation of metal-contaminated dust, and restrict the deposition of metal-contaminated dust to the mine site. At the plant community level, decreases in biomass and species richness are common effects of metal toxicity (DeMeglio 2019; Ernst 1989). Dust deposition is further discussed in Section 4.14, Soils; indirect impacts to wetlands are discussed in Section 4.22, Wetlands and Other Waters/Special Aquatic Sites.

4.26.4 Summary of Key Issues

Depending on the alternative, the magnitude and extent of direct permanent impacts from project construction, operations, and closure would be the removal of between 9,482 (Alternative 1) and 10,081 (Alternative 3) acres of vegetation[2]. Direct temporary impacts to vegetation range from 671 (Alternative 1) to 1,240 (Alternative 2) acres. The indirect impacts related to the potential deposition of dust range from 8,236 (Alternative 2) to 9,915 (Alternative 3) acres of vegetation. Table 4.26-1 summarizes the direct and indirect impacts to vegetation from the removal of vegetation and the potential deposition of fugitive dust, respectively, across all alternatives. Because there are no known or probable locations of rare or sensitive plant species in the analysis area, the direct impact of potential loss of rare or sensitive species habitat is not further discussed among action alternatives. The indirect impacts related to the potential introduction and spread of invasive species are discussed under Invasive Species. However, because there are no confirmed occurrences of invasive species in the analysis area and the probability of introduction is difficult to predict, impacts are not quantified among the alternatives.

[2] Totals assume base case scenario without the inclusion of variants.

Table 4.26-1: Summary of Vegetation Key Impacts

Variant	Impact	Alternative 1a	Alternative 1	Alternative 2	Alternative 3
All Project Components (Acres)					
Base Case	Permanent	9,504	9,482	9,637	10,018
	Temporary	822	671	1,241	777
	Indirect	9,159	9,295	8,236	9,915
Mine Site (Acres)					
Base Case	Permanent	8,292	8,292	8,399	8,292
	Temporary	1	1	1	1
	Indirect	3,022	3,022	3,012	3,021
Summer-Only Ferry Operations Variant	Permanent	--	8,325 [+33]	8,432 [+33]	--
	Temporary	--	1	1	--
	Indirect	--	3,007 [-15]	2,997 [-15]	--
Concentrate Pipeline Variant	Permanent	--	--	--	8,293 [+1]
	Temporary	--	--	--	1
	Indirect	--	--	--	3,020 [-2]
Transportation (Acres)					
Base Case	Permanent	1,188	1,165	896	1,681
	Temporary	594	602	428	648
	Indirect	6,053	6,189	4,424	6,799
Summer-Only Ferry Operations Variant	Permanent	--	--	918 [+22]	--
	Temporary	--	--	428	--
	Indirect	--	--	4,426 [+2]	--
Kokhanok East Ferry Terminal Variant	Permanent	--	1,20	--	--
	Temporary	--	556	--	--
	Indirect	--	5,754	--	--
Newhalen River North Crossing Variant	Permanent	--	--	916 [+20]	--
	Temporary	--	--	427 [-1]	--
	Indirect	--	--	4,416 [-8]	--
Port (Acres)					
Base Case	Permanent	21	22	42	32
	Temporary	7	7	9	4
	Indirect	84	84	85	35
Summer-Only Ferry Operations Variant	Permanent	--	49 [+27]	--	--
	Temporary	--	8 [+1]	--	--
	Indirect	--	83 [-1]	--	--
Pile-Supported Dock Variant	Permanent	--	21 [-1]	--	--
	Temporary	--	7	--	--
	Indirect	--	84	--	--
Natural Gas Pipeline (Acres)					
Base Case	Permanent	2	2	300	13
	Temporary	220	62	803	125
	Indirect	--	--	715	60
Kokhanok East Ferry Terminal Variant	Permanent	--	2	--	--
	Temporary	--	86 [+24]	--	--
	Indirect	--	--	--	--

4.26.5 No Action Alternative

The No Action Alternative is intended to be used as a baseline to facilitate the comparison of impacts between the action alternatives. Impacts from the proposed Applicant's Preferred Alternative (beneficial or adverse) would not occur under the No Action Alternative.

Under the No Action Alternative, federal agencies with decision-making authorities on the project would not issue permits under their respective authorities. The Applicant's Preferred Alternative would not be undertaken, and no construction, operations, or closure activities specific to the Applicant's Preferred Alternative would occur. Although no resource development would occur under the Applicant's Preferred Alternative, Pebble Limited Partnership (PLP) would retain the ability to apply for continued mineral exploration activities under the State's authorization process (ADNR 2018-RFI 073) or for any activity not requiring federal authorization. In addition, there are many valid mining claims in the area, and these lands would remain open to mineral entry and exploration by other individuals or companies.

It would be expected that current State-authorized activities associated with mineral exploration and reclamation, as well as scientific studies, would continue at levels similar to recent post-exploration activity. The State requires that sites be reclaimed at the conclusion of their State-authorized exploration program. If reclamation approval is not granted immediately after the cessation of activities, the State may require continued authorization for ongoing monitoring and reclamation work as it deems necessary.

4.26.6 Alternative 1a

The total direct impact under Alternative 1a would be the removal of 9,504 acres of vegetation, with temporary impacts to an additional 822 acres expected. Regarding indirect impacts, 9,159 acres of vegetation could be exposed to dust deposition. No variants are evaluated under Alternative 1a.

4.26.6.1 Mine Site

Alternative 1a would include development at the mine site with centerline construction for the bulk tailings storage facility (TSF) north embankment.

Vegetation Removal

Under Alternative 1a, the magnitude and extent of direct impacts during construction of the mine site would be the clearing, grading, and removal of 8,292 acres of vegetation across the Headwaters Koktuli River and Upper Talarik Creek (UTC) watersheds (Table 4.26-2). Direct permanent impacts to vegetation at the mine site represent 5 percent and less than 1 percent of vegetation mapped for the Headwaters Koktuli River and UTC watersheds, evaluated at the HUC 10 scale. Dwarf shrub represents 55 percent of the area of direct permanent impact, with open low shrub subdominant at 16 percent. Closed tall shrub comprises an additional 10 percent of the area of direct permanent impact. Direct temporary impacts would occur for 0.6 acre of dwarf to low shrub across the two watersheds. The majority (100 percent, as rounded) of all direct impacts would occur in the Headwaters Koktuli River watershed. The duration of most direct impacts to vegetation at the mine site are considered permanent, because features would remain in use through operations and into closure. For example, all road material sites would be stabilized and progressively reclaimed, but would remain active to support ongoing mine access road maintenance requirements through operations; mine laydown areas would be retained for use through operations; and all construction roads would continue to serve as site access roads. Less than 1 acre of direct impacts associated with excavation at each of the effluent discharge locations is considered temporary.

Table 4.26-2: Alternative 1a—Mine Site Permanent Impact Area

Vegetation Type	Headwaters Koktuli River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
			Acres	Percent Area
Dry to Moist Herbaceous	308	<1	308	4
Wet Herbaceous	477	1	478	6
Dwarf Shrub	4,542	12	4,553	55
Open Low Shrub	1,352	3	1,355	16
Open Tall Shrub	272	<1	272	3
Closed Low Shrub	162	--	162	2
Closed Tall Shrub	856	1	857	10
Other	307	<1	307	4
Mine Site Permanent Impact Area	**8,275**	**17**	**8,292**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Fugitive Dust

Fugitive dust would be generated during construction and operation of the mine. At the mine site, dust would be generated by ground-disturbing activities related to excavation, fill, road maintenance, and vehicle travel, as well as mining activities such as the removal, transport, and processing of ore. Wind would also be expected to generate dust from bare soil at the mine site.

During construction and operation of Alternative 1a, the magnitude and extent of indirect impacts would be the potential deposition of dust over 3,022 acres of vegetation across the Headwaters Koktuli River and UTC watersheds (Table 4.26-3). The dwarf shrub vegetation type comprises 62 percent of this area; open low shrub is subdominant at 12 percent. The majority (97 percent) of impacts would occur in the Headwaters Koktuli River watershed. The duration of these potential impacts would be considered long-term.

Table 4.26-3: Alternative 1a—Mine Site Fugitive Dust Impacts

Vegetation Type	Headwaters Koktuli River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
			Acres	Percent Area
Dry to Moist Herbaceous	120	1	121	4
Wet Herbaceous	117	10	127	4
Dwarf Shrub	1,838	41	1,879	62
Open Low Shrub	353	21	374	12
Open Tall Shrub	105	3	108	4
Closed Low Shrub	22	<1	22	1
Closed Tall Shrub	210	5	215	7
Other	175	<1	175	6
Mine Site Indirect Impact Area	**2,940**	**82**	**3,022**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

4.26.6.2 Transportation Corridor

Alternative 1a would include a transportation corridor with a mine access road to the Eagle Bay ferry terminal, a south crossing of the Newhalen River, a ferry crossing of Iliamna Lake to the south ferry terminal west of Kokhanok, and a port access road to the western side of Cook Inlet.

Vegetation Removal

Construction activities in the transportation corridor would require clearing, grading, and removal of vegetation along access roads, ferry terminals, laydown areas, and material sites. Segments of the natural gas pipeline adjacent to access roads are addressed in this section.

The magnitude, duration, and extent of impacts would be the permanent removal of 1,188 acres (Table 4.26-4), with temporary impacts to 594 acres of vegetation across seven watersheds (Table 4.26-5). The dwarf shrub vegetation type comprises 48 percent of the area of permanent impact, with open/closed forest (21 percent), and open tall shrub (11 percent) subdominant. Temporary impacts to vegetation would also be highest for dwarf shrub (44 percent), open/closed forest (25 percent), and open tall shrub (10 percent).

Table 4.26-4: Alternative 1a—Transportation Corridor Permanent Impact Area

Vegetation Type	Amakdedori Creek-Frontal Kamishak Bay (Acres)	Gibraltar Lake (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Newhalen River (Acres)	Paint River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
								Acres	Percent Area
Dry to Moist Herbaceous	4	--	1	2	1	--	8	14	1
Wet Herbaceous	5	1	<1	4	-	--	1	11	1
Dwarf Shrub	68	91	12	163	87	--	151	571	48
Open Low Shrub	13	4	<1	14	27	--	30	87	7
Open Tall Shrub	57	20	1	41	2	<1	4	125	11
Closed Low Shrub	<1	<1	<1	2	1	--	1	5	<1
Closed Tall Shrub	27	13	1	38	1	--	25	104	9
Open/Closed Forest	--	10	--	110	133	--	<1	253	21
Other	4	3	--	4	1	--	5	17	1
Transportation Corridor Permanent Impact Area	**179**	**141**	**14**	**377**	**252**	**<1**	**225**	**1,188**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Table 4.26-5: Alternative 1a—Transportation Corridor Temporary Impact Area

Vegetation Type	Amakdedori Creek-Frontal Kamishak Bay (Acres)	Gibraltar Lake (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Newhalen River (Acres)	Paint River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
								Acres	Percent Area
Dry to Moist Herbaceous	3	<1	1	1	<1	--	3	8	1
Wet Herbaceous	4	1	<1	3	<1	--	1	8	1
Dwarf Shrub	30	53	6	77	37	<1	58	262	44
Open Low Shrub	10	3	<1	8	11	--	12	44	7
Open Tall Shrub	25	8	<1	21	1	<1	2	57	10
Closed Low Shrub	<1	<!	<1	1	<1	--	1	2	<1
Closed Tall Shrub	13	8	<1	19	1	--	14	55	9
Open/Closed Forest	--	9	---	57	82	--	0	148	25
Other	3	1	--	2	1	--	2	8	1
Transportation Corridor Temporary Impact Area	**88**	**83**	**7**	**189**	**133**	**<1**	**94**	**594**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Fugitive Dust

Development and operations of the transportation corridor would generate less dust compared to the mine site, although dust deposition would occur over a larger geographic area. Although the transportation corridor crosses seven watersheds, dust generation is expected to be lower because the dust-producing activities would be less frequent (vehicles passing rather than ongoing movement of materials at the mine site), and the unvegetated area of the road is much smaller than the mine site.

During operations, daily transportation of materials (concentrate, fuel, reagents, and consumables) would require multiple truck round-trips per day. Section 4.12, Transportation and Navigation, describes the number of trips and the type and number of vehicles expected to use the access roads. Dust would likely be generated during gravel placement, gravel compaction activities, and from vehicular traffic and equipment operation on gravel roads.

In terms of magnitude and extent of indirect impacts, a total of 6,053 acres of vegetation would be exposed to the potential deposition of dust across seven watersheds (Table 4.26-6). The duration of these potential impacts would be considered long-term. The dwarf shrub vegetation type comprises 41 percent of the area of indirect impact; open/closed forest is subdominant at 24 percent. Closed and open tall shrub each comprise an additional 10 percent.

Table 4.26-6: Alternative 1a—Transportation Corridor Fugitive Dust Impact Area

Vegetation Type	Amakdedori Creek-Frontal Kamishak Bay (Acres)	Gibraltar Lake (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Newhalen River (Acres)	Paint River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
								Acres	Percent Area
Dry to Moist Herbaceous	32	2	5	8	5	--	39	91	1
Wet Herbaceous	48	23	<1	42	11	<1	17	140	2
Dwarf Shrub	291	479	54	755	365	1	544	2,489	41
Open Low Shrub	96	45	3	103	123	--	146	515	9
Open Tall Shrub	259	86	2	234	16	1	32	630	10
Closed Low Shrub	2	2	<1	10	3	--	11	29	<1
Closed Tall Shrub	137	91	5	185	14	--	155	586	10
Open/Closed Forest	--	91	--	571	811	--	4	1,478	24
Other	34	8	<1	23	5	--	25	95	2
Transportation Corridor Indirect Impact Area	**900**	**828**	**69**	**1,931**	**1,352**	**2**	**971**	**6,053**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

4.26.6.3 Amakdedori Port

Alternative 1a would include construction of a caisson dock at Amakdedori on Kamishak Bay. Due to sufficient water depths, dredging would not be required at this port location. The port would be supported by a permanent airstrip used primarily for construction, but retained for emergency access. Other shore-based infrastructure would include facilities for the receipt and storage of containers for concentrate and freight, fuel storage and transfer, power generation and distribution, maintenance, employee accommodation, and offices.

Vegetation Removal

Construction of the port would require clearing, grading, and removal of vegetation in areas along the access road, and where the shore-based facilities would be located, such as the airstrip and facilities for receipt and storage of containers, fuel storage and transfer, power generation and distribution, maintenance, and employee accommodation.

All temporary construction facilities would be removed after construction, and the sites would be reclaimed, unless being used for permanent facilities. The Amakdedori port facilities would be removed and reclaimed after closure activities are completed, except for those required to support shallow draft tug and barge access to the dock for the transfer of bulk supplies.

Under Alternative 1a, 21 acres of vegetation would be permanently impacted, with temporary impacts to an additional 7 acres; impacts would be restricted to the Amakdedori Creek-Frontal Kamishak Bay watershed (Table 4.26-7). The dwarf shrub vegetation type comprises 74 and 68 percent of the areas of permanent and temporary impacts, respectively; with sparse to partially vegetated land (i.e., other) covering an additional 20 and 21 percent of the areas of permanent and temporary impact, respectively.

Table 4.26-7: Alternative 1a—Amakdedori Port Permanent and Temporary Impact Areas

Vegetation Type	Amakdedori Creek-Frontal Kamishak Bay			
	Permanent Impact		Temporary Impact	
	Acres	Percent Area	Acres	Percent Area
Dry to Moist Herbaceous	1	5	1	10
Dwarf Shrub	16	74	5	68
Open Tall Shrub	<1	<1	<1	<1
Closed Low Shrub	<1	<1	<1	<1
Closed Tall Shrub	<1	<1	<1	<1
Other	4	20	2	21
Amakdedori Port Impact Area	**21**	**100**	**7**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Fugitive Dust

The production of fugitive dust at the port would mostly result from construction of the terminal, with dust emissions during the period of operations expected to be limited. Onshore port facilities would be removed during closure, except for necessary infrastructure to support shallow-draft tug and barge access to the dock.

During construction, the magnitude and extent of vegetation that would potentially be affected by dust deposition at the Amakdedori port is 84 acres; the entire area of impact is in the Amakdedori Creek-Frontal Kamishak Bay watershed (Table 4.26-8). The duration of these potential impacts would be considered long-term. The dwarf shrub vegetation type comprises 63 percent of the impacted area, with sparse to partially vegetated land (i.e., other), and the dry to moist herbaceous vegetation type covering an additional 14 and 11 percent of the area, respectively.

Table 4.26-8: Alternative 1a—Amakdedori Port Fugitive Dust Impact Area

Vegetation Type	Amakdedori Creek-Frontal Kamishak Bay	
	Acres	Percent Area
Dry to Moist Herbaceous	9	11
Wet Herbaceous	1	1
Dwarf Shrub	53	63
Open Low Shrub	1	1
Open Tall Shrub	2	3
Closed Low Shrub	1	1
Closed Tall Shrub	4	5
Other	12	14
Amakdedori Port Indirect Impact Area	**84**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

4.26.6.4 Natural Gas Pipeline Corridor

Alternative 1a would include a natural gas pipeline crossing Cook Inlet from the Kenai Peninsula to the Amakdedori port, along the port access road to Iliamna Lake, across the lake to Newhalen, overland to connect to the mine access road east of the Newhalen River crossing, and along the mine access road to the mine site.

Vegetation Removal

Construction of the natural gas pipeline corridor would require clearing, grading, and removal of vegetation; the right-of-way would be maintained through the life of the project. This natural gas pipeline corridor impact area includes the pipeline-only sections of the natural gas pipeline that are not co-located with access roads.

Construction of the compressor station on the Kenai Peninsula would require the removal of 2 acres of open/closed forest in Stariski Creek-Frontal Cook Inlet watershed; this loss is the only permanent impact to vegetation associated with installation of the natural gas pipeline under Alternative 1a. Temporary impacts of natural gas pipeline installation would affect 220 acres of vegetation across six watersheds (Table 4.26-9). The open/closed forest vegetation type comprises 39 percent of the area of temporary impact, with dwarf shrub (25 percent) and open low shrub (21 percent) subdominant.

Table 4.26-9: Alternative 1a—Natural Gas Pipeline Temporary Impact Area

Vegetation Type	Amakdedori Creek-Frontal Kamishak Bay (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Newhalen River (Acres)	Stariski Creek-Frontal Cook Inlet (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
							Acres	Percent Area
Dry to Moist Herbaceous	2	1	<1	--	<1	1	5	2
Wet Herbaceous	--	--	2	<1	--	--	2	1
Dwarf Shrub	7	4	24	7	--	13	54	25
Open Low Shrub	--	--	40	3	--	4	46	21
Open Tall Shrub	<1	--	8	<1	--	2	10	5
Closed Low Shrub	--	--	1	--	--	-	1	1
Closed Tall Shrub	<1	--	4	--	--	3	8	4
Open/Closed Forest	--	--	53	33	<1	--	87	39
Other	1	--	4	<1	<1	<1	6	3
Natural Gas Pipeline Temporary Impact Area	**10**	**5**	**138**	**43**	**1**	**23**	**220**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Fugitive Dust

Although fugitive dust would be generated during installation of the pipeline-only segments of the natural gas pipeline, dust generation during operation is expected to be minimal because these sections would not be regularly accessed. Subsequent indirect impacts to vegetation from fugitive dust would likely be limited, and are analyzed in the transportation corridor for Alternative 1a.

4.26.7 Alternative 1

The total direct permanent impact under the Alternative 1 base case would be the removal of 9,482 acres of vegetation, with temporary impacts to an additional 671 acres expected. Regarding indirect impacts, 9,295 acres of vegetation would be exposed to the potential deposition of dust. Three variants are considered under Alternative 1: the Summer-Only Ferry Operations Variant, the Kokhanok East Ferry Terminal Variant, and the Pile-Supported Dock Variant. The Summer-Only Ferry Operations Variant would restrict operation of the ferry across Iliamna Lake to the open-water season; the Kokhanok East Ferry Terminal Variant considers an alternate south ferry terminal site east of Kokhanok; and the Pile-Supported Dock Variant would use an alternate pile-supported dock design at Amakdedori port. Change in the total acres of direct and indirect impacts due to the incorporation of variants are summarized in Table 4.26-1, and further discussed below.

4.26.7.1 Mine Site

The mine site footprint under Alternative 1 is the same as Alternative 1a, the direct and indirect impacts of which are summarized under Alternative 1a.

Vegetation Removal

Summer-Only Ferry Operations Variant

This variant would restrict operation of the ferry across Iliamna Lake to the open-water season. Instead of daily transportation to the Amakdedori port, concentrate would be stored in a container-based system that would be stockpiled at the mine site during the period when the lake is frozen. The containers would be stored in a laydown area at the mine site, requiring relocation of the sewage tank pad.

Expansion of container storage at the mine site would increase the magnitude of permanent impacts to vegetation by 33 acres (Table 4.26-10). The area of permanent impact at the mine site accounting for the expanded container storage yard is dominated by dwarf shrub (55 percent), with the open low and closed tall shrub types representing an additional 16 and 10 percent, respectively. The duration and extent of permanent impacts under the Summer-Only Ferry Operations Variant would not change from the Alternative 1 base case.

Table 4.26-10: Alternative 1—Mine Site Summer-Only Ferry Operations Variant Permanent Impact Area

Vegetation Type	Headwaters Koktuli River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
			Acres	Percent Area
Dry to Moist Herbaceous	311	<1	311	4
Wet Herbaceous	476	1	477	6
Dwarf Shrub	4,569	12	4,581	55
Open Low Shrub	1,355	3	1,358	16
Open Tall Shrub	272	<1	272	3
Closed Low Shrub	162	--	162	2
Closed Tall Shrub	856	1	857	10
Other	308	<1	308	4
Mine Site Permanent Impact Area	**8,309**	**17**	**8,325**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Other Variants

There would be no change to the magnitude, duration, or extent of direct impacts to vegetation at the mine site under the Kokhanok East Ferry Terminal or Pile-Supported Dock variants.

Fugitive Dust

Summer-Only Ferry Operations Variant

Due to a more compact configuration of mine site facilities under adoption of the Summer-Only Ferry Operations Variant, the area of vegetation exposed to the potential deposition of fugitive dust would be decreased by 15 acres (Table 4.26-11). The area of indirect impact at the mine site accounting for the expanded container storage yard is dominated by dwarf shrub (62 percent), with the open low shrub type subdominant at 12 percent. The duration and extent of dust deposition under the Summer-Only Ferry Operations Variant would not change from the Alternative 1 base case.

Table 4.26-11: Alternative 1—Mine Site Summer-Only Ferry Operations Variant Fugitive Dust Impact Area

Vegetation Type	Headwaters Koktuli River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
			Acres	Percent Area
Dry to Moist Herbaceous	119	1	121	4
Wet Herbaceous	118	10	128	4
Dwarf Shrub	1,826	41	1,867	62
Open Low Shrub	350	21	372	12
Open Tall Shrub	105	3	108	4
Closed Low Shrub	22	<1	22	1
Closed Tall Shrub	210	5	215	7
Other	174	<1	174	6
Mine Site Indirect Impact Area	**2,925**	**82**	**3,007**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Other Variants

There would be no change to the magnitude, duration, or extent of indirect impacts to vegetation at the mine site under the Kokhanok East Ferry Terminal or Pile-Supported Dock variants.

4.26.7.2 Transportation Corridor

The transportation corridor footprint under Alternative 1 would include a mine access road in the UTC watershed to a north ferry terminal southwest of Newhalen, and a crossing of Iliamna Lake to the south ferry terminal west of Kokhanok, from where the alignment would rejoin Alternative 1a.

Vegetation Removal

Construction activities in the transportation corridor would require clearing, grading, and removal of vegetation along access roads, ferry terminals, laydown areas, and material sites. Segments of the natural gas pipeline adjacent to access roads are addressed in this section.

The magnitude, duration, and extent of impacts would be the permanent removal of 1,165 acres (Table 4.26-12), with temporary impacts to 602 acres of vegetation across seven watersheds (Table 4.26-13). The dwarf shrub vegetation type comprises 55 percent of the area of permanent impact with open tall shrub and closed tall shrub (23 percent collectively), and open/closed forest (10 percent) subdominant. Temporary impacts to vegetation would also be highest for dwarf shrub (54 percent), with open tall shrub, closed tall shrub, and open/closed forest each representing an additional 11 percent of the impact area.

Table 4.26-12: Alternative 1—Transportation Corridor Permanent Impact Area

Vegetation Type	Amakdedori Creek-Frontal Kamishak Bay (Acres)	Gibraltar Lake (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Newhalen River (Acres)	Paint River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
								Acres	Percent Area
Dry to Moist Herbaceous	4	--	1	1	--	--	9	15	1
Wet Herbaceous	5	1	<1	5	<1	--	1	13	1
Dwarf Shrub	68	91	12	215	1	--	254	642	55
Open Low Shrub	13	4	<1	25	4	--	33	79	7
Open Tall Shrub	57	20	1	47	11	<1	7	143	12
Closed Low Shrub	<1	<1	<1	3	--	--	2	5	<1
Closed Tall Shrub	27	13	1	39	1	--	49	128	11
Open/Closed Forest	--	10	--	55	35	--	16	116	10
Other	4	3	--	5	--	--	12	24	2
Transportation Corridor Permanent Impact Area	**179**	**141**	**14**	**395**	**52**	**<1**	**383**	**1,165**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Table 4.26-13: Alternative 1—Transportation Corridor Temporary Impact Area

Vegetation Type	Amakdedori Creek-Frontal Kamishak Bay (Acres)	Gibraltar Lake (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Newhalen River (Acres)	Paint River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
								Acres	Percent Area
Dry to Moist Herbaceous	3	<1	1	1	--	--	5	9	2
Wet Herbaceous	4	1	<1	3	<1	--	1	9	1
Dwarf Shrub	30	53	6	96	<1	<1	139	325	54
Open Low Shrub	10	3	<1	11	3	--	18	44	7
Open Tall Shrub	25	8	<1	24	7	<1	4	68	11
Closed Low Shrub	<1	<1	<1	1	--	--	2	4	1
Closed Tall Shrub	13	8	<1	19	<1	--	27	68	11
Open/Closed Forest	--	9	--	27	16	--	12	64	11
Other	3	1	--	3	--	--	5	11	2
Transportation Corridor Temporary Impact Area	**88**	**83**	**7**	**184**	**26**	**<1**	**213**	**602**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Summer-Only Ferry Operations Variant

With ferry operations limited to the open water season only, there would be increased truck traffic along the transportation corridor during the operating months to handle the movement of the full year of concentrate production, fuel, and consumables. The areas of permanent and temporary impact, however, would be the same as the Alternative 1 base case.

Kokhanok East Ferry Terminal Variant

This variant would increase the magnitude of direct permanent impacts on vegetation by 35 acres and reduce the temporary impacts by 46 acres. Similar to the Alternative 1 base case, the areas of permanent and temporary impact are dominated by dwarf shrub vegetation with open/closed forest and tall shrub types subdominant (Table 4.26-14 and Table 4.26-15). The duration and extent of direct impacts would not change from the Alternative 1 base case.

Table 4.26-14: Alternative 1—Transportation Corridor Kokhanok East Ferry Terminal Variant Permanent Impact Area

Vegetation Type	Amakdedori Creek-Frontal Kamishak Bay (Acres)	Gibraltar Lake (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Newhalen River (Acres)	Paint River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
								Acres	Percent Area
Closed Low Shrub	<1	<1	<1	6	--	--	2	8	1
Closed Tall Shrub	27	10	1	44	1	--	49	131	11
Dry to Moist Herbaceous	4	--	1	4	--	--	9	17	1
Dwarf Shrub	68	18	12	168	1	--	254	521	43
Open Low Shrub	13	1	<1	33	4	--	33	84	7
Open Tall Shrub	57	13	1	52	11	<1	7	140	12
Open/Closed Forest	--	--	--	191	35	--	16	242	20
Other	4	2	--	24	--	--	12	43	4
Wet Herbaceous	5	1	<1	5	<1	--	1	12	1
Transportation Corridor Permanent Impact Area	**179**	**45**	**14**	**527**	**52**	**<1**	**383**	**1,200**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Table 4.26-15: Alternative 1—Transportation Corridor Kokhanok East Ferry Terminal Variant Temporary Impact Area

Vegetation Type	Amakdedori Creek-Frontal Kamishak Bay (Acres)	Gibraltar Lake (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Newhalen River (Acres)	Paint River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
								Acres	Percent Area
Dry to Moist Herbaceous	3	<1	1	1	--	--	5	10	2
Wet Herbaceous	4	<1	<1	3	<1	--	1	8	2
Dwarf Shrub	30	8	6	65	<1	<1	139	249	45
Open Low Shrub	10	1	<1	11	3	-	18	42	8
Open Tall Shrub	25	4	<1	20	7	<1	4	61	11
Closed Low Shrub	<1	<1	<1	2	--	--	2	4	1
Closed Tall Shrub	13	7	<1	19	<1	--	27	66	12
Open/Closed Forest	--	--	--	76	16	--	12	103	19
Other	3	<1	--	5	--	--	5	13	2
Transportation Corridor Temporary Impact Area	**88**	**20**	**7**	**200**	**26**	**<1**	**213**	**556**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Pile-Supported Dock Variant

There would be no change to the magnitude, duration, or extent of direct impacts to vegetation in the transportation corridor under the Pile-Supported Dock Variant.

Fugitive Dust

Under Alternative 1, a total of 6,189 acres of vegetation across seven watersheds would potentially be impacted by dust in the transportation corridor. The duration of these potential impacts would be considered long-term. The dwarf shrub vegetation type comprises 51 percent of the area of impact, with closed and open tall shrub representing an additional 12 percent each, and open/closed forest contributing an additional 11 percent (Table 4.26-16).

Table 4.26-16: Alternative 1—Transportation Corridor Fugitive Dust Impact Area

Vegetation Type	Amakdedori Creek-Frontal Kamishak Bay (Acres)	Gibraltar Lake (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Newhalen River (Acres)	Paint River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
								Acres	Percent Area
Dry to Moist Herbaceous	32	2	5	9	--	--	60	107	2
Wet Herbaceous	48	23	<1	38	<1	<1	26	135	2
Dwarf Shrub	291	479	54	968	5	1	1,339	3,137	51
Open Low Shrub	96	45	3	138	31	--	202	515	8
Open Tall Shrub	259	86	2	261	68	1	57	734	12
Closed Low Shrub	2	2	<1	13	--	--	22	40	1
Closed Tall Shrub	137	91	5	191	7	--	295	726	12
Open/Closed Forest	--	91	--	270	169	--	135	666	11
Other	34	8	<1	31	1	--	56	130	2
Transportation Corridor Indirect Impact Area	**900**	**828**	**69**	**1,918**	**282**	**2**	**2,192**	**6,189**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Summer-Only Ferry Operations Variant

With ferry operations limited to the open water season only, there would be increased truck traffic along the transportation corridor during the operating months to handle the movement of the full year of concentrate production, fuel, and consumables. This extra activity would be expected to increase the deposition of fugitive dust along the transportation corridor without change to the magnitude, duration, or extent of indirect impact.

Kokhanok East Ferry Terminal Variant

Adoption of the East Ferry Terminal Variant would decrease the magnitude of fugitive dust impacts along the transportation corridor by 435 acres (from 6,189 to 5,754 acres). Similar to the Alternative 1 base case, dwarf shrub (42 percent) dominates this reduced area of indirect impact, with open/closed forest (19 percent) and closed (12 percent) and open tall shrub (11 percent) types subdominant (Table 4.26-17). The duration and extent of indirect impacts would not change from the Alternative 1 base case.

Table 4.26-17: Alternative 1—Transportation Corridor Kokhanok East Ferry Terminal Variant Fugitive Dust Impact Area

Vegetation Type	Amakdedori Creek-Frontal Kamishak Bay (Acres)	Gibraltar Lake (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Newhalen River (Acres)	Paint River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
								Acres	Percent Area
Dry to Moist Herbaceous	32	<1	5	12	--	--	60	109	2
Wet Herbaceous	48	2	<1	53	<1	<1	26	130	2
Dwarf Shrub	291	72	54	671	5	1	1,339	2,433	42
Open Low Shrub	96	13	3	142	31	--	202	486	8
Open Tall Shrub	259	43	2	209	68	1	57	640	11
Closed Low Shrub	2	1	<1	19	--	--	22	45	1
Closed Tall Shrub	137	73	5	178	7	--	295	695	12
Open/Closed Forest	--	--	--	772	169	--	135	1,077	19
Other	34	6	<1	44	1	--	56	141	2
Transportation Corridor Indirect Impact Area	**900**	**210**	**69**	**2,100**	**282**	**2**	**2,192**	**5,754**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Pile-Supported Dock Variant

There would be no change to the magnitude, duration, or extent of indirect impacts to vegetation in the transportation corridor under the Pile-Supported Dock Variant.

4.26.7.3 Amakdedori Port

Alternative 1 would include a port at Amakdedori on Kamishak Bay with an earthen fill causeway and sheet pile dock design. On-shore facilities, temporary facilities, and the reclamation and closure of the site would be the same as Alternative 1a.

Vegetation Removal

The onshore configuration of the earthen fill causeway and sheet pile dock design would require the removal of an additional 1 acre of sparse or partially vegetated land (i.e., 'other') relative to the impacts of the caisson dock proposed under Alternative 1a. The duration and extent of all impacts and the magnitude of temporary and fugitive dust impacts would remain unchanged from Alternative 1a; Table 4.26-7 and Table 4.26-8 summarize the vegetation types impacted.

Summer-Only Ferry Operations Variant

Under the Summer-Only Ferry Operations Variant, concentrate containers would be stockpiled at Amakdedori port, requiring increased storage capacity. The larger container storage yard would increase the magnitude of direct permanent impacts on vegetation at Amakdedori port by 27 acres (from 22 to 49 acres), and would increase direct temporary impacts by 1 acre (from 7 to 8 acres). The dwarf shrub vegetation type comprises 79 and 73 percent of this area of permanent and temporary impacts, respectively; sparse or partially vegetated land (i.e., 'other') represents an additional 10 and 19 percent cover of permanent and temporary impacts, respectively (Table 4.26-18). There would be no change in duration or extent of direct impacts from the Alternative 1 base case.

Table 4.26-18: Alternative 1—Amakdedori Port Summer-Only Ferry Operations Variant Permanent and Temporary Impact Areas

Vegetation Type	Amakdedori Creek-Frontal Kamishak Bay			
	Permanent Impact		Temporary Impact	
	Acres	Percent Area	Acres	Percent Area
Dry to Moist Herbaceous	1	2	1	13
Wet Herbaceous	<1	1	<1	1
Dwarf Shrub	39	79	5	73
Open Low Shrub	<1	<1	<1	<1
Open Tall Shrub	1	1	<1	<1
Closed Low Shrub	3	5	<1	1
Closed Tall Shrub	1	2	<1	5
Other	5	10	1	19
Amakdedori Port Impact Area	**49**	**100**	**8**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Other Variants

There would be no change to the magnitude, duration, or extent of direct impacts to vegetation at the Amakdedori port under the Kokhanok East Ferry Terminal or Pile-Supported Dock variants.

Fugitive Dust

Fugitive dust would be generated from construction of the terminal, and from the earthen fill causeway during operations. The magnitude and extent of vegetation that would potentially be affected by dust deposition is 84 acres in the Amakdedori Creek-Frontal Kamishak Bay watershed. Dwarf shrub comprises 64 percent of the area of indirect impact (Table 4.26-19). Potential impacts due to dust are considered an indirect but long-term consequence of development.

Table 4.26-19: Alternative 1—Amakdedori Port Fugitive Dust Impact Area

Vegetation Type	Amakdedori Creek-Frontal Kamishak Bay	
	Acres	Percent Area
Dry to Moist Herbaceous	9	11
Wet Herbaceous	1	1
Dwarf Shrub	53	64
Open Low Shrub	1	1
Open Tall Shrub	2	3
Closed Low Shrub	1	1
Closed Tall Shrub	4	5
Other	12	14
Amakdedori Port Indirect Impact Area	**84**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Summer-Only Ferry Operations Variant

Adoption of the Summer-Only Ferry Operations Variant would decrease the magnitude of vegetation potentially affected by dust deposition by 1 acre relative to the Alternative 1 base case. There would be no change to the duration and extent of indirect impacts relative to the Alternative 1 base case.

Other Variants

There would be no change to the magnitude, duration, or extent of indirect impacts to vegetation at the Amakdedori port under the Kokhanok East Ferry Terminal or Pile-Supported Dock variants.

4.26.7.4 Natural Gas Pipeline Corridor

The natural gas pipeline corridor footprint under Alternative 1 follows the alignment presented under Alternative 1a from the Kenai Peninsula to the south ferry terminal at Iliamna Lake. From here, it diverges from Alternative 1a across Iliamna Lake to the north ferry terminal southwest of Newhalen, and then along the mine access road to the mine site. Impacts evaluated here are for the pipeline-only sections of the natural gas pipeline that do not fall within the transportation corridor.

Vegetation Removal

Construction of the compressor station on the Kenai Peninsula would require the removal of 2 acres of open/closed forest in Stariski Creek-Frontal Cook Inlet watershed; this loss is the only permanent impact to vegetation associated with installation of the natural gas pipeline under Alternative 1. Temporary impacts of natural gas pipeline installation would affect 62 acres of vegetation across five watersheds. The dwarf shrub vegetation type comprises 62 percent of the area of temporary impact (Table 4.26-20).

Table 4.26-20: Alternative 1—Natural Gas Pipeline Corridor Temporary Impact Area

Vegetation Type	Amakdedori Creek-Frontal Kamishak Bay (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Stariski Creek-Frontal Cook Inlet (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
						Acres	Percent Area
Dry to Moist Herbaceous	2	1	--	<1	1	5	8
Wet Herbaceous	--	--	2	--	--	2	3
Dwarf Shrub	7	4	15	--	13	38	62
Open Low Shrub	--	--	2	--	4	6	9
Open Tall Shrub	<1	--	--	--	2	2	3
Closed Tall Shrub	<1	--	1	--	3	4	7
Open/Closed Forest	--	--	3	<1	--	4	6
Other	1	--	<1	<1	<1	2	3
Natural Gas Pipeline Corridor Temporary Impact Area	**10**	**5**	**23**	**1**	**23**	**62**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Kokhanok East Ferry Terminal Variant

Adoption of the Kokhanok East Ferry Terminal Variant would increase the magnitude of temporary impacts associated with installation of the natural gas pipeline by 24 acres; the magnitude of permanent impacts would not change from the Alternative 1 base case. Under the Kokhanok East Ferry Terminal Variant, the area of temporary impact is dominated by dwarf shrub (38 percent) with open/closed forest (20 percent) subdominant (Table 4.26-21). The duration and extent of direct impacts to vegetation would remain the same as the Alternative 1 base case.

Table 4.26-21: Alternative 1—Natural Gas Pipeline Corridor Kokhanok East Ferry Terminal Variant Temporary Impact Area

Vegetation Type	Amakdedori Creek-Frontal Kamishak Bay (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Stariski Creek-Frontal Cook Inlet (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
						Acres	Percent Area
Dry to Moist Herbaceous	2	1	2	<1	1	6	7
Wet Herbaceous	--	--	2	--	--	2	2
Dwarf Shrub	7	4	10	--	13	33	38
Open Low Shrub	--	--	3	--	4	7	8
Open Tall Shrub	<1	--	1	--	2	3	4
Closed Low Shrub	--	--	4	--	--	4	4
Closed Tall Shrub	<1	--	3	--	3	7	8
Open/Closed Forest	--	--	17	<1	--	17	20
Other	1	--	6	<1	<1	8	9
Natural Gas Pipeline Corridor Temporary Impact Area	**10**	**5**	**47**	**1**	**23**	**86**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a.

Other Variants

There would be no change to the magnitude, duration, or extent of direct impacts to vegetation in the natural gas pipeline corridor under the Summer-Only Ferry Operations or Pile-Supported Dock variants.

Fugitive Dust

Fugitive dust would be generated during construction of the pipeline-only segments of the natural gas pipeline; dust generation during operation is expected to be minimal because these sections would not be regularly accessed. Subsequent indirect impacts to vegetation from fugitive dust would likely be limited, and are analyzed in the transportation corridor for Alternative 1. There would be no change to the magnitude, duration, or extent of indirect impacts to vegetation in the natural gas pipeline corridor under the Summer-Only Ferry Operations Variant, Kokhanok East Ferry Terminal Variant, or Pile-Supported Dock Variant.

4.26.8 Alternative 2—North Road and Ferry with Downstream Dams

The total direct permanent impact under the Alternative 2 base case would be the removal of 9,637 acres of vegetation, with temporary impacts to an additional 1,241 acres expected. Regarding indirect impacts, 8,236 acres of vegetation would be exposed to the potential deposition of dust. Three variants are evaluated under Alternative 2: the Summer-Only Ferry Operations Variant, the Newhalen River North Crossing Variant, and the Pile-Supported Dock Variant. The Summer-Only Ferry Operations and Pile-Supported Dock variants are described under Alternative 1. The Newhalen River North Crossing Variant evaluates a crossing of the Newhalen River north of the location proposed under Alternative 1a; change in the total acres of direct and indirect impacts due to the incorporation of variants are summarized in Table 4.26-1 and further discussed below.

4.26.8.1 Mine Site

Mining methods and facilities would remain the same as those under Alternative 1a; however, Alternative 2 would use an alternative method for construction of the bulk TSF north embankment that would increase the footprint of direct permanent disturbance.

Vegetation Removal

Under Alternative 2, the magnitude and extent of direct permanent impacts during construction of the mine site would be the clearing, grading, and removal of 8,399 acres of vegetation across the Headwaters Koktuli River and UTC watersheds (Table 4.26-22). Direct permanent impacts to vegetation at the mine site represent 5 and less than 1 percent of vegetation mapped for the Headwaters Koktuli River and UTC watersheds, respectively, evaluated at the HUC 10 scale. Dwarf shrub represents 55 percent of the area of direct permanent impact, with open low shrub subdominant at 16 percent. Closed tall shrub comprises an additional 10 percent of the area of direct impact. The majority (100 percent, as rounded) of all direct impacts would occur in the Headwaters Koktuli River watershed. The duration of most direct impacts to vegetation at the mine site are considered permanent, because features would remain in use through operations and into closure. For example, all road material sites would be stabilized and progressively reclaimed, but would remain active to support ongoing mine access road maintenance requirements through operations; mine laydown areas would be retained for use through operations; and all construction roads would continue to serve as site access roads. Less than 1 acre of direct impacts associated with excavation at each of the effluent discharge locations is considered temporary.

Table 4.26-22: Alternative 2—Mine Site Permanent Impact Area

Vegetation Type	Headwaters Koktuli River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
			Acres	Percent Area
Dry to Moist Herbaceous	319	<1	319	4
Wet Herbaceous	479	1	479	6
Dwarf Shrub	4,603	12	4,615	55
Open Low Shrub	1,363	3	1,366	16
Open Tall Shrub	273	<1	273	3
Closed Low Shrub	164	--	164	2
Closed Tall Shrub	856	1	857	10
Other	325	<1	325	4
Mine Site Permanent Impact Area	**8,382**	**17**	**8,399**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Summer-Only Ferry Operations Variant

Under this variant, the magnitude of vegetation removal impacts during construction of the mine site would increase by 33 acres. The distribution of impacts among vegetation types, as well as the duration and extent of those impacts, would be the same as the Alternative 2 base case (Table 4.26-23).

Table 4.26-23: Alternative 2—Mine Site Summer-Only Ferry Operations Variant Permanent Impact Area

Vegetation Type	Headwaters Koktuli River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
			Acres	Percent Area
Dry to Moist Herbaceous	322	<1	322	4
Wet Herbaceous	478	1	479	6
Dwarf Shrub	4,630	12	4,642	55
Open Low Shrub	1,366	3	1,369	16
Open Tall Shrub	273	<1	274	3
Closed Low Shrub	163	--	163	2
Closed Tall Shrub	856	1	857	10
Other	326	<1	326	4
Mine Site Permanent Impact Area	**8,415**	**17**	**8,432**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Other Variants

There would be no change to the magnitude, duration, or extent of direct permanent impacts to vegetation at the mine site under the Newhalen River North Crossing or the Pile-Supported Dock variants.

Fugitive Dust

During construction and operations, the magnitude and extent of indirect impacts at the mine site would be the potential deposition of dust over 3,012 acres of vegetation across two watersheds. The dwarf shrub vegetation type comprises 62 percent of this area of indirect impact; open low shrub represents an additional 12 percent (Table 4.26-24). The duration of potential impacts due to dust deposition would be considered long-term.

Table 4.26-24: Alternative 2—Mine Site Fugitive Dust Impact Area

Vegetation Type	Headwaters Koktuli River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
			Acres	Percent Area
Dry to Moist Herbaceous	125	1	127	4
Wet Herbaceous	116	10	126	4
Dwarf Shrub	1,830	41	1,871	62
Open Low Shrub	349	21	370	12
Open Tall Shrub	103	3	106	4
Closed Low Shrub	20	<1	20	1
Closed Tall Shrub	210	5	215	7
Other	176	<1	176	6
Mine Site Indirect Impact Area	**2,930**	**82**	**3,012**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Summer-Only Ferry Operations Variant

Due to a more compact configuration of mine site facilities under adoption of the Summer-Only Ferry Operations Variant, the area of vegetation exposed to the potential deposition of fugitive dust is decreased by 15 acres (Table 4.26-25). The area of indirect impact at the mine site accounting for the expanded container storage yard is dominated by dwarf shrub (62 percent) with the open low shrub type subdominant at 12 percent. The extent and duration of dust deposition under the Summer-Only Ferry Operations Variant would not change from the Alternative 2 base case.

Table 4.26-25: Alternative 2—Mine Site Summer-Only Ferry Operations Variant Fugitive Dust Impact Area

Vegetation Type	Headwaters Koktuli River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
			Acres	Percent Area
Dry to Moist Herbaceous	125	1	126	4
Wet Herbaceous	117	10	127	4
Dwarf Shrub	1,819	41	1,859	62
Open Low Shrub	346	21	368	12
Open Tall Shrub	103	3	106	4
Closed Low Shrub	20	0	20	1
Closed Tall Shrub	210	5	215	7
Other	175	0	175	6
Mine Site Indirect Impact Area	**2,915**	**82**	**2,997**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Other Variants

There would be no change to the magnitude, duration, or extent of indirect impacts to vegetation at the mine site under the Newhalen River North Crossing or Pile-Supported Dock variants.

4.26.8.2 Transportation Corridor

The transportation corridor footprint under Alternative 2 follows the alignment presented under Alternative 1a from the mine site to the Eagle Bay ferry terminal. From the Eagle Bay ferry terminal, it diverges from Alternative 1a with a ferry crossing of Iliamna Lake to a ferry terminal near Pile Bay, and continues along a port access road to the Diamond Point port.

Vegetation Removal

Construction activities in the transportation corridor would require clearing, grading, and removal of vegetation along access roads, ferry terminals, laydown areas, and material sites. Segments of the natural gas pipeline adjacent to access roads are addressed in this section.

The magnitude and extent of direct permanent impacts would be the removal of 896 acres of vegetation across six watersheds (Table 4.26-26). In this area of permanent impact, the open/closed forest (34 percent) is the dominant vegetation type, with subdominant dwarf shrub (31 percent); closed tall shrub and open low shrub represent an additional 11 and 10 percent, respectively. The magnitude and extent of temporary impacts to vegetation would be the disturbance of 428 acres of vegetation across the same six watersheds (Table 4.26-27). Similar to the distribution of permanent impacts among vegetation types, temporary impacts would be highest for open/closed forest (41 percent), with dwarf shrub (26 percent), closed tall shrub (11 percent), and open low shrub (9 percent) impacted to a lesser degree.

Table 4.26-26: Alternative 2—Transportation Corridor Permanent Impact Area

Vegetation Type	Chinitna River-Frontal Cook Inlet (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Iliamna River (Acres)	Newhalen River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
							Acres	Percent Area
Dry to Moist Herbaceous	1	1	1	15	1	8	26	3
Wet Herbaceous	--	<1	<1	3	--	1	4	<1
Dwarf Shrub	<1	12	19	9	87	151	277	31
Open Low Shrub	9	<1	6	15	27	30	86	10
Open Tall Shrub	20	1	<1	15	2	4	41	5
Closed Low Shrub	--	<1	--	8	1	1	10	1
Closed Tall Shrub	31	1	4	39	1	25	102	11
Open/Closed Forest	--	--	110	59	133	<1	302	34
Other	20	--	<1	20	1	5	46	5
Transportation Corridor Permanent Impact Area	**82**	**14**	**141**	**181**	**252**	**225**	**896**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Table 4.26-27: Alternative 2—Transportation Corridor Temporary Impact Area

Vegetation Type	Chinitna River-Frontal Cook Inlet (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Iliamna River (Acres)	Newhalen River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
							Acres	Percent Area
Dry to Moist Herbaceous	1	1	1	5	<1	3	11	3
Wet Herbaceous	--	<1	<1	3	<1	1	4	1
Dwarf Shrub	<1	6	7	4	37	58	113	26
Open Low Shrub	4	<1	2	7	11	12	37	9
Open Tall Shrub	12	<1	<1	6	1	2	22	5
Closed Low Shrub	--	<1	--	1	<1	1	3	1
Closed Tall Shrub	14	<1	2	17	1	14	48	11
Open/Closed Forest	--	--	57	38	82	<1	178	41
Other	9	--	<1	3	1	2	14	3
Transportation Corridor Temporary Impact Area	**40**	**7**	**70**	**84**	**133**	**94**	**428**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Summer-Only Ferry Operations Variant

This variant would increase truck traffic along the transportation corridor during the months of ferry operation to accommodate the movement of a full year of concentrate production, fuel, and consumables. To support year-round shipping of concentrate from Diamond Point port, concentrate containers would be stored at a laydown area along the Williamsport-Pile Bay Road, thereby increasing the magnitude of permanent impacts to vegetation by 22 acres. Construction of the laydown area would result in the permanent loss of 11 acres of sparse to partially vegetated (i.e., other) land and 11 acres of tall shrub types; the percent distribution of permanent impact among vegetation types would be the same as that presented in Table 4.26-26 for the Alternative 2 base case. The magnitude of temporary impacts and extent of direct impacts in the transportation corridor under the Summer-Only Ferry Operations Variant would remain unchanged from the Alternative 2 base case.

Newhalen River North Crossing Variant

In terms of magnitude, the Newhalen River North Crossing Variant would increase permanent impacts to vegetation by 20 acres, and decrease temporary impacts by 1 acre. Specifically, rerouting of the transportation corridor through this alternate bridge location would result in the loss of 19 acres of open/closed forest and 1 acre of dwarf shrub, yet would reduce the temporary impacts to open/closed forest by 1 acre. The percent distribution of permanent and temporary impacts among vegetation types would be the same as those shown in Table 4.26-26 and Table 4.26-27, respectively, for the Alternative 2 base case. The duration and extent of direct impacts in the transportation corridor under the Newhalen River North Crossing Variant would remain unchanged from the Alternative 2 base case.

Pile-Supported Dock Variant

There would be no change to the magnitude, duration, or extent of direct impacts to vegetation in the transportation corridor under the Pile-Supported Dock Variant.

Fugitive Dust

Under Alternative 2, the magnitude and extent of vegetation that would potentially be impacted by dust deposition in the transportation corridor would be 4,424 acres across six watersheds (Table 4.26-28). The duration of these potential impacts would be considered long-term. The open/closed forest vegetation type comprises 41 percent of this area of indirect impact; dwarf shrub is subdominant at 24 percent. Closed tall shrub represents an additional 12 percent cover.

Table 4.26-28: Alternative 2—Transportation Corridor Fugitive Dust Impact Area

Vegetation Type	Chinitna River-Frontal Cook Inlet (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Iliamna River (Acres)	Newhalen River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
							Acres	Percent Area
Dry to Moist Herbaceous	7	5	5	63	5	39	123	3
Wet Herbaceous	2	<1	8	41	11	17	79	2
Dwarf Shrub	1	54	73	38	365	544	1,076	24
Open Low Shrub	37	3	30	78	123	146	417	9
Open Tall Shrub	113	2	1	52	16	32	216	5
Closed Low Shrub	--	<1	<1	17	3	11	31	1
Closed Tall Shrub	180	5	20	179	14	155	552	12
Open/Closed Forest	--	--	584	407	811	4	1,806	41
Other	74	<1	1	19	5	25	124	3
Transportation Corridor Indirect Impact Area	**414**	**69**	**723**	**894**	**1,352**	**971**	**4,424**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Summer-Only Ferry Operations Variant

Construction of a container storage yard to support year-round shipping from the Diamond Point port would increase the magnitude of indirect impacts to vegetation. The area exposed to the potential deposition of fugitive dust would be expanded to include 2 acres of closed tall shrub. The distribution of fugitive dust impacts among vegetation types in the transportation corridor would be the same as that presented in Table 4.26-28 for the Alternative 2 base case. The extent and duration of indirect impact in the transportation corridor would also remain unchanged from the Alternative 2 base case.

Newhalen River North Crossing Variant

Rerouting of the transportation corridor through this alternate bridge location would decrease the magnitude of indirect impacts due to the deposition of fugitive dust by 8 acres. This decrease is distributed among several vegetation types, and is not large enough to change the percent areas of impact presented for the transportation corridor in Table 4.26-28 for the Alternative 2 base case. The extent and duration of indirect impacts in the transportation corridor would also remain unchanged from the Alternative 2 base case.

Pile-Supported Dock Variant

There would be no change to the magnitude, duration, or extent of indirect impacts to vegetation in the transportation corridor under the Pile-Supported Dock Variant.

4.26.8.3 Diamond Point Port

Alternative 2 would include a dock with an earthen fill causeway and sheet pile jetty design placed at Diamond Point, at the juncture of Iliamna and Cottonwood bays. Due to the shallow approach to Diamond Point, dredging would be required at this port location. Dredged material would be stored in two bermed facilities, from which runoff water would be channeled into a sedimentation pond before discharge to Iliamna Bay. Incidental leakage from this storage facility could kill or damage salinity intolerant vegetation. An airstrip would not be constructed at the Diamond Point port. Temporary facilities and reclamation and closure of the site would be the same as Alternative 1a, but would occur at Diamond Point.

Vegetation Removal

Under Alternative 2, 42 acres of vegetation would be permanently impacted, with temporary impacts to an additional 9 acres; impacts would be restricted to the Chinitna River-Frontal Cook Inlet watershed (Table 4.26-29). The open and closed tall shrub vegetation types combined comprise 64 and 67 percent of the areas of permanent and temporary impact, respectively, with dry to moist herbaceous vegetation covering an additional 29 and 18 percent of the areas of permanent and temporary impact, respectively.

Table 4.26-29: Alternative 2—Diamond Point Port Permanent and Temporary Impact Areas

Vegetation Type	Chinitna River-Frontal Cook Inlet			
	Permanent Impact		Temporary Impact	
	Acres	Percent Area	Acres	Percent Area
Dry to Moist Herbaceous	12	29	2	18
Open Tall Shrub	6	14	2	21
Closed Tall Shrub	21	50	4	46
Other	3	7	1	15
Diamond Point Port Impact Area	**42**	**100**	**9**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Variants

There would be no change to the magnitude, duration, or extent of direct impacts to vegetation at the Diamond Point port under the Summer-Only Ferry Operations Variant, Newhalen River North Crossing Variant, or Pile-Supported Dock Variant.

Fugitive Dust

Under Alternative 2, 85 acres of vegetation would be exposed to the potential deposition of fugitive dust (Table 4.26-30). This indirect impact would be considered long-term, and would be restricted to the Chinitna River-Frontal Cook Inlet watershed. Collectively, the closed and open tall shrub vegetation types comprise 66 percent of the area of indirect impact. The dry to moist herbaceous and sparse to partially vegetated (i.e., other) vegetation types represent an additional 18 and 15 percent each, respectively.

Table 4.26-30: Alternative 2—Diamond Point Port Fugitive Dust Impact Area

Vegetation Type	Chinitna River-Frontal Cook Inlet	
	Acres	Percent Area
Dry to Moist Herbaceous	15	18
Wet Herbaceous	1	2
Open Tall Shrub	27	32
Closed Tall Shrub	29	34
Other	12	15
Diamond Point Port Indirect Impact Area	**85**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Variants

There would be no change to the magnitude, duration, or extent of indirect impacts to vegetation at the Diamond Point port under the Summer-Only Ferry Operations Variant, Newhalen River North Crossing Variant, or Pile-Supported Dock Variant.

4.26.8.4 Natural Gas Pipeline Corridor

Under Alternative 2, the natural gas pipeline corridor would cross Cook Inlet to Ursus Cove; continue northward to Diamond Point port; and then follow the port and mine access roads to the mine site. Impacts evaluated here are for the pipeline-only sections of the natural gas pipeline that are not co-located with access roads. Three temporary access roads would be built to install these pipeline-only sections of the pipeline. These access roads would be reclaimed after pipeline installation.

Vegetation Removal

Under Alternative 2, the magnitude and extent of permanent impacts to vegetation would be 300 acres across five watersheds (Table 4.26-31); 93 percent of the vegetation permanently lost would be open/closed forest. Temporary impacts of natural gas pipeline installation would affect 803 acres of vegetation across eight watersheds. Similar to permanent impacts, the area of temporary impact is dominated by open/closed forest (77 percent; Table 4.26-32).

Table 4.26-31: Alternative 2—Natural Gas Pipeline Corridor Permanent Impact Area

Vegetation Type	Chekok Creek (Acres)	Chinitna River-Frontal Cook Inlet (Acres)	Iliamna Lake (Acres)	Pile River (Acres)	Stariski Creek-Frontal Cook Inlet (Acres)	Combined Watershed	
						Acres	Percent Area
Dry to Moist Herbaceous	--	3	--	--	<1	3	1
Wet Herbaceous	--	-	<1	--	--	<1	<1
Dwarf Shrub	--	<1	9	--	--	9	3
Open Low Shrub	1	1	1	--	--	2	1
Open Tall Shrub	--	5	--	--	--	5	2
Closed Low Shrub	--	--	--	--	<1	<1	<1
Closed Tall Shrub	--	2	--	<1	-	2	1
Open/Closed Forest	40	--	185	52	2	278	93
Other	<1	--	<1	--	<1	<1	<1
Natural Gas Pipeline Corridor Permanent Impact Area	**41**	**11**	**194**	**52**	**2**	**300**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Table 4.26-32: Alternative 2—Natural Gas Pipeline Corridor Temporary Impact Area

Vegetation Type	Chekok Creek (Acres)	Chinitna River-Frontal Cook Inlet (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Iliamna River (Acres)	Pile River (Acres)	Stariski Creek-Frontal Cook Inlet (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
									Acres	Percent Area
Dry to Moist Herbaceous	--	16	1	1	<1	--	<1	1	20	3
Wet Herbaceous	--	<1	--	2	<1	<1	--	--	3	<1
Dwarf Shrub	--	7	4	3	--	--	--	13	27	3
Open Low Shrub	1	12	--	11	<1	<1	--	4	27	3
Open Tall Shrub	<1	31	--	4	<1	1	--	2	37	5
Closed Low Shrub	--	1	--	<1	--	--	--	--	1	<1
Closed Tall Shrub	<1	27	--	28	1	<1	--	3	59	7
Open/Closed Forest	25	<1	--	499	49	49	<1	--	622	77
Other	<1	3	--	3	--	--	<1	<1	7	1
Natural Gas Pipeline Corridor Temporary Impact Area	**27**	**97**	**5**	**550**	**50**	**50**	**1**	**23**	**803**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Variants

There would be no change to the magnitude, duration, or extent of direct impacts to vegetation in the natural gas pipeline corridor under the Summer-Only Ferry Operations Variant, Newhalen River North Crossing Variant, or Pile-Supported Dock Variant.

Fugitive Dust

Under Alternative 2, installation of the natural gas pipeline would expose 715 acres of vegetation across four watersheds to the potential deposition of fugitive dust (Table 4.26-33). The duration of these potential impacts would be considered long-term. The open/closed forest vegetation type comprises 85 percent of this area of indirect impact.

Table 4.26-33: Alternative 2—Natural Gas Pipeline Corridor Fugitive Dust Impact Area

Vegetation Type	Chekok Creek (Acres)	Chinitna River-Frontal Cook Inlet (Acres)	Iliamna Lake (Acres)	Pile River (Acres)	Combined Watershed	
					Acres	Percent Area
Dry to Moist Herbaceous	--	11	<1	--	11	1
Wet Herbaceous	--	<1	7	5	13	2
Dwarf Shrub	--	3	4	--	7	1
Open Low Shrub	2	10	11	2	25	3
Open Tall Shrub	<1	15	3	1	20	3
Closed Low Shrub	--	2	--	--	2	<1
Closed Tall Shrub	--	13	7	1	21	3
Open/Closed Forest	47	<1	405	152	605	85
Other	--	6	6	<1	12	2
Natural Gas Pipeline Corridor Indirect Impact Area	**49**	**60**	**443**	**162**	**715**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Variants

There would be no change to the magnitude, duration, or extent of indirect impacts to vegetation in the natural gas pipeline corridor under the Summer-Only Ferry Operations Variant, Newhalen River North Crossing Variant, or Pile-Supported Dock Variant.

4.26.9 Alternative 3—North Road Only

The total direct permanent impact under the Alternative 3 base case would be the removal of 10,018 acres of vegetation, with temporary impacts to an additional 777 acres expected. Regarding indirect impacts, 9,915 acres of vegetation would be exposed to the potential deposition of dust. The Concentrate Pipeline Variant, which would deliver concentrate to a port location north of Diamond Point port, with an option to construct an additional pipeline to return filtrate to the mine site, is the only variant considered under Alternative 3; change in the total acres of direct and indirect impacts due to the incorporation of variants are summarized in Table 4.26-1 and further discussed below.

4.26.9.1 Mine Site

The mine site footprint under Alternative 3 is the same as Alternative 1a, the direct and indirect impacts of which are summarized under Alternative 1a.

Vegetation Removal

Concentrate Pipeline Variant

With adoption of the Concentrate Pipeline Variant, an additional 1 acre of vegetation, dominated by the dwarf shrub type, would be permanently impacted for the construction of a pump house at the mine site.

Fugitive Dust

Concentrate Pipeline Variant

Due to a more compact configuration of mine site facilities under adoption of the Concentrate Pipeline Variant, the area of vegetation exposed to the potential deposition of fugitive dust is decreased by 2 acres. The duration and extent of indirect impacts to vegetation at the mine site under the Concentrate Pipeline Variant would remain the same as the Alternative 3 base case.

4.26.9.2 Transportation Corridor

The Alternative 3 transportation corridor has a north access road from the mine site with a southern crossing of the Newhalen River; from there, it continues to a port location north of Diamond Point on Iliamna Bay.

Vegetation Removal

Construction activities in the transportation corridor would require clearing, grading, and removal of vegetation along access roads, ferry terminals, laydown areas, and water extraction and material sites. Segments of the natural gas pipeline co-located with access roads are addressed in this section.

The magnitude and extent of permanent impacts would be the removal of 1,681 acres of vegetation across eight watersheds (Table 4.26-34). In this area of permanent impact, the open/closed forest (58 percent) is the dominant vegetation type, with dwarf shrub (20 percent) subdominant. The magnitude and extent of temporary impacts to vegetation would be the disturbance of 648 acres of vegetation, also across eight watersheds (Table 4.26-35). Similar to the distribution of permanent impacts among vegetation types, temporary impacts would be highest for open/closed forest (60 percent), with dwarf shrub (16 percent) subdominant.

Table 4.26-34: Alternative 3—Transportation Corridor Permanent Impact Area

Vegetation Type	Chekok Creek (Acres)	Chinitna River-Frontal Cook Inlet (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Iliamna River (Acres)	Newhalen River (Acres)	Pile River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
									Acres	Percent Area
Dry to Moist Herbaceous	--	1	1	2	15	1	--	8	28	2
Wet Herbaceous	--	--	<1	<1	2	<1	<1	2	4	<1
Dwarf Shrub	--	<1	12	21	9	114	--	186	342	20
Open Low Shrub	1	9	<1	11	16	33	--	39	111	7
Open Tall Shrub	<1	18	1	3	15	2	<1	5	45	3
Closed Low Shrub	--	--	<1	<1	5	2	--	1	8	<1
Closed Tall Shrub	<1	32	1	22	38	2	<1	32	128	8
Open/Closed Forest	62	--	--	595	61	177	75	1	971	58
Other	<1	19	--	3	12	3	--	6	44	3
Transportation Corridor Permanent Impact Area	**65**	**81**	**14**	**657**	**173**	**334**	**76**	**281**	**1,681**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Table 4.26-35: Alternative 3—Transportation Corridor Temporary Impact Area

Vegetation Type	Chekok Creek (Acres)	Chinitna River-Frontal Cook Inlet (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Iliamna River (Acres)	Newhalen River (Acres)	Pile River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
									Acres	Percent Area
Dry to Moist Herbaceous	--	1	1	1		<1	--	3	12	2
Wet Herbaceous	--	--	<1	1	2	<1	<1	1	4	1
Dwarf Shrub	--	<1	6	2	4	37	--	57	106	16
Open Low Shrub	<1	4	<1	5	7	11	--	12	40	6
Open Tall Shrub	<1	11	<1	2	6	1	<1	2	22	3
Closed Low Shrub	--	--	<1	<1	1	<1	--	1	3	<1
Closed Tall Shrub	<1	14	<1	14	17	1	<1	13	60	9
Open/Closed Forest	13	--	--	238	40	82	15	<1	388	60
Other	<1	6	--	1	3	1	--	2	13	2
Transportation Corridor Temporary Impact Area	**14**	**37**	**7**	**264**	**85**	**134**	**16**	**92**	**648**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Concentrate Pipeline Variant

This variant would slightly increase the road corridor width due to the co-location of the concentrate pipeline and the optional return water pipeline in a single trench with the natural gas pipeline at the toe of the road embankment. Addition of the concentrate pipeline would increase the average width of the road corridor by less than 10 percent; addition of the concentrate and water return pipelines would increase the average width of the road corridor by less than 3 feet. Because the Alternative 3 base case road width is conceptually engineered to accommodate the concentrate pipeline and optional return water pipeline, there is no change to the magnitude, duration, and extent of direct impacts to vegetation under the Concentrate Pipeline Variant.

Fugitive Dust

Under Alternative 3, the magnitude and extent of vegetation potentially impacted by dust deposition in the transportation corridor would be 6,799 acres across eight watersheds (Table 4.26-36). The open/closed forest vegetation type comprises 59 percent of this area of indirect impact; dwarf shrub represents an additional 15 percent cover. The duration of these potential impacts would be considered long-term.

Table 4.26-36: Alternative 3—Transportation Corridor Fugitive Dust Impact Area

Vegetation Type	Chekok Creek (Acres)	Chinitna River-Frontal Cook Inlet (Acres)	Headwaters Koktuli River (Acres)	Iliamna Lake (Acres)	Iliamna River (Acres)	Newhalen River (Acres)	Pile River (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
									Acres	Percent Area
Dry to Moist Herbaceous	<1	6	5	11	64	5	--	39	130	2
Wet Herbaceous	<1	2	<1	26	38	12	10	19	108	2
Dwarf Shrub	--	1	54	30	38	359	--	534	1,016	15
Open Low Shrub	6	37	3	62	83	126	<1	149	465	7
Open Tall Shrub	1	97	2	26	55	16	2	32	231	3
Closed Low Shrub	--	--	<1	2	17	3	--	11	33	<1
Closed Tall Shrub	2	165	5	125	182	14	1	154	648	10
Open/Closed Forest	138	--	--	2,540	399	815	145	4	4,040	59
Other	<1	69	<1	11	17	5	<1	25	128	2
Transportation Corridor Indirect Impact Area	**147**	**378**	**69**	**2,833**	**892**	**1,355**	**158**	**967**	**6,799**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Concentrate Pipeline Variant

There would be no change to the magnitude, duration, or extent of indirect impacts to vegetation in the transportation corridor under the Concentrate Pipeline Variant.

4.26.9.3 Port

Alternative 3 proposes a caisson dock design at a port site north of Diamond Point on Iliamna Bay. Due to the shallowness of Iliamna Bay, dredging would be required for boats to access the dock at this location. Dredged material would be stored in two bermed facilities, from which runoff would be channeled into a sedimentation pond before discharge to Iliamna Bay. Incidental leakage from this storage facility could degrade salinity-intolerant vegetation. Onshore facilities, temporary facilities, and physical reclamation and closure of the site would be the same as that for Alternative 2, but would occur at this location. An airstrip would not be constructed at the port site under Alternative 3.

Vegetation Removal

Under Alternative 3, 32 acres of vegetation would be permanently impacted, with temporary impacts to an additional 4 acres; impacts would be restricted to the Chinitna River-Frontal Cook Inlet watershed (Table 4.26-37). The closed tall shrub vegetation type comprises 65 and 84 percent of the areas of permanent and temporary impact, respectively.

Table 4.26-37: Alternative 3—Port Permanent and Temporary Impact Areas

Vegetation Type	Chinitna River-Frontal Cook Inlet			
	Permanent		Temporary	
	Acres	Percent Area	Acres	Percent Area
Dwarf Shrub	<1	1	<1	2
Open Low Shrub	<1	1	--	--
Open Tall Shrub	9	29	<1	11
Closed Tall Shrub	21	65	3	84
Other	1	4	<1	3
Port Direct Impact Area	**32**	**100**	**4**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Concentrate Pipeline Variant

There would be no change to the magnitude, duration, or extent of direct impacts to vegetation at the Alternative 3 port under the Concentrate Pipeline Variant.

Fugitive Dust

Under Alternative 3, 35 acres of vegetation would be exposed to the potential deposition of fugitive dust (Table 4.26-38). Similar to the areas of direct impact, the closed tall shrub vegetation type is dominant (85 percent) in the area of indirect impact. The deposition of fugitive dust is considered a long-term impact. The extent of any potential impacts would be restricted to the Chinitna River-Frontal Cook Inlet watershed.

Table 4.26-38: Alternative 3—Port Fugitive Dust Impact Area

Vegetation Type	Chinitna River-Frontal Cook Inlet	
	Acres	Percent Area
Dwarf Shrub	<1	<1
Open Tall Shrub	4	11
Closed Tall Shrub	29	85
Other	1	4
Port Indirect Impact Area	**35**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Concentrate Pipeline Variant

There would be no change to the magnitude, duration, or extent of indirect impacts to vegetation at the Alternative 3 port under the Concentrate Pipeline Variant.

4.26.9.4 Natural Gas Pipeline

The natural gas pipeline corridor under Alternative 3 follows the same general route from the Kenai Peninsula to the mine site as Alternative 2; however, due to greater co-location of the pipeline with the road corridor, many of the impacts associated with installation of the pipeline are evaluated under the Alternative 3 transportation corridor. Furthermore, the three temporary access points described for Alternative 2 would not apply to Alternative 3. Impacts evaluated here are for the pipeline-only sections of the natural gas pipeline that are not co-located with access roads.

Vegetation Removal

Under Alternative 3, the magnitude and extent of permanent impacts to vegetation would be 13 acres across two watersheds (Table 4.26-39). The area of permanent impact is dominated by the open tall shrub types (35 percent), with the dry to moist herbaceous vegetation type subdominant at 26 percent, and the open/closed forest comprising an additional 16 percent of the area. Temporary impacts associated with installation of the natural gas pipeline would affect 125 acres of vegetation across four watersheds (Table 4.26-40). The area of temporary impact is dominated by tall shrub types (50 percent collectively) with dwarf shrub (19 percent), and the dry to moist herbaceous vegetation type (15 percent) subdominant.

Table 4.26-39: Alternative 3—Natural Gas Pipeline Corridor Permanent Impact Area

Vegetation Type	Chinitna River-Frontal Cook Inlet (Acres)	Stariski Creek-Frontal Cook Inlet (Acres)	Combined Watershed	
			Acres	Percent Area
Dry to Moist Herbaceous	3	<1	3	26
Dwarf Shrub	<1	--	<1	4
Open Low Shrub	1	--	1	6
Open Tall Shrub	5	--	5	35
Closed Low Shrub	--	<1	<1	1
Closed Tall Shrub	2		2	13
Open/Closed Forest	--	2	2	16
Other	--	<1	<1	<1
Natural Gas Pipeline Corridor Permanent Impact Area	**11**	**2**	**13**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Table 4.26-40: Alternative 3—Natural Gas Pipeline Corridor Temporary Impact Area

Vegetation Type	Chinitna River-Frontal Cook Inlet (Acres)	Headwaters Koktuli River (Acres)	Stariski Creek-Frontal Cook Inlet (Acres)	Upper Talarik Creek (Acres)	Combined Watershed	
					Acres	Percent Area
Dry to Moist Herbaceous	16	1	<1	1	19	15
Wet Herbaceous	<1	--	--	--	<1	<1
Dwarf Shrub	7	4	--	13	24	19
Open Low Shrub	12	--	--	4	15	12
Open Tall Shrub	31	--	--	2	33	26
Closed Low Shrub	1	--	--	--	1	1
Closed Tall Shrub	27	--	--	3	30	24
Open/Closed Forest	<1	--	<1	--	1	1
Other	2	--	<1	<1	3	2
Natural Gas Pipeline Corridor Temporary Impact Area	**97**	**5**	**1**	**23**	**125**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

Concentrate Pipeline Variant

There would be no change to the magnitude, duration, or extent of direct or indirect impacts to vegetation in the natural gas pipeline corridor under the Concentrate Pipeline Variant.

Fugitive Dust

Under Alternative 3, installation of the natural gas pipeline would expose 60 acres of vegetation to the potential deposition of fugitive dust (Table 4.26-41). The duration of these potential impacts would be considered long-term, and the extent of impacts would be restricted to the Chinitna River-Frontal Cook Inlet watershed. The area of indirect impact is dominated by tall shrub types (47 percent collectively), with open low shrub and the dry to moist herbaceous vegetation type representing an additional 16 and 17 percent of the area, respectively. Sparsely to partially vegetated land (i.e., 'other') represents 10 percent of the area of indirect impact.

Table 4.26-41: Alternative 3—Natural Gas Pipeline Corridor Fugitive Dust Impact Area

Vegetation Type	Chinitna River-Frontal Cook Inlet (Acres)	Combined Watershed	
		Acres	Percent Area
Dry to Moist Herbaceous	11	11	17
Wet Herbaceous	<1	<1	<1
Dwarf Shrub	3	3	5
Open Low Shrub	10	10	16
Open Tall Shrub	15	15	25
Closed Low Shrub	2	2	4
Closed Tall Shrub	13	13	22
Open/Closed Forest	<1	<1	1
Other	6	6	10
Natural Gas Pipeline Corridor Indirect Impact Area	**60**	**60**	**100**

Sources: HDR and Three Parameters Plus 2011a; HDR 2019i; Three Parameters Plus and HDR 2011a

4.26.10 Invasive Species

Project activities, especially those involving the movement of goods and people, could result in the introduction and spread of invasive species in the analysis area. All taxa of invasive species with documented potential to establish in the analysis area (e.g., terrestrial and freshwater plants, marine and terrestrial animals) are addressed in this section.

PLP has prepared an ISMP (Owl Ridge 2019d) to prevent, minimize, and control the introduction and spread of invasive plants during all project phases. The plan, if implemented, would reduce the likelihood of adverse impacts from non-native species. The ISMP makes recommendations towards the prevention and minimization of invasive terrestrial vascular plant species introductions related to project activities, as well as recommendations for the management and control of any future infestations in the project area. Specifically, the plan recommends operational and behavioral methods to prevent the introduction of non-native plant propagules; encourages monitoring for non-native species so that populations do not reach sizes at which their control is no longer efficient or economic; and prioritizes treatment and sets management goals for the control of non-native species based on species invasiveness, population size, and infestation

location. Although the plan does not specifically address aquatic plants, terrestrial animals, marine species, or insects, the principles of early detection and rapid response can be applied to all taxa. If implemented, the plan would be revised annually and updated as needed to meet its goals and relevance to project operations; aquatic, marine, and terrestrial species could be added to the plan during these annual revisions (Owl Ridge 2019d) (see Chapter 5, Mitigation).

A single population of the non-native terrestrial plant, lambsquarters (*Chenopodium album*), has been documented in the analysis area; this is a historical (pre-1950) record, and it is not known if the population still exists (ACCS 2018b). The infestation, if still present, would affect Alternative 2 and Alternative 3 near the Diamond Point port. Lambsquarters is considered very weakly invasive; and in Alaska, is rarely observed outside disturbed areas, has little to no effect on native plant communities, and likely has no measurable impact to ecosystem processes (lambsquarters species biography) (ACCS 2011a).

Eighteen additional invasive terrestrial plant species with the potential to occur in the analysis area include (listed in decreasing order of invasiveness rank):

- Reed canarygrass (*Phalaris arundinacea*)
- orange hawkweed (*Hieracium aurantiacum*)
- creeping buttercup (*Ranunculus repens*)
- foxtail barley (*Hordeum jubatum*)
- smooth brome (*Bromus inermis*)
- oxeye daisy (*Leucanthemum vulgare*)
- white clover (*Trifolium repens*)
- common dandelion (*Taraxacum officinale*)
- timothy (*Phleum pretense*)
- Kentucky bluegrass (*Poa pratensis*)
- fall dandelion (*Leontodon autumnalis*)
- common sheep sorrel (*Rumex acetosella*)
- redroot pigweed (*Amaranthus retroflexus*)
- prostrate knotweed (*Polygonum aviculare*)
- common plantain (*Plantago major*)
- common chickweed (*Stellaria media*)
- shepherd's purse (*Capsella bursa-pastoris*)
- pineapple weed (*Matricaria discoidea*)

Although most of these species are considered moderate to very weakly invasive, the potential introduction of extremely invasive reed canarygrass or orange hawkweed to the project area would carry high ecological risk. Reed canarygrass is a known invader of wetland habitat, where it forms dense monocultures that increase siltation and alter hydrology (ACCS 2011b). Once established, it is extremely difficult to eradicate. Orange hawkweed also establishes as dense monocultures at the expense of native plants. It is one of the few invasive plants in Alaska able to establish in organic soils and subalpine habitats, and therefore has the potential to invade a niche unavailable to most non-natives in Alaska (ACCS 2011c). Under metrics set forth in the ISMP (Owl Ridge 2019d), both reed canarygrass and orange hawkweed are high-priority (Priority 1) species for treatment; all other plant species detected in proximity to the analysis area are categorized in the lowest priority level (Priority 3) for treatment.

No freshwater aquatic invasive species are documented in the analysis area; however, waterweed (*Elodea* spp.) is a species of statewide concern due to its ability to reproduce vegetatively, its capacity to survive freezing and brackish water, and potential for long-range dispersal via boat and floatplane. Once established, waterweed forms dense monocultures that displace native flora and alter freshwater habitats by decreasing flow and increasing sedimentation (ACCS 2011d; Nawrocki et al. 2011). Such impacts have been shown to degrade habitat for waterfowl and freshwater fish, and reduce floatplane travel (Schwoerer 2017).

Invasive marine species have not been documented in the analysis area; however, the carpet sea squirt (*Didemnum vexillum*) and the European green crab (*Carcinus maenas*) are present in ecologically similar regions of Alaska and are species of statewide concern. The carpet sea squirt drastically modifies invaded habitats through the rapid and smothering overgrowth of native sessile species. The species has also demonstrated high niche plasticity. If introduced to project waters, the carpet sea squirt could have significant negative impact to native species and a variety of marine habitats, as well as the mariculture industry and shellfish and groundfish fisheries (Bullard et al. 2007).

The European green crab feeds on rockweed species (*Fucus* spp.), which are abundant and widely distributed along the Alaska coast, smaller native shore crabs, mussels, and oysters; it also outcompetes the native Dungeness crab for food and habitat (McDonald et al. 2001). If introduced to project waters, it is expected to have negative impacts on marine habitat, food webs, and local commercial, personal use, and subsistence fisheries (Klassen and Locke 2007; Therriault et al. 2008).

Terrestrial vertebrate species have not been documented from the project area; however, the Norway rat (*Rattus norvegicus*) is a species of high concern due to damaging effect in neighboring ecosystems. Norway rats have high reproductive capacity and are opportunistic feeders capable of large effect on a variety of wildlife populations. Rats may also carry parasites, pathogens, and diseases that can be harmful to other species. In the Aleutian Archipelago, seabird colonies have suffered significant losses due to predation by rats (Buckelew et al. 2011). Most rat infestations in Alaska have resulted from rats escaping from ships while in port (USFWS 2007).The magnitude of impacts from the introduction or spread of additional invasive species would be measured by population size or infested area, the relative invasiveness of the species, and infestation location. Although difficult to quantify, the magnitude of potential invasive species introductions are expected to vary among action alternatives as the routings differ in their proportions of habitat susceptible to the establishment of non-native species. For example, alternatives intersecting the shallow marine environments at Diamond Point port or the shallow island environment at the northeastern end of Iliamna Lake present greater opportunity for the establishment of marine and freshwater aquatic invasive species (e.g., waterweed, European green crab) that exploit these littoral habitats. With regard to the potential introduction of terrestrial invasive plant species, alternatives with longer road lengths and more stream crossings would be more susceptible to infestation by non-native plant species adapted to roadside or riparian environments. Sweetclover (*Melilotus alba*) is a particularly effective competitor in fine-grained, disturbed mineral soils such as those found along gravel roadsides and river bars (Conn et al. 2008), and reed canarygrass (*Phalaris arundinacea*) is one of the most aggressive invaders of riparian habitat in Alaska (Lavergne and Molofsky 2004). Vehicles traveling along the transportation corridor could act to spread any roadside populations of invasive plant species. Although not considered sources of introduction, because they would be constructed on site, vessels operating in Iliamna Lake could disperse aquatic invasive species. The risk of introduction and spread of invasive species would remain post-closure due to monitoring activities. The duration of impacts could span the life of the project and continue after closure if invasive species established during the life of the project were not adequately controlled.

4.26.11 Cumulative Effects

Cumulative effects are the interactive, synergistic, or additive effects that would result from the incremental impact of the action, together with other past, present, and reasonably foreseeable future actions (RFFAs). Impacts to vegetation would include the direct impacts of vegetation removal and the potential for elimination of rare or sensitive plant species and habitat, and the indirect impacts of fugitive dust deposition and the potential introduction and spread of invasive species. The cumulative effects analysis area for vegetation is the maximum geographic extent of the footprint of the project, including all alternatives and variants, the Pebble Project expansion (including road, pipeline, and port facilities), and the area where direct and indirect effects to vegetation can be expected from project construction and operations, as well as any other past, present, and RFFAs that are in the vicinity of, and have the potential to contribute to the impacts of the project (see Figure 4.1-1 in Section 4.1, Introduction to Environmental Consequences, for an inset of the Pebble Project expansion).

Past, present, and RFFAs identified for the cumulative impact analysis area are detailed in Section 4.1, Introduction to Environmental Consequences. Not all RFFAs are considered to have potential for cumulatively impacting vegetation. Offshore-based developments, including oil and gas lease sales and non-industrialized, point-source activities, are unlikely to result in impacts beyond a temporary basis (e.g., tourism, recreation, fishing, and hunting). Other RFFAs removed from further consideration include those sufficiently distant from the analysis area to preclude the efficient co-use of infrastructure by other parties.

4.26.11.1 Past and Present Actions

Past and present actions that have affected or are currently affecting vegetation in the analysis area are minimal, because most vegetation in the area is undisturbed and in pristine condition. Past activities include limited infrastructure development, mining and oil and gas exploration, and small areas of residential development. Present activities, such as infrastructure and mining exploration projects currently have minimal impacts on vegetation. These impacts include vegetation removal and dust deposition, and may result in the undocumented elimination of rare or sensitive species or the introduction or spread of invasive species. Although these actions affect localized areas, they are additive to other vegetation-disturbing actions, thereby increasing the total acreage affected, and reducing the ecological functions that intact vegetation communities provide. Ground-disturbing actions are additive to dust impacts insofar that the more dust is produced, the more vegetation is potentially subject to dust deposition. Similarly, the movement of goods and people increase the likelihood of invasive species introduction and spread, with consequences for plant community species composition.

4.26.11.2 Reasonably Foreseeable Future Actions

RFFAs that could contribute cumulatively to known and projected impacts to vegetation in the analysis area were advanced for consideration. The following RFFAs, identified in Section 4.1, Introduction to Environmental Consequences, are included: Pebble Project expansion scenario, mining exploration activities for Pebble South/PEB, Big Chunk South, Big Chunk North, Fog Lake, and Groundhog mineral prospects; onshore oil and gas development; Lake and Peninsula/Kenai Peninsula Transportation and Community Infrastructure, including the potential Kaskanak Road, other road improvements, and the continued development of the Diamond Point rock quarry.

These projects are anticipated to include vegetation removal, dust deposition, and increased risk of invasive plant species introduction and spread. These actions would result in a net loss of vegetation, and likely precipitate changes in plant community composition, structure, and function.

Mineral exploration is likely to continue in the analysis area for the Pebble South/PEB, Big Chunk South, Big Chunk North, Fog Lake, and Groundhog projects (all based out of Iliamna). These exploration activities would include summer borehole drilling and temporary camp facilities that would result in limited vegetation removal related to core sampling and placement of facilities. Movement of personnel and equipment into these remote areas would increase the likelihood of introduction of invasive species. Ground-disturbing activities would increase the susceptibility of habitats to establishment of invasive terrestrial plant species and travel along gravel roads would be expected to increase dust deposition on vegetation, and potentially increase the spread of invasive plant species. Impacts to vegetation are expected to be temporary; limited in extent to the project footprint, except in the case of invasive species, which could spread beyond the footprint; and limited in magnitude, because not much activity would be expected.

Anticipated road improvement projects in the region include new transportation corridors currently being studied in the Lake and Peninsula Borough (LPB), such as the Williamsport-Pile Bay Road upgrade, Nondalton-Iliamna River Road corridor and bridge, and Kaskanak Road/Cook Inlet to Bristol Bay. The strategic plan for Iliamna includes a road connection to all villages in the lake area for safer travel. As discussed previously, roads affect vegetation through the direct removal of vegetation, and indirectly through dust deposition and increased likelihood of introduction and spread of invasive terrestrial plant species. Although BMPs can reduce the risks of invasive species introduction and spread, the potential for impacts remains as long as roads are in operation.

The cumulative effects from past, present, and RFFAs are expected to be consistent across project alternatives, except for the Pebble Project expansion scenario. This development scenario would involve expansion of the mine site, and construction of a concentrate pipeline and transportation corridor from the existing mine access road to a new deepwater port at Iniskin Bay; details of the Pebble Project expansion are given in Section 4.1, Introduction to Environmental Consequences. Although expansion of the mine site and development of the Iniskin Bay port would be the same for all alternatives, the length of the transportation and concentrate pipeline corridor varies by alternative due to the extent to which development could use existing infrastructure. Because Alternative 2 would include a northern access road and ferry and natural gas pipeline along the same corridors that would be used under mine expansion, further development would only require construction of a short (8-mile) road and pipeline segment from Williamsport east to Iniskin Bay. Therefore, cumulative effects to vegetation are least for this alternative. Alternatively, cumulative effects to vegetation would be greatest under Alternative 1, because this alternative would include development of transportation and natural gas pipeline corridors separate from the alignment that is proposed for Pebble Project expansion, and would therefore require construction of a longer (76-mile) concentrate pipeline and transportation corridor.

A summary of impacts associated with the Pebble Project and mine expansion scenario is provided in Table 4.26-42. Under mine expansion, cumulative direct and indirect impacts to vegetation are highest under Alternative 1 (55,243 acres) and lowest under Alternative 2 (53,897 acres). The No Action Alternative would not contribute to cumulative effects on vegetation, and is not evaluated here. Although expansion of the mine site and development of the Iniskin Bay port would be the same for all alternatives, the length of the transportation and concentrate pipeline corridor varies by alternative due to the extent to which development could use existing infrastructure. Because Alternative 2 would have a northern access road, ferry route, and natural gas pipeline along the same corridor that would likely be used under the Pebble Project expansion, further development would only require construction of a short (8-mile) road and pipeline segment from Williamsport to Iniskin Bay. Alternatively, cumulative effects to vegetation would be greatest under Alternative 1, because this alternative would develop transportation and

natural gas pipeline corridors separate from the alignment that would be used for expanded development, and would therefore require construction of a longer (76-mile) concentrate pipeline and transportation corridor.

Because project-specific base maps for vegetation have not been produced for the alignment of the concentrate pipeline, transportation corridor, and Iniskin Bay port that are proposed under mine expansion, the areas of impact given for this corridor and port should be considered estimates and used for comparison purposes only. Regardless of alternative, the expanded mine scenario would increase the area of vegetation lost or altered, impacts that would be additive to those of the project. Although expansion of the mine would result in impacts to vegetation across multiple watersheds, the Headwaters Koktuli River and UTC watersheds would experience the greatest magnitude of impact. In these watersheds, direct and indirect impacts to vegetation would increase from 4 to 17 percent under mine expansion[3]. A summary of cumulative effects on vegetation is presented by project alternative for all RFFAs in Table 4.26-43.

Table 4.26-42: Summary of Cumulative Impacts to Vegetation under the Pebble Project and the Project Expansion Scenarios

	Impact	Alternative 1a	Alternative 1	Alternative 2	Alternative 3
All Project Components (Acres)					
Project	Permanent	9,504	9,482	9,637	10,081
	Temporary	822	671	1,241	777
	Indirect	9,159	9,295	8,236	9,915
Expansion	Permanent	30,047	30,584	29,572	29,142
	Temporary	67	67	67	67
	Indirect	5,144	5,144	5,144	5,144
Cumulative	Permanent	39,551	40,066	39,209	39,223
	Temporary	889	738	1,308	844
	Indirect	14,303	14,439	13,380	15,059
Mine Site (Acres)					
Project	Permanent	8,292	8,292	8,399	8,292
	Temporary	1	1	1	1
	Indirect	3,022	3,022	3,012	3,024
Expansion	Permanent	29,007	29,007	29,007	29,007
	Temporary	-	-	-	-
	Indirect	4,397	4,397	4,397	4,397
Transportation (Acres)					
Project	Permanent	1,188	1,165	896	1,681
	Temporary	594	602	428	648
	Indirect	6,053	6,189	4,424	6,799

[3] Although total areas of direct and indirect impacts are different among alternatives for the proposed project and mine expansion, the variability among totals is not large enough to produce different percentages with respect to the watersheds impacted.

Table 4.26-42: Summary of Cumulative Impacts to Vegetation under the Pebble Project and the Project Expansion Scenarios

	Impact	Alternative 1a	Alternative 1	Alternative 2	Alternative 3
Port (Acres)					
Project	Permanent	21	22	42	32
	Temporary	7	7	9	4
	Indirect	84	84	85	35
Natural Gas Pipeline (Acres)					
Project	Permanent	2	2	300	13
	Temporary	220	62	803	125
	Indirect	-	-	715	60
Concentrate Pipeline/Transportation (Acres)					
Expansion	Permanent	1,007	1,544	532	102
	Temporary	61	61	61	61
	Indirect	682	682	682	682
Iniskin Bay Port					
Expansion	Permanent	33	33	33	33
	Temporary	6	6	6	6
	Indirect	65	65	65	65

Note:
Project-specific landcover mapping is not available for the full extent of the expanded mine development scenario. Therefore, the acreages provided above for the concentrate pipeline/transportation corridor and the Iniskin Bay port include impacts to vegetation and open water.

Table 4.26-43: Contribution to Cumulative Effects on Vegetation

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
Pebble Mine Expansion Scenario	**Mine Site**: Under the Pebble Project expansion scenario, the mine site footprint would be larger due to a larger open pit and new facilities to manage water and store tailings and waste rock. Pebble Project expansion would increase the amount of vegetation removed, fugitive dust generated, and likelihood of invasive species introduced or spread; impacts would be additive to those of the project, and would expand the extent of impacts in the UTC watershed. At the mine site, an additional 21,240 acres of vegetation would be removed. It is assumed that the vegetation types affected would be similar to those affected by the project (dwarf and open low shrub). **Other Facilities**: Under the Pebble Project expansion scenario, a north access road corridor would be constructed from the Eagle Bay ferry terminal, along the proposed Alternative 3 road alignment, and then extended to Iniskin Bay; new concentrate and diesel pipelines would be constructed from the mine site to Iniskin Bay along this same alignment. Development of these facilities would permanently impact an additional 1,040 acres. It is assumed that the vegetation types affected would be similar to those affected by the project in the Alternative 3 transportation and natural gas pipeline corridor (open/closed forest and dwarf shrub). **Magnitude**: The Pebble Project expansion scenario for Alternative 1a would permanently impact a total of 22,280 additional acres. **Duration**: The duration of cumulative impacts to vegetation would vary from temporary disturbance during construction to permanent removal of vegetation within the footprint of the mine and other project facilities. The duration of impacts would be extended as processing of low-grade ore and PAG waste material would continue for 20 to 40 years past the end of mining. This would delay the reclamation of vegetation	**Mine Site**: Identical to Alternative 1a. **Other Facilities**: Pebble Project expansion scenario under Alternative 1 is similar to Alternative 1a, except that the portion of the access road from the Eagle Bay ferry terminal to the existing Iliamna area road system would not already be constructed. The north access road would be extended east from the Eagle Bay ferry terminal to the Pile Bay terminus of the Williamsport-Pile Bay Road. Concentrate and diesel pipelines would be constructed along the proposed Alternative 3 road alignment and extended to a new deepwater port site at Iniskin Bay. **Magnitude**: Pebble Project expansion under Alternative 1 would permanently impact a total of 22,817 acres, slightly more acreage than Alternative 1a. **Duration/Extent**: The duration/extent of cumulative impacts to	**Mine Site**: Identical to Alternative 1a. **Other Facilities**: The north access road would be extended east from the Eagle Bay ferry terminal to the Pile Bay terminus of the Williamsport-Pile Bay Road. Concentrate and diesel pipelines would be constructed along the proposed Alternative 3 road alignment and extended to a new deepwater port site at Iniskin Bay. Because the natural gas pipeline and portions of the road would already exist under Alternative 2, the acres of disturbance resulting from the Pebble Project expansion would be fewer than those impacted under Alternative 1a. **Magnitude**: Pebble Project expansion under Alternative 2 would permanently impact a total of 21,699 acres, less acreage than Alternative 1a. **Duration/Extent**: The duration of impacts would be similar to the	**Mine Site**: Identical to Alternative 1a. **Other Facilities:** Overall expansion would use the existing north access road. Concentrate and diesel pipelines would be constructed along the existing road alignment and extended to a new deepwater port site at Iniskin Bay. Because the natural gas pipeline and most of the road would already exist under Alternative 3, the amount of additional disturbance resulting from the Pebble Project expansion scenario would be less than all other alternatives. **Magnitude**: Pebble Project expansion under Alternative 3 would permanently impact a total of 21,375 acres, Alternative 1a, which would be less than all other alternatives. **Duration/Extent**: The duration of impacts would be similar to Alternative 1a, although affecting fewer acres. **Contribution**: The contribution to

Table 4.26-43: Contribution to Cumulative Effects on Vegetation

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	affected by the low-grade ore and PAG material storage areas, thereby extending the duration of long-term impacts from dust deposition and risk of invasive species introduction and spread. **Extent:** The extent of impacts would be limited to the immediate vicinity of the disturbance footprint, except in the case of invasive species, which could spread beyond this footprint of direct disturbance. **Contribution:** Pebble Project expansion would impact vegetation through direct removal, deposition of dust, and increased potential for invasive species introduction and spread. These actions would be expected to contribute to the permanent loss of vegetation, reduction of ecological function, and changes in species composition. The contribution to cumulative effects is expected to be greater under Alternative 1a and Alternative 1, because expansion of these two alternatives would require the construction of separate transportation/pipeline corridor, and then concurrent use of the two corridors through the operational life of the mine. The extended duration of direct impacts contributes to cumulative effects insofar that it increases the likelihood of invasive species introduction and spread, as well as the magnitude, duration, and extent; and duration of indirect impacts related to fugitive dust and invasive species.	vegetation would be similar to Alternative 1a, although affecting more acres. **Contribution**: The contribution to cumulative effects would be similar to Alternative 1a, although affecting the most acres of any alternative.	Applicant's Proposed Alternative, although affecting fewer acres. **Contribution**: The contribution to cumulative impacts would be similar to Alternative 1a, although affecting fewer acres.	cumulative impacts would be similar to Alternative 1a, although affecting the least acres of any alternative.
Other Mineral Exploration Projects	**Magnitude**: Mining exploration activities, including additional borehole drilling, road and pad construction, and development of temporary camp facilities, would result in adverse effects to vegetation; however, this added impact would be limited in extent and localized to the disturbing action. For example, the 2018 drilling program proposed by PLP consisted of 61 geotechnical boreholes and 19 diamond-drilled core boreholes with diameters ranging from 2 to 8 inches.	Similar to Alternative 1a.	Similar to Alternative 1a.	Similar to Alternative 1a.

Table 4.26-43: Contribution to Cumulative Effects on Vegetation

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	Duration/Extent: Exploration activities typically occur at a discrete location for one season, although a multi-year program could expand the geographic area affected in a specific mineral prospect. Table 4.1-1 identifies seven mineral prospects where exploratory drilling is anticipated (four of which are in proximity of the Pebble Project). Because permit requirements typically stipulate site reclamation, the duration of some portion of these actions would be considered temporary. **Contribution**: Other mineral exploration would contribute to cumulative effects on vegetation through direct removal, deposition of dust, and increased potential for invasive species introduction and spread. These actions would be expected to contribute to the permanent loss of vegetation, reduction of ecological function, and changes in species composition.			
Oil and Gas Exploration and Development	**Magnitude**. Onshore oil and gas exploration activities could involve seismic and other forms of geophysical exploration; and in limited cases, drilling. Seismic exploration would involve overland activities, with permit conditions stipulating the avoidance and minimization of disturbance to vegetation. Should it occur, exploratory drilling would involve the construction of temporary pads and support facilities, with permit conditions to minimize impacts to vegetation and restore drill sites after exploration activities have ceased. **Duration/Extent**: Seismic exploration and exploratory drilling are typically single-season, temporary activities. The 2013 BBAP amended plan shows 13 oil and gas wells drilled on the western Alaska Peninsula, and a cluster of three wells near Iniskin Bay. It is possible that additional seismic testing and exploratory drilling could occur in the analysis area; however, based on historic activity, it is not expected to be intensive. Because permit requirements typically stipulate site reclamation,	Similar to Alternative 1a.	Similar to Alternative 1a.	Similar to Alternative 1a.

Table 4.26-43: Contribution to Cumulative Effects on Vegetation

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	the duration of some portion of these actions would be considered temporary. **Contribution**: Onshore oil and gas exploration activities would contribute to cumulative effects on vegetation through direct removal, deposition of dust, and increased potential for invasive species introduction and spread. These actions would be expected to contribute to the permanent loss of vegetation, reduction of ecological function, and changes in species composition.			
Road Improvement and Community Development Projects	**Magnitude**: Road improvement projects would require grading and filling, which would increase the generation of fugitive dust and the risk of invasive species introduction and spread. Road improvements in the communities of Iliamna, Newhalen, and Kokhanok would make the greatest contribution to cumulative effects. Limited road upgrades could also occur in the vicinity of the natural gas pipeline starting point near Stariski Creek, or in support of the mineral exploration previously discussed. The expansion of Diamond Point rock quarry would disturb 140 acres (ADNR 2014a) and has potential to adversely affect vegetation. The vegetation types affected are expected to be similar to those documented in the Diamond Point port analysis area for Alternative 2 and Alternative 3. **Duration/Extent**: Disturbance from road construction would typically occur over a single season, whereas development of the Diamond Point quarry is expected to last several years. Impacts to vegetation in the direct disturbance footprint of these projects would be permanent; construction-related impacts outside the footprint of direct disturbance are expected to be temporary; deposition of fugitive dust on vegetation would be long-term. Extent would be limited to the vicinity of communities and Diamond Point.	Similar to Alternative 1a; with greater impacts than Alternative 2 and Alternative 3.	The footprint of the Diamond Point rock quarry coincides with the Diamond Point port location for Alternative 2 and Alternative 3. Cumulative impacts under Alternative 2 would likely be less than Alternative 1a and Alternative 1 due to overlap between the Diamond Point port and rock quarry.	Similar to Alternative 2; less than Alternative 1a and Alternative 1.

Table 4.26-43: Contribution to Cumulative Effects on Vegetation

Reasonably Foreseeable Future Actions	Alternative 1a	Alternative 1 and Variants	Alternative 2 and Variants	Alternative 3 and Variant
	Contribution: Road improvements would contribute to cumulative effects on vegetation through direct removal, deposition of dust, and increased potential for invasive species introduction and spread. These actions would be expected to contribute to the permanent loss of vegetation, reduction of ecological function, and changes in species composition.			
Summary of Project contribution to Cumulative Effects	Overall, the contribution of Alternative 1a to cumulative effects on vegetation, when taking other past, present, and RFFAs into account, would impact an estimated 0.8 percent of watersheds intersecting the Pebble Project expansion footprint.	Similar to Alternative 1a, although slightly more acres would be impacted by Pebble Project expansion.	Similar to Alternative 1a, although fewer acres would be impacted by Pebble Project expansion.	Similar to Alternative 2, although slightly fewer acres would be impacted by Pebble Project expansion.

Notes:
Percent vegetation impacted by watershed is calculated as the cumulative acres of vegetation directly and indirectly impacted under a given alternative and mine expansion, relative to the combined area HUC 10 watersheds intersected by the proposed project and mine expansion. The Cook Inlet watershed is not included because it supports minimal vegetation. Because the total area of other HUC 10 watersheds includes open water, the percent of vegetation impacted by watershed is likely underestimated.
BBAP = Bristol Bay Area Plan
PAG = potentially acid-generating
PLP = Pebble Limited Partnership
RFFA = reasonably foreseeable future action
UTC = Upper Talarik Creek